Jameson L. Chassin

Second Edition

Operative Strategy in General Surgery

Volume I

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An Expositive Atlas

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With 1,008 Illustrations

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To Charlotte

Preface

In the time that has elapsed since the publication of the first edition, significant advances have altered the way we care for surgical patients. Continuing progress in surgical critical care enables us to operate an older and sicker patients. More effective means of maintaining adequate circulation and oxygenation in the face of sepsis and other complications continue to reduce surgical mortality. A striking advance in the treatment of postoperative sepsis is CT diagnosis of abdominal and thoracic abscesses combined with CT-guided percutaneous catheter drainage of these abscesses. With these advances, a skilled surgeon can perform a pancreatoduodenectomy or a hepatic lobectomy with a mortality rate between 1%–4% if no technical errors have been committed.

In short, with proper technique and good surgical judgment, complications are avoidable. If we are to achieve the lowest possible mortality rates, attention must be focused on surgical technique and methods of teaching surgical technique. This pedagogical problem first came to my attention in 1967 when, in addition to training my own residents, I accepted the assignment of teaching fourth-year residents from the New York University Medical School who began rotating to Booth Memorial Hospital (now the New York Hospital Medical Center of Queens) for a period of two or three months each. Since then I have guided residents through more than 5,000 major operations. It is obvious that we surgeons perform many intricate surgical maneuvers intuitively or automatically. Good teaching in the operating room, however, requires that the preceptor analyze and demonstrate the best way to perform each maneuver. He must also determine the pitfalls and danger points of each step of the operation and then articulate a strategy that will make the operation safe and efficient for the resident. This task prompted me to write this book.

Each operation described in this atlas is preceded by a brief review of the indications for, and the concept underlying, the choice of the procedure among possible alternatives. Following this is a checklist of the main points of preoperative care, then a list of pitfalls and danger points that require the surgeon's advance planning if success is to be consistently achieved. Immediately preceding the description of each surgical technique, I have written a section on operative strategy that analyzes the danger points and errors surgeons are prone to make; this analysis is accompanied by a detailed account of the maneuvers to be employed in avoiding these pitfalls.

For this second edition, I have revised every chapter that required updating owing to new developments in surgery. A new chapter devoted to laparoscopic cholecystectomy thoroughly discusses the danger points of this operation, with special emphasis on the means of avoiding damage to bile ducts and major blood vessels. Another new chapter covering hepatic resections was contributed by Dr. David M. Nagorney, who has vast experience with this operation at the Mayo Clinic. Among the chapters that were extensively revised or expanded are those that cover surgery for reflux esophagitis (including the Collis–Nissen fundoplication and bile diversion operations); esophageal carcinoma (including transhiatal esophagectomy); esophageal perforation; pancreatic carcinoma (including pylorus preservation); groin and massive ventral hernia (including Shouldice and mesh repairs); mucosal proctectomy and ileoanal pouch. Because this new edition is published in one volume instead of two, the order of chapters has been slightly reorganized for the reader's convenience.

This text is not a compendium of every operation ever devised. For each disease state, I have described one operative technique, one that I have found to be valuable and safe when performed either by expert surgeons or by residents. Alternate techniques are included only when indicated by variations in the anatomy or pathology. This policy has provided the space required to describe in meticulous detail each operation that is included. Discussions of postoperative care and complications are limited to those points that are pertinent to the operation described. Methods of preventing such complications as thromboembolism or atelectasis, which may occur after any operation, are not discussed here since whole texts on these subjects are available.

The descriptions of operative technique have been immensely aided by the excellent illustrations of Mr. Caspar Henselmann, whose drawings are based on actual observations of the operations. These illustrations are neither stylized nor idealized, but show the surgical field as the surgeon sees it. The drawings take the reader through the operation step by step. To further the teaching effectiveness, I have not separated the written description into text and captions, but rather provided a single narrative that follows the illustrations and explains those points that an illustration cannot show. Citations of figures are set in **bold** type, and the elements of the book are arranged so that related text and illustrations are always on the same or facing pages.

As with the first edition, considerable space is devoted to complicated operations, such as esophagogastrectomy, pancreatectomy, and low anterior resection, to enable both the surgeon in training and the more experienced practitioner to study in detail those operations that he or she will not perform every day and that are fraught with many technical pitfalls. For the surgeon beginning training, I have presented in Appendixes A through C the basic principles of foot, hand, and body stance; the use and abuse of various instruments; and the fundamentals of dissecting, sewing, and achieving hemostasis. Since brand names of surgical products and names of instruments vary geographically, an illustrated glossary (Appendix D) is included to explain these items.

Almost none of the recent American atlases of general surgery has been written by a single author. It was not a lack of humility that led me to undertake such an awesome task. Rather, it was my observation that when many operative techniques by multiple authors are included in one text, the reader is confused as to which technique to use under which circumstances. I hope that my description of operative techniques and strategies that I have found valuable—both in my practice and in teaching—will prove helpful to the reader. In writing about surgical concepts and techniques I have tried to indicate which statements are supported by data and which are still not thoroughly validated. The references at the end of each chapter were selected primarily to elucidate areas of controversy; a more exhaustive bibliography would be beyond the scope of this book.

Acknowledgments. I would like to express my gratitude to my associates in the Faculty Practice Group of the New York Hospital Medical Center of Queens (formerly Booth Memorial Medical Center): Doctors Kenneth M. Rifkind, James W. Turner, Fredric I. Weinbaum, Howard I. Tiszenkel, and Simon D. Fink, all of whom engage in a continuing pursuit of excellence in surgery

as well as teaching. Many hours of discussion have polished and refined all of our surgical thinking and analysis. Caspar Henselmann, whose illustrations for the first edition of this work were cited for their excellence by the Association of Medical Illustrators, has contributed many new drawings that clarify the teaching points in the new text.

Words cannot express my gratitude to my wife Charlotte, without those support and understanding this work could not have been accomplished.

Foreword to the First Edition

This surgical atlas should be of great value to all clinical surgeons, both those in training and those in surgical practice, and Dr. Chassin is superbly qualified to author this work. During more than three decades as a member of the faculty of the New York University School of Medicine, he has taught countless residents many aspects of the art of surgical technique. One measure of Dr. Chassin's unusual teaching ability is that he is both Professor of Clinical Surgery at New York University and Director of Surgery at Booth Memorial Hospital where our fourth-year surgical residents have rotated regularly for the past 12 years. Booth Memorial is the only hospital outside the New York University Medical Center to which New York University residents rotate. This simple fact well underlines Dr. Chassin's remarkable capability for teaching.

When a surgical complication develops after an operation, two or three possibilities should be considered. First, of course, was the diagnosis correct? If it was, then the cause of the complication is usually either an inadequate operative technique or a flawed concept underlying the selection of the operative procedure. When the surgical technique seems faultless, a postoperative complication would strongly indicate that the concept was erroneous, albeit cherished perhaps for decades.

Unlike any other atlas on operative technique, this book specifically discusses the conceptual basis of the operation as well as the strategy that will help the surgeon avoid common pitfalls. The operative technique is then described step by step.

I am confident that in the years ahead this atlas will be regarded as one of the major contributions to our literature of surgical technique.

Frank C. Spencer, MD
George David Stewart Professor and Chairman
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1980

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Colon and Rectum

Anus and Rectum

1 Concept and Strategy in Surgery

Developing a Concept

Successful surgery requires study, advance planning, clear thinking, and technical skill. Brilliant execution of the wrong operation at the wrong time can only lead to disaster. To achieve consistently good results for each surgical condition the surgeon has to develop a concept that combines analysis of the literature, study of the disordered physiology, and comprehension of the hypothesis underlying the contemplated operation.

To develop a concept properly a surgeon must:

Know the normal and pathological physiology and anatomy.

Explore the relative merits of alternative operations.

Analyze the operation selected for the problem at hand. Are there *valid data* to demonstrate that it will accomplish the desired goal? Is the mortality rate for the procedure such that the benefit outweighs the risk?

Reflect on his or her *own experience* of complications and deaths following the operation selected. This information is more relevant than are the results that may be reported from some renowned medical center, where one surgeon may have developed great expertise in a particular operation. Superior results under such circumstances obviously do not indicate that less-experienced surgeons will be as successful.

Review postoperative complications and poor results. When a complication or a death occurs, the surgeon must analyze the case carefully and attempt to make an objective appraisal of what went wrong. Was there poor judgment in the choice of operation? Was the diagnosis inaccurate? Was the assessment of the risk incorrect? Was there an error of technique? Did the surgeon lack the technical expertise to undertake the procedure?

Keep records of mortality and morbidity for each operation. Frequent analysis of results increases the data base of the surgeon's own experience. The knowledge the surgeon gains leads to self-renewal and improved performance: without it the surgeon learns nothing from experience.

Establishing Strategy

Establishing an *operative strategy*—the surgeon's advance planning of the technical steps in the operation—is vital to the safety and efficiency of complex surgical procedures. The operative strategy is what the surgeon ponders the night before the operation: Where are the pitfalls? How should they be avoided? The thesis of this book is that by creating a strategy the surgeon can reduce the incidence of operative misadventures and postoperative complications.

Anticipating and analyzing potential problems and danger points before an operation will more likely lead to a successful result than will frenzied activity in the operating room after the surgeon and patient are already in deep trouble. Anticipation enhances the surgeon's capacity for prompt decision-making in the operating room.

Making the Operation Easy

The main goal of any successful operative strategy is to make the operation easy. The main goal of this book is to make the operation easy. Easy operations are safe operations. A prime requirement to make an operation simple is good exposure with excellent light. Strategy also means planning the sequence of an operation to clearly expose vital structures early in the dissection so as to avoid damaging them.

Even more important is to do the easy steps of any operation first. This very often makes the next step easy. If the surgeon keeps on doing the easy steps, there may never be any hard steps to the operation.

Anytime the surgeon finds himself in difficulty, he should stop cutting and start thinking. Why is the step difficult? Poor exposure? Bad light? Bloody field? The good surgeon makes operations look easy because of good operative strategy. He rarely has to resort to spectacular maneuvers to extricate himself (and the patient) from danger.

Another aid to making an operation easy is for the surgeon to adopt the proper foot and body position for each surgical maneuver (see Appendix A).

The reputation for being a rapid operator is highly prized by some surgeons. More important than speed, however, are accuracy and delicacy of technique, especially when good anesthesia and patient-support technology are available. Nevertheless, *time should not be wasted.* A reduction in operating time is not achieved merely by performing rapid hand motions. An operation can be expedited without sacrificing safety only when thoughtful advance planning, anticipation, and an alert recognition of anatomical landmarks are combined with efficiency of execution. Together, they will eliminate wasted motion and wasted time.

A discussion of the concept underlying an operation and of operative strategy will be found in the text preceding the description of each operative technique.

2 Management of the Contaminated Operation

The incidence of postoperative wound sepsis varies with the magnitude of contamination. The generally accepted classification of operative wounds according to contamination, as listed by Altemeier et al., is:

1) Clean
   - Nontraumatic
   - No inflammation encountered
   - No break in technique
   - Respiratory, alimentary, genitourinary tracts not entered
2) Clean–Contaminated
   - Gastrointestinal or respiratory tracts entered without significant spillage
   - Appendectomy—not perforated—no cloudy peritoneal exudate
   - Prepared oropharynx entered
   - Genitourinary or biliary tract entered in absence of infected urine or bile
   - Minor break in technique
3) Contaminated
   - Major break in technique, or gross spillage from gastrointestinal tract
   - Traumatic wound, fresh
   - Entrance of genitourinary or biliary tracts in presence of infected urine or bile
4) Dirty and Infected
   - Acute bacterial inflammation encountered, without pus
   - Transection of "clean" tissue for the purpose of surgical access to a collection of pus
   - Perforated viscus encountered
   - Dirty traumatic wound

Table 2–1 demonstrates the high incidence of postoperative wound infection in good hospitals, in which accurate observations were made and records kept. If proper surgical technique and sound strategy are employed, figures such as these can be substantially reduced. The methods that prevent wound infection generally are effective also in preventing deep abdominal and pelvic sepsis following operative contamination.

Management should be aimed at (1) minimizing the bacterial inoculum and (2) enhancing host tissue defenses.

Table 2–1. Incidence of Infection in Relation to Wound Classification

	No. of Cases		Incidence of Wound Infection	
	Foothills Hospital[a]	Five Hospitals[b]	Foothills Hospital (%)[a]	Five Hospitals (%)[b]
Total	23.649	15.613	4.8	7.4
% Clean	76.4	74.8	1.8	5.0
% Clean–contaminated	17.5	16.5	8.9	10.8
% Contaminated	3.2	4.3	21.5	16.3
% Dirty	2.9	3.7	38.0	28.5

[a] Cruse JP, Foord R. Arch Surg 1973;107:206.
[b] Howard JM et al. Ann Surg 1964;160(Suppl.):1.

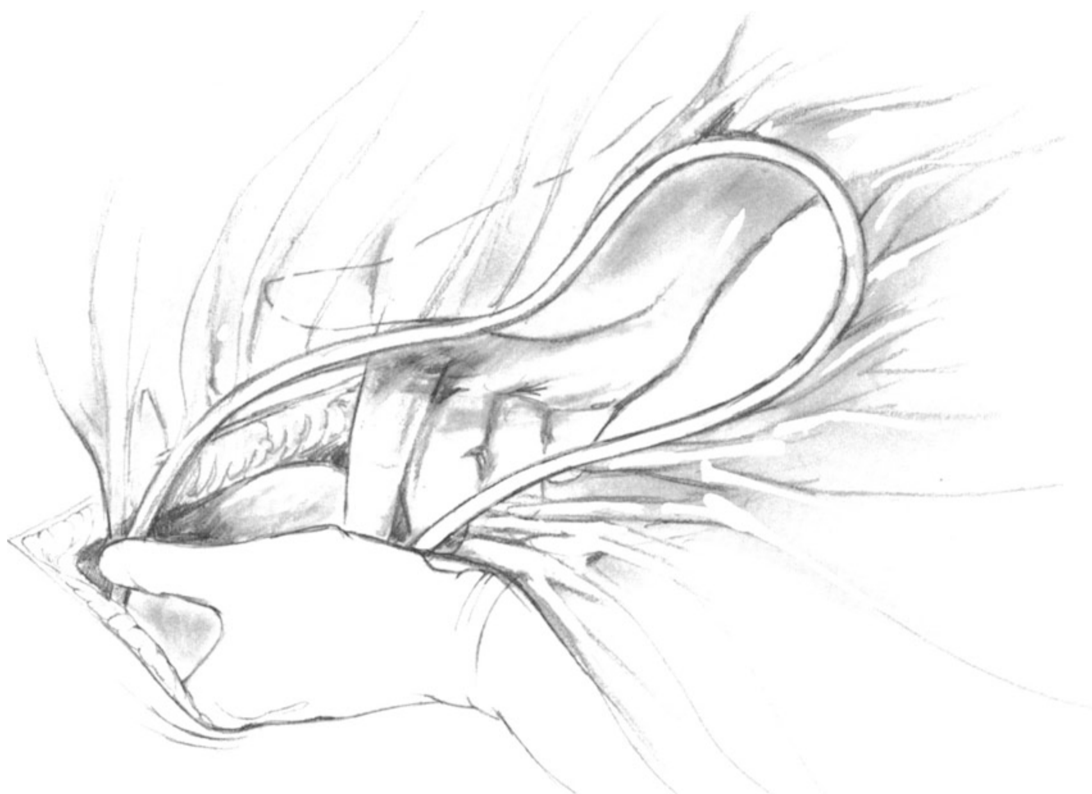


Fig. 2–1

Minimizing Bacterial Inoculum

As it is not possible to eliminate local peritoneal contamination in operations upon the biliary or gastrointestinal tracts, the surgeon should concentrate on localizing the spill and minimizing the bacterial insult to the abdominal wound and especially to the subcutaneous fat. Applying wet gauze pads to the wound does not accomplish this, as contaminated fluid can penetrate the gauze. Before initiating the contaminated portion of the operation, the surgeon should insert an impermeable plastic sheath to protect the wound and the subcutaneous fat from contamination. A device that may help accomplish this is the *Wound Protector*, a ring drape (**Figs. 2–1 and 2–2**). At the conclusion of the contaminated segment of the operation, the gauze pads, wound protector drape, gloves, and instruments all should be discarded.

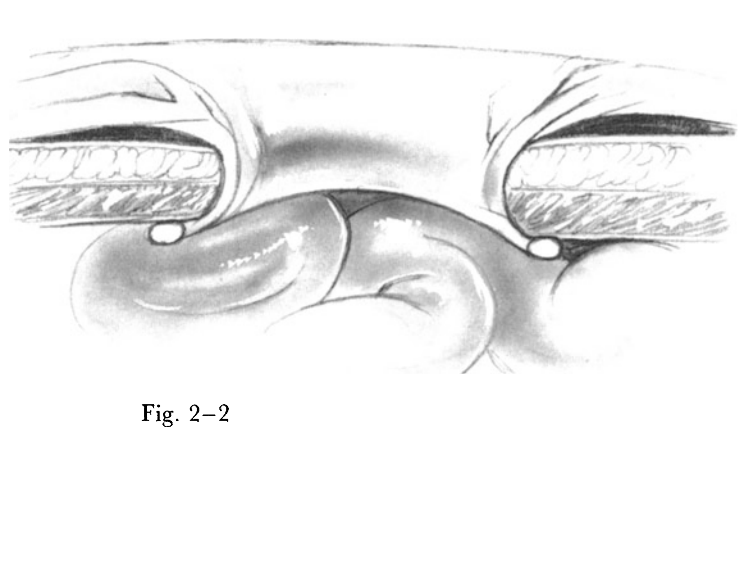


Fig. 2–2

While it has long been customary to pour several liters of saline into the peritoneal cavity just before closing the incision, the surgeon can achieve greater efficiency in washing bacteria out of the operative field with the method employed by chemists in preparing a chemically clean glass beaker: five or six rinsings with small quantities of liquid. During the contaminated portion of the operation, frequent *irrigations* with 100–200 ml saline, followed by aspiration, are effective in washing out bacteria as they are being spilled into the field. At the same time, be careful that this irrigation fluid does not spill over into the subcutaneous tissues. Replace the gauze pads after aspiration of the saline is *complete*.

Adding an appropriate *antibiotic* to the irrigating solution further enhances its efficacy. When antibiotic sensitivity studies are not available, a solution of 0.1% kanamycin is satisfactory in the abdomen, it has been found. In advanced sepsis, a dilute solution of an aminoglycoside and clindamycin may be preferred. In patients with renal failure, use these drugs with caution, as some absorption from the peritoneum is possible. Noon et al. reported that antibiotic irrigation of the abdominal cavity and the incision reduces the incidence of wound infection. For situations in which gram-positive organisms are a threat—such as in operations that use Marlex mesh to repair a hernia—50,000 units of bacitracin may be added to 500 ml of a 0.2% kanamycin solution.

Mechanical and antibiotic *bowel preparation* (see Chap. 34) has been demonstrated, in random studies conducted by Clarke et al., to lower the incidence of wound infection after colon anastomoses. Similar preparation in patients who have cancer of the stomach is appropriate because the necrotic interstices of the tumor often harbor virulent bacteria.

When latex drains are brought from a contaminated area in the abdomen through the incision, bacteria enter the subcutaneous tissues. The contamination is lessened, Cruse and Foord found, if the drain is brought out through a separate stab wound, reducing the incidence of wound infection. Cruse and Foord also found that the adhesive plastic skin drape failed to reduce the incidence of wound infection.

Enhancing Host Tissue Defenses

The defenses of host tissues are tremendously impaired by such *poor surgical techniques* as traumatic dissection, clamping large bites of tissue in hemostats, and leaving too many ligatures of too heavy a material. All these make the tissues less able to conquer bacterial invasion. In Cruse's study the use of the electrosurgical knife almost doubled the wound infection rate. Other factors that were correlated with marked increases in the incidence of wound infection in clean wounds were malnutrition, obesity, and diabetes.

Nutritional rehabilitation, including the use of total parenteral nutrition when necessary, helps restore the impaired immunological defenses of the depleted patient.

Perioperative antibiotics (see below) assure a therapeutic level in the serum and tissues before the incision. Even if minor hematomas should form, presumably they too will contain a therapeutic level of antibiotic. Polk and Lopez-Mayor proved that this reduces the incidence of wound infection.

Effective evacuation, by *suction catheters*, of blood, fibrin, and serum from the operative site restores the efficiency of phagocytosis, which these substances impair. Alexander et al. have noted that infections are prevented by this means. This is important in the splenic bed following splenectomy and in the presacral space following low colorectal anastomosis. In both locations a relatively small inoculum of bacteria combined with blood and serum may produce an abscess, whereas bacteria without blood or blood without bacteria may prove harmless. In the low colorectal anastomosis, infected hematoma and the resultant abscess formation probably are common causes of anastomotic failure. In Cruse and Foord's study, the use of closed-suction drainage following cholecystectomy reduced the incidence of postoperative infection to 0% as compared to 9.9% following the use of Penrose latex drains. Omitting the drain altogether is equally effective in avoiding wound infection after elective cholecystectomy.

Intermittent instillation of an antibiotic solution into closed-suction or sump catheters postoperatively is another method of enhancing the defenses of host tissues. The antibiotic selected depends on the nature of the contamination as well as on the pattern of bacterial resistance to antibiotics in each hospital. We have experienced favorable results with 0.1% kanamycin solution in the presacral space following low colorectal anastomosis and following total proctectomy when the perineum has been closed.

Schwab and Kelly prefer to administer continuous irrigation with a saline solution (50 ml per hour) in the presacral space after total proctectomy has been performed.

Leaving the skin and subcutaneous tissues completely unsutured, to close by granulation and contraction is an excellent method of preventing wound sepsis. To accomplish healing of the abdominal wall in the absence of skin sutures, the abdomen should be closed with a suture material that will not produce chronic draining sinuses. Sutures of PDS, using a modified Smead-Jones technique, will achieve this end nicely.

Keep the skin edges separated postoperatively by inserting a light packing over fine mesh gauze for 5–10 days. Change the packing daily, using a sterile technique. If the wound is clean, secondary closure may be performed with sterile micropore adhesive strips. Interrupted nylon vertical mattress skin sutures may also be inserted in the operating room, about 2–3 cm apart. The sutures should be left untied beneath the gauze pack until the appropriate time.

This type of management is particularly suitable for the gross contamination that occurs in operations for advanced peritonitis, gangrenous appendicitis, or abdominal abscess.

Management of Infected Operative Wound

Infection of the operative wound may be revealed by such signs as local erythema, tenderness, fever, or tachycardia. If local pain and systemic toxicity are out of proportion to the degree of local findings in the wound, one should suspect infection by anaerobic organisms, especially Clostridia.

If there is the slightest suspicion of infection, the incision should be explored by opening the skin down to the fascia. Obtain samples for bacteriological identification. If infection is found, the skin should be opened over the entire length of the infected part of the wound, which should then be irrigated. Necrotic tissue should be debrided. The skin edges should be kept open with gauze packing, which should be changed once or twice daily. This gives the surgeon the opportunity to observe the area closely. Serious infections, such as necrotizing fasciitis or myositis, must be diagnosed early and treated with appropriate systemic antibiotics and debridement.

Perioperative Antibiotics

Studies by Polk and Lopez-Mayor and by Altemeier et al. have demonstrated that when significant contamination may be anticipated because of the nature of the operation, the incidence of wound infection is reduced if an adequate blood level of the proper antibiotic is provided before the incision is made. This type of management is appropriate for patients who undergo open colon anastomosis, exploration of an infected common bile duct, cholecystectomy for acute cholecystitis, or gastrectomy for carcinoma. Some institutions use prophylactic antibiotics for elective cholecystectomy in the elderly because patients over age 70 who suffer gallstones have a high incidence of gram-negative and anaerobic bacteria in their bile.

Antibiotics should be initiated intravenously 1 hour before surgery and repeated after 4 hours. Continuing the prophylactic antibiotic beyond 1–2 doses is of no value and raises the risk of encouraging the development of antibiotic resistance. Exceptions to this rule usually are made for patients who have drainage tubes in the pleural cavity or the common bile duct. Whether these exceptions are valid is not entirely clear from the data currently available.

Which antibiotic to employ for prophylaxis varies with the proposed operation and with the bacterial sensitivity pattern in each hospital. Polk used cephaloridine. We use cefazolin or cefotetan now because we prefer intravenous administration.

Throughout this book, reference to the use of prophylactic antibiotics immediately before and during surgery will be indicated by the term "perioperative antibiotics."

References

Alexander JW et al. Prevention of wound infections: a case for closed suction drainage to remove wound fluids deficient in opsonic properties. Am J Surg 1976;132:59.

Amer Coll of Surg Subcommittee, Altemeier WA et al. Manual on control of infection in surgical patients. Lippincott, Philadelphia; 1976.

Clarke JS et al. Preoperative oral antibiotics reduce septic complications of colon operations. Ann Surg 1977; 186:251.

Cruse PJ, Foord R. A five-year prospective study of 23,649 surgical wounds. Arch Surg 1973;107:206.

Noon GP et al. Clinical evaluation of peritoneal irrigation with antibiotic solution. Surgery 1967;62:73.

Platt R, Zaleznik DF, Hopkins CC et al. Perioperative antibiotic prophylaxis for herniorrhaphy and breast surgery. N Engl J Med 1990;322:153.

Polk HC Jr, Lopez-Mayor JF. Post-operative wound infection: a prospective study of determinant factors and prevention. Surgery 1967;66:97.

Schwab PM, Kelly KA. Primary closure of the perineal wound after proctectomy. Mayo Clin Proc 1974;49:176.

3 Rational Use of Drains

Purpose of Drains

Drains permit the escape from the body of pus, blood, serum, lymph, bile, pancreatic juice, or intestinal contents. They form a walled-off passageway, from the source of pus or other undesirable collection, to the outside. This passageway or tract must persist for a period long enough to assure complete evacuation of the collection.

In the presence of a discrete abscess, the need for and purpose of a drain is obvious and noncontroversial, as its therapeutic benefits are clear. In most other situations, the drain acts as a prophylactic instrument to prevent the accumulation of undesirable products. Because it is a foreign body, the drain also has the paradoxical effect of potentiating infection, as Magee et al. have pointed out. When and how a drain should be used for prophylactic purposes has long been a source of controversy.

Pros and Cons of Various Drains

Latex and Cigarette (Penrose)

Perhaps the most widely used method of drainage in the United States, the soft latex drain of various dimensions, is generally made of a thin radiopaque sheet of rubber. It has the advantage of being inexpensive. It is also successful in encouraging fibrosis, so that it forms a well-established tract within 8–10 days.

However, there are many disadvantages. If the surgeon does not take pains to bring the drain out in a straight line without any wrinkles, stagnant pools of serum accumulate around the wrinkled areas of the drain. After the drain is removed, the patient may have a 24-hour increase in temperature of 2°–3°. More fundamentally, the latex drain does not really empty a cavity. It simply permits the secretions to overflow from the abdomen to the outside. It is not particularly effective in evacuating oozing blood before a clot forms. There is no method of irrigating the depth of the wound with this type of drain, as there is when a tube or sump type is used.

Finally, the most important objection to the latex drain arises from the fact that it requires a 1–2 cm stab wound in the abdominal wall. This permits the retrograde passage of pathogenic bacteria down into the drain tract, which accounts for the occurrence of staphylococcal infection in the drain site following an uncomplicated cholecystectomy and subphrenic abscess following an essentially sterile splenectomy. These problems have been described by Nora et al. and Cerise et al.

Tube Drain, Polyethylene or Rubber

Both of these substances establish tracts to the outside, as they are mildly irritating and stimulate adhesions. They are effective in evacuating air and serum from the pleural cavity and bile from the common bile duct. Drain-tract infection following the use of tube drains is rare, for reasons discussed below.

Among the disadvantages of rubber or polyethylene tubes is that they will clog up with clotted serum or blood unless they are a large size. However, large tubes are unsuitable for placement deep in the abdominal cavity for a period of more than a few days, as there is considerable danger of erosion through an adjacent segment of intestine, which results in intestinal fistula.

Tube Drain, Silicone

Silicone or Silastic tubes are less reactive than are other types of drains. They are less prone to plug up as a result of the clotting of serum. Because of the soft texture of silicone, erosion into the intestine is uncommon.

One disadvantage of silicone drains is that their lack of reactivity may result in the failure of tract formation. When a Silastic T-tube used in the common bile duct is removed, the patient may develop bile peritonitis, because a firm fibrous channel has not been established between the bile duct and the outside.

Sump Suction Drains

Generally constructed of silicone or polyethylene tubing, sump drains must be attached to a source of continuous suction.

They are quite effective in evacuating blood and serum, especially if suction is instituted in the operating room, so that the blood may be evacuated before it clots. Instillation of an antibiotic solution also is feasible when indicated. If used regularly, fluid instillation is also effective in preventing obstruction of the drain due to the coagulation of serum or secretions. Drain tract infections with sumps are uncommon even though unsterile, bacteria-laden air is drawn down into the depths of the patient's wound by the continuous suction. Baker and Borchardt have demonstrated this phenomenon and have noted it may be minimized by the low-volume suction provided by a Gomco pump. A major disadvantage of sump drains is the requirement that the patient be attached permanently to a suction device, thereby impairing mobility.

Closed-Suction Drain

This device consists of one or two multiperforated silicone or polyethylene catheters attached to a sterile plastic container, which is the source of continuous suction. This is a closed system; the catheters are brought out through puncture wounds. Morris has reported that the incidence of infection is lower than that encountered with other techniques. Patient mobility is unimpaired, for the plastic container is easily attached to the patient's attire. Irrigation of the depths of the wound with an antibiotic solution can be undertaken by disconnecting the catheter from the suction device and instilling the medication with a sterile syringe.

The closed-suction drain should not be left in the abdomen for more than 10 days as we know of cases where tissues have been sucked into the fenestrations of a Jackson-Pratt catheter so firmly that it was impossible to remove the catheter except by relaparotomy.

Gauze Packing

When a gauze pack is inserted into an abscess cavity and is brought to the outside, the gauze in effect serves as a drain. Unless the packing is changed frequently, this has the disadvantage of potentiating sepsis by providing a foreign body that protects bacteria from phagocytosis.

Prevention of Drain-Tract Infection

Retrograde transit of bacteria from the patient's skin down into the drain tract is a source of postoperative sepsis. As Nora et al. and Cerise et al. have reported, this problem occasionally follows clean operations such as elective cholecystectomy and splenectomy.

When a polyethylene sump or a silicone closed-suction catheter is brought through a puncture wound of the skin, it is easy to suture it in place. On the other hand, when a latex drain is brought out through a 1–2 cm stab wound in the abdominal wall, there is no possibility of eliminating to-and-fro motion of the drain or retrograde passage of bacteria into the drain tract. Consequently, when latex or gauze drains must be used in cases of established abscesses, the surgeon must accept an added risk of retrograde contamination with bacteria, in spite of sterile technique when dressings are changed.

Management of Intraperitoneal Sepsis

A distinction must be made, in managing intraperitoneal sepsis, between an isolated abscess—for instance, around the appendix—and multiple abscesses involving the intestines, accompanied by generalized peritonitis. In the latter type of sepsis, the presence of fibrin and necrotic tissue prevents adequate phagocytosis and perpetuates sepsis.

When an abscess has developed rigid walls that do not collapse after evacuation of the pus, large drains must be inserted in order to establish a reliable tract to the outside. Sometimes 2 to 5 weeks may be required for a rigid abscess cavity to fill with granulation tissue. It is not safe to remove the drains until injecting the abscess with an aqueous iodinated contrast medium has produced an X ray that demonstrates the cavity is no longer significantly larger in diameter than the drainage tract. If this is not done, subphrenic or pelvic sepsis can recur readily. For rigid-walled abscesses of this type, several large latex drains should be inserted together with one or two sump drains. An additional straight 10F catheter should be inserted for intermittent instillation of an appropriate dilute antibiotic solution. At lease one drain should be left in place until the sinogram X ray shows that the abscess cavity has essentially disappeared. Care should be taken that none of the rigid tubes comes into contact with the intestine or stomach, as intestinal fistula can be a serious complication.

Percutaneous Drainage of Abdominal Abscesses with CT or Ultrasound Guidance

Treatment of abdominal abscesses has undergone a revolutionary change in the past decade due to the demonstrated efficacy of percutaneous drainage by the interventional radiologist. In the case of most abdominal abscesses, the skilled radiologist can find a safe route along which to insert a drainage catheter that will evacuate the pus without the necessity of performing a laparotomy for drainage. This technology is especially welcome in the critically ill patient who may not tolerate a major operation. As described by vanSonnenberg et al., these percutaneous catheters require close attention after their insertion if consistently successful results are to be achieved.

Other Indications and Methods of Drainage

Abscess

In abscesses of the extremities, trunk, or perirectal area, the important step is to unroof the abscess by making a cruciate incision so that the tract will not close before all the pus has been evacuated. For superficial abscesses, an unroofing procedure is adequate, and any type of temporary drain is sufficient. When the danger exists that the superficial portion of the tract will close before deep healing takes place, insertion of gauze packing is indicated. This should be changed often enough to keep the packing from blocking the egress of pus.

Blood and Serum

The presence of blood, serum, or fibrin in a perfectly sterile area is not dangerous to the patient. However, following any major operation, the operative field is never completely sterile. For this reason, postoperative puddles of blood or serum in combination with even a small number of bacteria can result in abscess formation, because the red blood cell impairs antibacterial defenses, as Davis and Yull have stated. In the low colorectal anastomosis, accumulated serum or blood in the presacral space, together with secondary infection and abscess formation, is probably a frequent cause of anastomotic leakage. For these reasons, during any abdominal operation strenuous efforts should be exerted to eliminate bleeding. If these efforts have to be supplemented by some type of drainage, the ideal method is to insert one or two multiperforated Silastic tubes, which are brought out through puncture wounds in the abdominal wall and attached to a closed-suction system. If it is important to keep this system functioning for more than 2 or 3 days, as it is in the low colorectal anastomosis, then tubes of large size—6 mm in external diameter—should be employed, and patency guaranteed by intermittent instillation of a dilute antibiotic solution.

Following radical mastectomy or regional lymph node dissections of the neck, axilla, or groin, closed-suction drainage is also extremely effective. Here, tubing of smaller diameter is acceptable. This technique has also been successfully employed following abdominoperineal proctectomy with primary closure of the perineal floor and skin.

Bile

Because bile has an extremely low surface tension, it will tend to leak through anastomoses by way of tiny defects or even via suture tracts. This is essentially harmless if a passageway to the outside is established. For this purpose either a sump drain or closed-suction system works nicely. Silastic tubes are contraindicated, as the formation of a fibrous tract to the outside for the bile is desirable. This is especially true in the use of a T-tube in the common bile duct.

Pancreatic Secretions

Pure pancreatic juice in the abdominal cavity is not dangerous. This is evident in patients who have pancreatic ascites or fistula. However, if the pancreatic secretion is activated by the presence of bile, duodenal contents, or pus, the trypsinogen is converted to trypsin and the adjacent tissues are subjected to a raging inflammatory reaction. Recently constructed adjacent anastomoses may be digested and destroyed. Eventually, hemorrhage from retroperitoneal blood vessels ensues. Consequently, it is important to evacuate bilious and pancreatic secretions completely, especially after Whipple pancreatic resection. This is accomplished by inserting a long plastic catheter into the pancreatic duct in the tail of the pancreas. The catheter is brought through the segment of jejunum to which the duct is anastomosed. Then it is brought through a jejunostomy opening to an outside drainage bag. Unless the tube is displaced accidentally, it will convey all the pancreatic secretions out of the abdominal cavity.

In addition, a suction catheter should be inserted in the vicinity of the anastomosis, between the tail of the pancreas and the jejunum. Daily irrigation with an antibiotic solution may be necessary to keep the drain functioning if it must remain in for more than a few days.

Duodenal Stump

Occasionally, after closing a difficult duodenal stump, the surgeon will have some doubt about the adequacy of the suture line. Under these conditions a 14F whistle-tip or Foley catheter should be inserted as a lateral duodenostomy to prevent the buildup of pressure in the duodenal stump (see Figs. 24–33 and 24–34). After a difficult duodenal resection, even if the closure appears to be satisfactory, some surgeons prefer to institute drainage in this area because there may have been trauma to the head of the pancreas. For this purpose a closed suction or latex drain is used, provided that it does not come into contact with the suture line.

Anastomosis

Placing a drain down to an anastomosis of the gastrointestinal tract because the surgeon has some doubt about its integrity makes little sense, according to Berliner et al. and Manz et al. If anastomotic breakdown occurs, the presence of a drain may not prevent generalized peritonitis. If the surgeon believes there is any significant risk of anastomotic failure, the anastomosis should be taken apart and be done over again, or else both ends should be exteriorized, to be reconnected at a second-stage operation. The surgeon must not fall into the trap of fuzzy thinking, which would permit the acceptance of an anastomosis that might be less than adequate, rather than reconstructing the anastomosis or eliminating it from this stage of the operation.

In treating some cases of Crohn's disease accompanied by extensive cellulitis, some surgeons believe the inflamed areas should be drained. In reality, cases of cellulitis or contamination, such as might follow a perforated duodenal ulcer, do not benefit from drainage. It is well established that the peritoneal cavity as a whole cannot be drained.

If complete hemostasis in the vicinity of an anastomosis cannot be achieved, there may be some merit to the insertion of a silicone closed-suction drain for a few days, provided it does not come into direct contact with the suture line.

References

Baker BH, Borchardt KA. Sump drains and airborne bacteria as a cause of wound infections. J Surg Res 1974;17:407.

Berliner SD et al. Use and abuse of intraperitoneal drains in colon surgery. Arch Surg 1964;89:686.

Cerise EJ et al. Abdominal drains: their role as a source of infection following splenectomy. Ann Surg 1970; 171:764.

Davis HJ, Yull AB. A toxic factor in abdominal injury. II. The role of the red cell component. J Trauma 1964;4:84.

Magee C et al. Potentiation of wound infection by surgical drains. Am J Surg 1976;131:547.

Manz CW et al. The detrimental effects of drains on colonic anastomoses: an experimental study. Dis Colon Rectum 1970;13:17.

Morris AM. A controlled trial of closed wound suction. Br J Surg 1973;60:357.

Nora PF et al. Prophylactic abdominal drains. Arch Surg 1972;105:173.

vanSonnenberg E, D'Agostino HB, Casola G, Halasz NA et al. Percutaneous abscess drainage: current concepts. Radiology 1991;181:617–626.

4 Surgical Stapling: Principles and Precautions

Principles of Stapling Gastric and Intestinal Anastomoses

Preserving Tissue Viability

Preserving the viability of the tissues distal to the line of staples is basic to the concept underlying the use of staples to perform a surgical anastomosis. The flow of blood penetrates the double staggered rows of staples that have been applied to the tissues. Unless the tissues are much too thick to be suitable for stapling, one will notice blood oozing through the staple line because the staples assume the configuration of a B when they are fired. Consequently, there is tissue along the staple line that completely escapes being enclosed by the staples, permitting the passage of blood to and beyond the stapled anastomosis. If the tissues being stapled are so thick that compression by the stapling device is likely to produce necrosis, this technique is contraindicated. On the other hand, if the tissues are so thin that the staples cannot provide a firm approximation, bleeding and anastomotic leakage may occur.

There is some leeway when approximating tissues of varying thickness. Staples of two sizes are available for use with the TA stapling devices. The 3.5-mm staple is 3.5 mm in leg length and 4.0 mm wide across the base. The 4.8-mm staple also is 4.0 mm wide across the base, but its leg length is 4.8 mm. When the TA device is compressed sufficiently so that the thin black band on its handle reaches the exact midpoint of the wide black band, the degree of compression, using the 3.5-mm staple, is approximately 1.5 mm. With the same technique, the 4.8-mm staple compresses the tissues to approximately 2 mm. The GIA compresses tissues to a thickness of approximately 1.75 mm.

Stapling in Eversion

Even when tissues are stapled in eversion, with mucosa facing mucosa, satisfactory healing takes place. Ravitch et al. (1966) have demonstrated this phenomenon in anastomoses of the intestine. When a *sutured* anastomosis is performed with everting technique, the results are inferior to the inverted seromuscular anastomosis. On the other hand, the everted *stapled* anastomosis in experimental animals healed nicely with even less inflammation in the first 10–15 days than did the inverted sutured anastomosis. Extensive experience in humans, reported by Steichen and Ravitch, confirms the safety of mucosa-to-mucosa approximation when it is performed by stapling devices (see also "Complications of Stapling Compared with Suturing," p. 15).

Instruments Used in Surgical Stapling

Stapling Devices Used for Gastrointestinal Tract Anastomosis

TA–55 and TA–90

The TA–55 applies a doubled staggered row of staples approximately 55 mm long; the TA–90 applies a doubled staggered row about 90 mm long. Each may be used with 3.5-mm or 4.8-mm staples, according to the principles described above. These devices are used to approximate the walls of stomach or intestine in an everting fashion. They find application in closure of the duodenal stump, of the gastric pouch in gastrectomy, and of the end of the colon when a side-to-end coloproctostomy is performed.

GIA

The GIA device creates a stapled anastomosis with the tissues in inversion. It applies two doubled staggered rows of staples while the knife in its assembly divides the tissue between the two double rows. It is used for side-to-side anastomoses, such as gastrojejunostomy, and "functional end-to-end" anastomoses.

EEA

The EEA device utilizes a circular anvil, a circular staple cartridge, and a circular knife to produce a doubled staggered row of staples that approximate two tubular structures in inversion while the knife cuts the tissue just inside the staple line. This creates an end-to-end anastomosis 21.4 mm in internal diameter. It compresses the tissues to a thickness of approximately 2.0 mm. While smaller cartridges that produce a circular anastomosis of smaller diameter are available, only one size of staple is obtain-able. When the device is inserted through the anal canal, it is ideally suited for a low colorectal anastomosis.

The EEA stapler has also been used successfully for esophageal and gastroduodenal anastomoses.

Other Stapling Devices

LDS

The LDS device can apply two staples, which serve as ligatures, while it divides the tissue between these two staple-ligatures. Its principal application is in dividing the branches of the gastroepiploic vessels that supply the greater curvature of the stomach, a procedure carried out when the omentum is liberated during gastrectomy.

Skin Stapler

All the instruments mentioned above are manufactured by the U.S. Surgical Crop., which along with the Ethicon Company also makes staplers for closing skin incisions. These staplers close skin incisions efficiently and rapidly, with satisfactory cosmetic results.

Fascia Stapler

Since the fascia stapler violates the principles discussed in Chap. 5, we have not used it in our operations.

Indications for Stapling an Anastomosis

Stapled anastomoses, when constructed with proper technique, are no better and no worse than those done with sutures (see below). Stapling has the disadvantage of increased expense. It has the advantage of speed—a stapled anastomosis can generally be completed in 2–5 minutes—which is a tremendous benefit in the poor-risk patient who is critically ill and who may be undergoing an emergency operation. Even with the availability of skilled anesthesiologists, expert in the physiological support of the desperately ill patient, there is indubitably an advantage to completing the operation speedily.

Stapling technology is also an attractive option for the low anterior resection in patients who have lesions of the middle third of the rectum at 6–10 cm from the anal verge. Although there are pitfalls of a technical nature in the use of the EEA device, after the technique has been mastered it seems to be superior to suturing in this location.

Contraindications

The use of staples is contraindicated under the same conditions that would make construction of a sutured anastomosis dangerous. There is no evidence that staples are safer than sutures, for instance, in the presence of advanced peritonitis.

Another contraindication is the presence of tissues that are too thick or too thin to meet the requirements for stapling, as discussed above.

There are occasional, although rare, instances in which the exposure does not allow enough room to insert a stapling instrument into a body cavity. If this is the case, it is contraindicated to apply traction to the tissues in order to permit the introduction of a stapling device.

Causes of Failure Following Stapled Anastomosis

Quality of the Tissues

The blood supply of the bowel to be anastomosed must be vigorous when staples are used, just as it must be with sutures. Bowel that is not fit for suturing is not suitable for stapling.

When the GIA is used to anastomose the jejunum to the back wall of a gastric pouch (see Fig. 24–47), at least 2.0–2.5 cm of gastric wall should be left between the GIA staple line and the closed end of the gastric pouch. Otherwise, ischemia can develop in this strip of stomach between the two staple lines and produce anastomotic failure. Do not let the ease of inserting staples impair good judgment about the adequacy of tissue perfusion in the vicinity of any staple line. Always think of blood supply.

The stapling technique requires that the bowel be of such quality that it will remain viable when compressed to the thickness mentioned above during the process of constructing a stapled anastomosis. For example, when a chronic obstruction has caused the gastric wall to become hypertrophied to a thickness of 6–8 mm, compression by the TA–90 stapling device to a thickness of 2.0–2.4 mm may produce a linear tear in the serosa adjacent to the stapling device. Seeing this, the surgeon should invert the staple line with a layer of seromuscular Lembert sutures. Otherwise the staple line should be excised and the closure accomplished entirely with sutures. Although tissue thickness rarely is a contraindication to the use of staples, failure by the surgeon to identify those cases in which the tissues are unsuitable for reliance on stapling may lead to serious complications.

Linear tension that exerts a distracting force against a sutured anastomosis certainly is detrimental. In the stapled anastomosis this tension is even more undesirable. One should assume that the fine wire in the staples will tend to cut through tissues more readily than sutures, thereby producing a leaking anastomosis. This is a clinical impression unsupported by data, but we have observed a colostomy closure fail because of the postoperative dehiscence of the staple line. This occurred because the surgeon did not free enough proximal and distal colon from adhesions to the parietal peritoneum to relieve tension on the stapled closure. Other complications of this type are discussed in the section on staple complications (see below).

Instrument Failure

Misalignment of the GIA instrument may occur, especially if it has been dropped on a ceramic floor and the two forks of the instrument diverge instead of remaining parallel. In this case the increased distance between the cartridge and the anvil prevents the staples at the distal end of the instrument from closing properly. As a precaution, the *staple formation should be checked following the completion of each anastomosis*. In addition, when the GIA is used frequently it should be test-fired once a month on a latex drain or a sheet of plastic to check proper B formation (**Fig. 4–1a,b**).

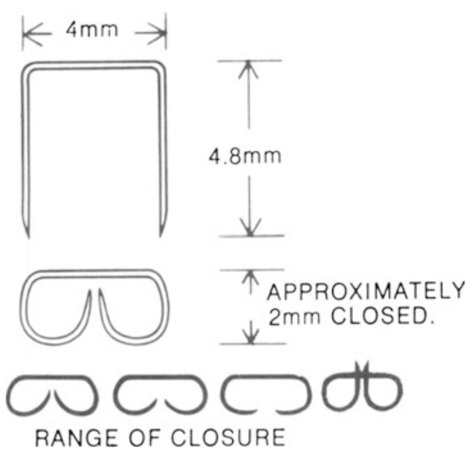


Fig. 4–1a

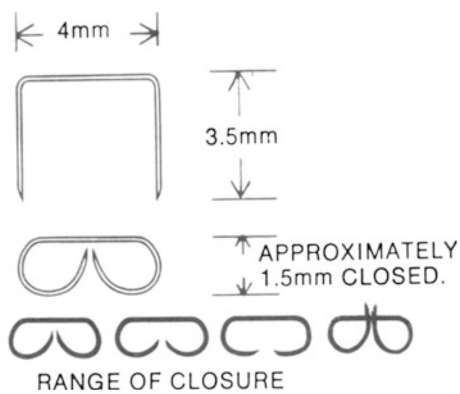


Fig. 4–1b. Dimensions of 3.5 staples.

Partial failure of the knife assembly in the GIA instrument may occur on rare occasions. When this happens the scalpel fails to make a complete incision between the two double rows of staples. If this is not detected by careful inspection, the resulting anastomosis will have an extremely narrow lumen.

Complete failure of the staple cartridge to discharge staples has been known to happen. An inattentive surgeon may not notice this, for pressure alone may hold the bowel walls in apposition temporarily. A cartridge will also fail to discharge staples if it has been spent and not replaced by a fresh cartridge before *each* application of the instrument.

Human Error—Judgment

A staple line should not cross the mesentery of bowel. If this happens, intramural hematomas may occur, which would interfere with proper healing. Also, mesenteric fat should not be included between the seromuscular layers of an anastomosis.

Whenever the GIA device is used on the gastric wall, carefully inspect the staple line for gastric bleeding. Transfix bleeding points with absorbable sutures. Occasionally an entire GIA staple line in the stomach bleeds excessively. If it does, the entire staple line should be oversewn with absorbable sutures inserted in the lumen of the stomach. Although it is preferable to insert sutures superficial to the staple line, with the GIA device there may not be sufficient tissue beyond the staples to accomplish this. On such occasions we have not had complications when 4–0 PG atraumatic sutures were inserted in the lumen of a GIA anastomosis and were passed deep to the staples. These sutures must not be tied with excessive tension. We have not observed significant bleeding following GIA stapling in organs other than stomach. Minor bleeding may be controlled by cautious electrocoagulation.

When an excessive amount of tissue is bunched up in the crotch of the GIA, firing the knife assembly may fail to incise the bowel between the two doubled rows of staples because the knife blade cannot penetrate the compressed tissue. As a result there will be narrowing or absence of an anastomotic lumen. Every GIA staple line must be inspected upon removing the instrument. If the incision between the staple lines has not been made by the GIA knife assembly, it should be accomplished with a straight scissors. Although this type of GIA failure is rare, its possibility should not be overlooked.

Occasionally the GIA is used to cut and staple across two layers of gastric wall, as in the Janeway gastrostomy (see Chap. 26) or the Collis gastroplasty (Chap. 13). Because the two layers of stomach may be too thick for the GIA to compress them safely to a

1.75-mm width, these staple lines should be oversewn with sutures. If a GIA with 4.8-mm staples is used, it may not be necessary to oversew gastric staple lines.

Multiple Allis clamps should be applied to the walls of intestine included in a TA staple line. This prevents the bowel from retracting out of the jaws of the instrument as the tissue is being compressed. If the tissue should retract from the jaws of the instrument, obviously the stapled closure would fail.

If an anastomosis constructed by the stapling technique has too small a lumen, this inadequate lumen probably will not dilate very much following the passage of stool or food, as it will if interrupted sutures have been used. If a stapled stoma is made too small, the two staggered rows of staples may keep it that way permanently after the anastomosis has been constructed. Consequently, more attention should be paid to the size of the lumen when constructing a stapled anastomosis than when constructing one by sutures.

Avoid making a false intramural passage when inserting the forks of the GIA into stab wounds of the intestine or stomach, as this would prevent the formation of a proper anastomosis. Place each fork accurately in the lumen of the intestine or stomach.

The tissues of the bowel and esophagus should be in a relaxed position when a stapling device is applied to them. If excessive tension is applied to the tissue while the stapler is being fired, this tends to make the tissue too thin for proper purchase by the staples.

Special Precautions

1) After completing a stapled anastomosis, always inspect the entire circumference meticulously to ascertain that each staple has been formed into an adequate B. Test the lumen by invaginating the bowel wall with the index finger. Any point at which two or more staple lines cross should be carefully checked for possible leakage. Inspect the serosa for possible cracks or tears. If there is any doubt about the integrity of a stapled anastomosis, oversew it with a layer of interrupted seromuscular Lembert sutures. If the saving of time is a consideration, use a continuous Lembert suture of 4–0 atraumatic PG. Although the need to oversew the staple line will occur in no more than 1%–2% of the cases managed by a surgeon experienced in performing stapled anastomoses, oversewing can be an essential step in preventing leaks in some situations.

2) In the last step of a functional end-to-end anastomosis, the defect is closed with a TA-55 device. If the two GIA staple lines (**Fig. 4–2**) are kept in perfect apposition during this maneuver, after the TA–55 is fired six rows of staples can be seen to come together at one point. We believe that such a point is weak and that it permits the development of an anastomotic leak, because the presence of many staples and much tissue in one spot results in the failure of proper closure. Occasionally this can be seen in the operating room when carefully inspecting the completed anastomosis. To prevent this weak point we have modified our technique by deliberately avoiding perfect apposition of the two GIA staple lines. Greater security will be achieved when applying the TA–55 if the bowel is aligned so that the GIA staple lines are not in exact apposition (**Figs. 4–3 and 4–4**).

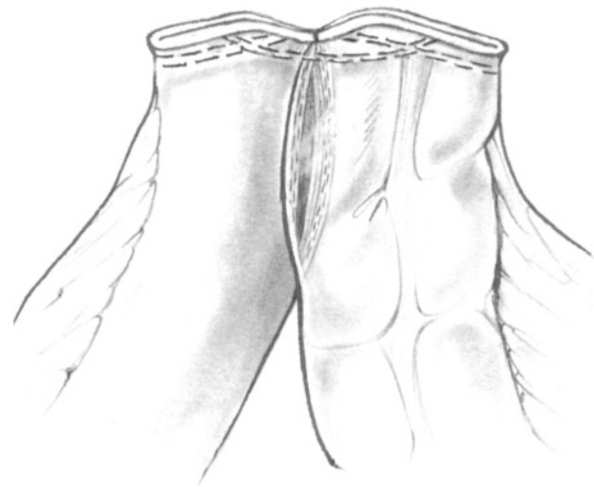


Fig. 4–2

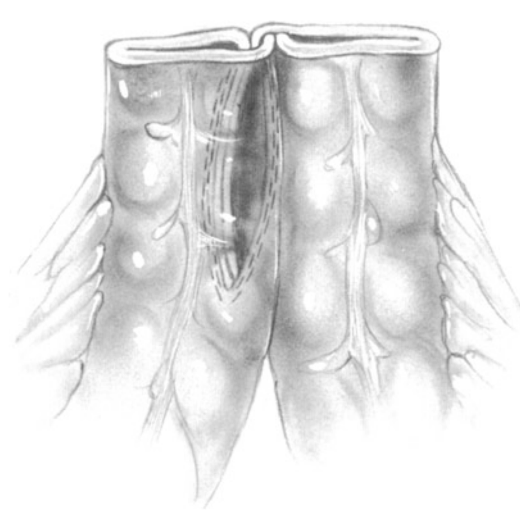


Fig. 4–3

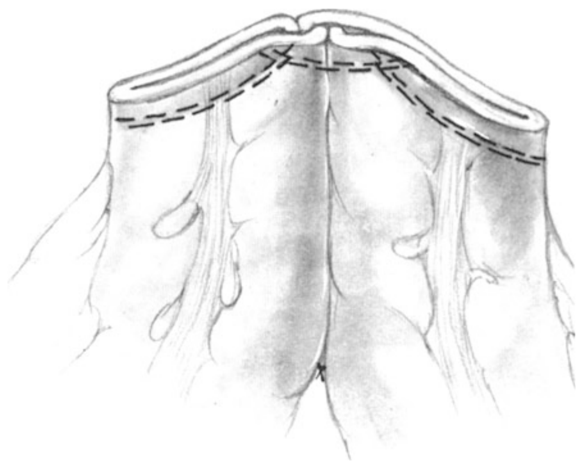


Fig. 4–4

A better way of avoiding this problem is to use our modification of the functional end-to-end anastomosis, as illustrated in Figs. 37–33, 37–34, 37–35, and 37–36.

3) Using the EEA for colorectal anastomosis is an excellent technique, provided that precautions are taken to avoid the many possible technical pitfalls. These are described in Chap. 39.

One general problem in inserting the EEA anvil into the colon or esophagus occurs when the lumen is too narrow to accommodate the anvil's 32-mm diameter. This may result from muscle spasm, perhaps induced by narcotics such as fentanyl, which is commonly employed in the administration of "balanced" anesthesia. Excessively forceful dilatation tears the seromuscular coat of the colon. If dilating the bowel results in tissue too thin to hold staples firmly, stapling is contraindicated. We do not believe the smallest EEA cartridge (EEA–25) should be used in either the esophagus or the rectum because the resulting stoma may be too small.

Complications of Stapling Compared with Suturing*

Although the first clinically useful stapling device with developed by DePetz in 1927, further progress was not remarkable until the early 1960's when the Institute for Experimental Apparatus and Instruments in Moscow developed a group of instruments capable of performing gastrointestinal tract anastomoses. Since these instruments were somewhat cumbersome and required that individual staples be inserted into the instrument by hand prior to each use, they did not receive widespread acceptance. Ravitch et al. (1959) were responsible for introducing a modified form of the Russian stapling device to this country. A great advance in the utility of the staplers was achieved with the development of instant loading with sterile cartridges, each containing as many as 33 staples. Ravitch and his associates also reported further studies in animals and humans and described techniques for the performance of gastrectomy as well as small bowel and colonic anastomoses.

It has been estimated, on the basis of staple sales, that several hundred thousand operations using stapling techniques are performed in the United States every year.

Gritsman, one of the pioneers in the development of the Russian stapling apparatus, in 1966 reported a collective series of 1,663 stapled gastric resections performed by a large number of surgeons in the former USSR, with a mortality rate of 2%. He compared these with a second series, which he collected from the world literature, of 52,886 gastrectomies done with suture technique by 62 surgeons, with a mortality rate of 4.4%. Steichen and Ravitch reported 147 of their own stapled gastrointestinal operations with 11 complications. Latimer and associates studied 112 stapled operative procedures with a stapler-related complication rate of 1.9%. Lawson and associates reported 122 operations on the alimentary canal done with stapling devices, accompanied by a 4.0% complication rate. No study has yet been reported comparing complications following stapled anastomoses with those following hand-sutured procedures performed by the same group of surgeons. In an effort to shed light on the relative merits of these two techniques, the authors are reporting a study of this type with reference to 812 consecutive gastrointestinal procedures.

Material and Methods

By reviewing the operating room log book of the Booth Memorial Medical Center for the period between July 1, 1973 and June 30, 1977, the names and chart numbers of all patients having gastrointestinal operations were obtained. These charts were then reviewed to determine the nature of each operative procedure, the technique of anastomosis, and any complications which may have occurred during the course of hospitalization.

* From "The Stapled Gastrointestinal Tract Anastomosis: Incidence of Postoperative Complications Compared with the Sutured Anastomosis," by Jameson L. Chassin, M.D., Kenneth M. Rifkind, M.D., Barry Sussman, M.D., Barry Kassel, M.D., Arnold Fingaret, M.D., Sharon Drager, M.D., Pamela S. Chassin, in *Annals of Surgery*. Vol. 188, No. 5, November 1978. Copyright © 1978 by J.B. Lippincott Company. Reprinted by permission.

Classification of Complications

Complications of anastomoses were grouped in three categories: 1) If an enterocutaneous fistula, leak, hemorrhage, or obstruction occurred at the site of the anastomosis, this was obviously a "related" complication. Included also are cases of perianastomotic abscess and generalized peritonitis. 2) If the patient developed a subphrenic or pelvic abscess at a distance from the anastomosis with no direct contact, this was considered "possibly related," as was the development of intestinal obstruction due to adhesions not at the anastomotic site. 3) Complications were considered "unrelated" if the patient developed such conditions as myocardial infarction, atelectasis, cerebrovascular accident, or pulmonary embolism. A study of comparative wound infection rates is not included in this report even though the technique selected for anastomosis might indeed have influenced the incidence of infection in the incision. The reason for this omission stems from the fact that skin wounds, contaminated by the intra-abdominal procedure, were either left open, sutured closed, or drained according to the prejudices of the surgeon. Since there was no uniform pattern of wound management during the period under study, a statistical review of infected wounds as a "related" complication would prove meaningless.

Classification of Operative Procedures

Each gastrointestinal anastomosis was considered to be an operative procedure. Consequently, if a patient had both a small bowel resection with anastomosis and a colon resection with anastomosis, these were counted as two procedures. Billroth II subtotal gastrectomy, for the purpose of this study, was classified as two procedures: 1) duodenal stump closure and 2) gastroenterostomy. In this way it was possible to calculate the specific morbidity rate for each type of suture or staple procedure.

Anterior resections performed at or below the peritoneal reflection were classified as being done by suture if no staples were involved. These were all end-to-end anastomoses in this series. The Baker side-to-end colorectal anastomosis is a special case combining an everted stapled closure of the distal end of colon with suture anastomosis between the side of colon and the end of the rectal stump. In only two cases were low colorectal anastomoses done exclusively with staples. The new EEA stapling device, especially designed to perform this type of anastomosis, was not available during the time period of this study.

Surgical Technique

In each case the operative techniques were those described by Ravitch and Steichen. The everted stapled closures were not turned in with an additional layer of sutures in the cases included in this series. Ten attending surgeons and twelve surgical residents performed the operations, utilizing the Auto Suture TA–55, TA–90, and GIA stapling devices. When anastomoses were performed by hand suturing, standard techniques were utilized. In most cases involving either the small bowel or colon, open anastomoses were constructed using fine catgut for the mucosa and interrupted nonabsorbable sutures for the seromuscular layer, although occasionally a one-layer technique was used.

Case Selection

All gastrointestinal anastomoses done during the period under study were reviewed. Six patients were rejected because they died of unrelated causes, such as myocardial infarction, stroke, or preexisting sepsis, so soon after operation as not to allow sufficient time to elapse for an anastomotic complication to become manifest. All other cases were included in the study. Whether staples or sutures were to be utilized in any case was a decision left entirely to the judgment or personal preference of the operating surgeon.

Technical Training

Although a course of instruction in surgical stapling given at the University of Pittsburgh was attended by the senior author, much of the staff's early training in the application of the stapling devices was provided by representatives of the manufacturer.

Adverse Factor Analysis

Since this is a retrospective study, it is possible that a disproportionate number of patients with conditions having an adverse effect on anastomotic healing might have accumulated in one of the two groups under study, thus jeopardizing the validity of the comparison. Consequently, seven categories of adverse factors were selected: 1) emergent or urgent nature of the surgery; 2) peritonitis, gastrointestinal perforation, or intra-abdominal abscess; 3) gangrenous intestine; 4) gastric or intestinal obstruction; 5) Crohn's disease; 6) carcinoma, localized; 7) nonresectable carcinoma, liver metastases, or peritoneal carcinomatosis.

Most surgeons would agree from their personal experience that these factors do have an adverse effect on anastomotic healing, and statistical validation for most of the above items is evident in the report by Schrock et al. Charts of patients included in this study were reviewed for the presence of any of the above adverse factors. The incidence rate of each adverse factor was calculated individually for the various suture and staple techniques. Not subjected to this adverse factor analysis were colostomy closures and anterior resections because these cases were not done under emergency conditions and few of the other adverse factors were operative.

Results

Mean age of all patients having sutured anastomoses was 62.5 years compared to 63.3 for stapled cases. Analysis of the specific mean ages for each of the sutured and of the stapled operative procedures under study did not disclose any clinically significant differences.

Table 4–1 summarizes the incidence of factors having an adverse effect on anastomotic healing. It is obvious that with the exception of Crohn's disease, each of the adverse factors was more prevalent in patients undergoing stapled procedures. For example, 24% of 438 stapled anastomoses were done under emergency conditions compared to 9% of sutured procedures. Carcinomatosis, gastric or intestinal obstruction, gangrene of bowel, and infection were also more prevalent among the stapled cases.

Complications following each of the operative procedures under study are summarized in Table 4–2. There is no statistically significant difference in the incidence of "related" complications between the sutured and stapled groups when tested by the Chi-square method (3.0% vs 2.8%). The same is true of the incidence of "possibly related" complications for the two groups (1.4% vs 1.3%). It is interesting to note that of the 27 complications following those operative procedures of the types listed in Table 4–1, 22 occurred in patients having adverse factors. All of the complications are described in Tables 4–3 through 4–10.

As will be evident from a perusal of Tables 4–3 through 4–10, it is often difficult to ascertain whether a complication was related to the healing anastomosis or whether it was an inevitable result of the pathological process for which the operation was performed. In questionable cases the complications were included in our statistics as "possibly related."

Discussion

The incidence of anastomotic complications (Table 4–2) following stapled procedures was so nearly identical with that following hand-sutured operations as to be startling. Review of the data in Table 4–1 indicates that if there is any bias in this retrospective study, it heavily favors the sutured procedures. A much higher proportion of acutely ill patients undergoing emergency surgery had their anastomoses performed by the stapling technique in order to save operating time. Patients suffering from abdominal abscess, peritonitis, gangrenous bowel, intestinal obstruction, and peritoneal carcinomatosis underwent anastomoses by stapling far more frequently than by suturing. With respect to cases of small intestinal obstruction undergoing resection and anastomosis, of the 28 cases in this series, 25

Table 4–1. Incidence of Factors with Adverse Effect on Anastomotic Healing

	No.	Operations Nonelective	Perforation or Pus	Bowel Gangrene	Obstruction	Crohn's Disease	Carcinoma	Nonresectable CA or Metastses
Gastrojejunal								
sutured	32	19%	3%	0	26%	0	29%	23%
stapled	111	22%	5%	0	18%	1%	35%	24%
Duodenal stump								
sutured	31	13%	0	0	—[a]	0	13%	3%
stapled	68	28%	6%	0	—[a]	0	29%	3%
Ileocolonic								
sutured	57	7%	7%	5%	7%	14%	67%	9%
stapled	85	21%	20%	6%	15%	11%	71%	12%
Colocolonic								
sutured	71	6%	8%	4%	1%	1%	54%	8%
stapled	61	8%	8%	0	2%	2%	63%	33%
Small intestine								
sutured	30	30%	6%	3%	10%	0	30%	30%
stapled	105	39%	18%	20%	24%	3%	42%	27%
Esophagogastric								
sutured	4	0	0	0	0	0	100%	25%
stapled	6	0	0	0	0	0	100%	33%
Total								
sutured	225	9%	6%	3%	7%	4%	46%	13%
stapled	436	24%	11%	6%	14%	3%	47%	21%

[a] Not relevant.

Table 4–2. Complications Following Sutured and Stapled Operative Procedures

		Complications	
	No.	Related	Possibly Related
Gastrojejunostomy			
sutured	32	0	1 (3%)
stapled	111	1 (1%)	3 (3%)
Duodenal stump closure			
sutured	31	2 (6%)	0
stapled	68	3 (4%)	0
Ileocolonic			
sutured	57	3 (5%)	2 (4%)
stapled	85	3 (4%)	2 (2%)
Colocolonic			
sutured	71	0	1 (1%)
stapled	61	0	0
Small intestine			
sutured	30	1 (3%)	0
stapled	105	4 (4%)	1 (1%)
Closure colostomy			
sutured	33	0	0
stapled	33	2 (6%)	0
Esophagogastric			
sutured	4	0	0
stapled	6	0	0
Anterior resection			
sutured	38	3 (8%)	0
Baker	44	0	0
stapled	2	0	0
Total			
sutured	296	9 (3.0%)	4 (1.4%)
stapled	472	13 (2.8%)	6 (1.3%)
Baker	44	0	0
Total	812		

were anastomosed with staples; of 22 with strangulation of small bowel, 21 had stapled procedures. It is notable that 69% of all 32 anastomotic complications occurred in patients with one or more adverse factors.

Schrock and his associates demonstrated that a marked increase in the incidence of clinically apparent anastomotic leakage followed ileocolonic and colonic resections if the operations were done under emergency conditions or were accompanied by bacterial or fecal contamination, operative hemorrhage, or shock. For example, when peritonitis, abscesses, or fistulae were encountered at operation, anastomoses leaked in 10.5% of cases, compared to 3.7% in the absence of infection. Emergent cases exhibited an 8.2% leak rate. Even the presence of a localized colonic carcinoma resulted in a rate of clinical leakage twice that of operations performed for benign disease. Our study tends to confirm their findings with respect to both sutured and stapled anastomoses. Crohn's disease is included in our list of adverse factors due to the fact that most of our patients undergoing surgery for this condition had sustained one of the complications of the disease which produced some variety of intraperitoneal infection.

Although the procedure of right hemicolectomy with primary anastomosis has a reputation for successful healing even when performed under unfavorable conditions, Table 4–5 demonstrates that a number of anastomotic complications occurred following ileocolectomy performed in the presence of carcinomatosis, intestinal necrosis, peritonitis, or abscess. Welch and Donaldson noted a high mortality (18%) when right colectomy with anastomosis was performed for acute colonic obstruction, while Dutton et al. found that 36% of their patients died following emergency resection and anastomosis of the obstructed right colon.

In one patient a pelvic abscess followed subtotal colectomy and ileosigmoid stapled anastomosis done

Table 4–3. Complications Following Gastrojejunostomy

Sutured (32)
- Related—(0)
- Possibly related—(1)
  - Subhepatic abscess after gastrectomy for obstructing ulcer; relap.

Stapled (111)
- Related—(1)
  - Postoperative gastric hemorrhage, three units; no relap.; *technical error*
- Possibly related—(3)
  - Subhepatic abscess after gastrectomy for carcinoma; relap.
  - Subhepatic abscess after gastrectomy for carcinoma of residual gastric pouch; relap.
  - Obstruction due to fibrosis at efferent stoma after gastrojejunostomy for Crohn's duodenitis; relap.

Table 4–4. Complications Following Closure of Duodenal Stump

Sutured (31)
- Related—(2)
  - Duodenal fistula after gastrectomy for carcinoma; healed without relap.
  - Duodenal leak and peritonitis following suture closure of duodenum and tube duodenostomy during emergency gastrectomy for massive hemorrhage—fatal

Stapled (68)
- Related—(3)
  - Duodenal fistula healed in four weeks—minor; no relap.
  - Duodenal fistula along drain tract following gastrectomy for carcinoma appeared on p.o. 22, after discharge from hospital; healed in three weeks—minor; no relap.
  - Duodenal leak; reoperation p.o. 4 to insert tube duodenostomy; healed in two weeks; *technical error*—stump too thick for stapled technique

Table 4–5. Complications Following Ileocolonic Resection and Anastomosis

- Sutured (57)
  - Related—(3)
    - Perianastomotic abscess after palliative right colectomy in 75-year-old patient with carcinomatosis; relap. p.o. 10
    - Obstruction, inflammation at anastomosis; relap. for bypass p.o. 15 (probable leak)
    - Death p.o. 11 of 90-year-old following resection and jejunocaecostomy for gangrene of ileum; febrile p.o. course; no autopsy (suspected leak)
  - Possibly related—(2)
    - Recurrent pelvic abscess after resection for perforated Crohn's ileitis with pelvic abscess and peritonitis; relap. p.o. 11
    - Transient small bowel obstruction in patient with peritoneal metastases; Cantor tube
- Stapled (85)
  - Related—(3)
    - Leak and peritonitis after subtotal colectomy and ileosigmoidostomy for Crohn's colitis; relap. p.o. 8
    - Subhepatic abscess adjoining anastomosis; patient readmitted for I. & D. p.o. 26
    - Obstruction due to kink, adhesions and small abscess at anastomosis in 90-year-old; probable leak; relap. p.o. 9
  - Possibly related—(2)
    - Small pelvic abscess noted at relap. for intestinal obstruction 15 days after emergency subtotal colectomy and ileosigmoid anastomosis for acutely obstructing carcinoma of left colon
    - RUQ abscess and infected ascites after resection right colon for necrotic tumor with peritoneal carcinomatosis; relap. p.o. 3. Died of pulmonary emboli p.o. 12

for an acutely obstructing carcinoma of the left colon. This is considered by the authors to be a case of poor surgical judgment, as results with preliminary colostomy followed by staged resection for left colon obstruction have been superior to one-stage resection (Dutton et al., 1976; Welch and Donaldson, 1974). In our series, closure of colostomy resulted in no deaths and only a 3% incidence of anastomotic complications.

Three cases of subhepatic or subphrenic abscess, cited in Table 4–3, followed gastrectomy either for carcinoma or obstruction. In each of these cases it is considered highly improbable that the infection resulted from any leak at the site of the gastrojejunostomy. Rather, contamination by virulent organisms present in the stomach appears to be the likely cause of these infections.

In the case of the postoperative gastric hemorrhage following a stapled gastrojejunostomy, this was considered to be a technical error. Performed early in our experience with stapling techniques, inadequate attention was paid to the oozing of blood from the gastrojejunal staple line. It is now known that it is imperative to correct this bleeding by means of electrocoagulation or suture ligation.

Table 4–6. Complications Following Colon Resection and Colocolonic Anastomosis

- Sutured (71)
  - Related—(0)
  - Possibly related—(0)
    - Postoperative small bowel obstruction successfully treated by Cantor tube
- Stapled (61)
  - No anastomotic complications

In reviewing duodenal stump closure it is notable that two of the five leaks occurred in patients with gastric carcinoma in whom the duodenum appeared to be free of pathology. The only fatal duodenal complication occurred in a patient in shock undergoing emergency gastrectomy for massive hemorrhage from a large posterior penetrating duodenal ulcer, in whom the precaution was taken of performing a tube duodenostomy at the time of gastrectomy. This was not successful in preventing duodenal fistula and peritonitis. In two stapled duodenal closures, minor leaks appeared along the drain tracts. In one patient, who was discharged from the hospital healed, a duodenal fistula occurred along the drain tract on the twenty-first postoperative day. Another patient with a duodenal leak following stapled closure underwent reoperation on the fourth postoperative day. No gross leak could be seen, but drains were inserted and the fistula persisted for three weeks. This complication was con-

Table 4–7. Complications Following Small Intestinal Anastomoses

- Sutured (30)
  - Related—(1)
    - Enterocutaneous fistula, 12 days duration, after side-to-side ileosigmoidostomy for carcinomatosis with obstruction
- Stapled (105)
  - Related—(4)
    - Leak following operation for strangulated hernia; resection done in groin and anastomosis forcibly reduced into abdominal cavity via hernial opening; relap. p.o. 7; *technical error*
    - Enterocutaneous fistula following resection and anastomosis of multiple segments of small bowel for strangulating intestinal obstruction and abdominal abscesses, 10 days after hysterectomy; healed on hyperalimentation
    - Enterocutaneous fistula following 2 small intestinal resections, sigmoid resection and drainage of abscesses for Crohn's enterocolitis and peritonitis; died of sepsis
    - Enterocutaneous fistula following small bowel resection and resection enterovesical fistula in 71-year-old with carcinomatosis and obstruction; died of sepsis
  - Possibly related—(1)
    - Relaparotomy, enterolysis for adhesive small bowel obstruction 30 days after resection of jejunal angiodysplasia; no leak

Table 4–8. Complications Following Colostomy Closure

Sutured (33)
No anastomotic complications
Stapled (33)
Related—(2)
Obstruction; perianastomotic inflammation; re-resection p.o. 14
Fecal fistula; stapled anastomosis constructed under tension; *technical error*

sidered due to a technical error in that the duodenal stump was excessively scarred, making it too thick for proper closure by stapling. Since the stapling device will compress tissues to a thickness of 1 to 1.5 mm when using the 3.5-mm staple, it is important to remember that no tissue which may be necrotized by this degree of compression should be stapled. Vital to the success of any stapled closure is the viability of the tissue distal to the staple line. Stapling is not equivalent to a completely hemostatic ligature. One can uniformly observe a brief period of gentle oozing through the stapled closure. When tissue is too thick for this to occur, the technique is contraindicated. Some leeway in this area may be obtained by using the larger 4.8-mm staple, which will permit the closure of moderately thickened tissue. With the use of the larger staple, the tissue compression is increased to a 2 mm thickness.

One of the technical failures following a stapled anastomosis occurred in a patient with a strangulating inguinal hernia requiring resection of the patient's ileum. The resection and anastomosis was carried out in the inguinal incision after which the anastomosed segment was pushed through the fairly narrow hernial ring into the abdominal cavity. This complication was attributed to the technical error of applying excessive force to a fresh anastomosis. Another technical error was responsible for a large fecal fistula which followed stapled anastomosis for closure of a transverse colostomy. The operation was performed through a small incision with inadequate mobilization of colon from adjacent adhesions. This resulted in excessive tension on the stapled closure, with consequent leakage.

Table 4–9. Complications Following Esophagogastrostomy

Sutured (4)
No anastomotic complications
Stapled (5)
No anastomotic complications

Table 4–10. Complications Following Anterior Resection of Rectum

Sutured (38)
Related (3)
Perianastomotic abscess; drained transrectally
Fecal fistula; conservative treatment
Localized leak in patient with gauze pack in place for 3 days due to presacral hemorrhage. No relap.
Sutured and stapled (Baker side-to-end) (44)
No anastomotic complications
Stapled (2)
No anastomotic complications

Needless to say, in an indeterminate number of additional cases, technical errors were detected and corrected during the course of stapling. Upon the completion of any stapling procedure, it behooves the surgeon to examine the entire anastomosis with meticulous care to seek out any possible imperfections. In the case of gastrojejunal anastomoses with the GIA device, complete hemostasis must be assured prior to completion of the procedure.

In our earlier application of stapled anastomoses to the small intestine, the authors felt some apprehension that the everted staple line might give rise to postoperative adhesions due to the rim of exposed mucosa. It was gratifying to observe that during the 4-year period of this study no patient returned with intestinal obstruction due to an adhesion involving one of these everted lines of staples. Since the period of observation is a brief one, some degree of apprehension remains and it may be advisable, when convenient, to cover the everted mucosa with adjacent mesentery or omentum.

Among the 32 complications related to anastomotic healing listed in Tables 4–3 through 4–10, there were only four fatalities from sepsis. This low rate is considered to be due to the emphasis in this institution upon prompt relaparotomy in all cases suspected of having anastomotic leakage. In these situations the anastomosis is generally divided and both limbs of intestine are exteriorized either as enterostomy or colostomy and mucous fistula.

The satisfactory results following stapling procedures in this series were not due to the efforts of a single experienced and skillful surgeon, but rather of a large number of staff surgeons and residents. It should be noted, however, that acquisition of experience and skill with these instruments was achieved in a gradual, organized fashion. No one inexperienced in the stapling technique performed an anastomosis without a preceptor being part of the operating team. Despite its apparent simplicity, there are just as many pitfalls to be avoided in learning stapling techniques as there are in learning how to sew. Once this technique is mastered, there appears to be no significant difference in results, comparing stapled and sutured anastomoses. Since the average stapled anastomosis takes no more than two to three minutes to perform, one reason for the increasing popularity of stapling is readily apparent. At present, approximately 60% of the anastomoses in our institution are done with stapling techniques. They are particularly appropriate in critically ill patients in whom curtailment of operating and anesthesia time may be important.

In conclusion, data presented in this study do not show any significant difference in the incidence of anastomotic complications when stapled anastomoses are compared with sutured procedures in the gastrointestinal tract.

References

DePetz AA. Aseptic technique of stomach resection. Ann Surg 1927;86:388.

Dutton JW et al. Mortality and prognosis of obstructing carcinoma of the large bowel. Am J Surg 1976;131:36.

Gritsman JJ. Mechanical suture by Soviet apparatus in gastric resection: use in 4,000 operations. Surgery 1966;59:663.

Latimer RG et al. Automatic staple suturing for gastrointestinal surgery. Am J Surg 1975;130:766.

Lawson WR et al. Mechanical suture methods in thoracic and abdominal surgery. Br J Surg 1977;64:115.

Ravitch MM et al. Experimental and clinical use of the Soviet bronchus stapling instruments. Surgery 1959;46:1, 97.

Ravitch MM et al. Closure of duodenal, gastric and intestinal stumps with wire staples: experimental and clinical studies. Ann Surg 1966;163:573.

Ravitch MM, Rivarola A. Enteroanastomosis with an automatic stapling instrument. Surgery 1966;59:270.

Ravitch MM, Steichen FM. Techniques of staple suturing in gastrointestinal tract. Ann Surg 1972;175:815.

Schrock TR et al. Factors contributing to leakage of colonic anastomoses. Ann Surg 1973;177:513.

Steichen FM, Ravitch MM. Mechanical sutures in surgery. Br J Surg 1973;70:191.

Welch JP, Donaldson GA. Management of severe obstruction of the large bowel due to malignant disease. Am J Surg 1974;127:492.

5 Incision, Exposure, and Closure

Achieving Exposure

Many dangerous surgical mishaps occur because the operative exposure is inadequate. The first step in obtaining good exposure is a well-planned incision of sufficient length.

The second step requires that the intestines be packed away from the area of operation. If a dissection requires the exposure of a large portion of the abdominal cavity, such as for left hemicolectomy or excision of an abdominal aortic aneurysm, the small intestine should be exteriorized for the duration of the dissection.

The third step is the retraction of the wound edges. This is accomplished by having an assistant apply a Richardson retractor to the abdominal wall, and deep retractors, such as the Harrington, to deeper structures. In some situations, a mechanical self-retaining retractor, such as the Balfour or the Thompson, may be inserted to separate the lips of a long abdominal incision. In the thoracoabdominal incision, a Finochietto retractor is excellent for separating the ribs.

One disadvantage of using a mechanical self-retaining retractor in the abdomen is that it may inflict trauma if intense pressure is exerted against the rectus muscles. This pressure can be lessened by using long incisions and by padding the musculature with moist gauze pads.

The *"chain" retractor* (**Fig. 5–1**), developed at the University of Alabama Medical School, as reported by Aldrete et al., is an inexpensive improvisation that permits the insertion of a retractor blade beneath the lower end of the sternum or beneath either costal margin. The retractor is attached to an ordinary link chain, which can be purchased in a hardware store for about $2.00. To the side rail at the head of the operating table the anesthesiologist attaches a curved steel post borrowed from the gynecological lithotomy stirrup set. When the post is adjusted to the proper height, the chain is fixed to a snap at the tip. By rotating the post in the proper direction, the lower end of the sternum and the thoracic cage can be retracted forcefully cephalad and anteriorly to elevate the sternum by as much as 8–10 cm.

This device is ideal for operations around the lower esophagus, such as a vagotomy or hiatus hernia repair. It does not require the purchase of new instruments other than 25–30 cm of chain. It may be installed when necessary, without preparation, even in the middle of an operation. It is also very helpful in liberating the splenic flexure of the colon. Here the device is placed on the left side of the operating table and the retractor is positioned to draw the left costal margin to the left, cephalad and anteriorly, thus improving exposure tremendously. Whenever exposure for operations on the biliary tract is difficult, application of the "chain" retractor to the right costal margin can be of benefit.

The Thompson retractor (Fig. D–24 in the glossary) attaches to the O.R. table and has a large variety of components for retraction. This device is therefore more flexible in operation than is the Upper Hand retractor.

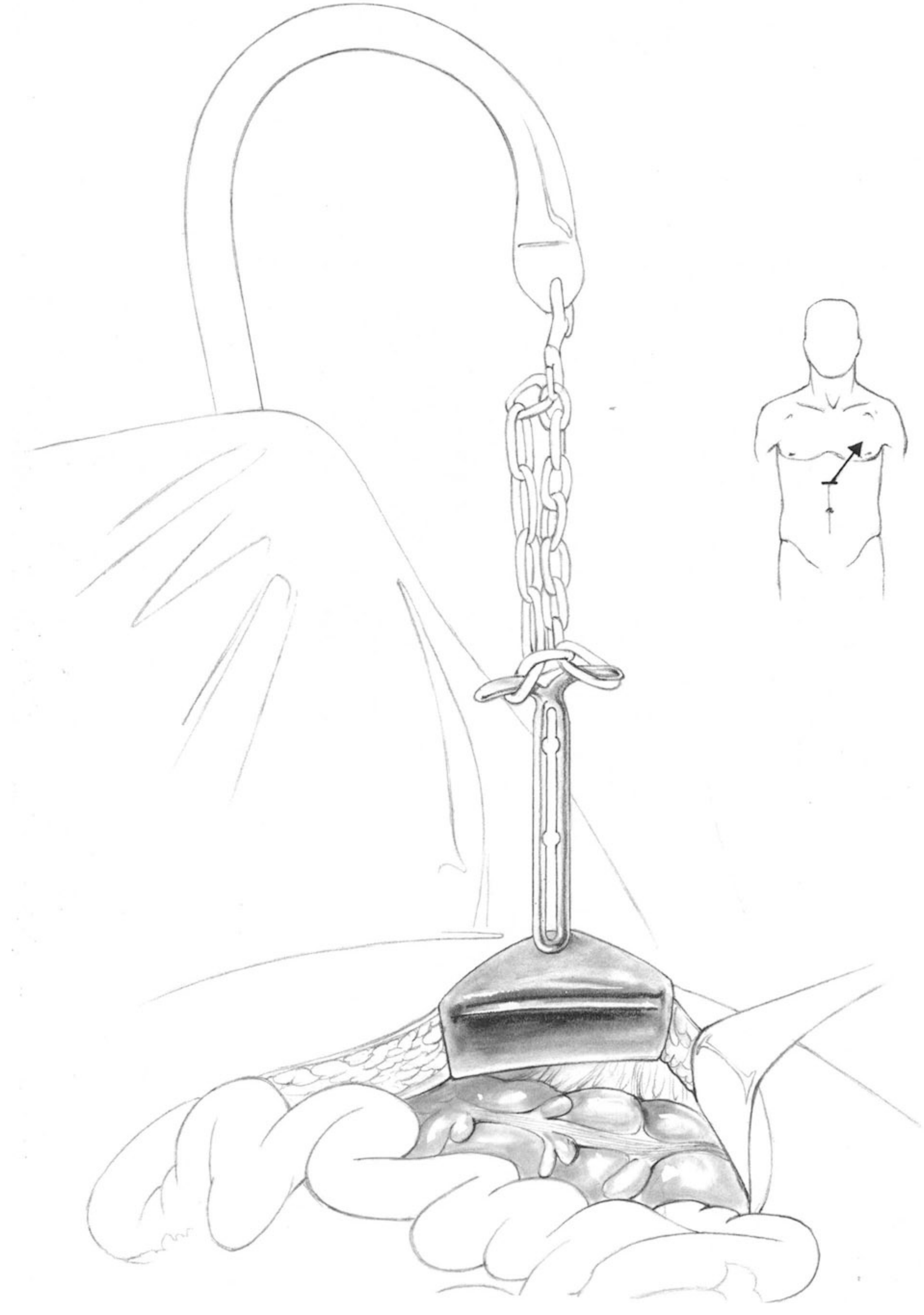


Fig. 5–1

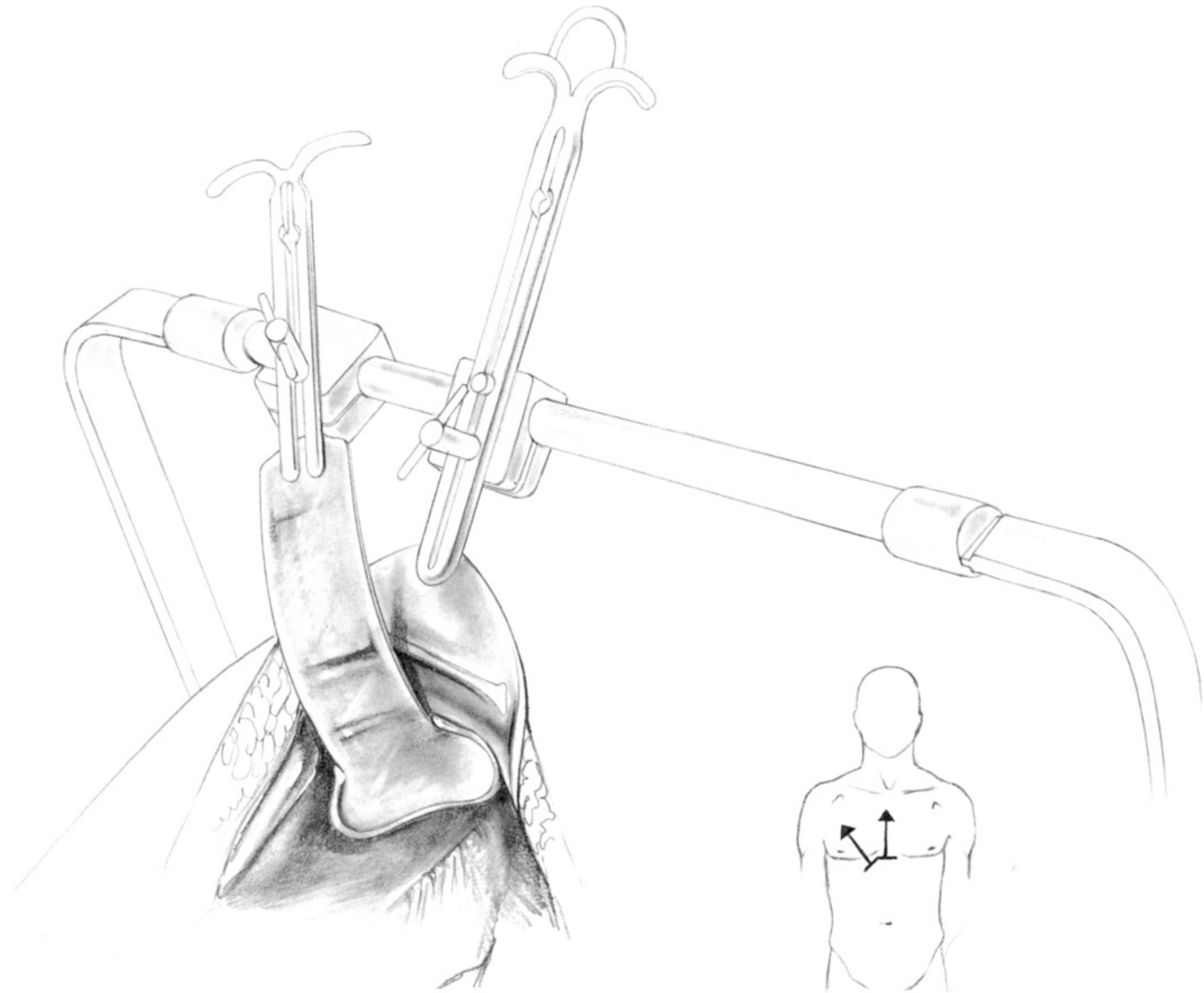


Fig. 5–2

Another mechanical retractor that is attached to the operating table to improve upper abdominal exposure is the *Upper Hand retractor* (**Fig. 5–2**) developed by Lally. This device is a steel bridge that is attached to both sides of the operating table and passes across the patient at the midsternal level. Its height is set at 4–10 cm above the sternum, depending upon the type of retraction desired. Two separate retractor blades can be attached to the steel bridge, one of which may be used to elevate the lower sternum in a manner similar to the "chain" retractor. A second blade may be attached to the bridge to retract the liver for biliary tract surgery; this method sometimes eliminates the need for a second assistant.

The primary aim of the "chain" and the Upper Hand retractors is not to reduce the number of assistants in the operating room, though. These devices are used because the exposure they provide in upper abdominal incisions cannot be duplicated by hand-held retractors.

In recent years, much more sophisticated retractors have been developed that attach to the operating table and permit multiple blades to forcibly retract various parts of the anatomy. At this time, the mechanical retractor that we prefer is the Thompson (see Appendix D).

Incisions for Abdominal Surgery

Although many surgeons have long believed that transverse incisions are stronger and have a lower incidence of dehiscence than midline incisions, this belief is false (see following section). Some think that the upper transverse incision interferes less with respiration than does the upper midline incision.

Clinically, this does not appear to be important. A long, vertical *midline incision* gives excellent exposure for all parts of the abdomen. It also provides flexibility, since extensions in either direction are simple to execute. With the aid of either the "chain" or Thompson retractor, splenectomy, splenic flexure resection, hiatus hernia repair, vagotomy, pancreatectomy, and biliary tract surgery can easily be done. Whenever exposure in the upper abdomen by this technique is inadequate, it is a simple matter to extend the midline incision into a right or left *thoracoabdominal* approach by dividing the costal cartilage and intercostal muscles. Yet another advantage of midline incisions is the speed with which they can be opened and closed.

In spite of these advantages, we often use a *subcostal* approach for cholecystectomy because a shorter length of incision provides direct exposure of the gallbladder bed. If the gallbladder has already been removed, and if a secondary common duct exploration is necessary or a pancreaticoduodenectomy is contemplated, a midline incision extending 6–8 cm below the umbilicus provides excellent exposure and is preferred.

For the usual appendectomy, the traditional *McBurney* incision affords reasonable exposure, a strong abdominal wall, and a good cosmetic result. To accomplish the same exposure with a vertical incision would require either a long midline or paramedian incision or an incision along the lateral border of the rectus muscle, which might transect two intercostal nerves and produce some degree of abdominal weakness.

Avoiding Wound Dehiscence and Hernia

Although a number of reports have appeared in the literature specifying rates of dehiscence well under 1%, both Efron and a *Lancet* editorial reported that the incidence of abdominal wound disruption is more like 3%–5% throughout the world for "routine" surgery performed by surgeons who do not have a particular interest in avoiding this complication. Goligher et al. in a controlled study found a 10% incidence of wound dehiscence in 107 patients whose wounds had been closed in multiple layers, using chromic catgut, rather than with mass sutures. Because abdominal wound dehiscence has been followed by mortality rates as high as 35% and by a high incidence of large incisional hernias, the problem deserves close study.

The major causes of wound disruption are:

Inadequate strength of suture material
Rapid absorption of suture material, e.g., catgut
Knots becoming untied, especially with some monofilaments like nylon and Prolene
Sutures tearing through the tissue

All these causes except the last are self-explanatory: suture tear is poorly understood by the majority of surgeons. A stitch will tear through if it is tied too tightly or if it encompasses too small a mass of tissue. While it is true that in some patients there appears to be a diminution in the strength of the tissue and its resistance to tearing, especially in the aged and in extremely depleted individuals, this does not explain the fact that many wound disruptions occur in healthy patients. Through extensive experience in the experimental laboratory with healing laparotomy wounds in normal and protein-depleted rats, we have compiled unpublished data demonstrating that as long as the incision is held together for a sufficient period of time, healing does occur. The rate of increase in the tensile strength of the healing wound is markedly depressed after an animal has lost 25% of its body weight, but 3 weeks following the laparotomy, satisfactory wound strength has developed. The problem, therefore, when collagen deposition takes place at a slow rate, is to support these wounds for a sufficient period of time to permit healing to occur. When a healthy, middle-aged patient with good muscular development disrupts the incision following an uncomplicated cholecystectomy, there must be a mechanical explanation. Often the surgeon has closed the wound with multiple small stitches of fine suture material. Under these circumstances, a healthy sneeze by a muscular individual tears the sutures out of the fascia and peritoneum because the muscle pull exceeds the combined suture-tissue strength.

If the problem, then, is to maintain tissue approximation during a sneeze or abdominal distension for a period of time sufficient for even the depleted patient to heal, what is the best technique to use? We now have adequate data to identify the principles that must be observed if the rate of dehiscence is to be reduced below 1%, especially in the poor-risk patient. 1) Jones et al., Sanders et al., Jenkins, and Spencer et al. found that proper technique demands that a large mass of tissue be included in the stitch. 2) According to Sanders et al., Jenkins, and Martyak and Curtis, the stitch must be tied in a relatively loose fashion so that approximation is achieved and not much more.

Although Jones used a near-and-far type stitch with monofilament wire, resulting in only one dehiscence in 197 cases, his description and illustrations seem to indicate that no more than 1 cm of tissue was included in the stitch on either side of the incision. Spencer used a bite of 3 cm on each side of the linea alba and placed his wire sutures 1 cm apart. He experienced one wound disruption in 293 patients. According to Tera and Alberg, a midline incision closed in this manner resists 3 times the bursting force of a paramedian incision closed in layers and 1.7 times that of a transverse incision, when tested in a cadaver.

In clinical trials Goligher et al. found that the use of a layer closure, supplemented by large and closely spaced retention sutures through all the layers of the abdominal wall and skin, can keep the wound dehiscence rate in the vicinity of 1%.

Many surgeons believe that a patient who is at an increased risk of having a wound dehiscence by virtue of malnutrition, chronic steroid therapy, or chronic obstructive pulmonary disease should have an abdominal incision closed with "retention sutures" that go through the skin, through the entire abdominal wall. We strongly disagree with the use of this type of closure for several reasons:

1) Wound healing is delayed in this group of patients, so that the wound requires the support of sutures for at least 4 weeks. Since this type of massive suture frequently cuts through the skin long before the passage of 4 weeks, the surgeon frequently removes the sutures somewhere around the 15th–20th postoperative day. In this case, the patient is not protected against wound dehiscence.
2) In patients who are at increased risk because of abdominal sepsis, this is an especially poor choice of closure because any subcutaneous wound infection is exceedingly difficult to treat properly. If one removes the skin sutures, it is still not feasible to drain the infection adequately, since the skin is being continuously held in apposition by the retention sutures. We have observed patients who developed necrotizing fasciitis that was not recognized until quite late in the course of the infection because of the inability to inspect the subcutaneous and fascial layers properly.
3) The objective of the "retention suture" is to take a sufficiently large bite of tissue on both sides so that the stitch will not cut through prior to adequate healing. The technique of abdominal closure described in this chapter accomplishes the same end as a "retention suture" by enclosing a 3-cm bite of tissue on each side of the incision. In effect, we are inserting a retention suture through the fascia and muscle layers but avoiding inclusion of the skin. Including the skin in a "retention suture" has many liabilities and no advantages, since there is no significant holding power in the skin layer. After an extensive experience with a large number of elderly, malnourished, and high-risk patients, we have found that the closure described in this chapter has all the advantages of a retention suture and none of the disadvantages, and is highly effective in preventing dehiscence.

There is evidence that closure of the midline incision need not be done exclusively with wire nor exclusively with interrupted sutures. Jenkins, and Martyak and Curtis reported on studies in which the same large-size tissue bites using one continuous suture of No. 2 nylon were taken in the linea alba, resulting in a minimal number of wound disruptions.

Modified Smead-Jones Closure of Midline Incisions

Since 1961 virtually all the abdominal surgery we have performed has been through midline incisions, which have been closed by the modified Smead-Jones technique described below. Appendectomies were done by the McBurney incision and are not included in this series. Most cholecystectomies have been performed through right subcostal incisions. From 1961 to 1970, because of the mistaken belief that the transverse incision was less prone to wound dehiscence, 478 of these subcostal incisions were closed with continuous catgut to the peritoneum and interrupted cotton sutures to the fascia. There were five wound disruptions in this group, for a 1% dehiscence rate.

In our last 500 subcostal incisions, closed by the modified Smead-Jones technique, no dehiscences were noted. A study was done of approximately 1500 midline and 300 subcostal incisions, performed by the author or residents under his supervision, that employed a modified Smead-Jones technique using monofilament wire. Results of this study revealed that 30% of the patients were operated upon for carcinoma and 30% underwent colon resection and anastomosis. The mean age of the patients was in the seventh decade. Many of the patients, encountered before parenteral hyperalimentation became available, were nutritionally depleted and seriously ill, including a number with abdominal sepsis. Incisions made through a previous scar in the abdominal wall were eliminated from the study. There was only one wound dehiscence in this group of 1800 cases. The patient was an 83-year-old debilitated man suffering from carcinomatosis. His dehiscence was due to a technical error: an inadequate bite of tissue was enclosed in the abdominal sutures, all of which cut through by the eighth postoperative day.

Although there was some trepidation at the onset of this study that the intra-abdominal loops of wire might trap intestine, it is striking that there were no cases of intestinal fistula or other evidence that the bowel was lacerated by a wire suture. In the 1800 abdominal closures, using probably 16,000 sutures, there were only three suture sinuses leading to a wire stitch. There were six instances in which the end of a broken wire had penetrated the skin, with no evidence of surrounding inflammation; this complication occurred in thin patients. In two cases, marked induration appeared for a distance of 2–3 cm at the fascial level of the wound. Upon exploration, a granuloma was found in each case. Since both of these granulomas were in contiguity with a wire suture, it was assumed that this represented a foreign-body reaction secondary to the wire knot. When postoperative incisional hernias appeared, the diameter of the ring was almost always 1–3 cm, as though one wire had either broken or cut through. Often the location of the hernia was adjacent to the umbilicus, where special care should have been taken to avoid leaving a gap in the closure.

While the above statistics reveal that complications from monofilament wire, used by the technique to be described, are astonishingly rare, wire does have one serious disadvantage. It appears to produce a higher incidence of pain in the incision than is seen with other types of suture material. It is estimated that 2%–4% of patients who undergo this type of abdominal closure require the removal of one or two of the wire sutures from the abdominal wall because of localized pain. This is generally performed as an office procedure, using local anesthesia. In six cases (0.3% of the series), because of the persistent complaint of incisional pain, which was not localized, general anesthesia was employed for the removal of all the wire sutures in the abdominal wall. One explanation for the pain is that after a period of 6–12 months, many of the steel wire sutures break, as revealed by X ray. It is remarkable that, as far as we know, none of these broken wires has given rise to any clinically evident intra-abdominal complication. One-third of the six patients continued to experience pain even after all the wires had been excised.

Although the incidence of serious complications accompanying this technique is minimal, nevertheless the complaint of pain is annoying to patient and surgeon alike. Consequently, other suture materials have been studied for use in abdominal closure. A brief trial of 0 Prolene using the same technique of closure revealed an excessive number of suture sinuses and incisional pain, probably because of the large number of knots required. Although we have not had any experience with it, there is also a technique that uses continuous No. 2 nylon in the abdominal wall, taking large bites of tissue, with the knots tied inside the abdominal cavity; Martyak and Curtis have reported it has produced no dehiscence in 280 operations.

While the nature of suture material may change in the future, it seems clear that a mass closure of the midline incision, paying special attention not to tie the stitches too tightly, can virtually eliminate the problem of wound disruption. The first edition of this book stated, "An absorbable suture . . . that can remain strong for 1 or 2 months instead of only 2 weeks would be the ideal stitch for abdominal closure." Polydiaxone suture (PDS) fulfills this requirement. For the past 6 years, we have used No. 1 size PDS for abdominal closures by the technique described below, with results equal to those of wire sutures, but avoiding the long-term wound pain problems encountered with wire.

Operative Technique for Midline Incision

Making the Incision

Hold a large gauze pad in the left hand and apply lateral traction on the skin, as the first assistant does the same on the opposite side of the incision. Use the scalpel with a firm sweep along the course of the incision (**Fig. 5–3**). The initial stroke should go well into the subcutaneous fat. Then reapply the gauze pads to provide lateral traction against the subcutaneous fat, and use the belly of the scalpel

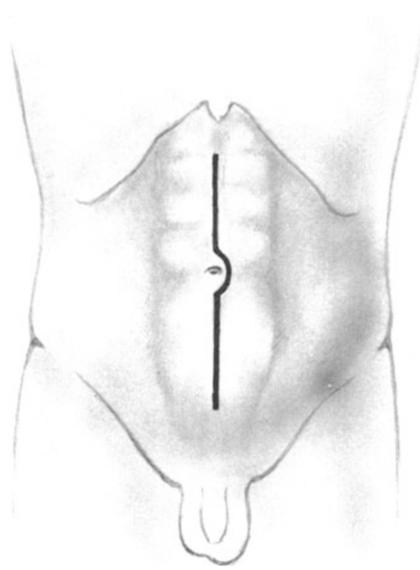


Fig. 5–3

blade to carry the incision down to the linea alba, making as few knife strokes as possible. The linea alba can be identified in the upper abdomen by observing the decussation of fascial fibers. Confirm this by palpating the tip of the xiphoid, which indicates the midline.

The custom of discarding the scalpel used for the skin incision, in the belief that it has thereby incurred bacterial contamination, is not supported by data, as Jacobs has shown, or by logic; it need not be observed.

Whether towels or an adherent sheet of plastic (Vi-Drape) are affixed to the skin in an effort to prevent contamination from the skin into the incision is up to the surgeon. There do not appear to be any data proving any advantage in covering the skin with either material.

Because the subcutaneous fat seems to be the body tissue most susceptible to infection, every effort should be made to minimize trauma to this layer. Use as few hemostats and ligatures as possible; most bleeding points will stop spontaneously in a few minutes. Electrocoagulation of subcutaneous bleeders should be performed with accuracy and minimal trauma.

Continuing lateral traction with gauze pads, divide the linea alba with the scalpel. If the incision is to be continued around and below the umbilicus, leave a 5–8 mm patch of linea alba attached to the umbilicus to permit purchase by a suture when the closure is being accomplished. Otherwise, a gap between sutures may appear at the umbilicus, leading to an incisional hernia.

The peritoneum should be opened to the left of the falciform ligament. When the peritoneum is opened close to its attachment to the undersurface of the left rectus muscle, virtually no blood vessels are encountered. Consequently, elevate the peritoneum between two forceps and incise it just above and to the left of the umbilicus. Using a Metzenbaum scissors, continue this incision in a cephalad direction until the upper pole of the incision is reached. If bleeding points are encountered here, electrocoagulate them.

So as not to cut the bladder, be certain when opening the peritoneum in the lower abdomen to identify the prevesical fat and bladder. As the peritoneum approaches the prevesical region, the preperitoneal fat cannot be separated from the peritoneum and becomes somewhat thickened and more vascular. If there is any question about the location of the upper margin of the bladder, note that the balloon of the indwelling Foley catheter can be milked in a cephalad direction. It is easy to identify the upper extremity of the bladder this way. It is not necessary to open the peritoneum into prevesical fat, as this does not improve exposure. However, opening the fascial layer down to and beyond the pyramidalis muscles to the pubis does indeed improve exposure for low-lying pelvic pathology.

Closure of Midline Incision

This closure is almost identical with that reported by Spencer et al. in 1963. As mentioned above, we have modified the Smead-Jones technique by increasing the width of the tissue bite, which is in accord with the clinical data compiled by Sanders et al. and Jenkins indicating that the large bite and the loose suture are essential in preventing dehiscence. It is not necessary, in the upper abdomen, to include the peritoneum or falciform ligament in the suture, and this layer is generally ignored. Below the umbilicus there is no distinct linea alba, and the rectus muscle belly is exposed. In this region include the peritoneum in the stitch.

Apply Allis clamps to the linea alba at the midpoint of the incision, one clamp on each side. Below the umbilicus the Allis clamps should include a bite of peritoneum as well as of anterior fascia. With the suture of No. 1 PDS, encompass 3 cm of tissue on each side of the linea alba; then take a small bite of the linea alba, about 5 mm in width, on each side. This results in a small loop within a large loop (**Fig. 5–4**). The purpose of the small loop is simply to orient the linea alba so that it will remain in apposition rather than one side moving on top of the other. Place the small loop 5–10 mm below the main body of the suture to help eliminate the gap between adjacent sutures. Insert the next suture no more than 2 cm below the first. Large curved Ferguson needles are used for this procedure.

Tie the sutures with 4 square throws. *Avoid excessive tension!* When half the incision has been closed, start at the other end and approach the midpoint with successive sutures (Fig. 5–4). Do not tie the last few stitches, thus leaving enough space to insert the remaining stitch under direct vision. In no case should the surgeon insert a stitch without at all times seeing the point of the needle. Then tie all the remaining sutures (**Fig. 5–5**).

Accomplish skin closure by interrupted 4–0 nylon vertical mattress sutures, a continuous subcuticular suture of 4–0 PG, or staples.

A description of the *McBurney* incision is included in Chap. 33; the *Pfannenstiel* incision will be found in Chap. 52; and the *subcostal* incision under "Cholecystectomy" in Chap. 60 of this work.

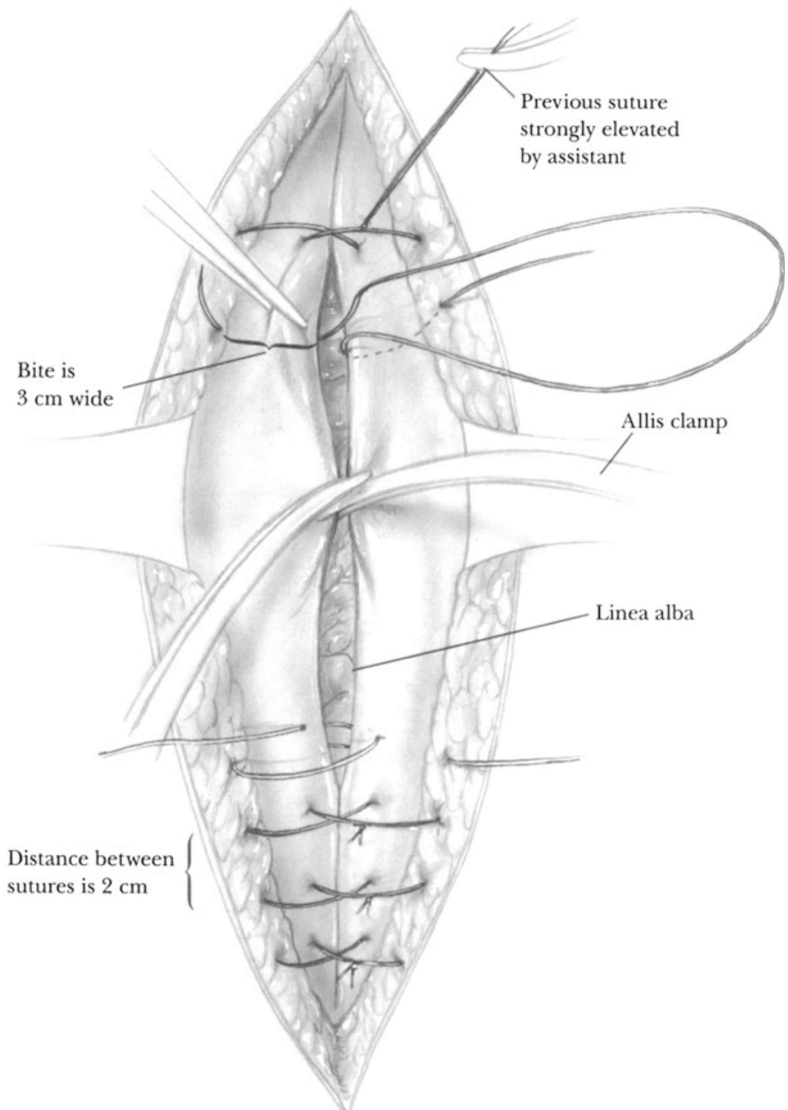

Previous suture
strongly elevated
by assistant
Bite is
3 cm wide
Allis clamp
Linea alba
Distance between
sutures is 2 cm

Fig. 5–4

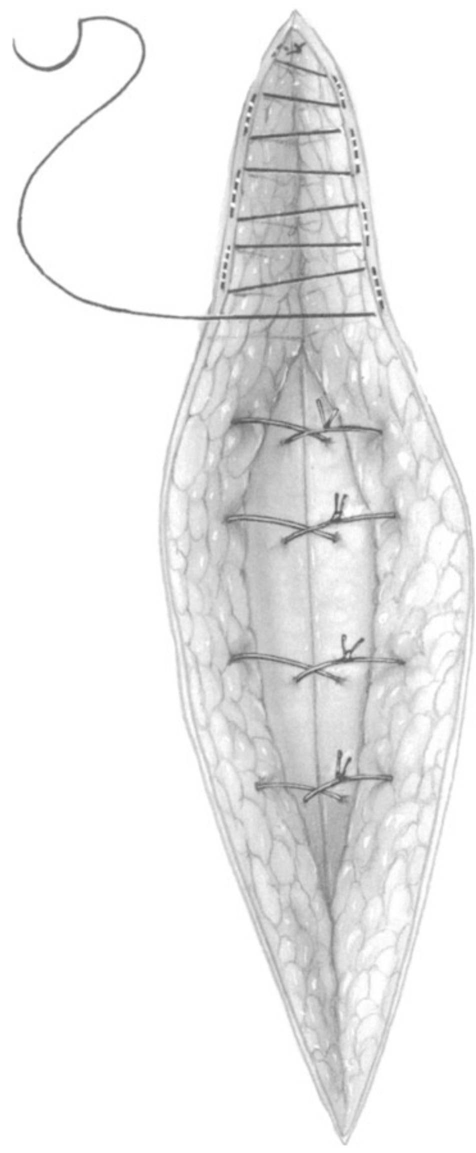


Fig. 5–5

References

Aldrete JS et al. Scientific exhibit at Clinical Congress Am Coll Surgeons. Dallas TX; 1977.

Efron G. Abdominal wound disruption. Lancet 1965; 1:1287.

Goligher JC et al. A controlled clinical trial of three methods of closure of laparotomy wounds. Br J Surg 1975;62:823.

Jacobs HB. Skin knife-deep knife: The ritual and practice of skin incisions. Ann Surg 1974;179:102.

Jenkins TPN. The burst abdominal wound—a mechanical approach. Br J Surg 1976;63:873.

Jones TE et al. The use of alloy steel wire in the closure of abdominal wounds. Surg Gynecol Obstet 1941; 72:1056.

Lally JJ. New exposure instrument for the upper abdomen. Int Surg 1967;47:396.

Lancet Editorial. Burst abdomen. Lancet 1977;1:28.

Malt RA. Abdominal incisions, sutures and sacrilege. N Engl J Med 1977;297:722.

Martyak SN, Curtis LE. Abdominal incision and closure. Am J Surg 1976;131:476.

Sanders RJ et al. Principles of abdominal wound closure—I. Animal studies. Arch Surg 1977;112:1184.

Spencer FC et al. Experiences with wire closure of abdominal incisions in 293 selected patients. Surg Gynecol Obstet 1963;117:235.

Tera H, Aberg C. Tissue strength of structures involved in musculo-aponeurotic layer sutures in laparotomy incisions. Acta Chir Scand 1976;142:349.

Esophagus

6 Operations to Resect, Replace, or Bypass the Esophagus for Cancer

Concept: Selection of Operation for Carcinoma near Esophagogastric Junction

A number of surgeons have asserted that resection of the lower esophagus and proximal stomach for lesions near the gastric cardia, followed by esophagogastric anastomosis, is an operation with a high mortality rate and a high incidence of reflux esophagitis. On the other hand, we have observed that very few patients experience serious symptoms of reflux esophagitis following esophagogastrectomy with an end-to-side anastomosis. No dietary restrictions have been necessary. In 44 consecutive cases, among patients whose average age was over 70, we encountered (and reported) no clinical anastomotic leaks and no deaths.

If a tumor occupies a large segment of the gastric fundus, requiring more than 50% of the stomach to be removed for an adequate cancer operation, then total gastrectomy is indicated because the gastric remnant will be too small to permit construction of a proper end-to-side esophagogastric anastomosis. The end-to-end anastomosis results in an excessive number of leaks *as well as reflux bile esophagitis*. Otherwise, esophagogastrectomy properly performed is a safe operation with good nutritional and symptomatic results.

For cancer of the distal 10 cm of the esophagus, we have found a *left* thoracoabdominal incision with esophagogastric resection and anastomosis to be successful. If the tumor extends more proximally than was anticipated, we simply mobilize the esophagus above the arch of the aorta and perform a supra-aortic anastomosis.

Concept: Selection of Operation for Lesions of Mid- and Upper Esophagus

Except for lesions of the lower 10 cm of the esophagus, the operation of choice for carcinoma of the esophagus is subtotal resection by right thoracotomy, combined with mobilization of the stomach through a midline laparotomy. This should be followed by end-to-side esophagogastric anastomosis at the apex of the right chest or in the neck. With adequate preoperative preparation, this operation too can be done safely and result in good postoperative digestive function. In some institutions a course of preoperative radiation and/or chemotherapy is given to these patients (Orringer et al.). Conclusive data to support this policy are not yet available.

Chasseray and associates performed a prospective randomized study comparing a laparotomy-right thoracotomy with laparotomy-right thoracotomy and cervicotomy for esophageal resection. There was a significantly greater leak rate when a cervical anastomosis was done (26%) compared with an anastomosis in the right chest (4%). Many of the leaking cervical anastomoses resulted in postoperative strictures that required dilatation. Removing a greater length of esophagus by virtue of a cervical anastomosis did not result in improved long-term survival as compared with an intrathoracic anastomosis.

Concept: Transthoracic or Transhiatal Approach When Resecting Esophageal Cancer?

Although the concept of using a left thoracotomy or a left thoracoabdominal incision for the resection of lower esophageal and esophagocardiac cancers has gained wide acceptance, some authors have reported excessive mortality and anastomotic leak rates in these operations. This has not been our experience. Also, a number of other authors have noted exceedingly low mortality and complication rates.

Akiyama in 1980 reported 106 resections of lower esophageal and esophagogastric carcinomas through left thoracoabdominal incisions with a hospital mortality rate of 0.9% and an anastomotic leak rate of 2.8%. None of these anastomotic leaks was of clinical significance. Ellis et al. reported 106 esophagectomies. Fifty-four were done through left thoracotomy incisions. A laparotomy and right thoracotomy approach was used for lesions of the upper half of the esophagus, and 10 patients with thoracoabdominal incisions were included. The total hospital mortality was 1.3%, and the intrathoracic anastomoses demonstrated a 2% leak rate. All anastomoses were done by suturing. Finally, Mathisen and associates reported on 104 esophageal resections for cancer. Of these, 64 were done through left thoracoabdominal incisions, while 40 underwent laparotomy-right thoracotomy. The hospital mortality rate was 2.9%, and there were no anastomotic leaks.

On the other hand, Orringer (1984) has recommended that all resectable esophageal carcinomas as well as esophagogastric lesions be resected without performing a thoracotomy, using a transhiatal approach combined with dissection through a cervical incision. While most of this operation can be done under direct vision, dissection in the area of the carina is performed blindly. Orringer reported on 100 transhiatal operations, of which 96 included a gastric pull-up and an esophagogastric anastomosis performed in the neck. Four patients required a colon interposition between the cervical esophagus and the stomach. There was a 6% hospital mortality rate as well as a 5% leak rate from the cervical anastomosis. The average blood loss was 880 ml. Avoiding a thoracotomy may make this operation more suitable for patients with chronic obstructive pulmonary disease. Since there has been no randomized prospective study comparing the transhiatal with the transthoracic approach for esophageal carcinoma, there is no clear-cut answer as to which approach is superior.

One cannot be dogmatic in selecting one of these procedures over the other. Each operative procedure requires a knowledge of the anatomy, meticulous and delicate surgical technique, as well as devoted postoperative care to achieve the excellent results reported by Akiyama, Ellis, Mathisen, or Orringer.

Concept: Selection of Operation for Nonresectable Esophageal Carcinoma

Although it is possible to interpose a segment of isoperistaltic left colon between the cervical esophagus or pharynx and the stomach, when this operation is performed for palliation of esophageal carcinoma, the mortality rate is very high and the length of survival is limited. With the development of endoscopic laser technology, opening the obstructed esophageal channel with a laser device seems to be effective and much safer than a surgical bypass in these patients.

References

Akiyama H. Surgery for carcinoma of the esophagus. Curr Probl Surg 1980;17:56–120.

Belsey R. Reconstruction of the esophagus with left colon. J Thorac Cardiovasc Surg 1965;49:33.

Chasseray VM, Kiroff GK, Buard JJL et al. Cervical or thoracic anastomosis for esophagectomy for carcinoma. Clin Chirurgicale 1989;169:55.

Chassin JL. Esophagogastrectomy: data favoring end-to-side anastomosis. Ann Surg 1978;188:22.

Ellis FH Jr, Gibb SP, Watkins EW Jr. Esophagogastrectomy. Ann Surg 1983;198:531–540.

Mathisen DJ, Grillo HC, Wilkins EW Jr, Moncure AC et al. Transthoracic esophagectomy: a safe approach to carcinoma of the esophagus. Ann Thorac Surg 1988; 45:137–143.

Orringer MB. Transhiatal esophagectomy without thoracotomy for carcinoma of the thoracic esophagus. Ann Surg 1984;200:282–288.

Orringer MB, Forastiere AA, Perez-Tamayo C, Urba S et al. Chemotherapy and radiation therapy before transhiatal esophagectomy for esophageal carcinoma. Ann Thorac Surg 1990;49:348–354.

7 Esophagectomy: Right Thoracotomy and Laparotomy

Indications

Esophagectomy via right thoracotomy is indicated in carcinoma of the esophagus, except for tumors of the distal 10 cm.

Preoperative Preparation

Institute nutritional rehabilitation, either by parenteral alimentation or by nasogastric tube feeding, in patients who have lost more than 10 lbs.

Perform preoperative esophagoscopy and biopsy.

Improve oral and dental hygiene, if necessary.

Stop patient from smoking.

Conduct a pulmonary function study.

Preoperative chemotherapy and radiation therapy is an unsettled issue. Until more data are accumulated, no definitive statement can be made.

Preoperative bronchoscopy is indicated in those patients whose lesion may have invaded the left main bronchus or trachea.

A nasogastric tube should be passed prior to operation.

Perioperative antibiotics should be administered.

Pitfalls and Danger Points

Hemorrhage from aorta

Perforation of trachea or bronchus

Anastomotic leak

Anastomotic stenosis

Inadvertent interruption of gastroepiploic arcade on greater curvature of stomach

Operative Strategy

When a tumor of the esophagus is densely adherent to the aortic arch, extreme caution is indicated. If the aorta is inadvertently perforated while the tumor is being removed from the arch, it will be extremely difficult to salvage the patient. If the surrounding aortic wall is indurated by fibrosis or tumor, this will make control of hemorrhage virtually impossible. Furthermore, it is doubtful that heroic measures for the resection of such invasive tumors will prove any more beneficial to the patient than would a palliative operation. The same is probably true of tumors that invade the right main bronchus. Long-term survival following the resection of a carcinoma of the middle esophagus is generally limited to those patients whose lesion is confined to the esophagus and shows no evidence of extrinsic invasion.

In favorable cases of this type, both Logan and Skinner have performed radical operations, including excision of the right and left mediastinal pleura, extensive mediastinal lymph node dissection, and thoracic duct dissection. Logan's mortality rate for these operations was over 20%, but modern postoperative care can lower this rate. Up to now the survival data are inadequate to prove that this procedure is effective.

Anastomotic leakage and postoperative stenosis have been minimized by the adoption of several techniques. Obviously it is important to maintain the blood supply to the stomach. This requires meticulous attention to the gastroepiploic arcade. *The esophageal hiatus must be enlarged sufficiently to prevent any element of venous compression, as deficiency of the venous circulation is as detrimental as arterial ischemia.* Also, as Chassin has pointed out, the use of an end-to-side esophagogastric anastomosis has markedly reduced the incidence of anastomotic leaks (see Chap. 8).

Since the submucosal spread of esophageal carcinoma has been observed by microscopy to extend a considerable distance cephalad from the visible carcinoma, a 10 cm margin of apparently normal esophagus should be removed with the specimen. The upper limit of the specimen should be checked by frozen section examination.

Operative Technique

Incision and Position

Use a small sandbag to elevate the patient's right side 30°, with the right arm abducted and suspended from the "ether screen" cephalad to the surgical field. Turn the patient's head to the left in case

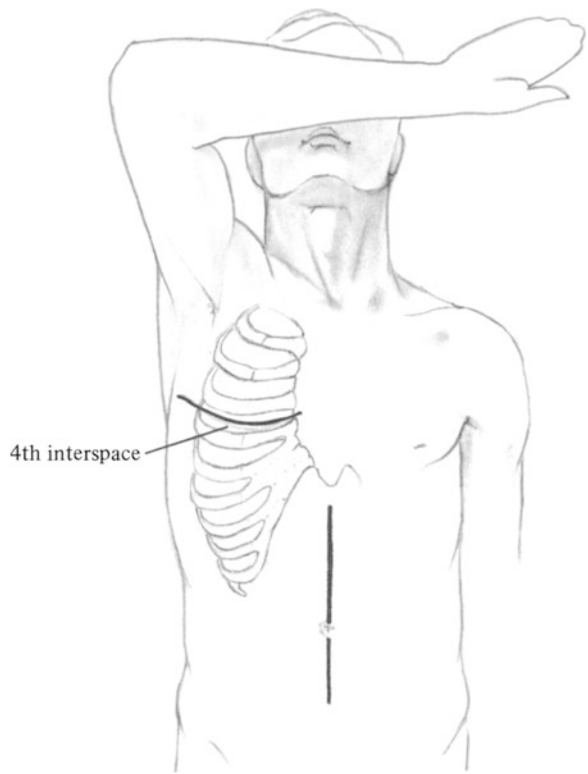


Fig. 7–1

the right cervical region has to be exposed for the upper anastomosis. Prepare the right neck, the right hemithorax, and the abdomen. Rotate the operating table slightly so that the abdomen is parallel with the floor. After the induction of one-lung endotracheal anesthesia, perform a midline upper abdominal incision for a preliminary exploration of the liver and lower esophagus to help determine whether an attempt should be made at resection. A moderate degree of hepatic metastasis does not contraindicate a palliative esophagectomy. Then make an incision along the course of the fourth intercostal space from the sternum to the posterior axillary line in men (**Fig. 7–1**). In women, make the skin incision in the inframammary fold. Incise the pectoral and anterior serratus muscles with the electrocoagulator along the fourth interspace (**Figs. 7–2 and 7–3**). Similarly incise the intercostal muscles along the upper border of the fifth rib. Identify the internal mammary artery near the sternal margin where it is divided and occluded by ligature. Enter the pleura of the fourth intercostal space, and then divide the cartilaginous portion of the fourth rib near its articulation with the sternum (**Fig. 7–4**). Clamp the

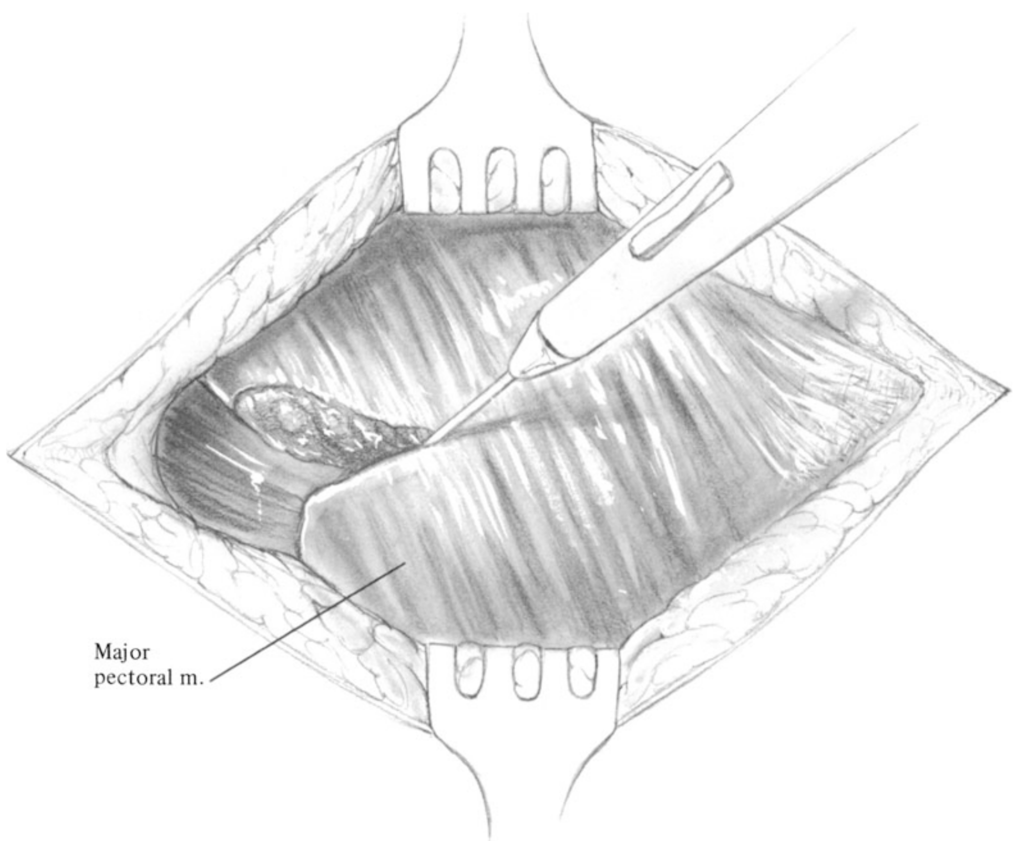


Fig. 7–2

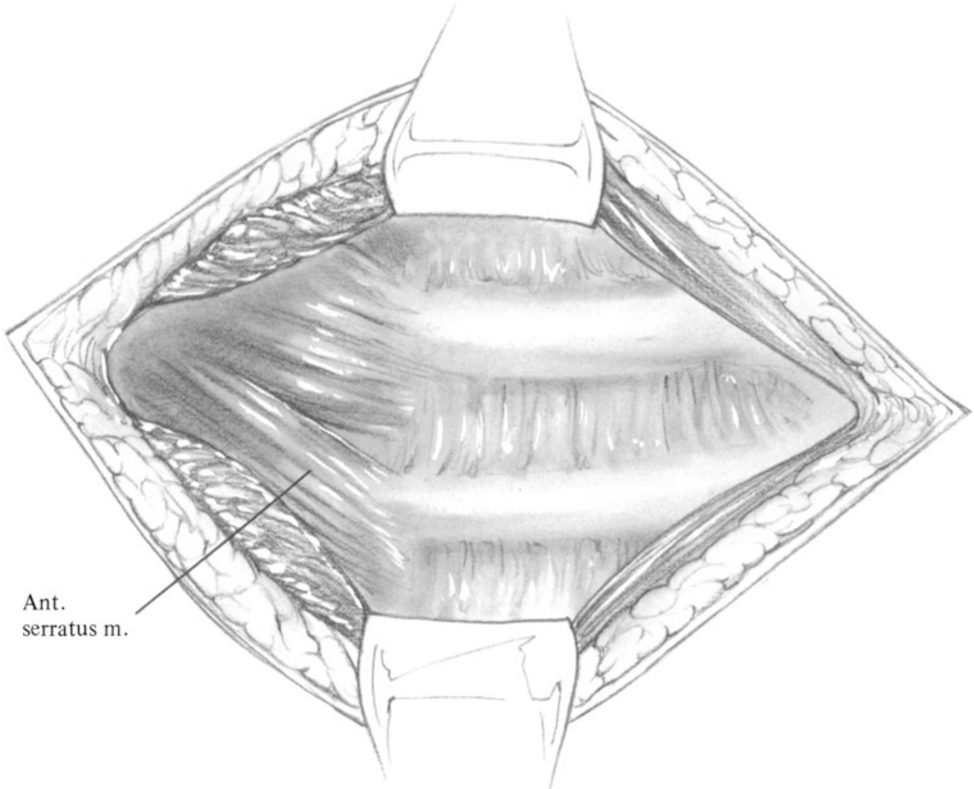


Fig. 7–3

Fig. 7–4

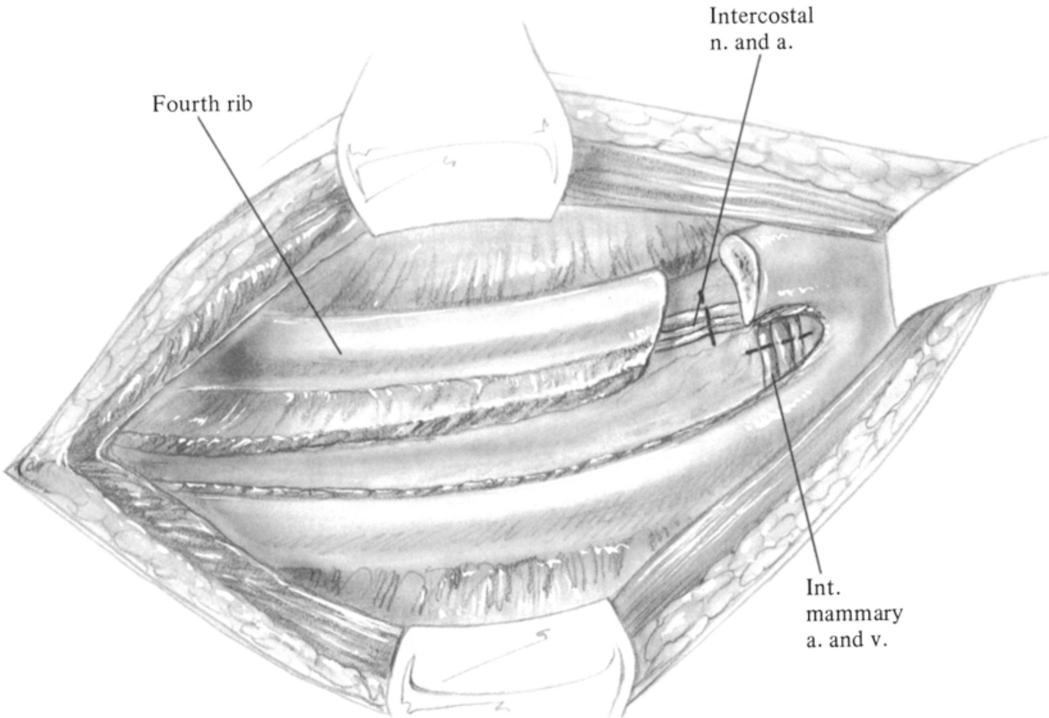

Intercostal
n. and a.
Fourth rib
Int.
mammary
a. and v.

Fig. 7–5

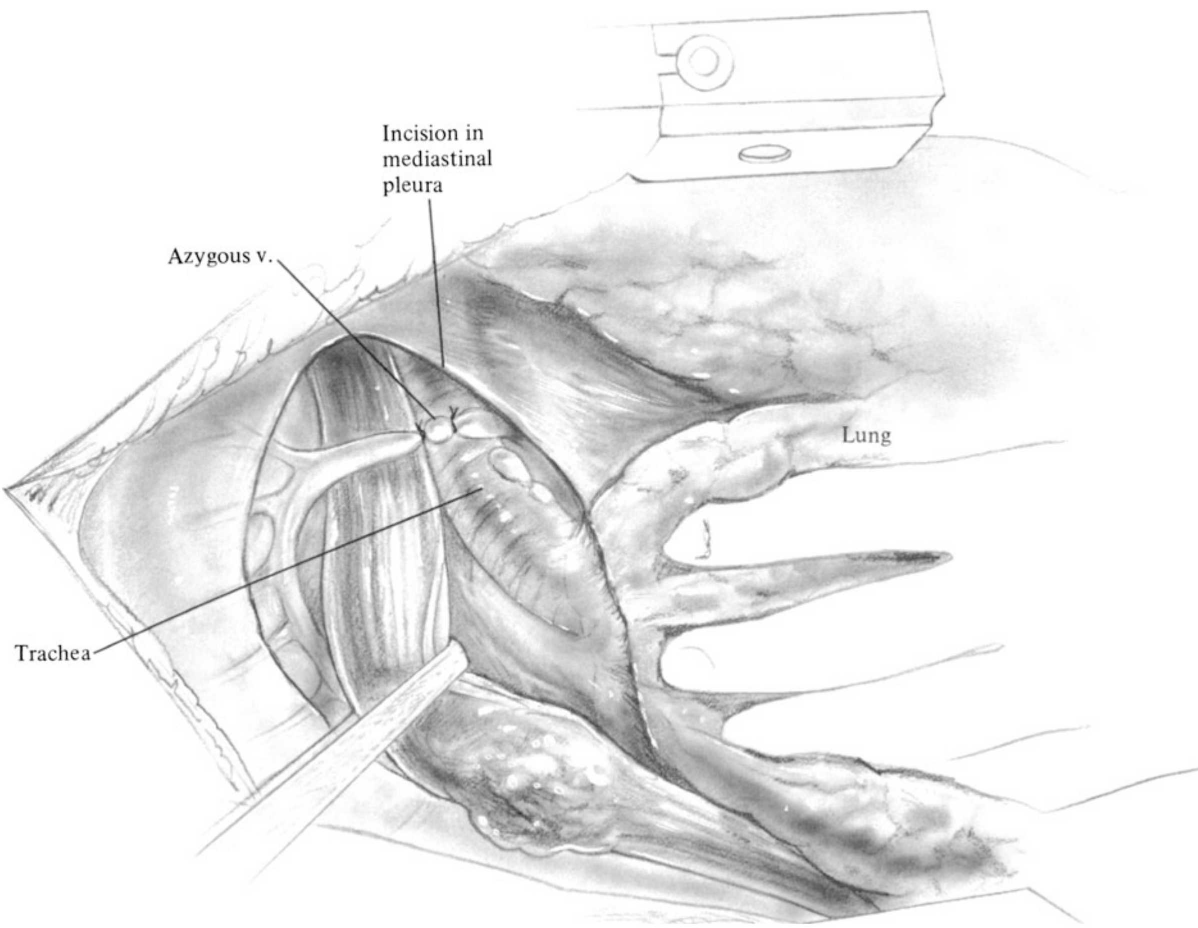

Incision in
mediastinal
pleura
Azygous v.
Lung
Trachea

Fig. 7–6

neurovascular bundle, divide it, and ligate with 2–0 silk (**Fig. 7–5**).

Insert a Finochietto retractor over gauze pads and separate the ribs. If an additional costal cartilage requires division for adequate exposure, do not hesitate to perform this maneuver. Retract the lung anteriorly, cover it with gauze pads, and hold it with Harrington retractors.

To perform this procedure, some surgeons prefer to make a complete posterolateral incision from the region of the paraspinal muscles to the sternum through the fourth or fifth interspace, but we have found the above exposure to be satisfactory. Also, using the anterior incision permits placing the patient in a position that is convenient for operating in the abdomen, in the thorax, and even in the neck, as necessary.

Mobilization of Esophagus

Make an incision in the mediastinal pleura, exposing the esophagus. The azygous vein should then be identified, skeletonized, divided, and ligated with 2–0 silk (**Fig. 7–6**). Encircle the esophagus with the index finger at a point away from the tumor. Dissection will reveal several small arterial branches to the esophagus. Divide each branch between Hemoclips. Wherever the pericardium or pleura is adherent to the tumor, excise patches of these structures and leave them attached to the specimen. Also include adjacent mediastinal lymph nodes in the specimen. Dissect the esophagus from the apex of the chest to the diaphragmatic hiatus. This will require the division of the proximal vagal trunks. In order to minimize the spillage of tumor cells, ligate the lumen of the esophagus proximal and distal to the tumor, utilizing narrow umbilical tapes or TA-55 surgical staples.

Remove the Harrington retractors and gauze pads permitting the right lung to expand. Cover the thoracic incision with a sterile towel.

Mobilization of Stomach

Expose the abdominal incision. Use a Thompson retractor to elevate the sternum. Elevate the left lobe of the liver in a cephalad direction with the Weinberg blade of the Thompson retractor and incise the peritoneum overlying the abdominal esophagus. Mobilize the lower esophagus as in performing a vagotomy and transect the vagal trunks and the surrounding phrenoesophageal ligaments (**Figs. 7–7, 7–8, and 7–9**). The cephalad portion of the gastrohepatic ligament, generally containing an accessory left hepatic artery, should be doubly clamped, divided, and ligated with 2–0 silk or

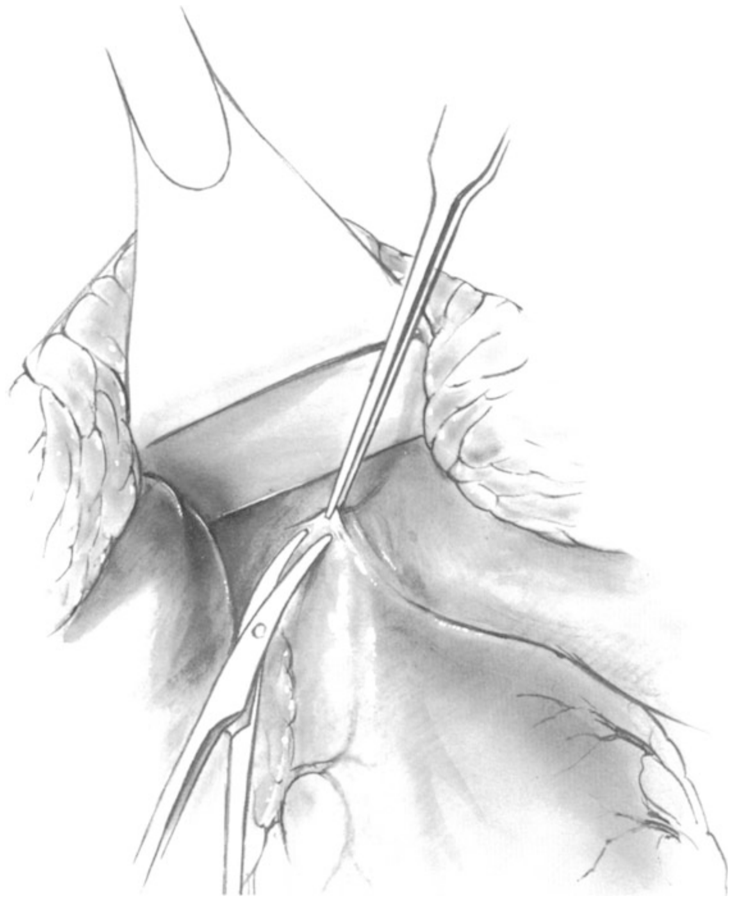


Fig. 7–7

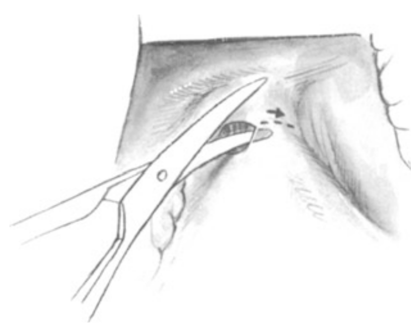


Fig. 7–8

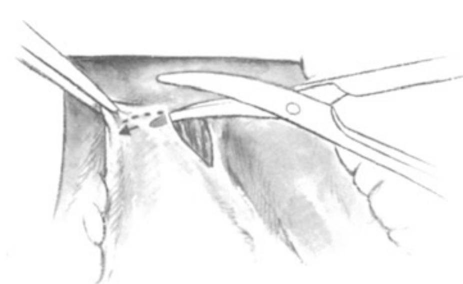


Fig. 7–9

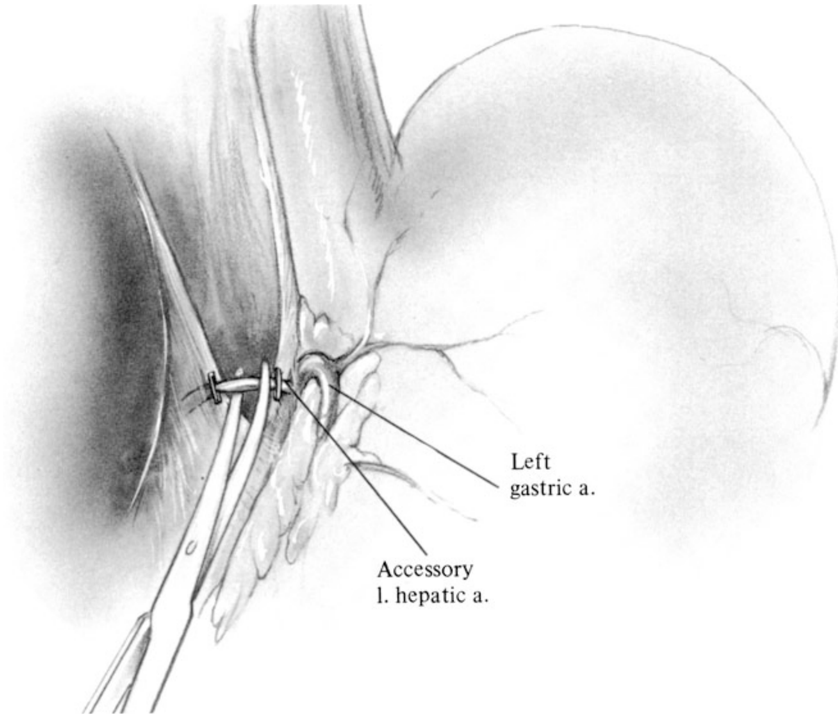


Fig. 7–10

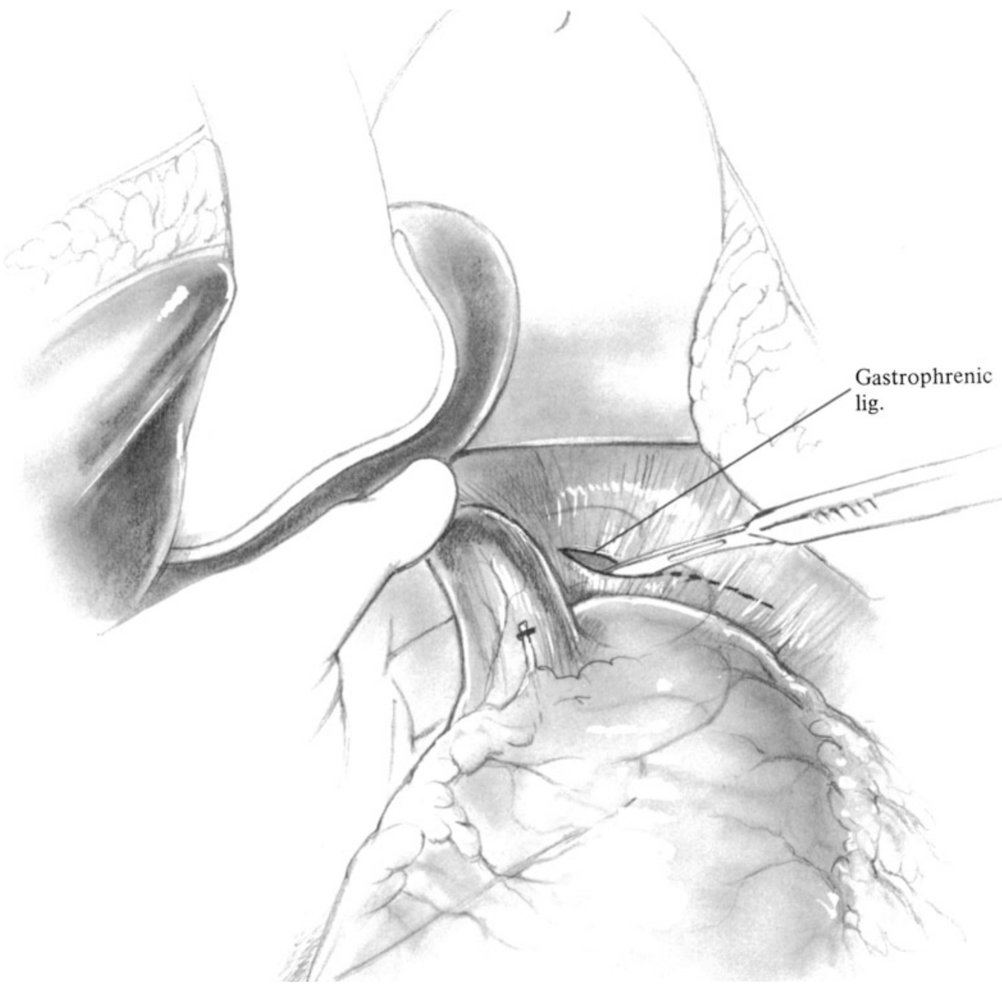


Fig. 7–11

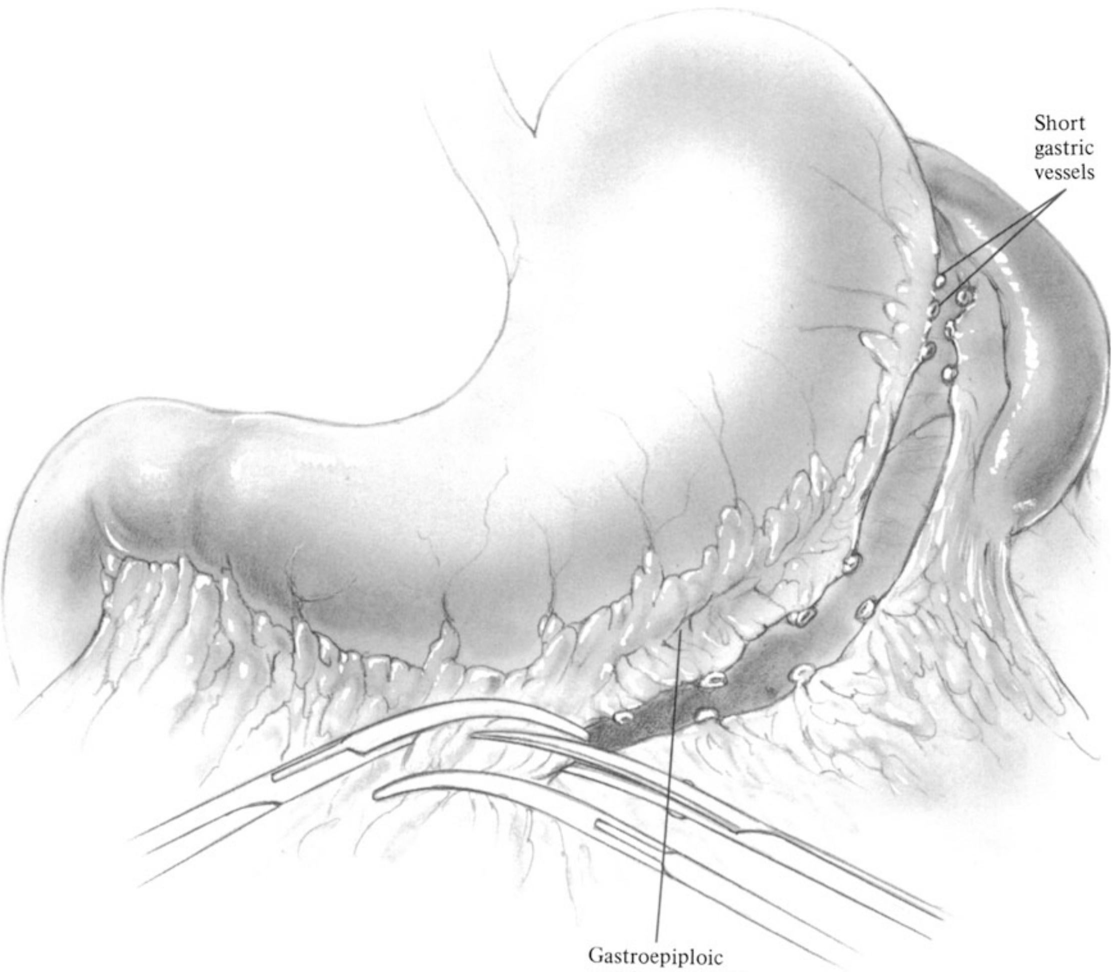


Fig. 7–12a

Hemoclips (**Fig. 7–10**). Insert the left hand behind the esophagus and cardia of the stomach, elevate the gastrophrenic ligaments on the index finger and transect them (**Fig. 7–11**). This dissection will lead to the cephalad short gastric vessel; divide it between clamps and ligate it, along with the remaining short gastrics. The spleen need not be removed.

Divide and ligate the *left* gastroepiploic artery, but do the remainder of the dissection *outside* the gastroepiploic arcade, *which must be kept intact and free of trauma*. This is accomplished by dividing the greater omentum serially between Kelly clamps, leaving 3–5 cm of omentum attached to the arcade as a margin of safety. Discontinue this dissection 6–8 cm proximal to the pylorus (**Figs. 7–12a and 7–12b**).

Fig. 7–12b

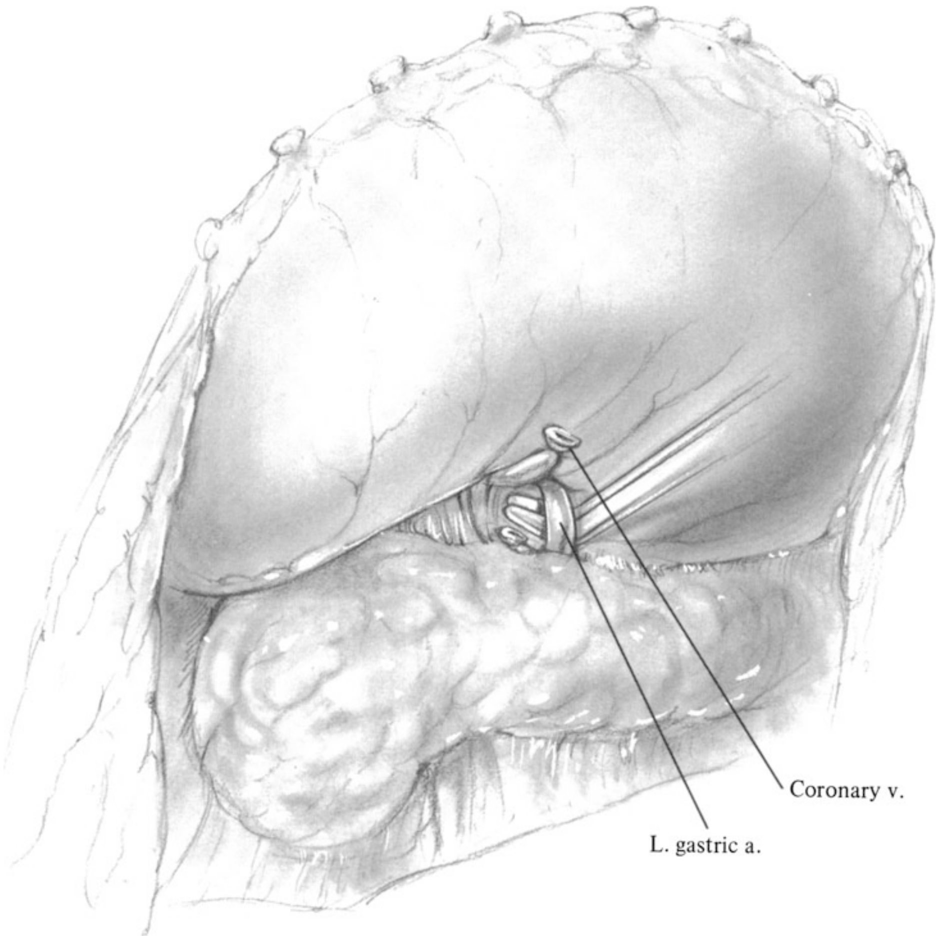


Fig. 7–13

With the greater curvature of the stomach elevated, use palpation to identify the origin of the left gastric artery at the celiac axis. The coronary vein is situated just caudal to the artery. Clear it and encircle it with a Mixter clamp and then divide it between 2–0 silk ligatures. Skeletonize the left gastric artery (**Fig. 7–13**) so that two 2–0 ligatures may be placed on the proximal portion of the artery and one on the specimen side. Transect the vessel. Follow this with an extensive Kocher maneuver.

Kocher Maneuver

Make an incision in the peritoneum lateral to the proximal duodenum (**Fig. 7–14**). Insert the left index finger behind the peritoneum and compress this tissue between fingertip and thumb, causing the retroperitoneal blood vessels and fat to fall away. Incise the peritoneum on the index finger with a scissors until the third portion of the duodenum is reached. Note that dividing the peritoneum alone is not sufficient to release the duodenum from its posterior attachments. There remains a ligamentous structure connecting the posterior duodenum to the region of Gerota's fascia.

Fig. 7–14

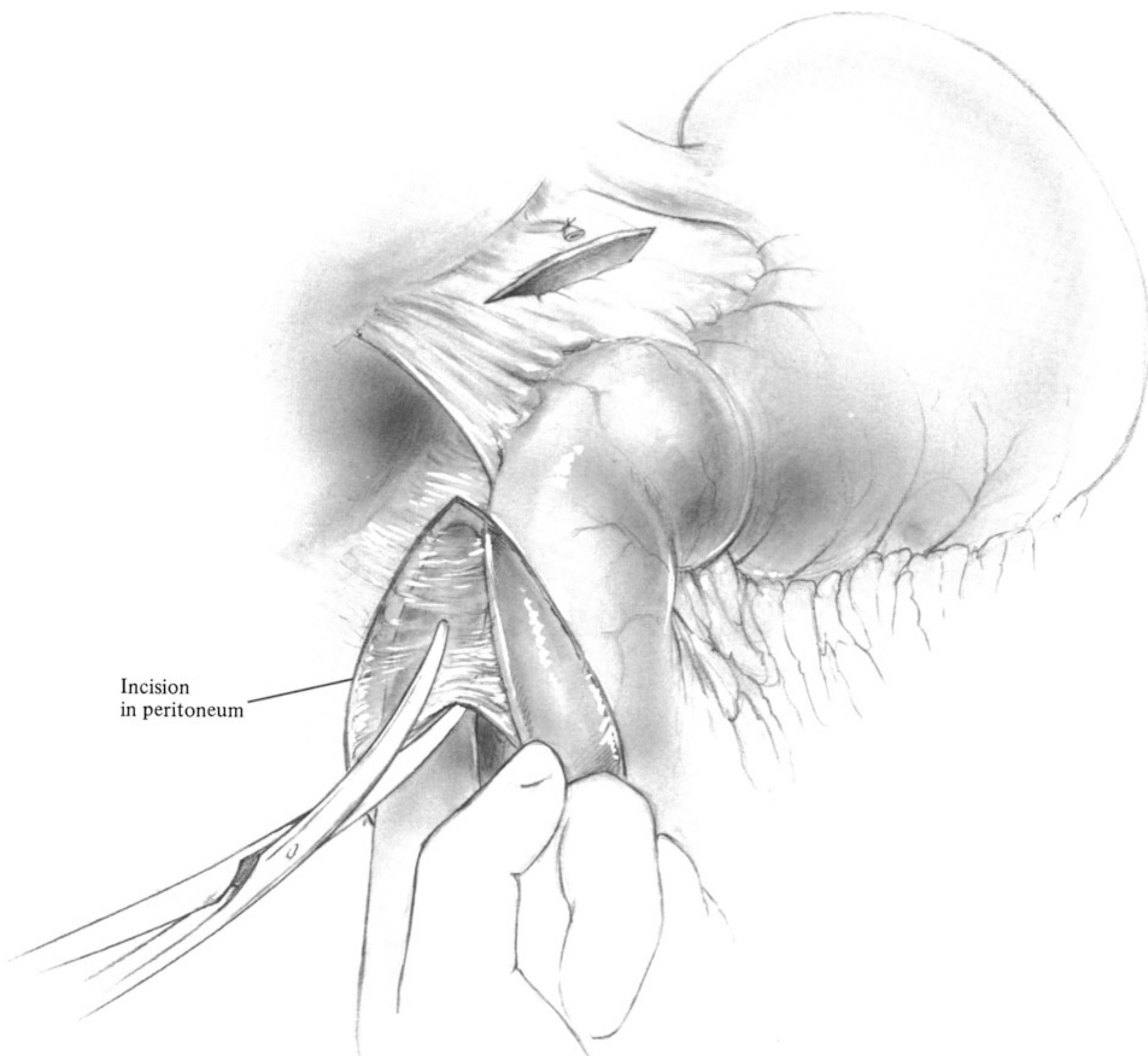


Fig. 7–15

This ligamentous structure is easily delineated by inserting the left index finger behind the pancreas. Move the finger laterally, exposing a lateral duodenal "ligament" behind the descending duodenum. Again, pinch the tissue between fingertip and thumb, which will leave vascular and fatty tissue behind, allowing this ligamentous structure to be divided. Incise it with a Metzenbaum scissors (**Fig. 7–15**). Repeat this maneuver, going around the second and third portions of duodenum (behind the hepatic flexure); this will lead to the point at which the superior mesenteric vein crosses over the duodenum. Be careful: excessive traction with the index finger may tear this vessel.

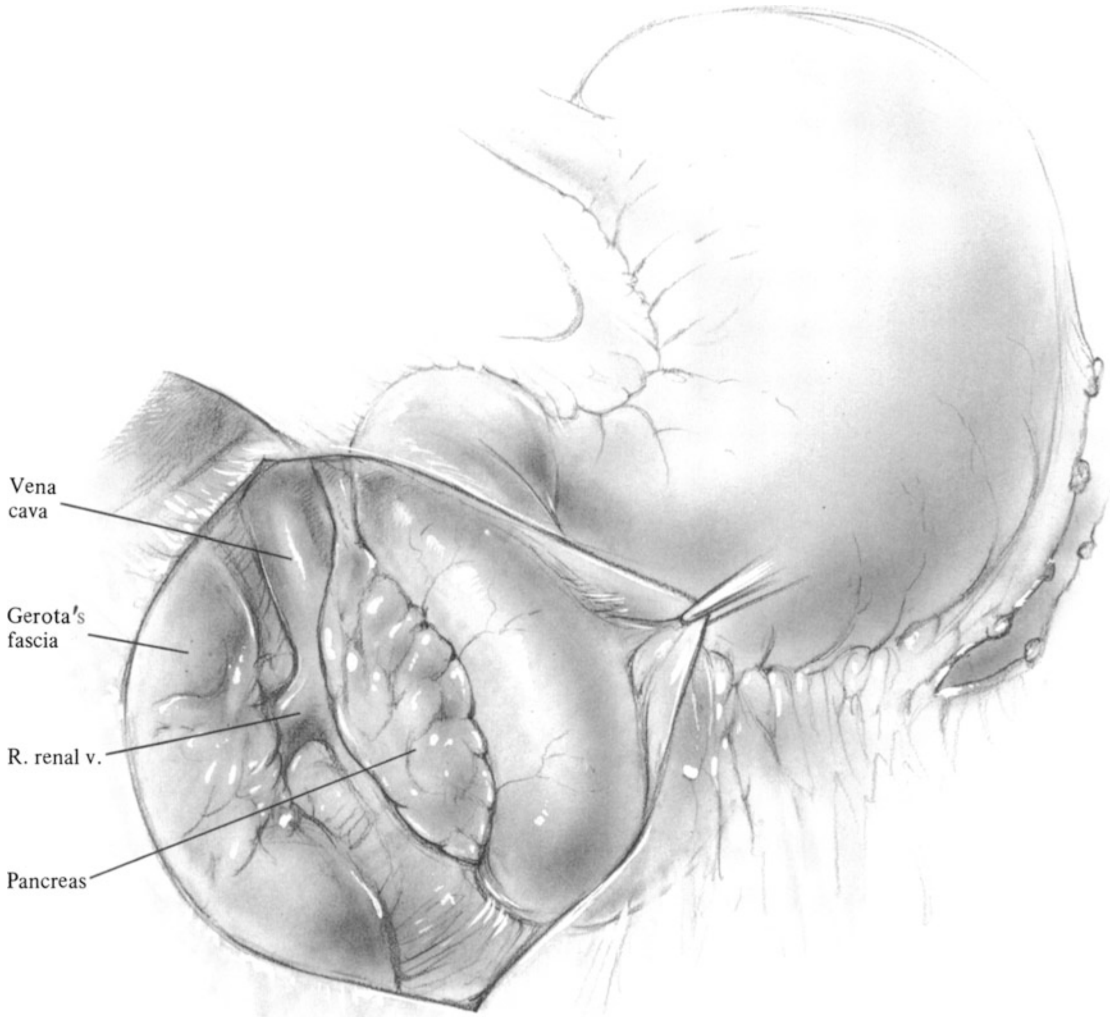


Fig. 7–16

For esophagogastric resection the Kocher maneuver need not be continued much beyond the junction of the second and third portions of the duodenum. At this point the left hand is easily passed behind the head of the pancreas, which should be elevated from the renal capsule, vena cava, and aorta (**Fig. 7–16**). This will permit the pyloroduodenal segment to be placed high in the abdomen, 8–10 cm from the esophageal hiatus, which in turn will permit the gastric fundus to reach the thoracic apex, or neck, without tension.

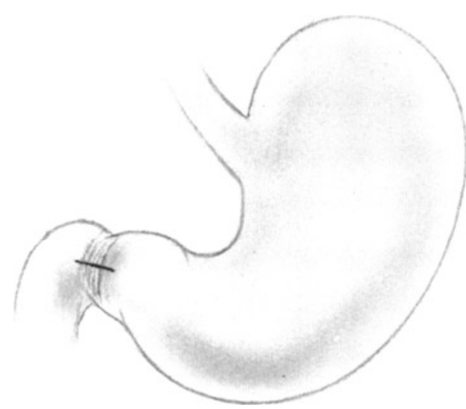


Fig. 7–17

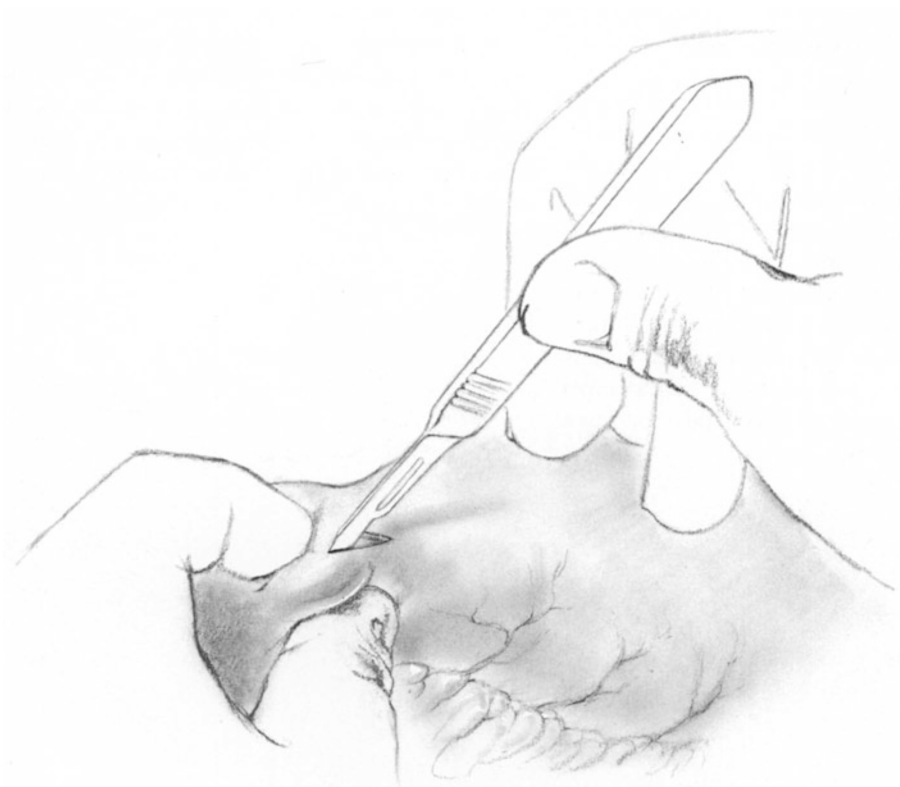


Fig. 7–18

Pyloromyotomy

Although in 80% of patients satisfactory results may be obtained without it, pyloromyotomy is generally performed at this point in order to prevent secondary operations for excessive gastric stasis due to vagotomy. Pyloromyotomy is accomplished by making a 1.5–2.0 cm incision across the anterior surface of the pyloric sphincter muscle (**Figs. 7–17, 7–18, 7–19**). It is difficult to do this in an adult who has normal muscle, but much easier in an infant who suffers hypertrophic pyloric stenosis. Frequently, sharp dissection with a No. 15 scalpel blade must be done through most of the circular muscle. Make a blunt separation of the muscle fibers with a hemostat until the mucosa bulges out. This procedure may be expedited by invaginating the anterior gastric wall into the pyloric sphincter with the index finger to divulse the few remaining circular muscle fibers. Exercise care not to perforate the mucosa; this is prone to occur at the duodenal end of the incision.

Fig. 7–19

Advancement of Stomach into Right Chest

Divide the right crux of the diaphragm transversely, using electrocautery (**Fig. 7–20**), and further dilate the esophageal hiatus manually. Advance the stomach into the right hemithorax, which should again be exposed by expanding the Finochietto retractor. There must be *no constriction of the veins* in the vascular pedicle of the stomach at the hiatus. Suture the wall of the stomach to the margins of the hiatus by means of interrupted 3–0 silk or Tevdek sutures spaced 2 cm apart in order to avoid postoperative herniation of bowel into the chest.

With the right lung collapsed, expose the esophagogastric junction in the right chest. When the esophageal carcinoma is located in the middle or upper esophagus, it is not necessary to remove the lesser curvature of the stomach and the celiac lymph nodes.

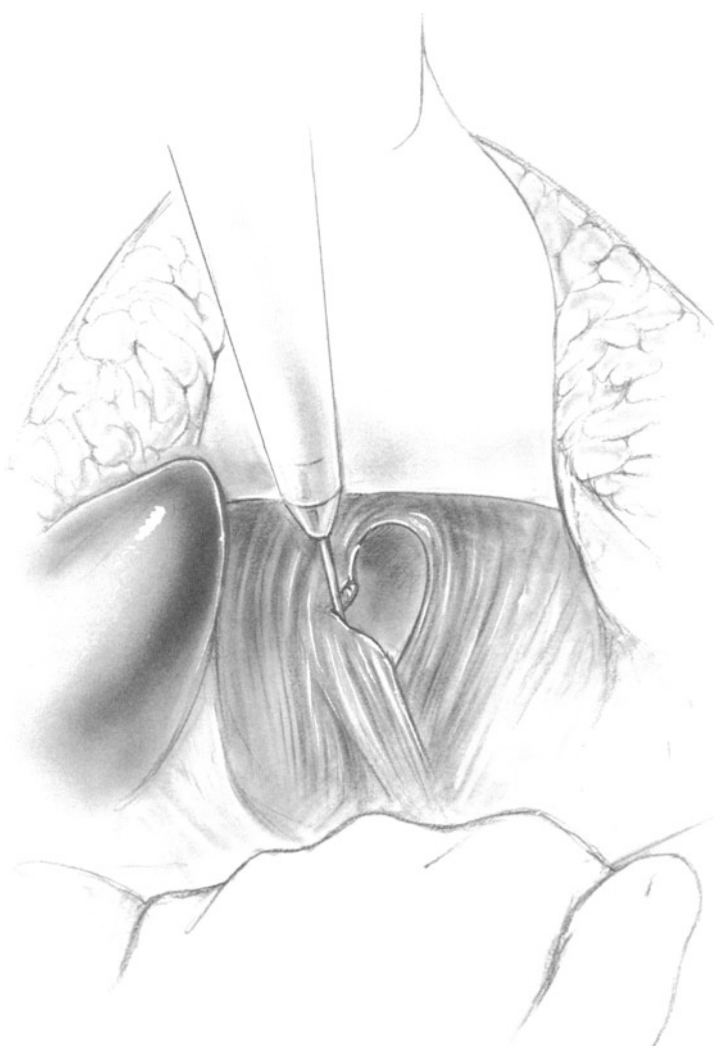


Fig. 7–20

After clearing the areolar tissue and the fat pad from the region of the esophagocardiac junction, apply a TA–55 stapler (4.8 mm staples) to the gastric side of this junction and fire the staples. Apply an Allen clamp to the esophagus, which should be transected flush with the TA–55 stapler. Place a rubber glove over the divided esophagus and fix it in place with a narrow tape ligature. Lightly electrocoagulate the everted gastric mucosa and remove the stapling device (**Fig. 7–21**). It is not necessary to invert this stapled closure with a layer of sutures; the fundus of the stomach reaches the apex of the thorax without tension. Take care to avoid twisting the stomach and its vascular pedicle.

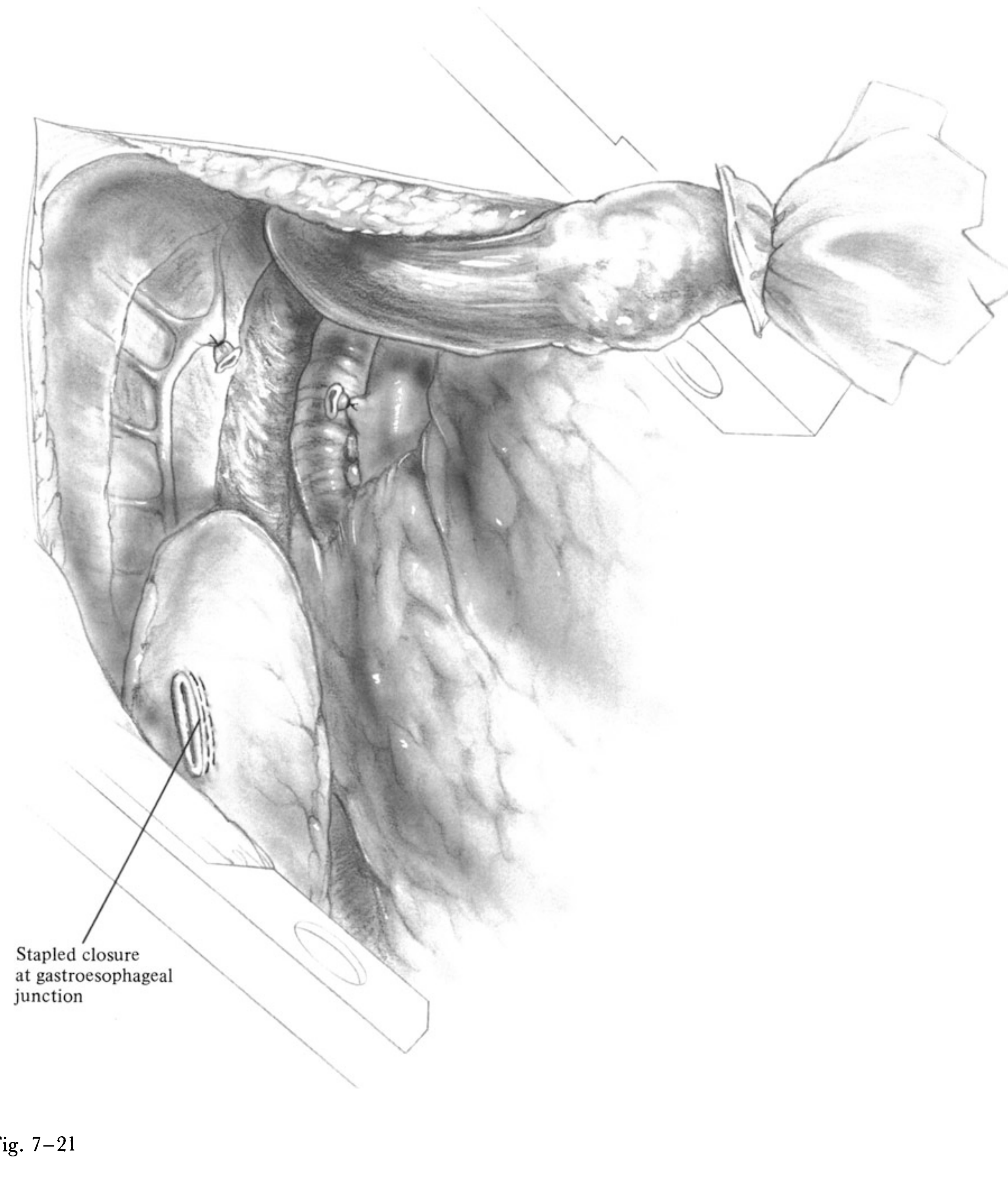


Fig. 7–21

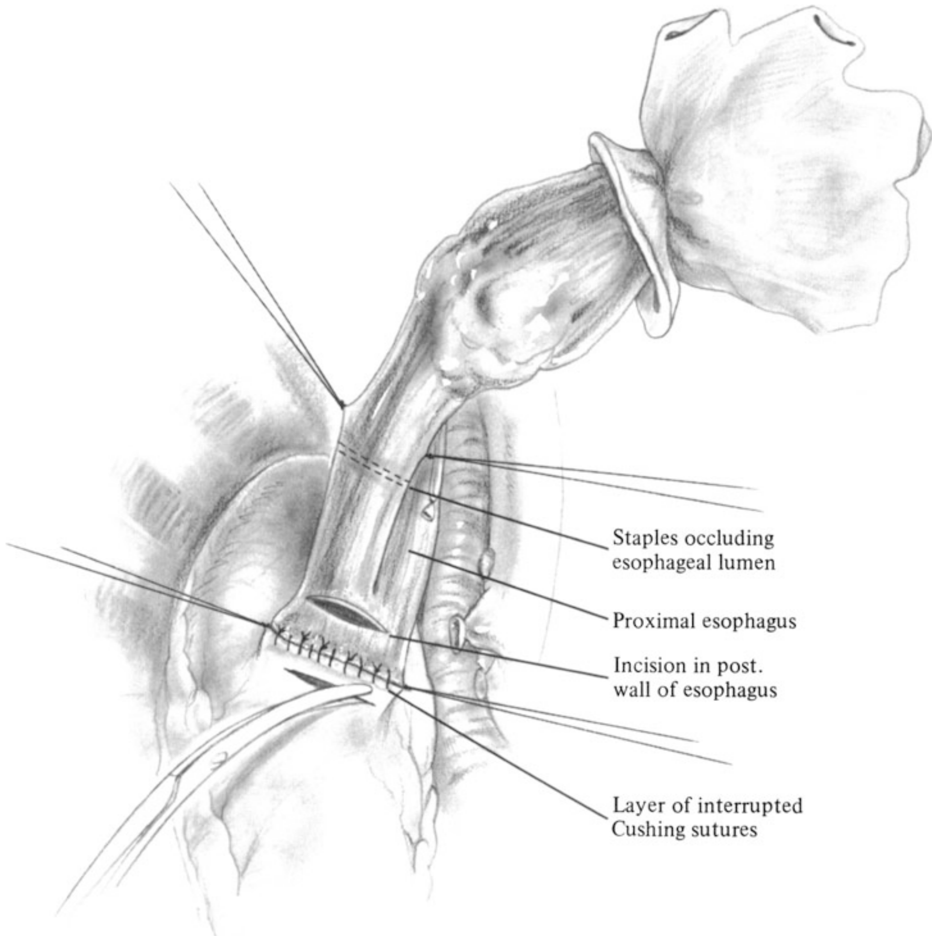


Fig. 7–22

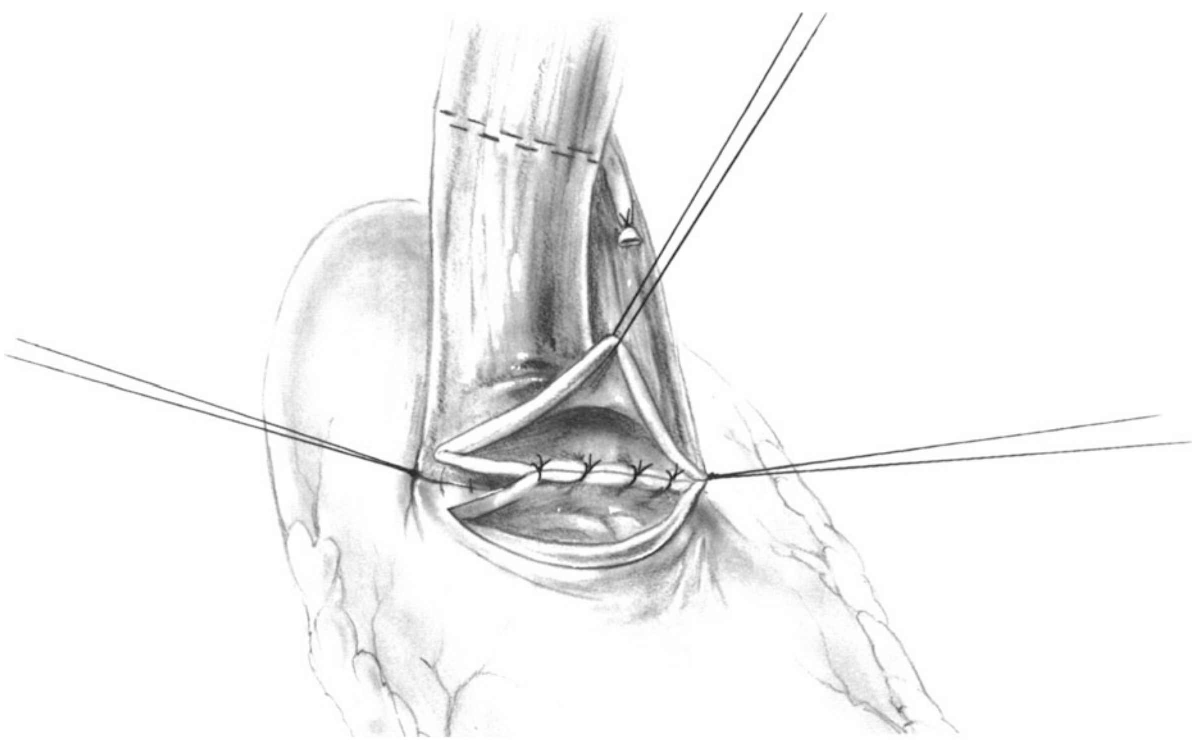


Fig. 7–23

Esophagogastric Anastomosis

Select a point on the proximal esophagus 10 cm above the tumor for the anastomosis. Before removing the specimen, insert the posterior layer of sutures to attach the posterior esophagus to the anterior seromuscular layer of the stomach at a point 6–7 cm from the cephalad end of the fundus (**Fig. 7–22**). The posterior layer should consist of about five interrupted atraumatic 4–0 silk Cushing sutures. Each bite should be 5 mm in width and deep enough to catch submucosa. Using the Stratte needle-holder (see Glossary) often makes suturing the esophagus easier.

Transect the posterior wall of the esophagus with a scalpel at a point 6 mm beyond the first line of sutures. One can be certain that the esophageal mucosa has been transected when the nasogastric tube appears in the esophageal lumen. Now make a transverse incision in the stomach and control the bleeding points. This incision should be slightly longer than the diameter of the esophagus (Fig. 7–22).

Approximate the posterior mucosal layer by means of interrupted or continuous 5–0 atraumatic PG sutures, with the knots tied inside the lumen (**Fig. 7–23**). Then pass the nasogastric tube from the proximal esophagus through the anastomosis into the stomach.

In accordance with the suggestion of Fisher et al., detach the specimen by dividing the anterior wall of the esophagus with a scissors in such fashion as to leave the anterior wall of the esophagus 1 cm longer than the posterior (**Fig. 7–24**). This maneuver will enlarge the stoma if the incision in the stomach is large enough to match that of the elliptical esophageal lumen.

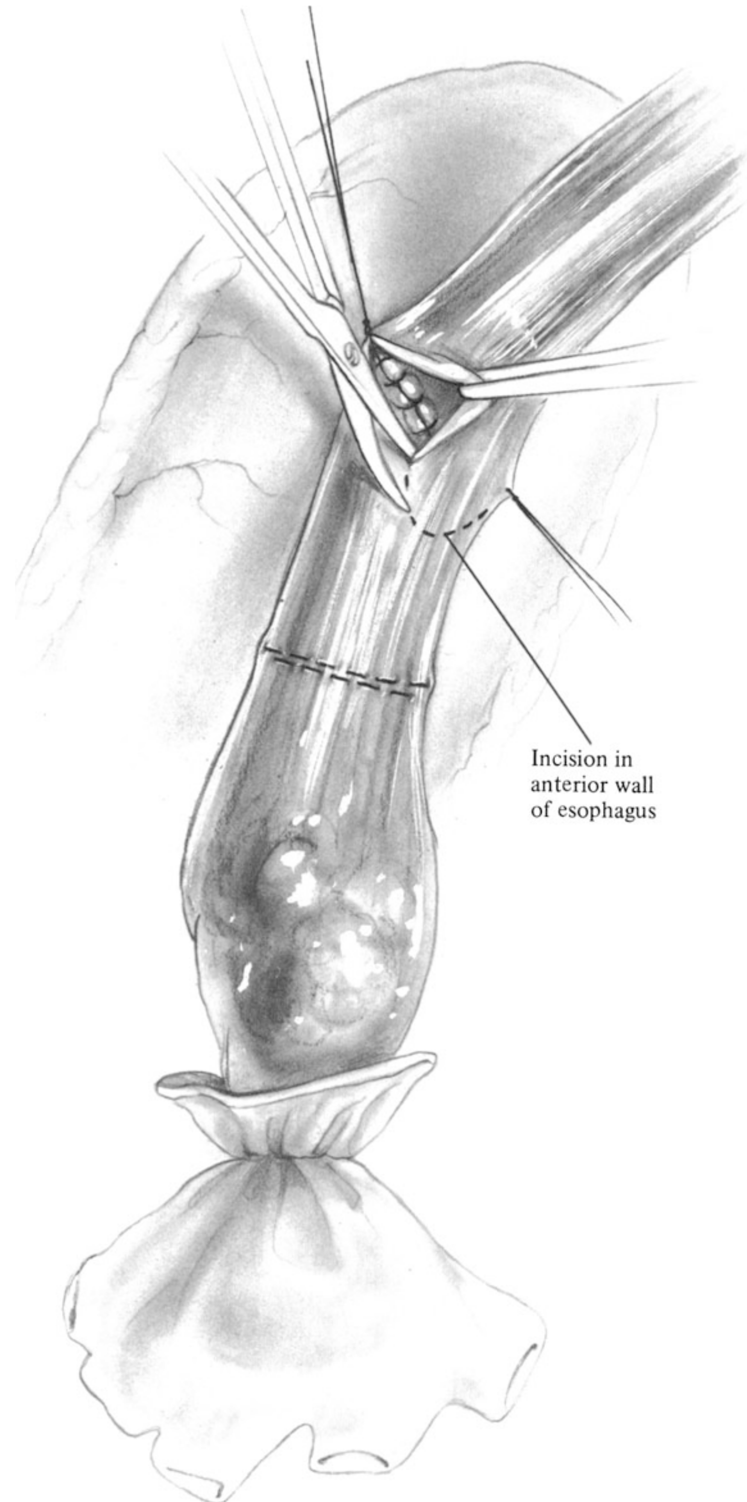


Fig. 7–24

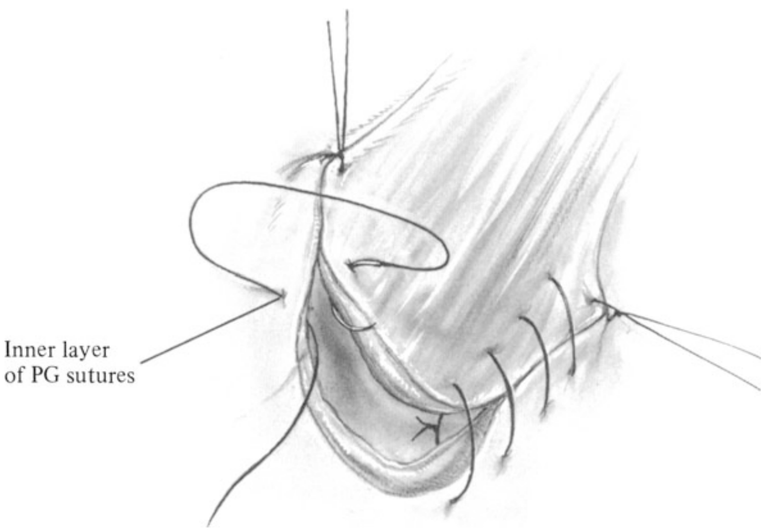


Fig. 7–25

Execute the anterior mucosal layer by means of interrupted sutures of 5–0 PG, with the knots tied inside the lumen, thus inverting the mucosa (**Fig. 7–25**). Accomplish the second anterior layer by means of interrupted Cushing sutures of 4–0 silk (**Fig. 7–26**). The sutures must *not* be tied with excessive force.

At this point, some surgeons (Boyd et al.) prefer to perform a Nissen fundoplication, which can be done if there is enough loose gastric wall to permit a wraparound without constricting the esophagus. Otherwise, a partial fundoplication may be accomplished by inserting several sutures between the outer walls of the esophagus and adjacent stomach. We have observed that even if fundoplication is not performed, few patients develop reflux esophagitis following this operation—as long as end-to-side esophagogastric anastomosis has been accomplished 6 cm or more below the cephalad margin of the gastric remnant.

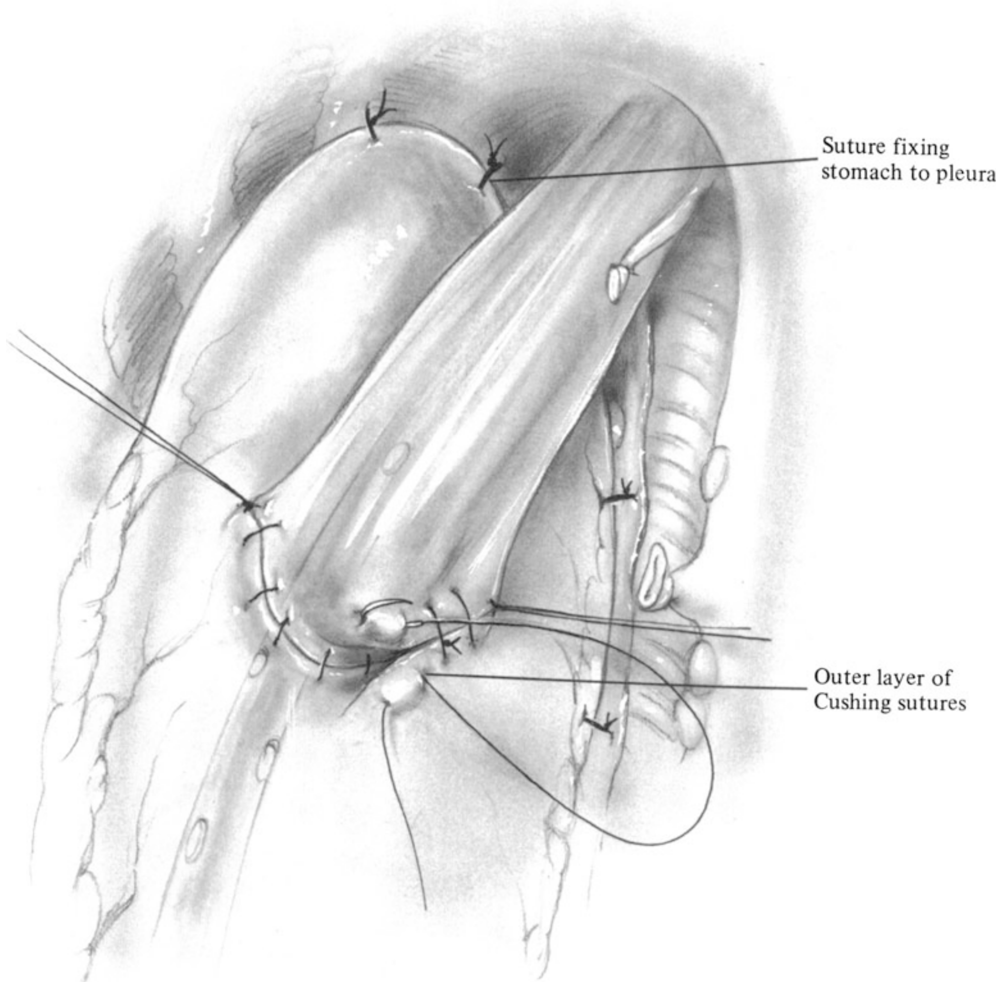


Fig. 7–26

Surgeons who lack wide experience with this anastomosis might find it wise to inflate the gastric pouch with a solution of methylene blue, injected into the nasogastric tube by the anesthesiologist, in order to test the anastomosis for leakage.

As a final, essential step in this operation, prevent tension on the anastomosis by tacking the fundus of the stomach to the prevertebral fascia and mediastinal pleura at the apex of the thorax. Use interrupted sutures of 3–0 silk or Tevdek for this purpose (Fig. 7–26). These sutures must not penetrate the lumen of the stomach, for as Fisher et al. have noted, a gastropleural fistula may result.

As soon as the specimen has been removed, examine the proximal end of the esophagus by frozen section to see if there has been submucosal extension of the cancer. If the pathologist notices tumor cells in the esophageal margin, more esophagus should be resected.

Stapled Esophagogastric Anastomosis

A stapling technique developed by Chassin for this anastomosis is described in Chap. 8.

Cervical Esophagogastric Anastomosis

In treating carcinoma of the mid-esophagus it is often necessary to resect the entire thoracic esophagus to obtain a sufficient margin of normal tissue above the tumor. This requires an esophagogastric reconstruction in the neck.

Fig. 7–27

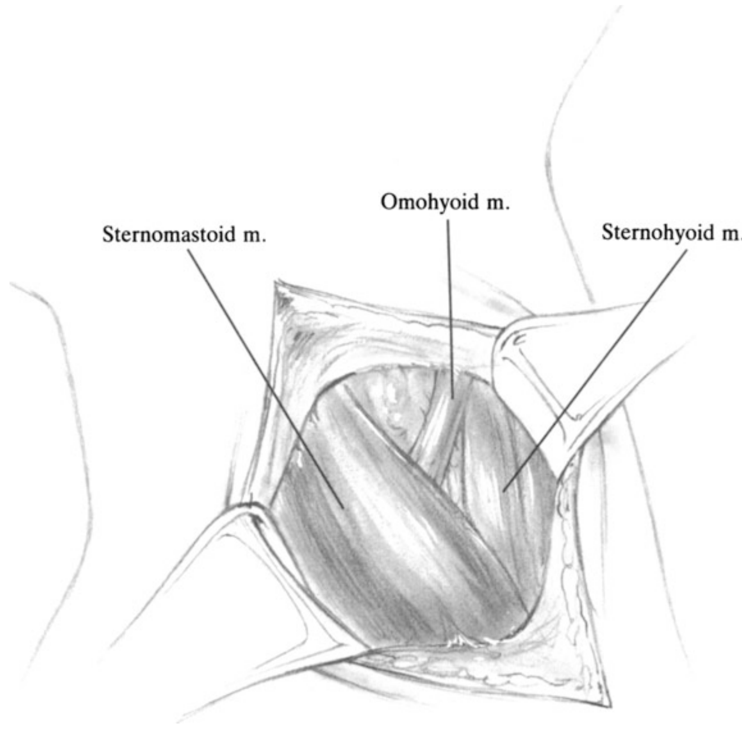


Fig. 7–28

With the patient's head turned slightly to the left, make an oblique incision along the anterior border of the right sternomastoid muscle (**Fig. 7–27**). Carry the incision through the platysma. Identify (**Fig. 7–28**) and transect the omohyoid muscle. Retract the sternomastoid muscle and carotid sheath laterally and retract the prethyroid muscles medially, exposing the thyroid gland (**Fig. 7–29**). The

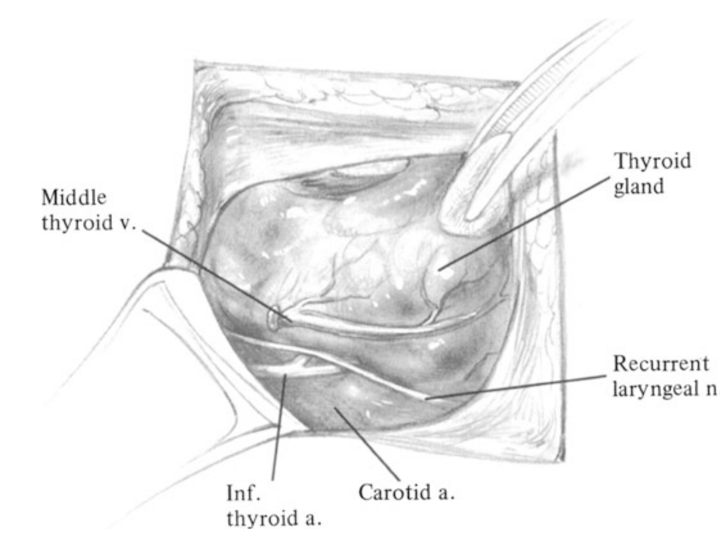


Fig. 7–29

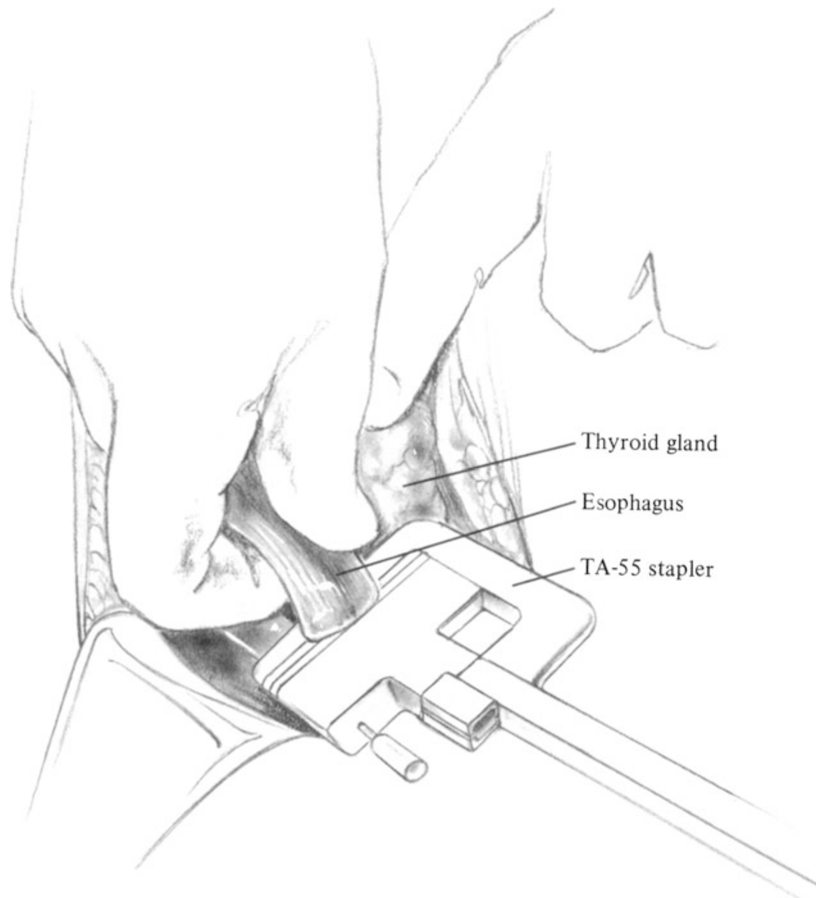


Fig. 7–30

middle thyroid vein, when present, should be doubly ligated and divided. Place the areolar tissue between the gland and the carotid sheath on stretch by upward and medial retraction of the thyroid. Excessive traction applied to the thyroid or larynx may injure the contralateral recurrent laryngeal nerve. Identify and skeletonize the inferior thyroid artery, which crosses the lower third of the surgical field in a transverse direction, by a Metzenbaum dissection toward the prevertebral fascia. Dissect it toward the thyroid gland until the recurrent laryngeal nerve can be seen. Then dissect the nerve upward to achieve thorough exposure, so that it may be preserved (Fig. 7–29).

At this point the tracheoesophageal groove will be seen and the cervical esophagus can be encircled by the surgeon's index finger, which should be passed between the esophagus and the prevertebral fascia and then between the esophagus and trachea. The finger should stay close to the esophageal wall. Otherwise, the *left* recurrent laryngeal nerve may be avulsed during this dissection. Although the inferior thyroid artery generally will have to be ligated and divided before the esophagus is mobilized, in some cases its course is low enough in the neck so that it can be preserved.

Since the thoracic esophagus has been dissected up to the thoracic inlet, it is a simple matter to transect the esophagus low in the neck. When the proper point of transection of the esophagus has been selected, apply a TA–55 stapler to the specimen side (**Fig. 7–30**) and transect the esophagus flush with the stapler. Remove the specimen through the thoracic incision.

Now pass the fundus of the stomach, which has already been passed into the thorax, through

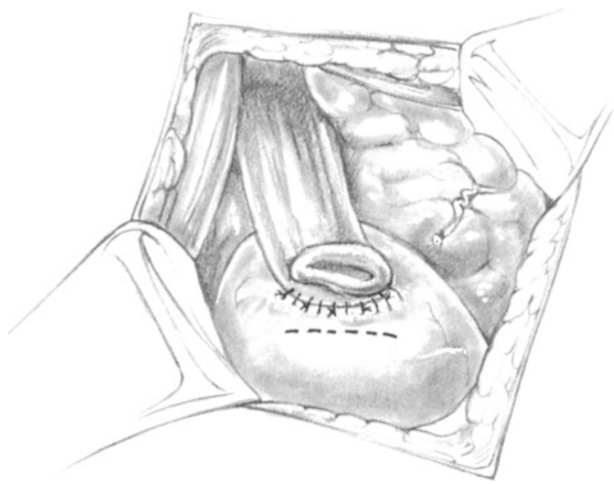


Fig. 7–31

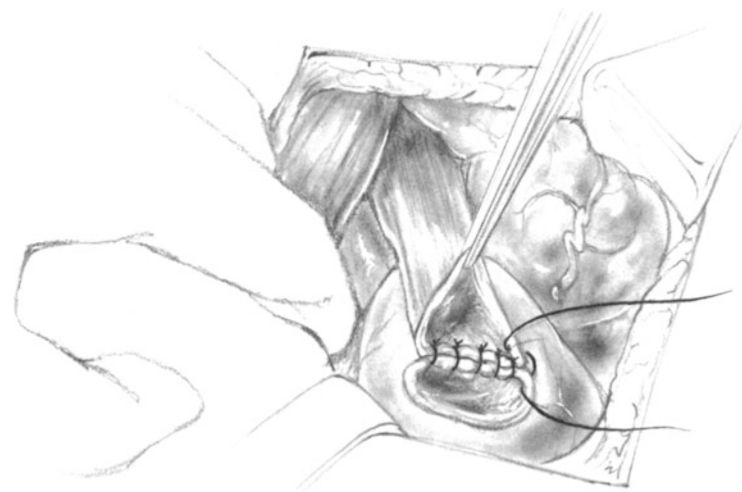


Fig. 7–32

the thoracic inlet into the cervical region. The fundus should reach the hypopharynx without tension. Anchor it to the prevertebral fascia with several 3–0 cotton sutures. Then construct an end-to-side anastomosis by the same technique described above (**Figs. 7–31, 7–32** and 7–25, 7–26).

We have not been impressed by the various stapling techniques recommended for the esophagogastric anastomosis in the neck.

Lavage the operative site with an antibiotic solution and initiate wound closure by inserting a layer of interrupted 4–0 PG sutures approximating the anterior border of the sternomastoid to the prethyroid strap muscles. Several similar sutures may be used loosely to approximate the platysma. Close the skin, generally by means of a continuous 4–0 PG subcuticular suture, leaving sufficient space to bring a latex drain out from the prevertebral region through the lower pole of the incision.

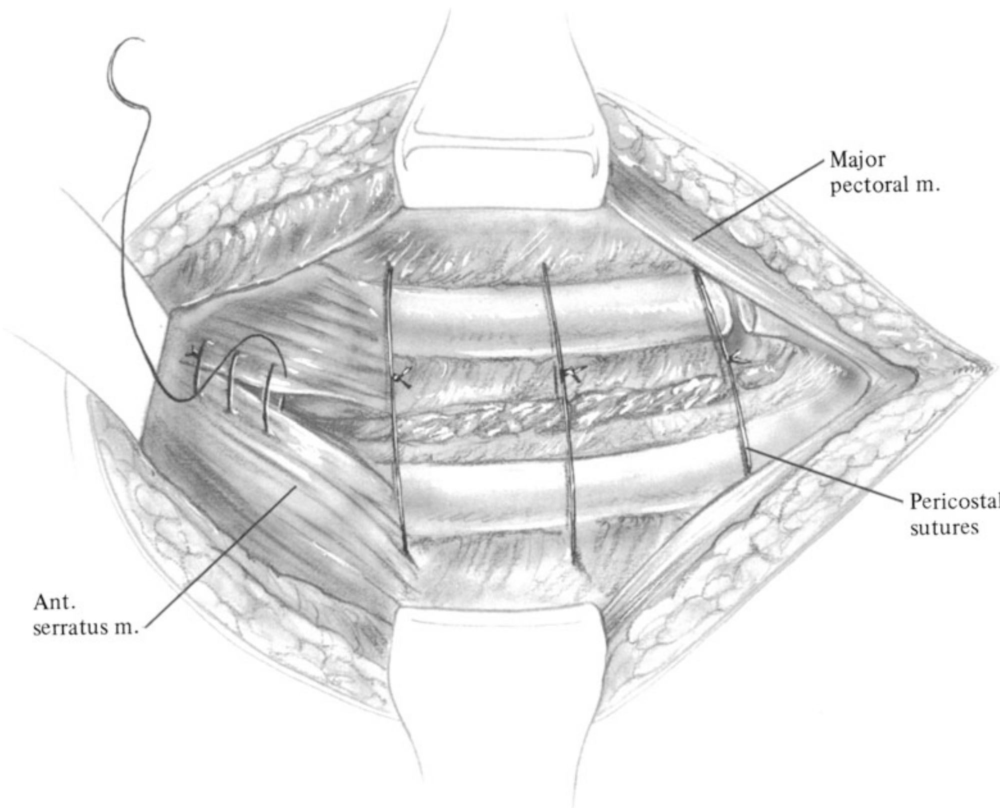


Fig. 7–33

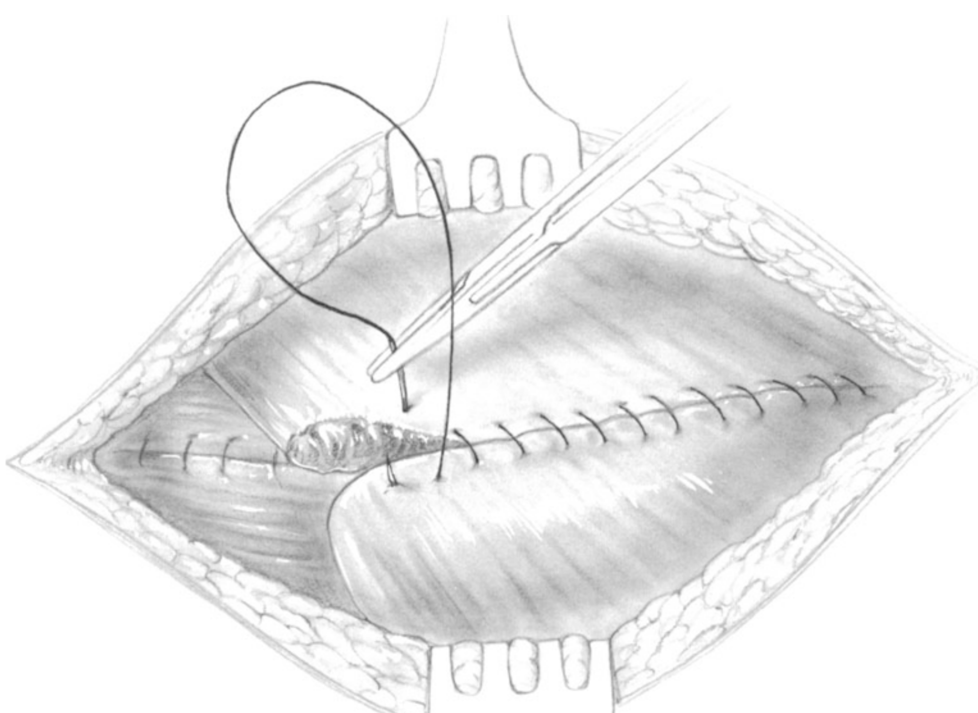


Fig. 7–34

Closure

Make a stab wound in the ninth intercostal space. Insert a 36F multi-eyed plastic catheter through the stab wound and use 4–0 catgut to suture the catheter to the posterior pleura in the upper thorax. After thoroughly irrigating the thoracic and abdominal cavities with an antibiotic solution, approximate the ribs with four or five interrupted pericostal sutures of No. 1 PDSG and approximate the serratus and pectoral muscles in layers by means of continuous 2–0 atraumatic PG (**Figs. 7–33 and 7–34**). Close the skin with continuous 3–0 nylon or subcuticular 4–0 PG.

Before closing the abdomen insert a needle-catheter feeding jejunostomy.

Close the abdominal wall in the usual fashion by means of interrupted No. 1 PDS sutures.

Postoperative Care

Keep the nasogastric tube on low suction for 4–5 days. The patient should be permitted nothing by mouth until an esophagram with an aqueous contrast medium has been performed in the X-ray department on the seventh postoperative day to ascertain the integrity of the anastomosis. If no leak can be seen, the patient is given a liquid diet. This should be advanced to a full diet in 3–5 days.

The thoracic drainage tube is attached to Pleur-Evac underwater drainage for 4–5 days, and the routine steps for management of a postoperative thoracotomy patient are carried out, including frequent determination of arterial blood gases and pH. Tracheal suction is used with caution to avoid possible trauma to the anastomosis. Ventilatory support is employed when necessary.

Prophylactic antibiotics are continued until removal of the thoracotomy drainage tube.

Use the needle-catheter jejunostomy for enteral alimentation beginning promptly after surgery.

Complications

Anastomotic leaks constitute by far the most important complication of this operation, but they are *preventable if proper surgical technique is used.* Over half the patients who develop clinical leakage die, according to the literature. Triggiani and Belsey have reported that unless the anastomosis is defunctionalized by cervical esophagostomy combined with adequate thoracic drainage, most patients will not survive an intrathoracic anastomotic leak.

On two occasions we have observed a small perianastomotic collection of contrast material in patients who were studied by X-ray esophagrams on the seventh postoperative day. In both cases there was absolutely no *clinical* evidence of leak. Both were treated conservatively, and oral feedings were instituted five days after the abnormal X rays without ill effect. These were both end-to-end esophagogastric anastomoses, a technique now avoided.

Fisher et al. have reported finding a gastropleural fistula following leakage from one of the sutures used to tack the stomach to the mediastinal pleura. This case proved fatal. As consultants we have seen one similar case involving a stitch between the gastric wall and the diaphragmatic hiatus. In this patient, bile-stained fluid appeared in the thoracic drainage tube on the second postoperative day. This was confirmed by the insertion into the nasogastric tube of methylene blue dye, which was recovered in the thoracic drainage. The problem was managed by prompt reopening of the thoracic incision and closure of the defect in the gastric wall by several inverting 4–0 seromuscular sutures. The patient made an uneventful recovery.

A subphrenic or subhepatic abscess may follow an operation for an ulcerated malignancy because a necrotic gastric tumor often harbors virulent organisms. The incidence of this complication can be reduced by antibiotic irrigation during the procedure and by administering prophylactic antibiotics before and during the operation. Treatment is by drainage, either by surgery or by CT-directed percutaneous catheter.

Pulmonary complications were common in the past, but their incidence has been minimized by proper postoperative pulmonary care. Whenever indicated by arterial oxygen and carbon dioxide determinations, postoperative ventilatory support should be utilized, especially in aged patients whose pulmonary reserve is diminished.

Cardiac failure and arrhythmia are not uncommon in patients who are in their seventh or eighth decade of life. Generally, with careful monitoring and early detection, these complications can be easily managed. This requires the use of a Swan-Ganz catheter for measurement of pulmonary wedge pressure and of cardiac output in some of these cases.

In the absence of recurrent mediastinal cancer, stenosis of the anastomosis has not occurred in any of the cases Chassin has managed and reported on. When this complication does occur, repeated passage of Maloney bougies may reverse the condition.

References

Boyd AD et al. Esophagogastrostomy: analysis of 55 cases. J Thorac Cardiovasc Surg 1975;70:817.

Chassin JL. Esophagogastrectomy: data favoring end-to-side anastomosis. Ann Surg 1978;188:22.

Fisher RD et al. Esophagogastrostomy in the treatment of carcinoma of the distal two-thirds of the esophagus. Ann Thorac Surg 1972;14:658.

Logan A. The surgical treatment of carcinoma of the esophagus and cardia. J Thorac Cardiovasc Surg 1963; 46:150.

Skinner DB, Little AG, Ferson MK, Soriano A. Selection of operation for esophageal cancer based on staging. Ann Surg 1986;204:391–401.

Triggiani E, Belsey R. Oesophageal trauma: incidence, diagnosis and management. Thorax 1977;32:241.

8 Esophagogastrectomy: Left Thoracoabdominal

Indications

Esophagogastrectomy by the left thoracoabdominal approach is indicated for malignant lesions of the distal 10 cm of the esophagus, of the esophagogastric junction, and of the gastric fundus.

Preoperative Care

In these cases nutritional rehabilitation is often important. Also

Cessation of smoking
Pulmonary function studies
Preoperative esophagoscopy and biopsy
Perioperative antibiotics
Nasogastric tube before the operation

Pitfalls and Danger Points

Anastomotic failure.

Vascularity of gastric pouch. Meticulous attention must be paid to preserving the entire arcade of right gastroepiploic artery and vein along greater curvature of stomach.

Hemorrhage. Occasionally, the left gastric artery is embedded in tumor by invasion from metastatic lymph nodes. Unless this vessel can be identified, transecting the artery through the tumor may produce hemorrhage that is difficult to control.

Pancreas. Trauma to tail of pancreas while spleen and gastric lesion are being removed may induce acute hemorrhagic pancreatitis.

Sepsis. Some malignancies in proximal portion of stomach are ulcerated and bulky with areas of necrosis that contain virulent bacteria. These may produce postoperative subhepatic or subphrenic abscesses by contaminating the operation even if there is no anastomotic leakage.

Inadequate cancer operation. Because gastric and esophageal malignancies can spread for some distance submucosally without being visible, frozen section studies of both proximal and distal margins of the excision are helpful.

Paralysis of the diaphragm.

Operative Strategy

Objectives of Esophagogastrectomy

In operations done for cure the objective is the wide removal of the primary tumor, along with a 6–10 cm margin of normal esophagus in a proximal direction and a 6-cm margin of normal stomach below. Even if the stomach is not involved, when the tumor is situated low in the esophagus, the proximal lesser curvature of the stomach should be included in order to remove the left gastric artery at its origin and to remove the celiac lymph nodes. Splenectomy and removal of the lymph nodes at the splenic hilus should be done for lesions of the proximal stomach. Any suspicious nodes along the superior border of the pancreas should be removed also.

Thoracoabdominal Incision with Preservation of Phrenic Nerve Function

When gastric cancer encroaches upon the gastroesophageal junction, an operation that is done by abdominal incision exclusively is contraindicated for several reasons. In the first place, this anastomosis will frequently require the surgeon's hand and the needle-holder to be in an awkward position, and may result in leakage. Furthermore, the abdominal incision makes it difficult to perform a wide excision of possible areas of invasion of the distal esophagus. Some upper gastric lesions we have seen have extended up into the esophagus as far as 10 cm.

The left thoracoabdominal incision, we have found, is both safe and efficacious. It is easy to divide all the muscles of the thoracic cage rapidly by electrocautery. Even patients in their eighties have tolerated this incision well when given adequate postoperative support.

The diaphragm should *not* be incised radially from the costal margin to the esophageal hiatus because this would transect the phrenic nerve and paralyze the left diaphragm. Many patients who require gastric surgery for cancer are aged and have limited pulmonary reserve, and as atelectasis is a common postoperative complication, it is better to make a circumferential incision in the periphery of the diaphragm so as to preserve phrenic nerve function and normal diaphragmatic motion.

Postoperative pain at the site of the divided costal margin has been alleged to be common following the thoracoabdominal incision. In our experience proper resuturing of the costal margin with monofilament steel wire results in solid healing of this area. Pain has *not* been a problem.

Anastomotic Leakage

Delicacy of suture technique and adequate exposure are very important in preventing anastomotic leaks. If a gastric or lower esophageal lesion has spread up the lower esophagus for a distance of more than 6–8 cm, the esophagogastric anastomosis should not be constructed high up under the aortic arch, as this is a hazardous technique. Instead, 1-cm posterior segments of two additional ribs should be resected, and the esophagus should be liberated behind the arch of the aorta and passed up to a supra-aortic position. This exposure permits the anastomosis to be done in a manner less traumatic to the tissues than an anastomosis constructed high up under the aortic arch. Otherwise, the surgeon's hand and wrist are situated in an awkward position, which makes smooth rotation of the wrist and needle-holder very difficult. Jerky suturing motions produce small tears in the esophagus, especially in the difficult posterior layer.

End-to-End versus End-to-Side Anastomosis

In a report published in the *Annals of Surgery* (1978), we have shown that the end-to-end esophagogastric anastomosis carries with it a much higher rate of leakage as well as a higher mortality rate than the end-to-side. Explanations for the increased complication rate following end-to-end esophagogastrostomy are not hard to find:

It is necessary to close a portion of the end of the stomach because of the disparity between the lumen of the stomach and that of the esophagus. This increases the technical difficulty of doing the end-to-end anastomosis (**Figs. 8–1a and 8–1b**).

The blood supply of the gastric pouch at its proximal margin is inferior to that at the site of the end-to-side anastomosis.

Inserting the posterior layer of esophagogastric sutures may be difficult because traction is often being applied to the esophagus to improve exposure while the surgeon's hand and the needle-holder device may have to assume positions that are awkward for efficient and nontraumatic suturing.

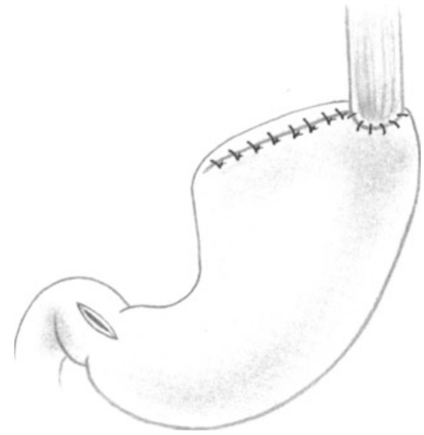


Fig. 8–1a

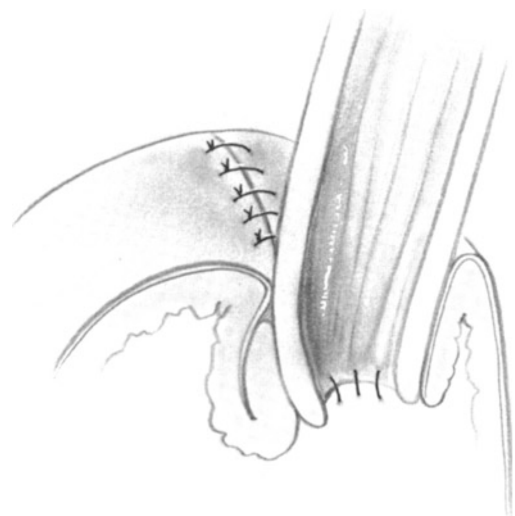


Fig. 8–1b

This produces imperfections in the suture line. As seen in **Fig. 8–2a**, protection from posterior leakage is achieved in the end-to-side cases by the buttress effect of a 6–7 cm segment of gastric wall behind the esophagus. In end-to-end operations, however, there is no second line of defense against technical error.

Although the anterior layer of either the end-to-end or the end-to-side esophagogastrostomy is much easier to construct without technical defects than the posterior layer, even here the end-to-side version offers advantages. **Fig. 8–2b** illustrates how the anterior wall of the esophagus invaginates itself into the stomach for additional protection. If this were attempted with an end-to-end anastomosis, the large inverted cuff would produce stenosis at the stoma (Fig. 8–1b).

Additional protection against leakage from the

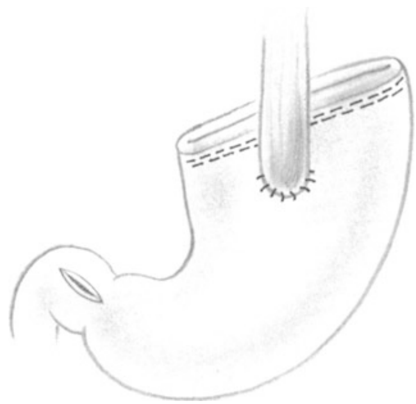


Fig. 8–2a

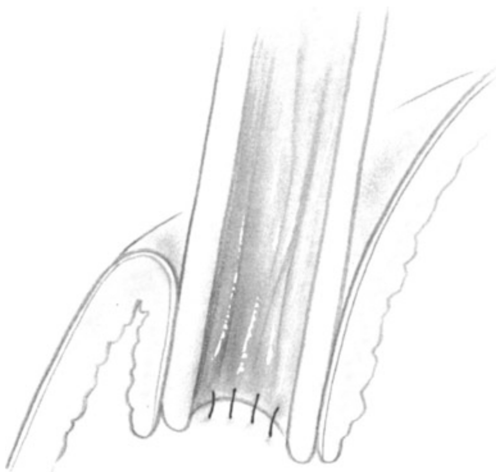


Fig. 8–2b

anterior aspect of the end-to-side anastomosis can be achieved by performing a Nissen fundoplication around the anastomosis. This also helps prevent postoperative gastroesophageal reflux, but it requires the presence of a large gastric pouch and cannot be performed, unless modified, when the proximal stomach has been resected.

Avoiding Postoperative Reflux Esophagitis

Another serious drawback of an end-to-end esophagogastric anastomosis is the occurrence of reflux esophagitis in patients who achieve long-term survival. This can be avoided by implanting the end of the esophagus end-to-side into the stomach at least 6 cm beyond the proximal margin of the gastric pouch. This type of construction functions as a valve, probably because air in the gastric pouch behind the distal esophagus compresses the overlying esophagus. This is fortunate, as there is rarely enough remaining stomach to fashion an adequate "fundoplication" when the gastric fundus has been resected.

When the anastomosis is performed by our stapling method, described below, there should preferably be a distance of 8 cm between the proximal gastric margin and the overlying esophagus because the stapled anastomotic stoma uses a slightly larger area of anterior gastric wall than does the suture technique.

Efficacy of Stapling Techniques for the Esophagogastric Anastomosis

We have developed and reported, in the *American Journal of Surgery* (1978), a stapling technique for end-to-side esophagogastrostomy that has been used in 31 consecutive cases without evidence of leak, either on clinical grounds or when checked by routine esophagram X rays on the seventh postoperative day. It can be done swiftly, and after a long and sometimes complicated dissection, an accurate anastomosis that takes only 2 or 3 minutes of operating time constitutes a welcome epilogue, especially when treating poor-risk patients.

While the EEA–31 and EEA–28 size cartridges produce a good anastomosis, the use of the EEA–25 size results in a high incidence of anastomotic stenosis requiring postoperative dilatations.

Postoperative Sepsis

To prevent postoperative sepsis, be meticulous in avoiding spillage of the gastric content, which can contaminate the subhepatic or subcutaneous space. Any instruments that come in contact with the lumen of the stomach or esophagus should be treated as dirty, and the area should be walled off wherever possible. During the operation, the operative field should be irrigated frequently with a dilute antibiotic solution.

Operative Technique

Incision and Position

Endotracheal one-lung anesthesia will permit atraumatic collapse of the left lung during the esophageal dissection.

Fig. 8–3

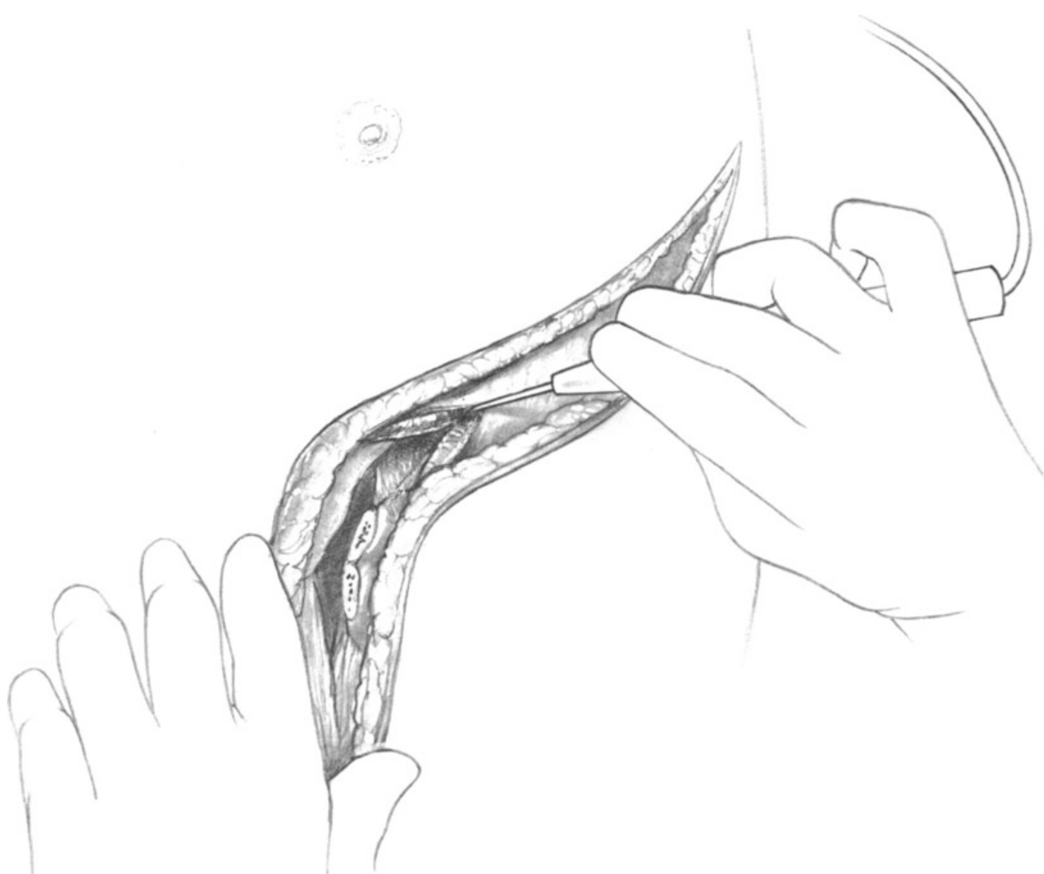


Fig. 8–4

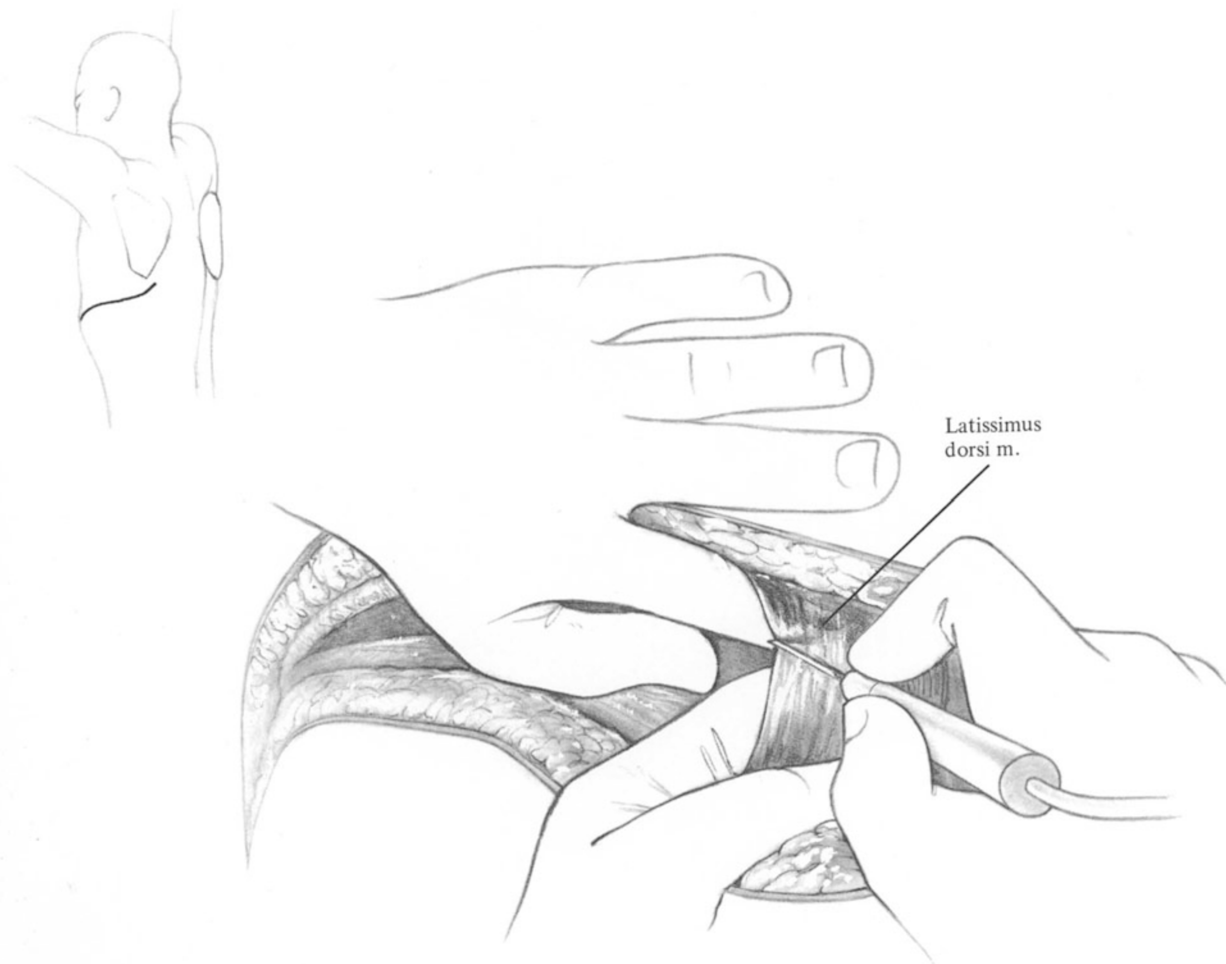


Fig. 8–5

With the aid of sandbags and wide adhesive tape across the patient's hips, elevate the patient's left side to a 60° angle. Pad the patient's left arm and suspend it in a forward position (**Fig. 8–3**).

Begin the incision at the umbilicus and continue it up the midline about halfway to the xiphoid. Then explore the abdomen. The presence of metastasis of a moderate degree to the celiac lymph nodes or to the liver does not constitute a contraindication to resection.

Redirect the incision to cross the costal margin into the sixth intercostal space and continue it to the region of the erector spinae muscle near the tip of the scapula. After the skin incision has been completed, use the coagulating current to divide the latissimus dorsi muscle in as caudal a location as possible (**Fig. 8–4**). The index fingers of both the surgeon and first assistant should be inserted side by side beneath the latissimus muscle while the electrocoagulator divides the muscle (**Fig. 8–5**). A similar method should be applied to the division of the anterior serratus muscle. The rhomboid muscles medial to the scapula need not be divided unless a supra-aortic dissection proves necessary.

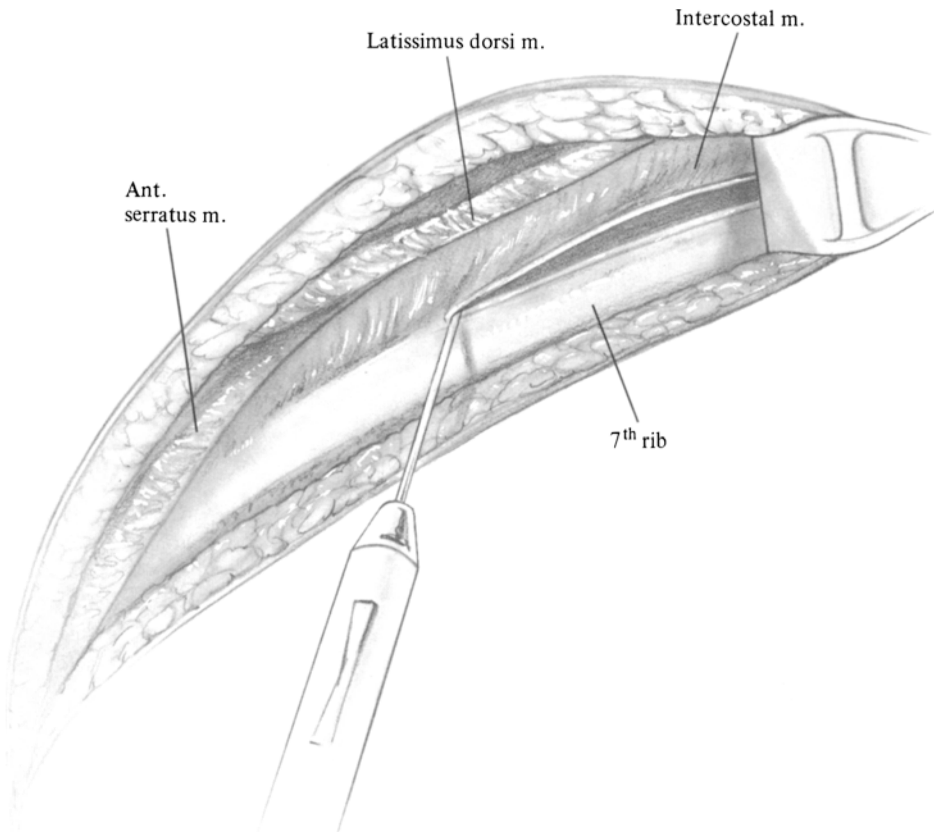


Fig. 8–6

Next retract the scapula in a cephalad direction and count down the interspaces from the first rib to confirm the location of the sixth interspace. Divide the intercostal musculature by electrocautery along the superior surface of the seventh rib and enter the pleura (**Fig. 8–6**). Divide the costal margin with a scalpel or a rib cutter. Divide the internal mammary artery, deep and slightly lateral to the costal margin, and ligate or electrocoagulate it (**Fig. 8–7**).

Then incise the diaphragm in a circumferential fashion (**Figs. 8–7 and 8–8**) along a line 3–4 cm from its insertion into the rib cage. Use the electrocoagulator for this incision, which should extend laterally about 15 cm from the divided costal margin. Spread the intercostal incision by inserting a Finochietto retractor.

Liberation of Esophagus

Divide the inferior pulmonary ligament with long Metzenbaum scissors, going in a cephalad direction until the inferior pulmonary vein has been reached. Collapse the lung, cover it with moist gauze pads, and retract it in a cephalad and anterior direction with Harrington retractors.

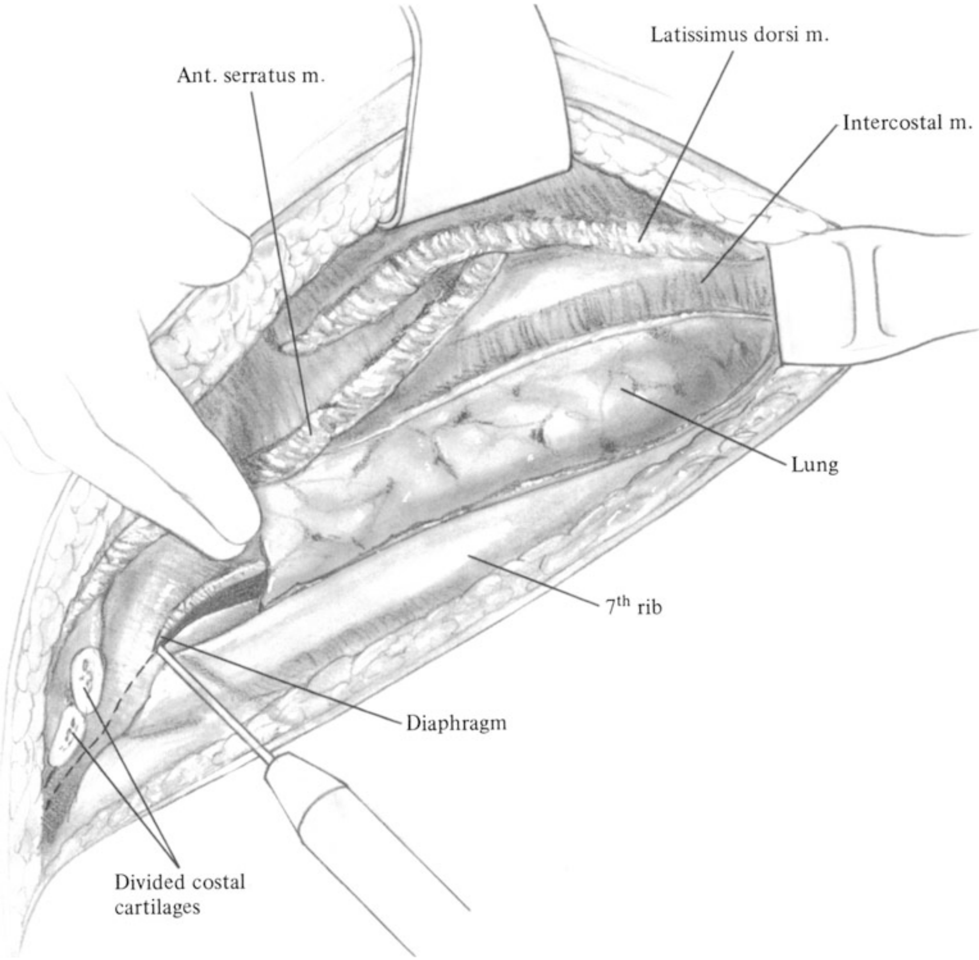

Latissimus dorsi m.
Ant. serratus m.
Intercostal m.
Lung
7th rib
Diaphragm
Divided costal
cartilages

Fig. 8–7

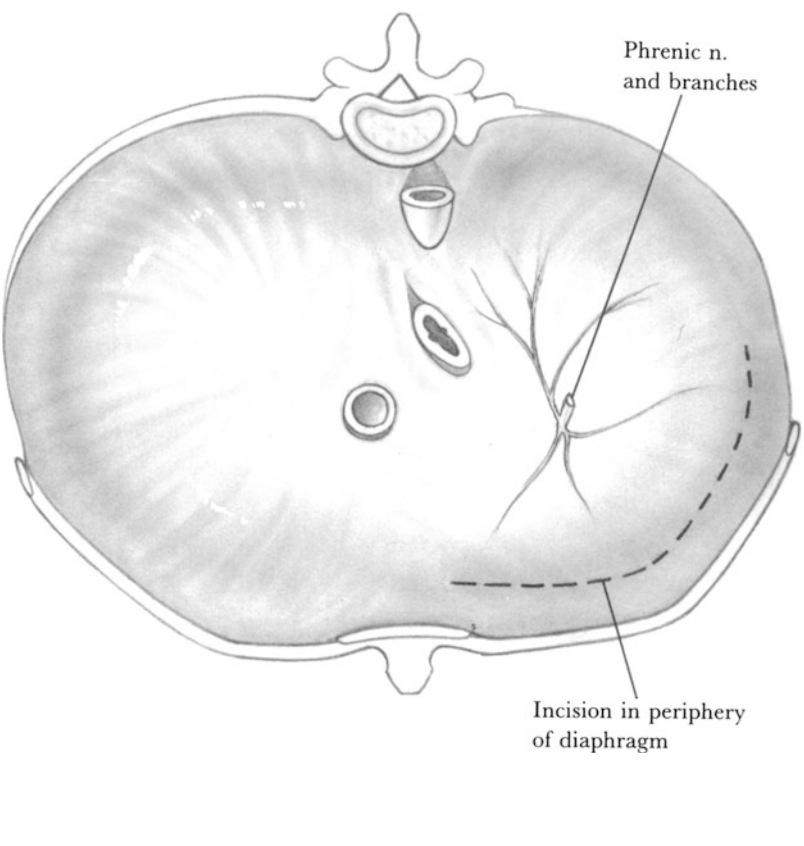

Phrenic n.
and branches
Incision in periphery
of diaphragm

Fig. 8–8

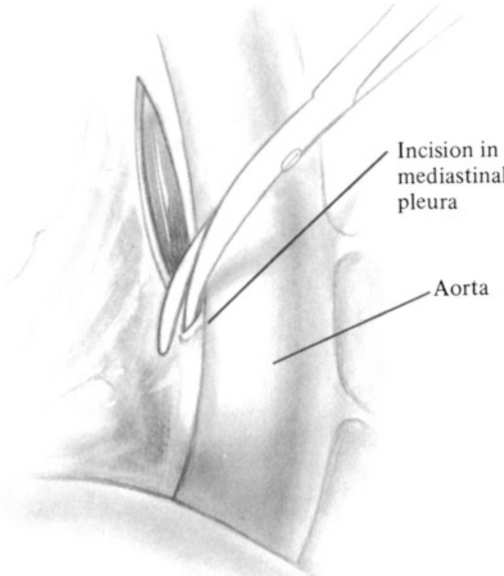


Fig. 8–9

Incise the mediastinal pleura from the aorta to the hiatus, beginning at a point above the tumor (**Fig. 8–9**). Encircle the esophagus first with the index finger and then with a latex drain (**Fig. 8–10**). Divide the vagus nerves as they approach the esophagus from the hilus of the lung. Dissect the tumor and the attached vagus nerves away from the mediastinal structures. If the pleura of the right thoracic cavity or pericardium has been invaded by tumor, include it in the resection. The dissection of the esophagus should free this organ from the arch of the aorta down to the hiatus. Generally, only two or three branches of the descending aorta will join the esophagus. These should be occluded by Hemoclips and divided. Use an umbilical tape ligature or a row of 3.5 mm staples (TA–55) to occlude the lumen of the esophagus (above the tumor) in order to prevent the cephalad migration of the tumor cells (**Fig.**

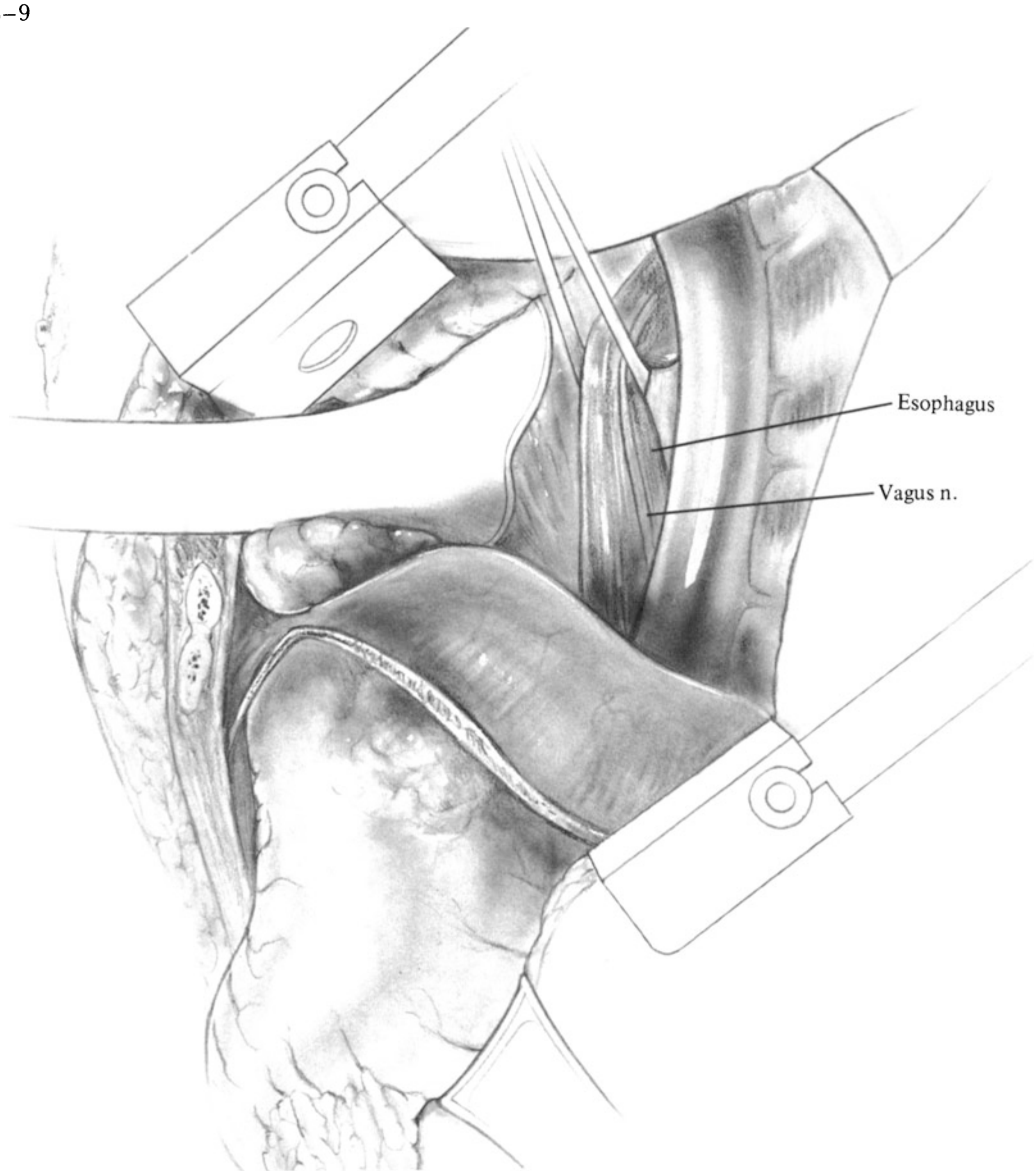


Fig. 8–10

8–11), but delay division of the esophagus until the stomach is mobilized.

Splenectomy

Retract the spleen medially and divide the lienophrenic ligament (**Fig. 8–12**). Gently elevate the spleen and tail of the pancreas from the retroperitoneal tissues by finger dissection. Divide the lienocolic ligament. Identify the splenic artery and vein on the posterior surface of the splenic hilus. Each should be divided and ligated with 2–0 silk. It may be convenient to remove the spleen as a separate specimen after dividing each of the short gastric vessels. Do this on the anterior aspect of the stomach to visualize the greater curvature accurately, thereby avoiding any possibility of trauma to the stomach.

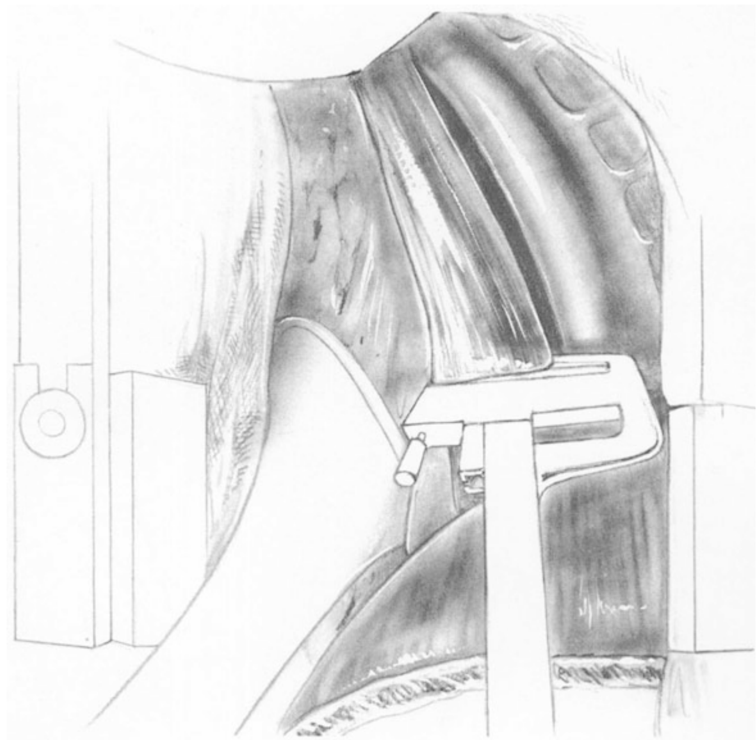


Fig. 8–11

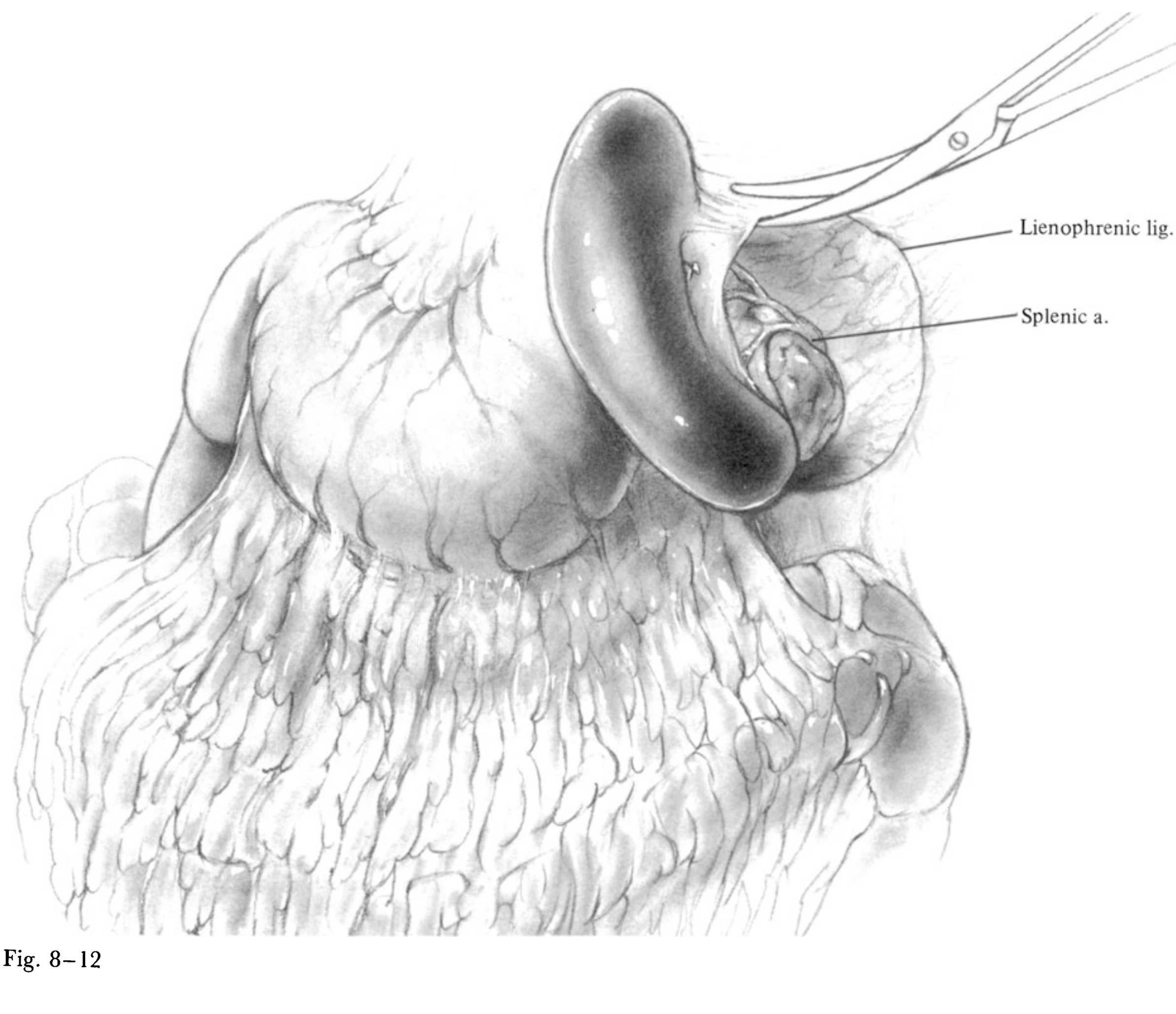


Fig. 8–12

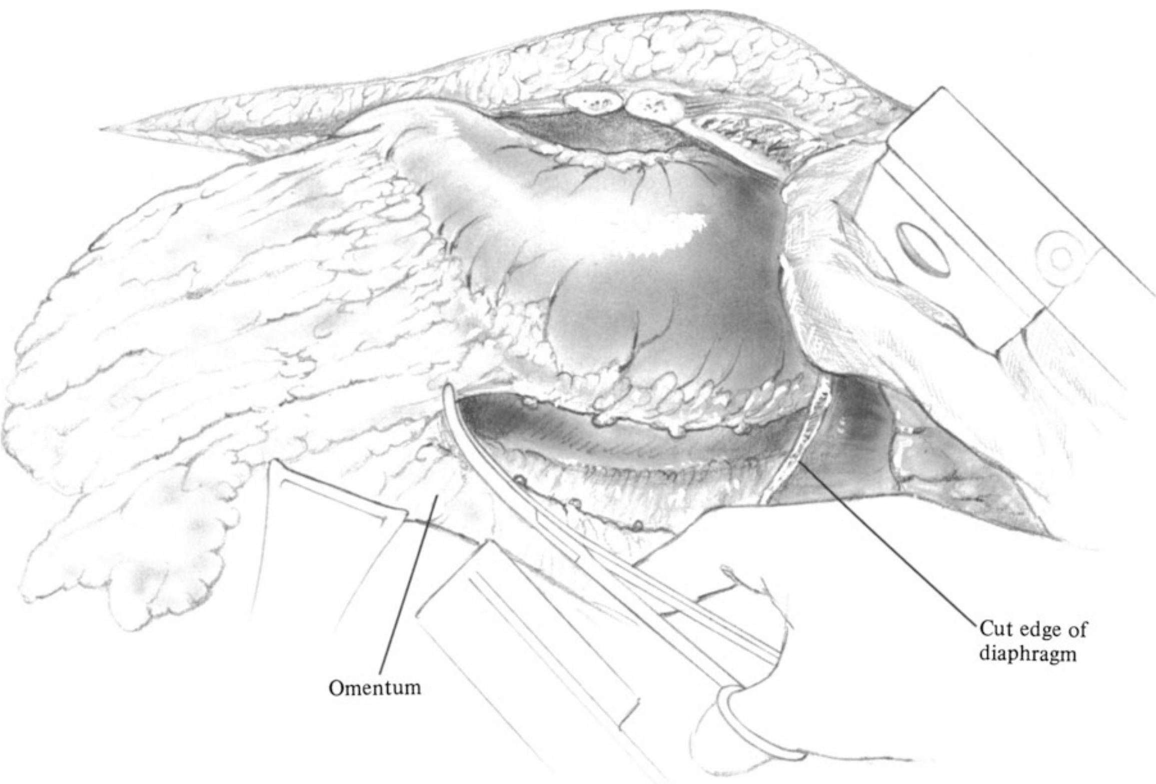


Fig. 8–13a

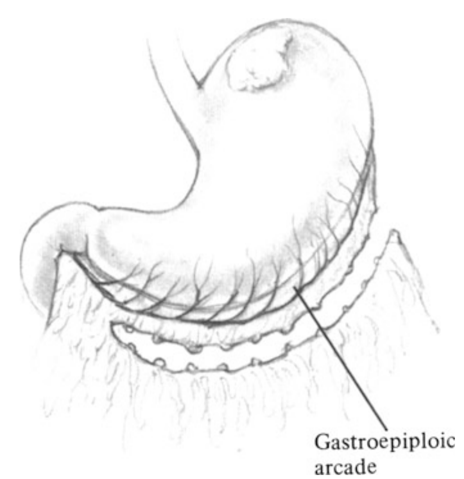


Fig. 8–13b

Gastric Mobilization

The gastroepiploic arcade along the greater curvature of the stomach *must be preserved with compulsive attention to detail*, as the inadvertent occlusion of this vessel in a clamp or ligature will result in inadequate vascularity of the gastric pouch and anastomotic leakage. Preservation of the arcade is accomplished from above down by inserting the index finger behind the gastrocolic omentum, which is then divided between clamps. Be sure always to *leave 3–5 cm of redundant omentum attached* to the vascular arcade. Continue the dissection to a point 6–8 cm cephalad to the pylorus (**Figs. 8–13a and 8–13b**). The greater curvature now should be elevated. In order to accomplish this, incise its avascular attachments to the posterior parietal peritoneum at the pancreas.

Identify the celiac axis by palpating the origins of the splenic, hepatic, and left gastric arteries. Dissect lymphatic and areolar tissues away from the celiac axis toward the specimen. Skeletonize the coronary vein, and divide and ligate it with 2–0 silk. Immediately cephalad to this structure is the left gastric artery which should be doubly ligated with 2–0 silk and divided (**Figs. 8–14a and 8–14b**). Incise the gastrohepatic ligament near its attachment to the liver (**Fig. 8–15**). An accessory left hepatic artery generally can be found in the cephalad portion of the gastrohepatic ligament. Divide this and ligate it with 2–0 silk, and divide the remainder of the ligament and the peritoneum overlying the esophagus.

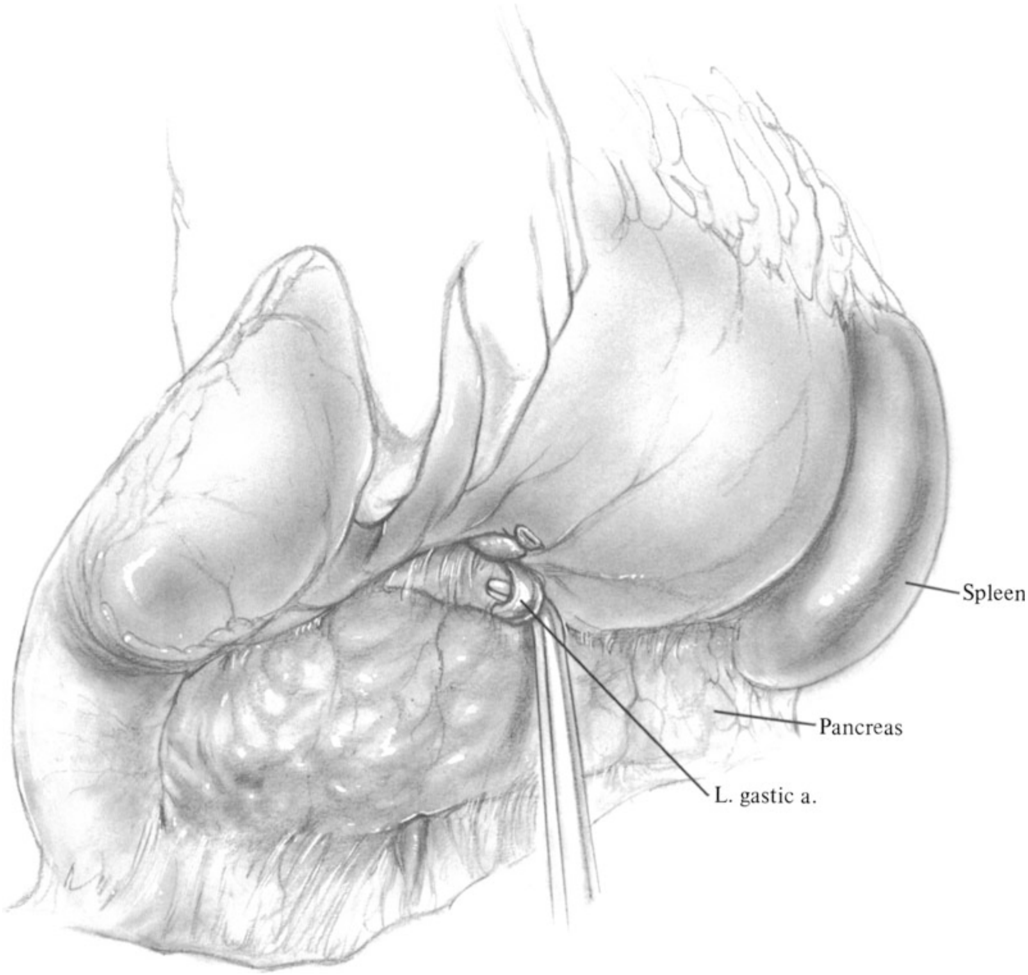


Fig. 8–14a

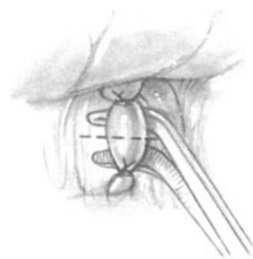


Fig. 8–14b

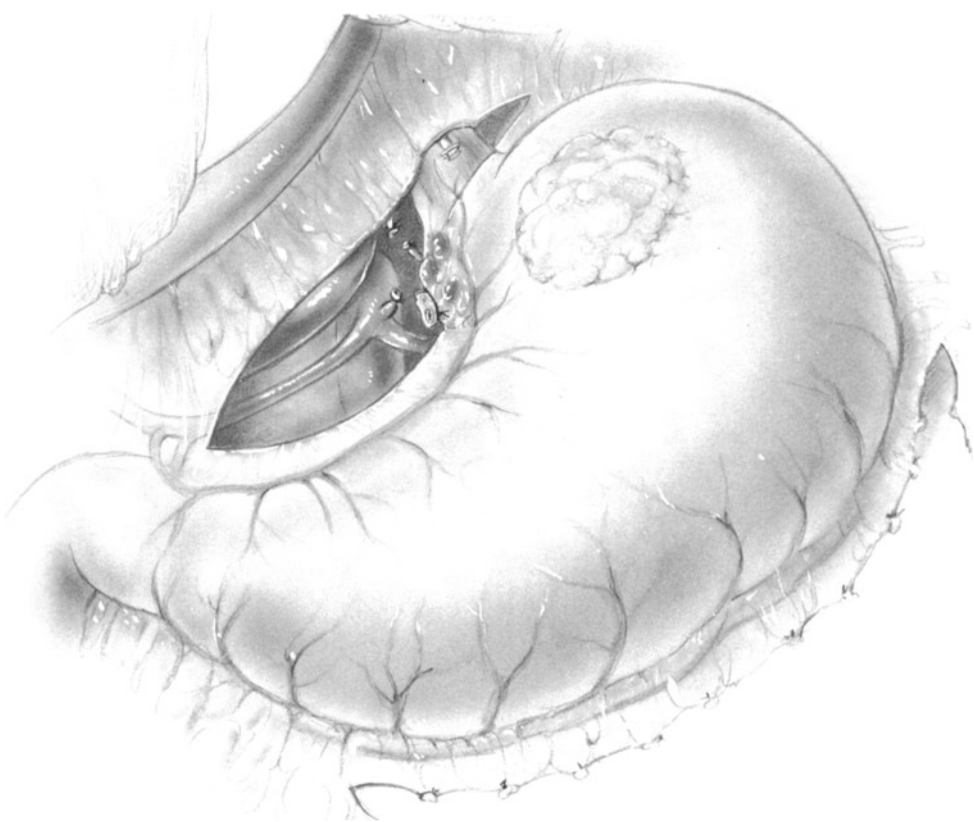


Fig. 8–15

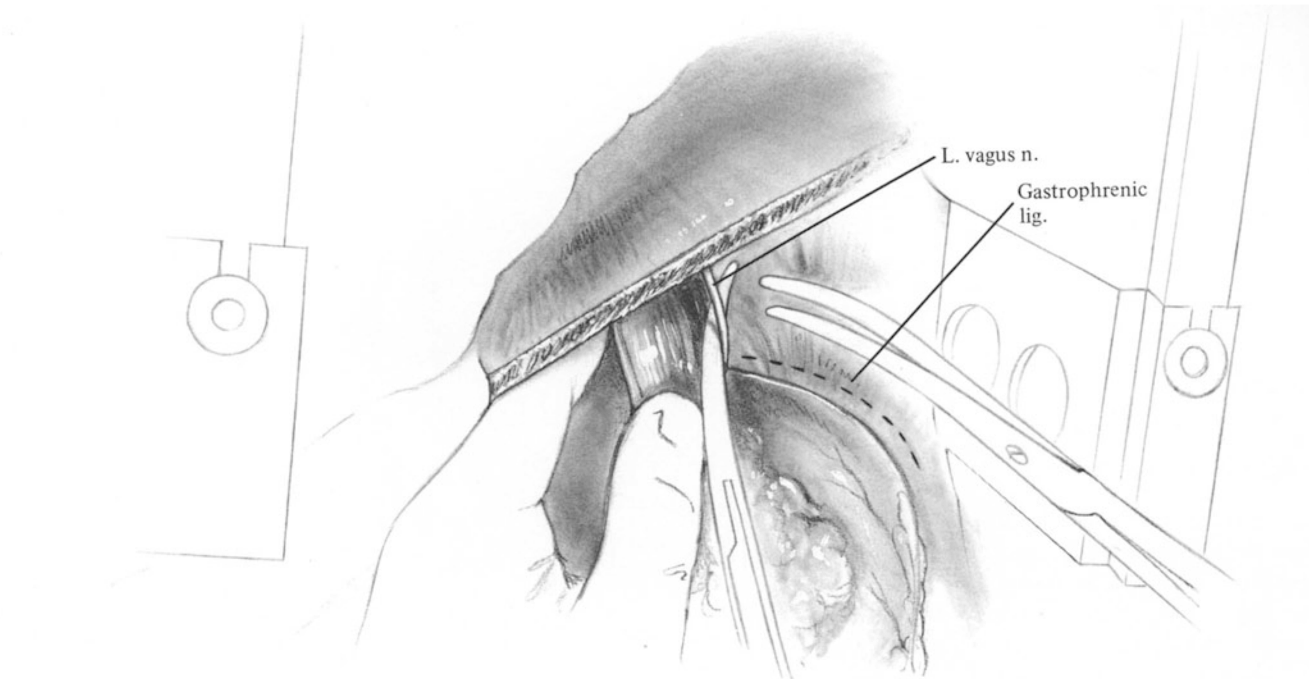


Fig. 8–16

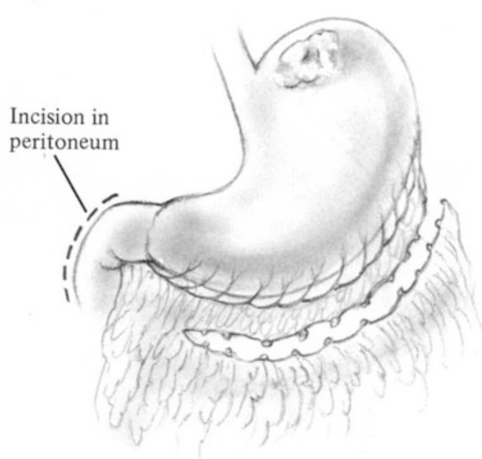


Fig. 8–17

Fig. 8–18

Hiatal Dissection

A gastrophrenic ligament attaches the posterior aspect of the gastric fundus to the posterior diaphragm. Divide this, using the left index finger as a guide. If tumor has encroached upon the hiatus, leave crural musculature attached to the tumor and divide it from the surrounding diaphragm with the electrocautery. This may require division and ligature of the inferior phrenic artery. Divide the vagus nerves just below the hiatus (**Fig. 8–16**) and divide the phrenoesophageal ligaments; this frees the esophagus and stomach from the arch of the aorta down to the duodenum.

Kocher Maneuver

In order to achieve maximum upward mobility of the gastric pouch, divide the avascular lateral duodenal ligament and pass a hand behind the duodenum and the head of the pancreas (**Figs. 8–17 and 8–18**). If necessary, continue this Kocher maneuver along the duodenum as far distally as the superior mesenteric vein (see Figs. 7–15 and 7–16).

Pyloromyotomy

Make a longitudinal incision 1.5–2.0 cm long across the anterior surface of the pvlorus. Carefully deepen it, using the scalpel as well as blunt dissection, until the mucosa pouts out (**Figs. 8–19a, 8–19b, and 8–19c**). Because the pyloric sphincter is not hypertrophied, as it is in infants who require this operation, it is easier to perforate the mucosa than it is in infants. The greatest danger of perforation is at the duodenal end of the pyloromyotomy. A tiny mucosal perforation may be repaired with 5–0 silk sutures and covered with omentum. A significant rent in the mucosa should be corrected by converting the pyloromyotomy into a Heineke-Mikulicz pyloroplasty. Pyloroplasty is a less desirable procedure than pyloromyotomy because it may impair the intramural flow of blood from the duodenum up into gastric pouch. The objection may be merely theoretical, however, as many surgeons have used the pyloroplasty as a routine drainage procedure in esophagogastrectomy. Fisher et al. have been satisfied merely to dilate the pylorus by invaginating the anterior wall of the stomach forcibly into the pylorus, using a finger. We have successfully used this technique in some patients.

Fig. 8–19a

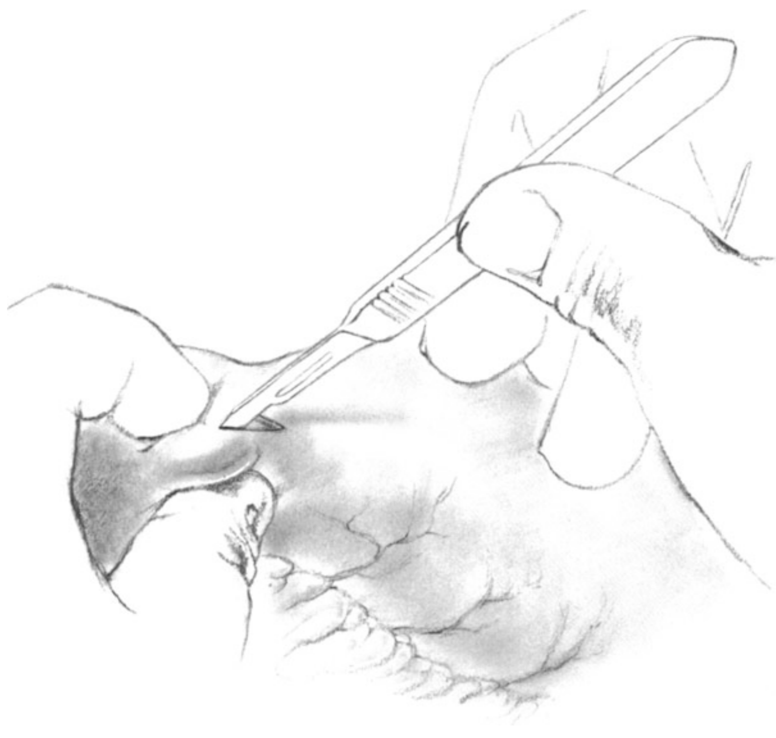


Fig. 8–19b

Fig. 8–19c

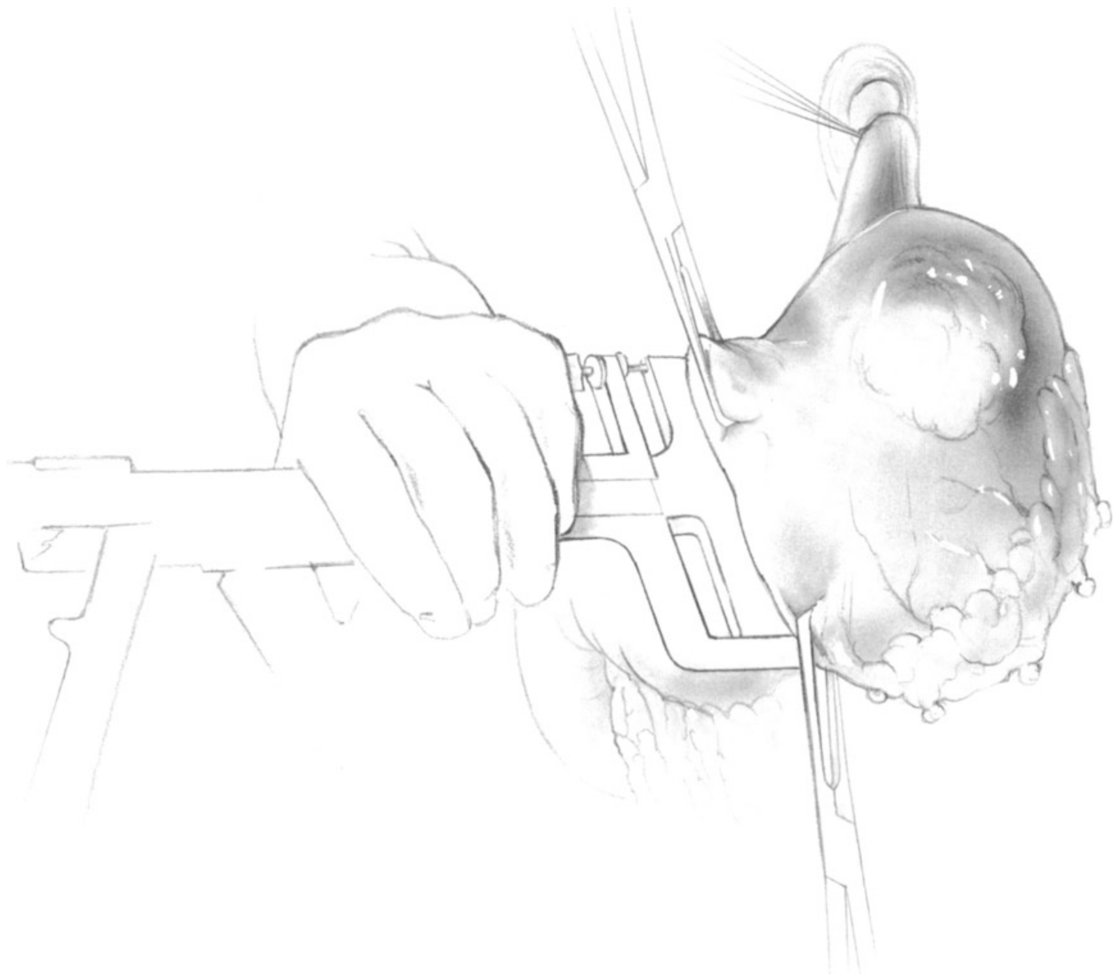


Fig. 8–20a

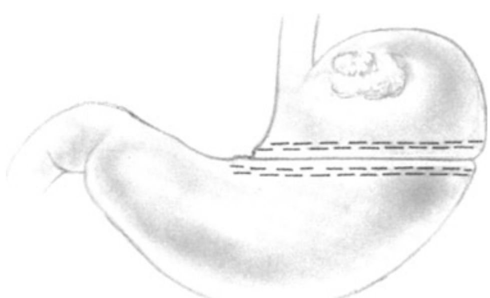


Fig. 8–20b

Transection of Stomach and of Esophagus

To treat a primary tumor of the lower esophagus, apply the TA–90 Auto Suture stapler (loaded with 4.8 mm staples) in an oblique fashion so as to remove the stump of the left gastric artery, the celiac lymph nodes on the lesser curvature of the stomach, and 5–6 cm of the greater curvature. To treat lesions of the proximal stomach, which is the operation illustrated in **Figs. 8–20a and 8–20b**, apply the stapler so that 5–6 cm of normal stomach distal to the lesion are removed.

Divide the stomach between two TA–90 Auto Suture staplers. Make an incision with the scalpel flush with the stapler that is attached to the residual gastric pouch. If two TA–90 staplers are not available, the first stapler should be applied to the stomach, fired, and then reapplied 1 cm lower on the gastric wall. The transection should be made

Fig. 8–21

flush with the stapler on the gastric pouch. Sterilize the area by lightly running the electrocoagulator over the mucosa and remove the device. Before applying the stapling device, *be certain that the nasogastric tube has been withdrawn*, as transfixing the nasogastric tube with a row of staples can complicate the procedure considerably.

In a previous step the esophageal lumen proximal to the tumor was occluded with a row of staples (**Fig. 8–11**). Now transect the esophagus 8–10 cm proximal to the tumor and remove the specimen

Fig. 8–22

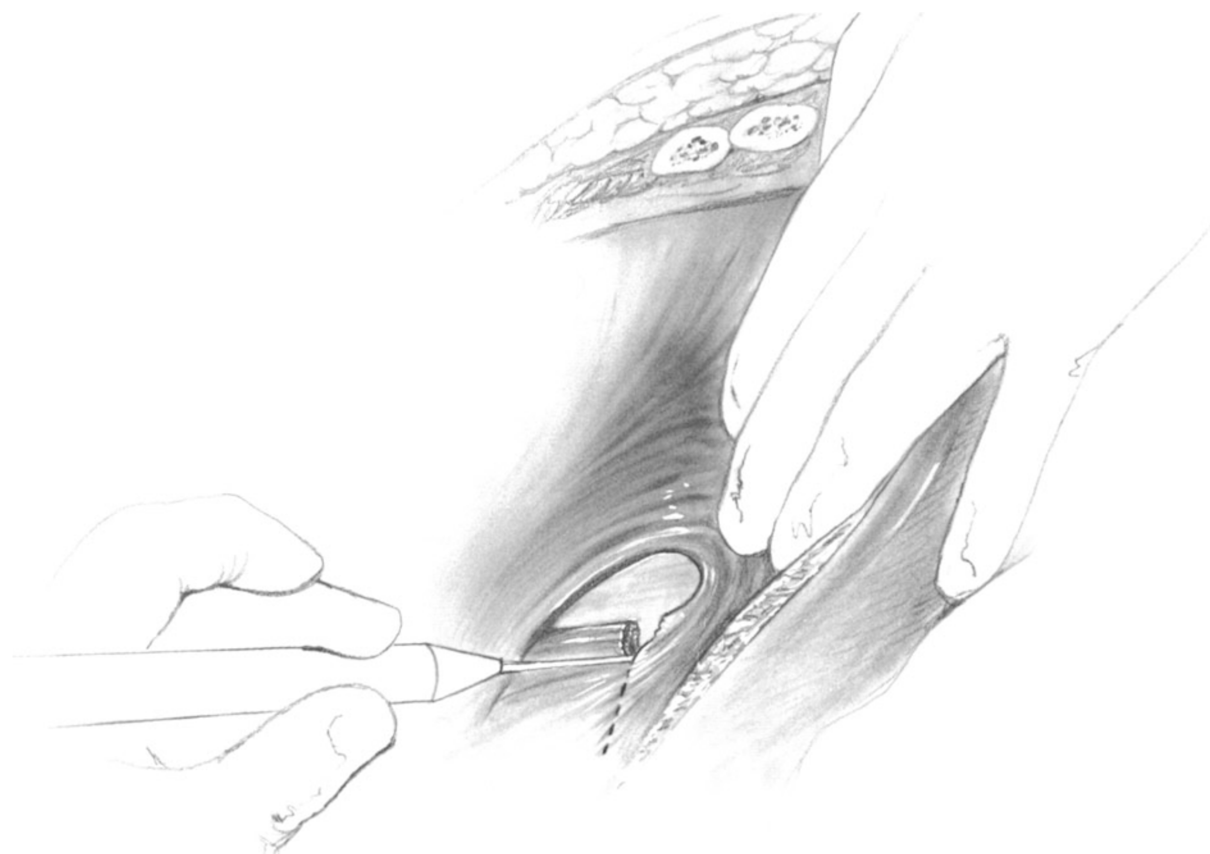


Fig. 8–23

(**Fig. 8–21**). Submit the proximal and distal margins of the specimen to frozen section examination. Clean the lumen of the proximal esophagus with a suction device (**Fig. 8–22**).

Enlargement of Hiatus

Make a transverse incision by electrocautery in the left branch of the crux (**Fig. 8–23**). This should be of sufficient magnitude to allow the gastric pouch to pass into the mediastinum *without constriction* of its venous circulation.

Enlargement of Thoracic Incision if Supra-aortic Anastomosis Is Necessary

A properly fashioned end-to-side esophagogastric anastomosis requires the presence of 6–8 cm of esophagus below the aortic arch. If there is not 6–8 cm of esophagus below the aortic arch, the surgeon should not hesitate to enlarge the thoracic incision so that the esophagus can be passed behind the arch into a supra-aortic position. This will make the anastomosis far simpler and safer to perform, and requires only a few minutes to accomplish.

Now move to a position on the left side of the patient. Extend the skin incision up from the tip of the scapula in a cephalad direction between the scapula and the spine. With the electrocautery divide the rhomboid and trapezius muscles medial to the scapula. Retract the scapula in a cephalad direction and free the erector spinal muscle from the necks of the sixth and fifth ribs. Free a short (1 cm) segment of the sixth (and often of the fifth) rib of its surrounding periosteum and excise it (**Fig. 8–24**). Divide and either ligate or electrocoagulate the in-

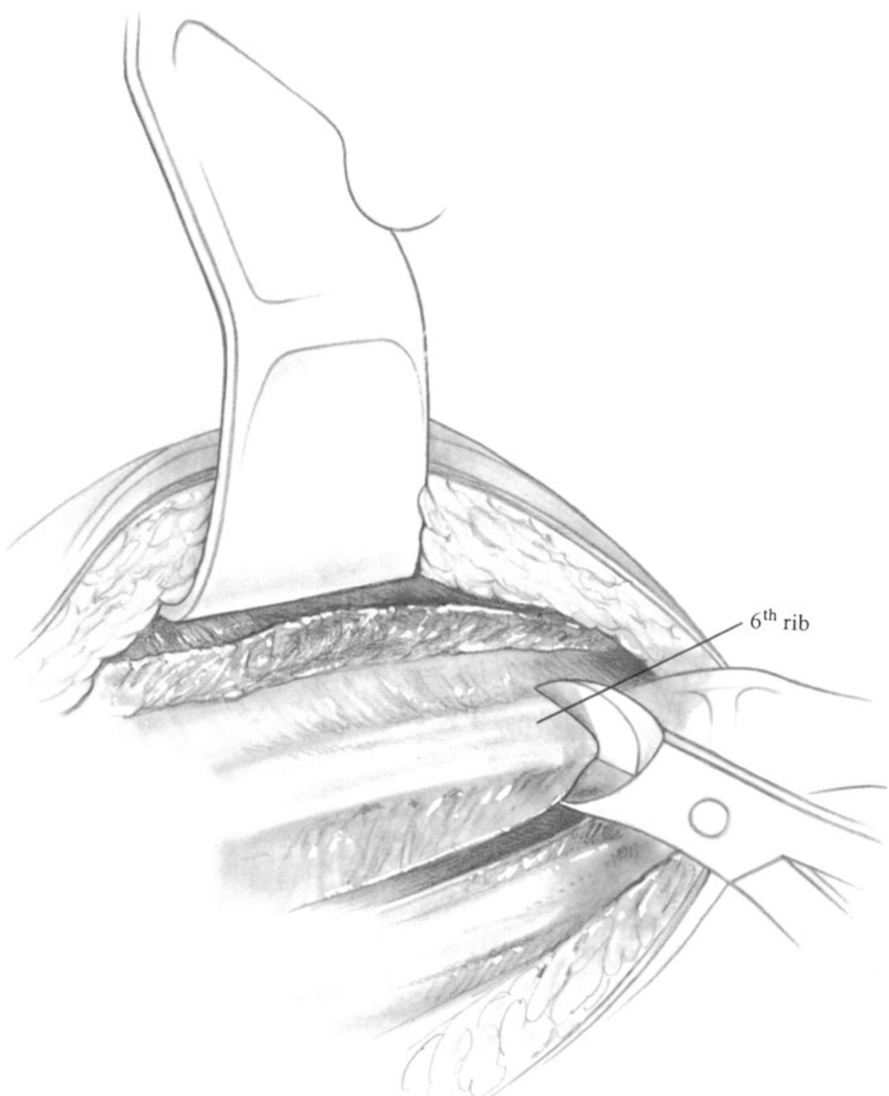


Fig. 8–24

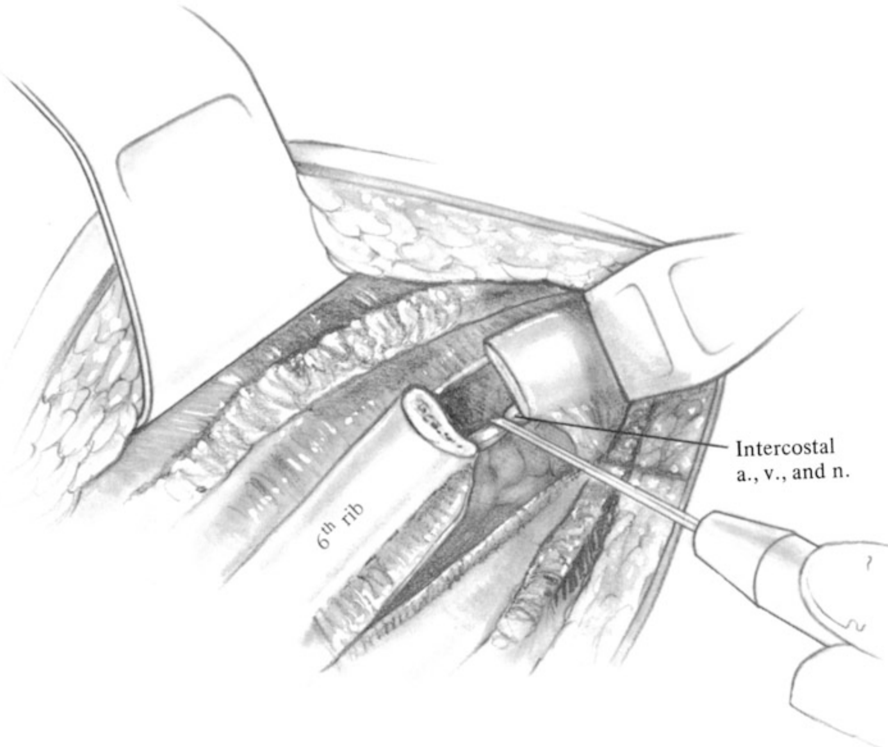


Fig. 8–25

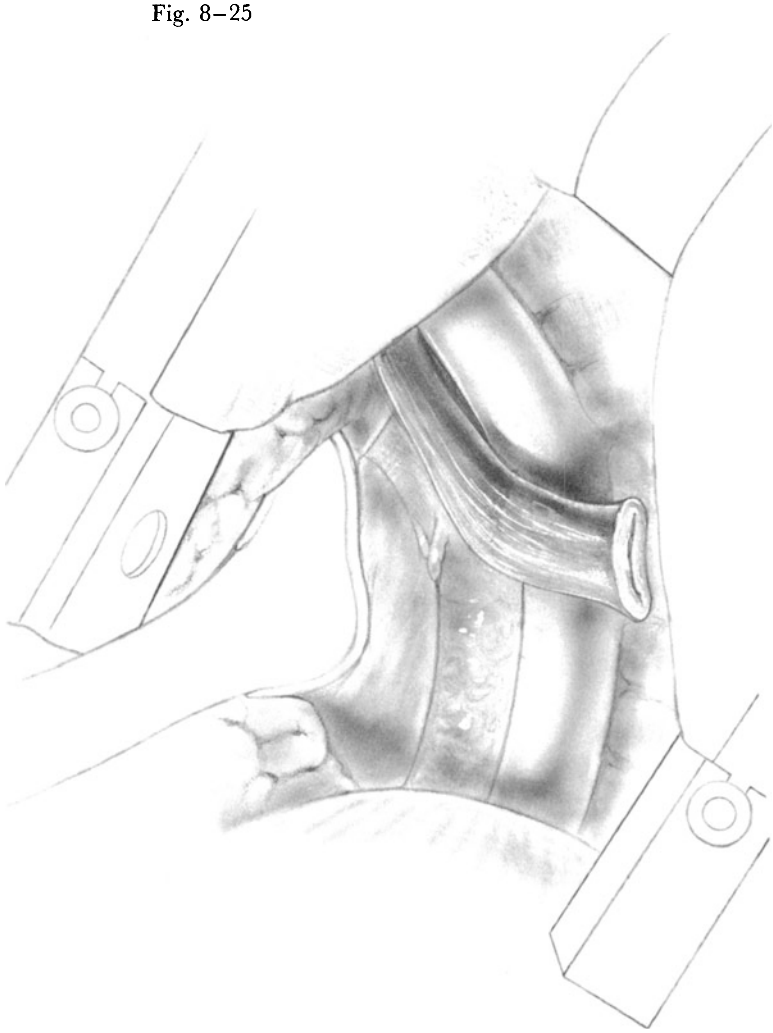


Fig. 8–26

tercostal nerves with their accompanying vessels (**Fig. 8–25**). Reinsert the Finochietto retractor (**Fig. 8–26**). If the exposure is still inadequate, a segment of the fourth rib may also be excised, but this has rarely been necessary.

Enter the space between the anterior wall of the esophagus and the aortic arch with the index finger (**Fig. 8–27a–c**). There are no vascular attachments in this area. The index finger will emerge cephalad to the aortic arch behind the mediastinal pleura. Incise the mediastinal pleura on the index finger,

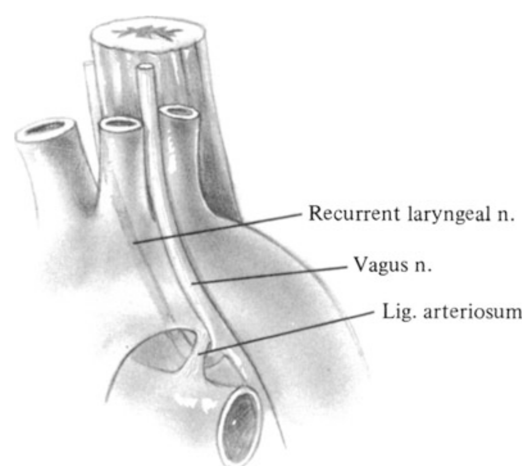


Fig. 8–27a

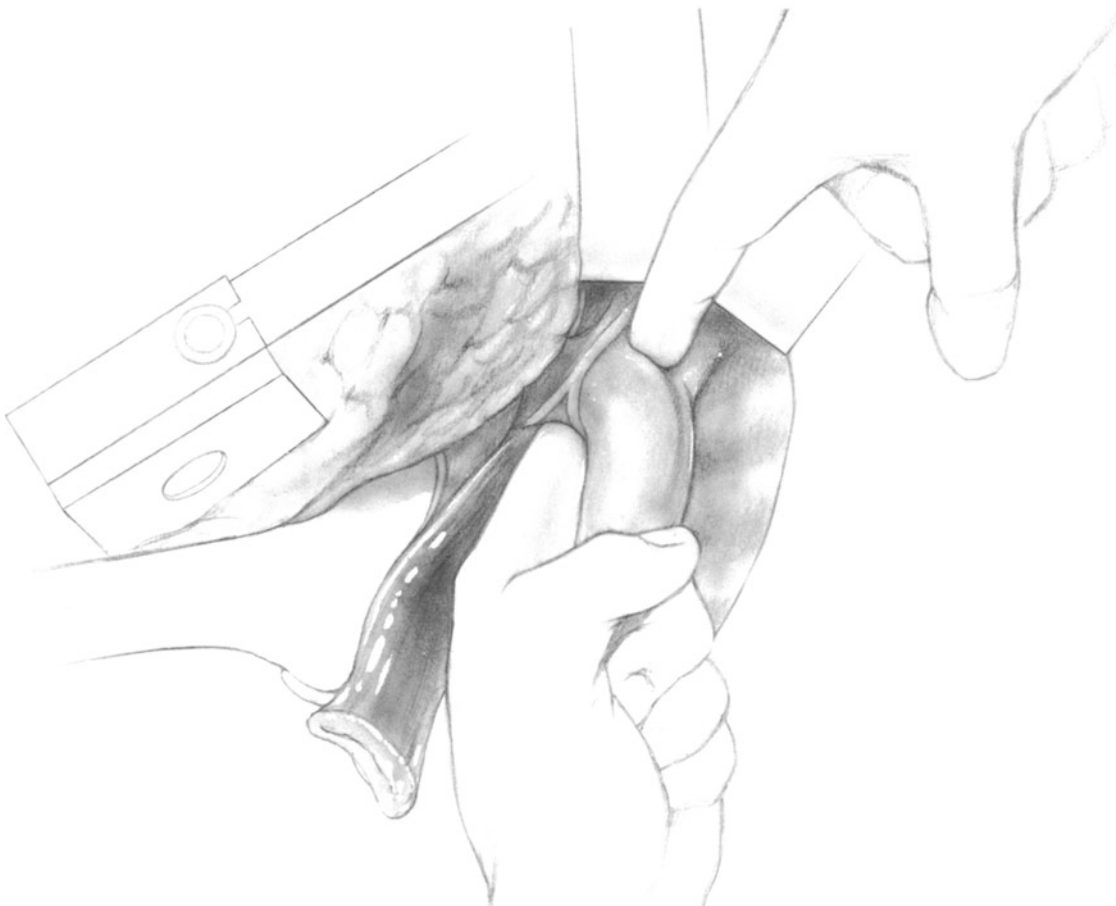


Fig. 8–27b

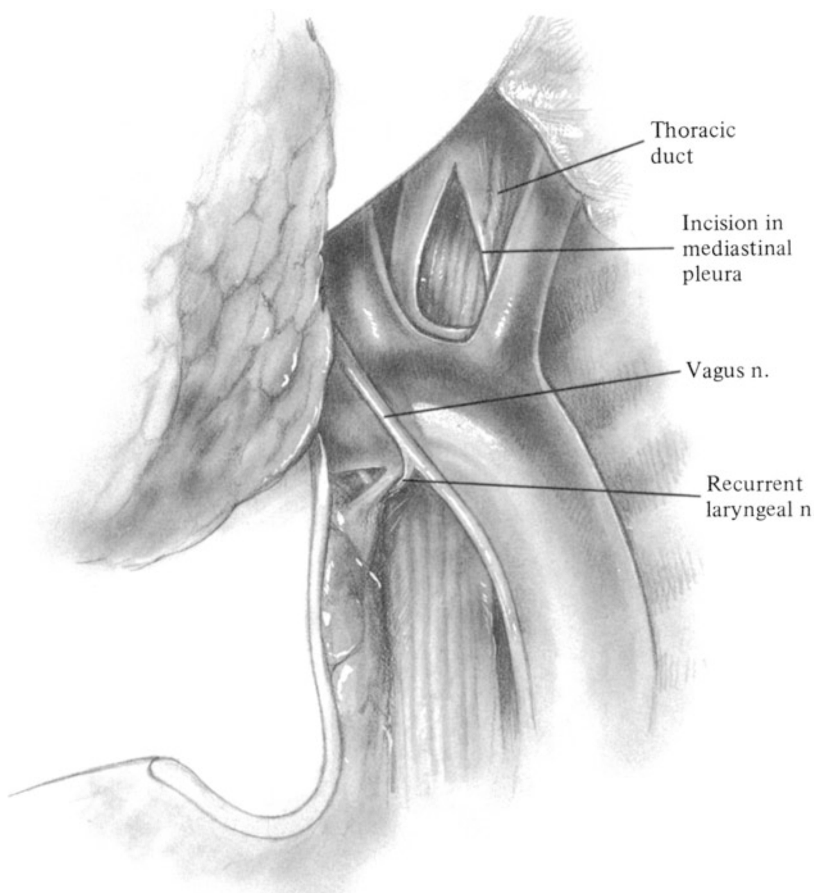


Fig. 8–27c

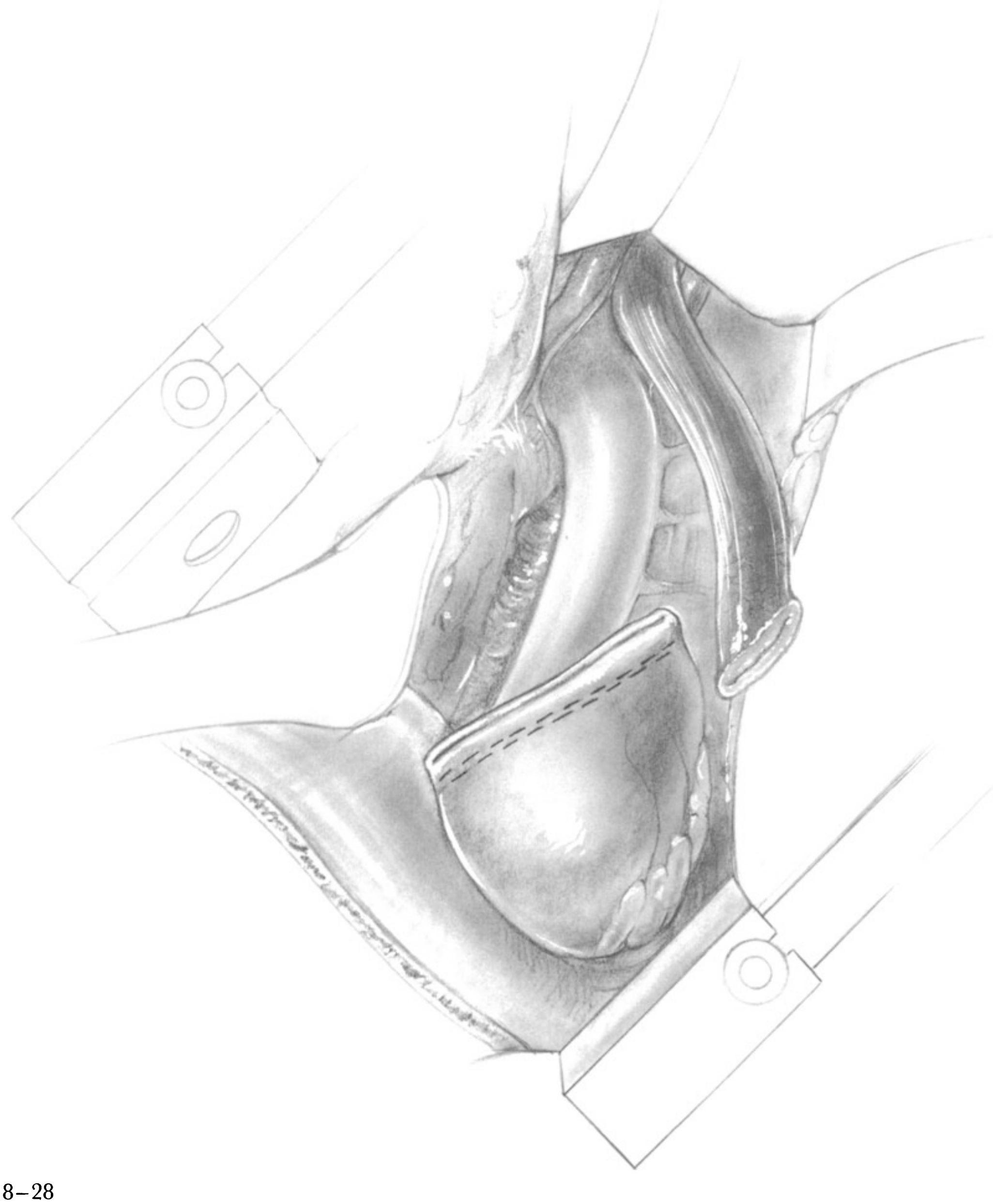


Fig. 8–28

making a window extending along the anterior surface of the esophagus up to the thoracic inlet. Now dissect the esophagus free of all its attachments in the mediastinum in the vicinity of the aortic arch. Avoid damage to the left recurrent laryngeal nerve, to the thoracic duct, and to the left vagus nerve located medial to the esophagus above the aortic arch. One or two vessels may have to be divided between Hemoclips.

Deliver the esophagus from behind the aortic arch up through the window in the pleura between the left carotid and subclavian arteries (**Fig. 8–28**). If the space between the carotid and subclavian arteries is narrow, bring the esophagus out through a pleural incision lateral to the subclavian artery. Irrigate the mediastinum and the esophageal lumen with antibiotic solution.

The esophagogastric anastomosis, as described below, should be constructed in a position lateral and anterior to the aortic arch. Exposure for the anastomosis in this location is excellent. Bring the esophagus down over the anterior wall of the stomach. An overlap of 6–7 cm is desirable. If the esophageal dissection has been carried out without undue trauma, the esophageal segment will have an excellent blood supply even though its distal 10 cm has been liberated from its bed in the mediastinum.

Esophagogastric Anastomosis, Sutured

The technique of sutured esophagogastric anastomosis is described and illustrated in Chap. 7.

Esophagogastric Anastomosis Performed by Stapling Technique (Chassin, Am J Surg, 1978)

This stapling technique for esophagogastric anastomosis involves attaching the posterior aspect of the distal esophagus to the anterior wall of the stomach. It requires an overlap to enable 7–8 cm of the esophagus to lie freely over the front of the stomach. If a 7–8 cm overlap is not available, this stapling technique is contraindicated.

Make a stab wound, 1.5 cm long, on the anterior wall of the gastric pouch at a point 7–8 cm from the cephalad margin of the stomach (**Fig. 8–29**). Insert one fork of the GIA stapling device through the stab wound into the stomach and the other fork into the open end of the overlying esophagus (**Fig. 8–30**).

Fig. 8–29

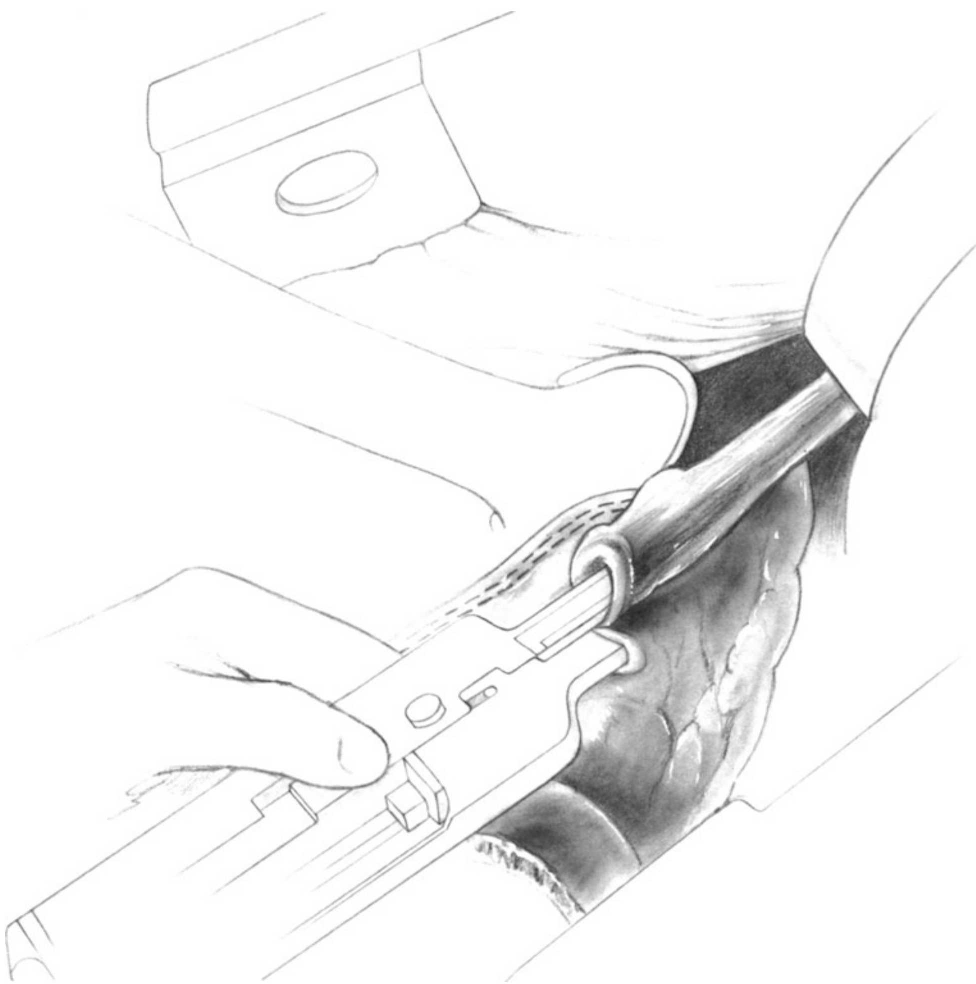


Fig. 8–30

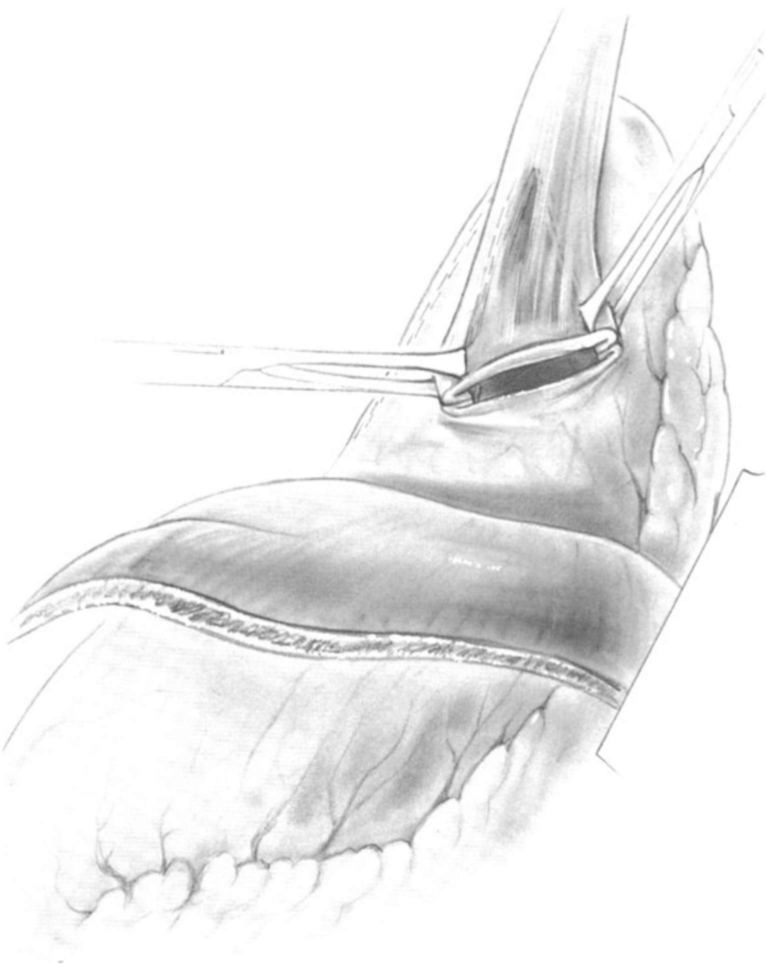


Fig. 8–31

The GIA device should be inserted to a depth of 3.5–4.0 cm. Fire and remove the stapling device. This step will leave both the end of the esophagus and a large opening in the stomach unclosed (**Fig. 8–31**). The posterior layer of the anastomosis will already have been accomplished by the GIA device. Complete the remainder of the anastomosis in an everting fashion by triangulation with two applications of the TA–55 stapler. To facilitate this, insert a 4–0 temporary guy suture through the full thickness of the anterior esophageal wall at its midpoint, carry the suture through the center of the remaining opening in the gastric wall (**Fig. 8–32**), and tie the suture. Apply Allis clamps to approximate the everted walls of the esophagus and stomach. Apply the first Allis clamp just behind the termination of the GIA staple line on the medial side. Hold the suture and the Allis clamps so that a TA–55 device can be applied just beneath the clamps and the suture (**Fig. 8–33**). Tighten and fire the

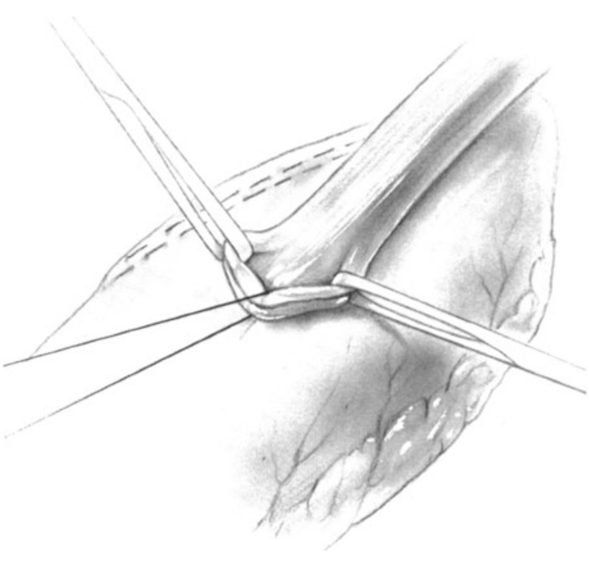


Fig. 8–32

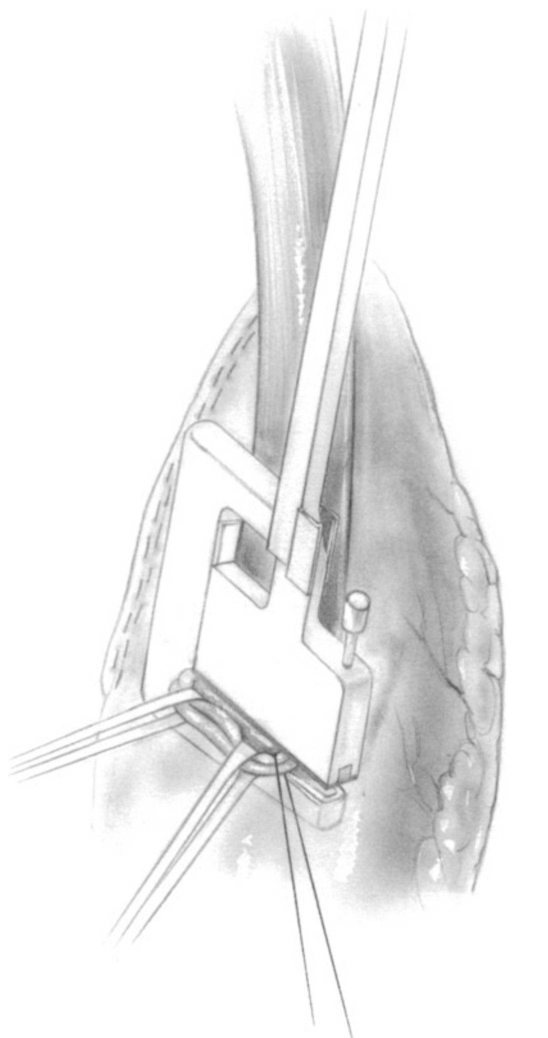


Fig. 8–33

stapling device. Excise the esophageal and gastric tissues flush with the stapling device with a Mayo scissors. Leave the guy suture intact.

Use an identical procedure to approximate the lateral side of the esophagogastric defect. Apply additional Allis clamps. Then place the TA–55 stapling device into position deep to the Allis clamps and the previously placed guy suture. Close and fire the stapler and remove the redundant tissue with the Mayo scissors (**Fig. 8–34**). It is essential that a small portion of the lateral termination of the GIA stapled anastomosis be included in the final TA–55 staple line. Include the guy suture also in this last application of the TA–55. These measures eliminate any possibility of leaving a gap between the various staple lines. The integrity of the anastomosis may be tested by inserting a sterile solution of methylene blue through the nasogastric tube into the gastric pouch. The appearance of the completed stapled anastomosis is shown in **Fig. 8–35**.

Whether a Nissen fundoplication is to be constructed following this anastomosis depends upon

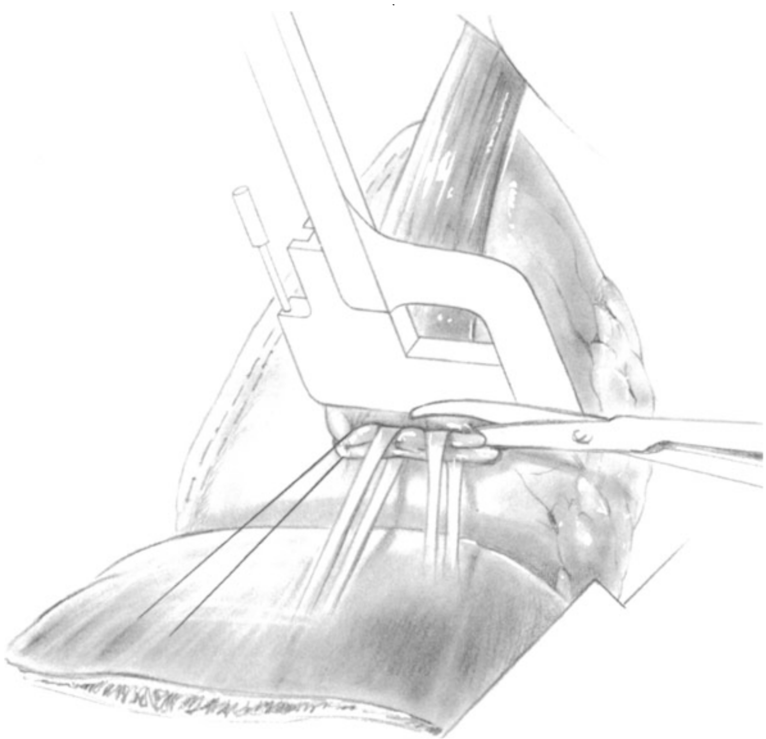


Fig. 8–34

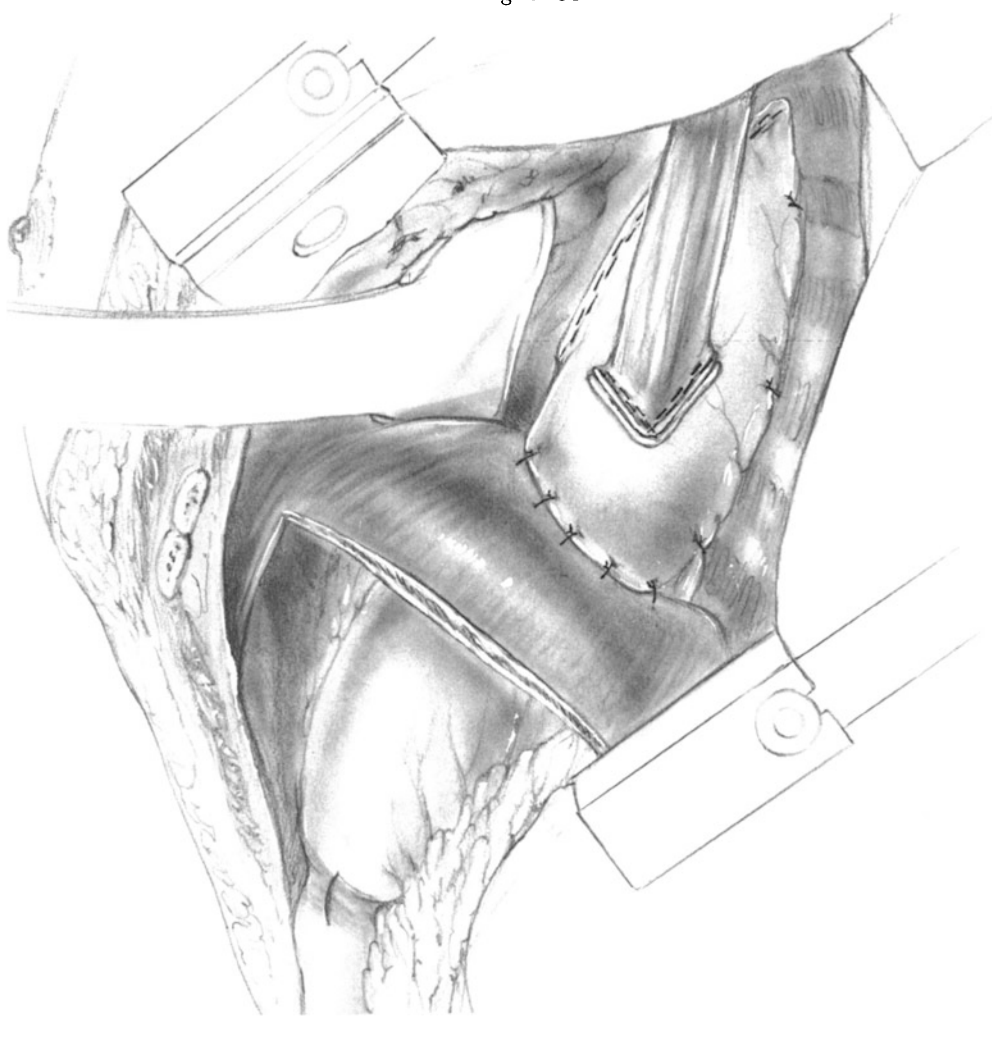


Fig. 8–35

the judgment of the surgeon and the availability of loose gastric wall. In some cases a partial fundoplication can be accomplished.

Esophagogastric Anastomosis Performed by EEA Stapling Technique

The EEA stapling technique is especially suitable for patients in whom the lumen of the esophagus is large enough to admit a 28- or 31-mm stapling device. The esophageal lumen can be measured by attempting to insert a metal sizer which comes in 25-, 28-, and 31-mm sizes. It is dangerous to stretch the esophagus, because this can result in one or more longitudinal tears of the mucosa and submucosa. If a tear is detected, resect an additional segment of the esophagus to remove the laceration. If the tear is not detected and a stapled anastomosis is constructed, postoperative leakage is a potentially dangerous complication. If dilatation of the esophagus is necessary, do it with great caution. Next, attempt to insert the 25-mm, and then the 28-mm, sizer. If the 28-mm sizer passes easily, then the EEA stapling technique is a good one. If only the 25-mm sizer can be inserted, there is danger of postoperative stenosis when this size staple cartridge is used. Although this type of stenosis will frequently respond well to postoperative dilatation, we prefer to utilize the GIA technique described above (Fig. 8–29 to 8–35). Using the GIA technique will correct for the narrow esophagus without requiring any postoperative dilatation. After inserting a 28- or 31-mm sizer, place a purse-string suture of 2–0 Prolene, making certain to include the mucosa as well as the muscularis in each bite. Then insert four guy sutures, one in each quadrant of the esophagus, to help keep the lumen open.

Make a 3-cm linear incision somewhere in the antrum of the gastric pouch utilizing the electrocautery. Through this opening in the anterior wall of the gastric pouch, insert the cartridge of an EEA stapling device after having removed the anvil.

Then choose a point 5–6 cm from the proximal cut end of the gastric pouch and insert a small purse-string suture of 2–0 Prolene. After this has been accomplished, make a stab wound in the middle of this purse-string (**Fig. 8–36**) and permit the shaft of the EEA device to emerge from the stab wound. Tie the purse-string suture around the shaft. Now attach the anvil to the shaft of the EEA device. Gently insert the anvil of the device into the open end of the esophagus. Draw the esophagus down over the anvil. When this has been accomplished, tie the purse-string around the instrument's shaft, fixing the esophagus in position (**Fig. 8–37**). Now approximate the anvil to the cartridge of the EEA device by turning the wing-nut in a clockwise direction. After this has been accomplished, fire the stapling device.

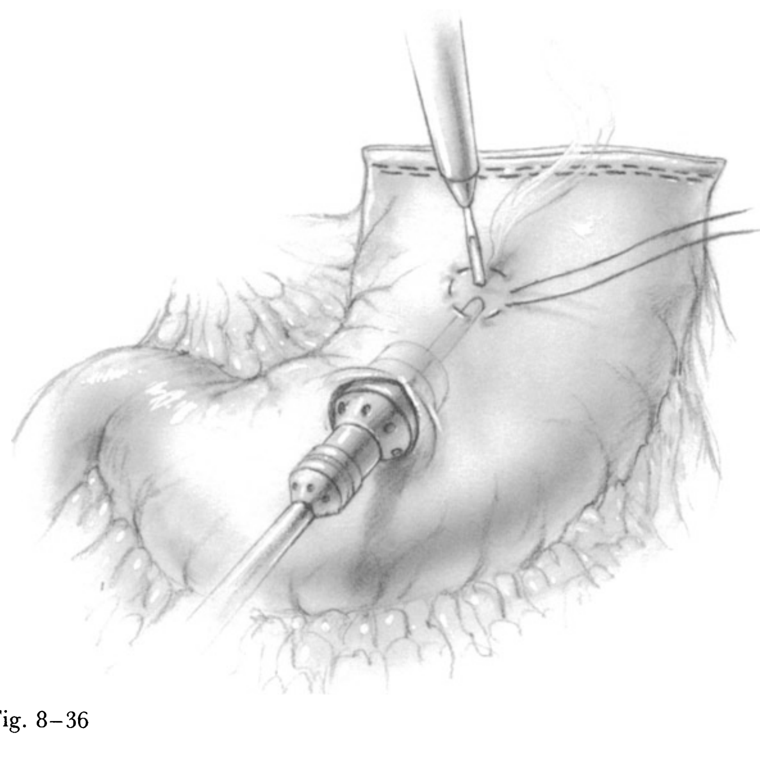


Fig. 8–36

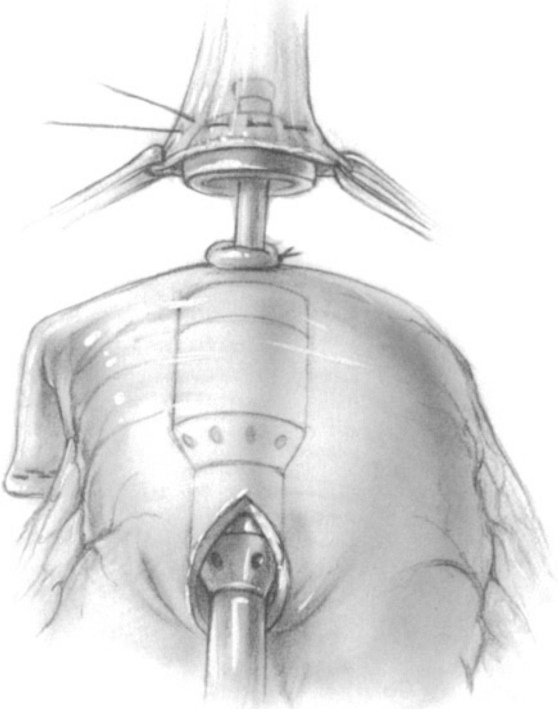


Fig. 8–37

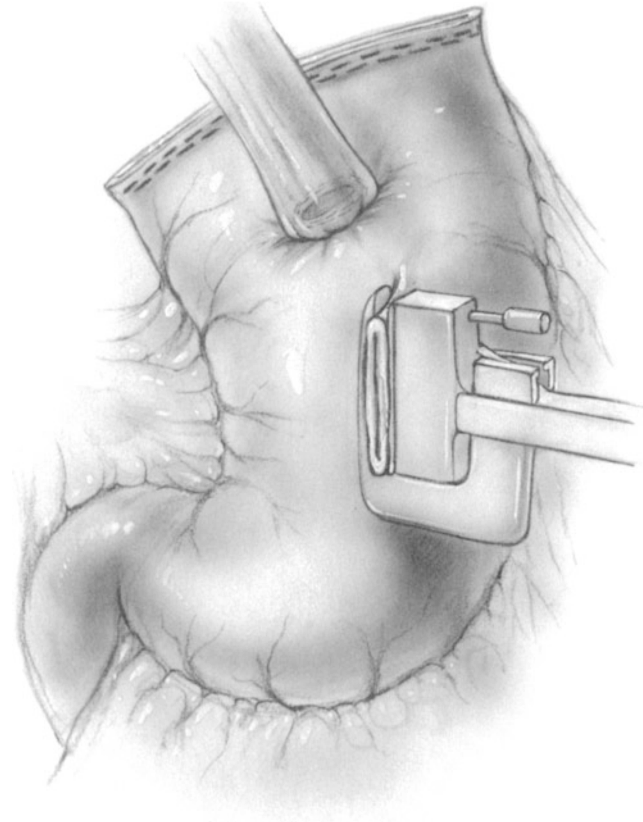


Fig. 8–38

Now rotate the wing-nut for seven half-turns in a counterclockwise direction, gently disengage the anvil from the newly created anastomosis, and remove the entire device from the gastric pouch. Carefully inspect the newly constructed circular anastomosis between the open end of the esophagus and the anterior surface of the gastric pouch to see that all the staples have fired and that the anastomosis is intact. Confirm this by inserting the index finger through the previously made gastrotomy incision and pass the finger into the esophagus, confirming the presence of an open lumen. Now apply Allis clamps to the gastrotomy incision on the anterior wall of the gastric pouch. Apply a TA–55 stapling device with 4.8-mm staples and fire. Excise any redundant gastric tissue and lightly electrocoagulate the everted mucosa. Remove the staple device and carefully inspect the staple line to be sure that all of the staples have closed. Many surgeons will oversew the gastrotomy incision with a layer of continuous or interrupted Lembert sutures of a nonabsorbable nature, although this step may not be essential if 4.8 mm staples are used (**Fig. 8–38**).

Muehrcke and Donnelly reported four leaks from stapled gastrotomies in 195 patients undergoing esophageal resection using EEA stapling instruments. One possible explanation for the failure of the stapled gastrotomy closure to heal properly is the use of a 3.5-mm staple. In a stomach of normal thickness, the use of a small staple can produce a line of necrosis. We prefer that a 4.8-mm staple be used when closing the stomach. These authors found that there was a reduction in the leak rate from their gastrotomy closures if they oversewed the gastrotomy staple line with a continuous noninverting layer of 3–0 Mersilene.

Stabilizing the Gastric Pouch

To prevent any gravity-induced tension on the anastomosis, the apex of the gastric pouch should be sutured to the mediastinal pleura or the prevertebral fascia with 3–0 silk or Tevdek sutures.

The gastric pouch should then be fixed to the enlarged diaphragmatic hiatus with interrupted 3–0 silk or Tevdek sutures, which attach the gastric wall to the margins of the hiatus (Fig. 8–35). These sutures should be 2 cm apart and should not penetrate the gastric mucosa, lest they induce a gastropleural fistula.

Perform a needle-catheter jejunostomy for postoperative enteral alimentation.

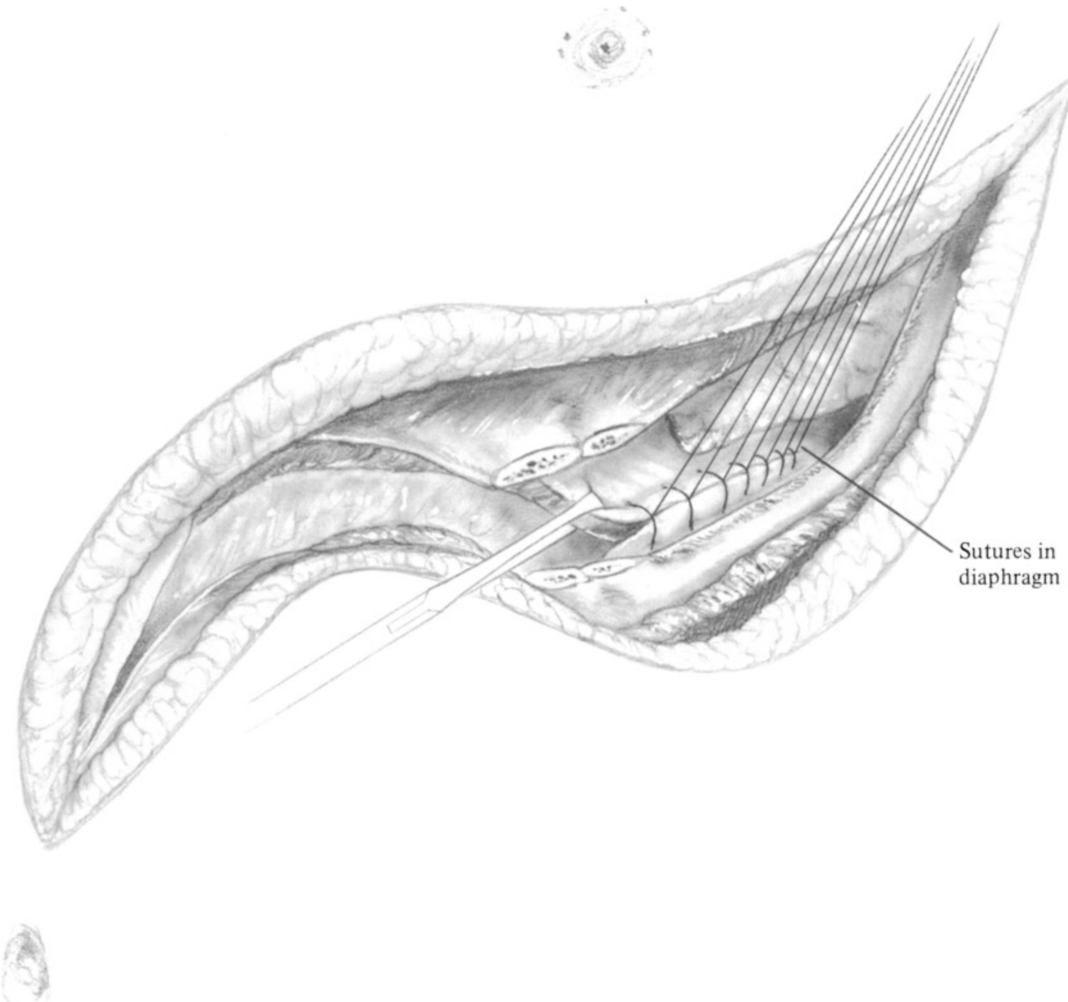


Fig. 8–39

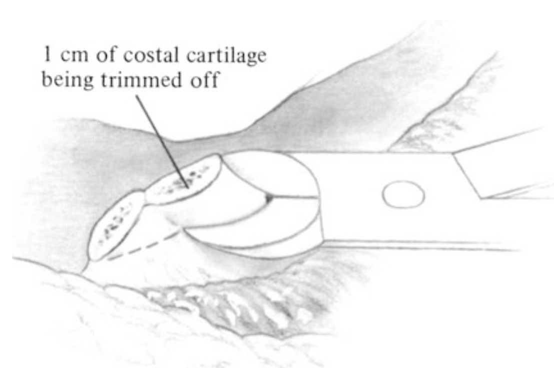


Fig. 8–40

Closure

Irrigate the thoracic and abdominal cavities with an antibiotic solution. This should be suctioned off and the incision in the diaphragm closed with interrupted sutures of 2–0 Tevdek (**Fig. 8–39**). Take fairly large (1 cm) bites, as a dehiscence of this suture line can have serious consequences, such as herniation of small intestine into the chest.

Excise approximately 1 cm of cartilage from the costal margin to improve apposition (**Fig. 8–40**). Close the incision in the costal margin with one or two sutures of 2–0 monofilament stainless steel wire (**Fig. 8–41**). Insert four or five periocostal sutures of No. 1 PDS to approximate the sixth and seventh ribs (**Fig. 8–42**). Bring a 30F plastic catheter through the ninth intercostal space in the anterior axillary line and carry it up to the level of the anastomosis. Suture it there to the parietal pleura posterior to the aorta, using 4–0 catgut. Inflate the lung to eliminate any atelectatic patches. If a significant number of air

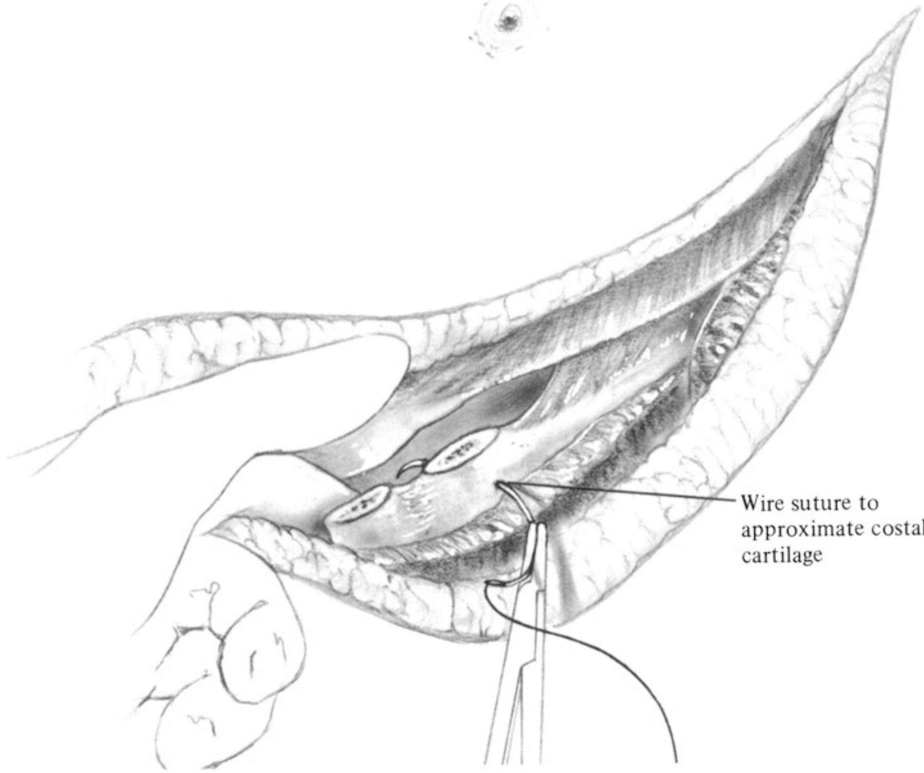


Fig. 8–41

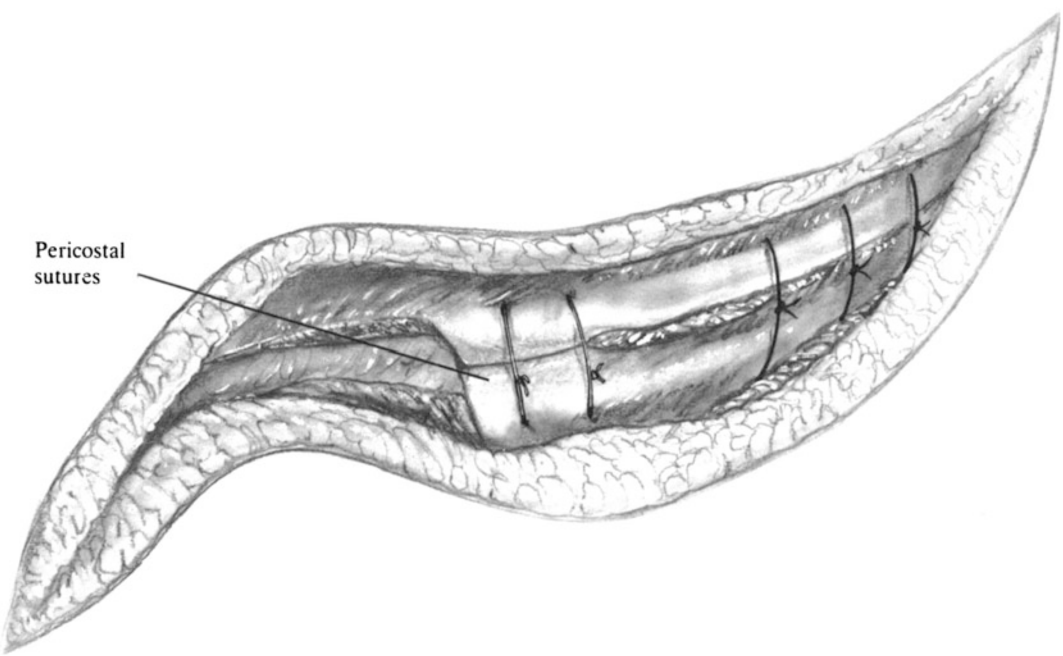


Fig. 8–42

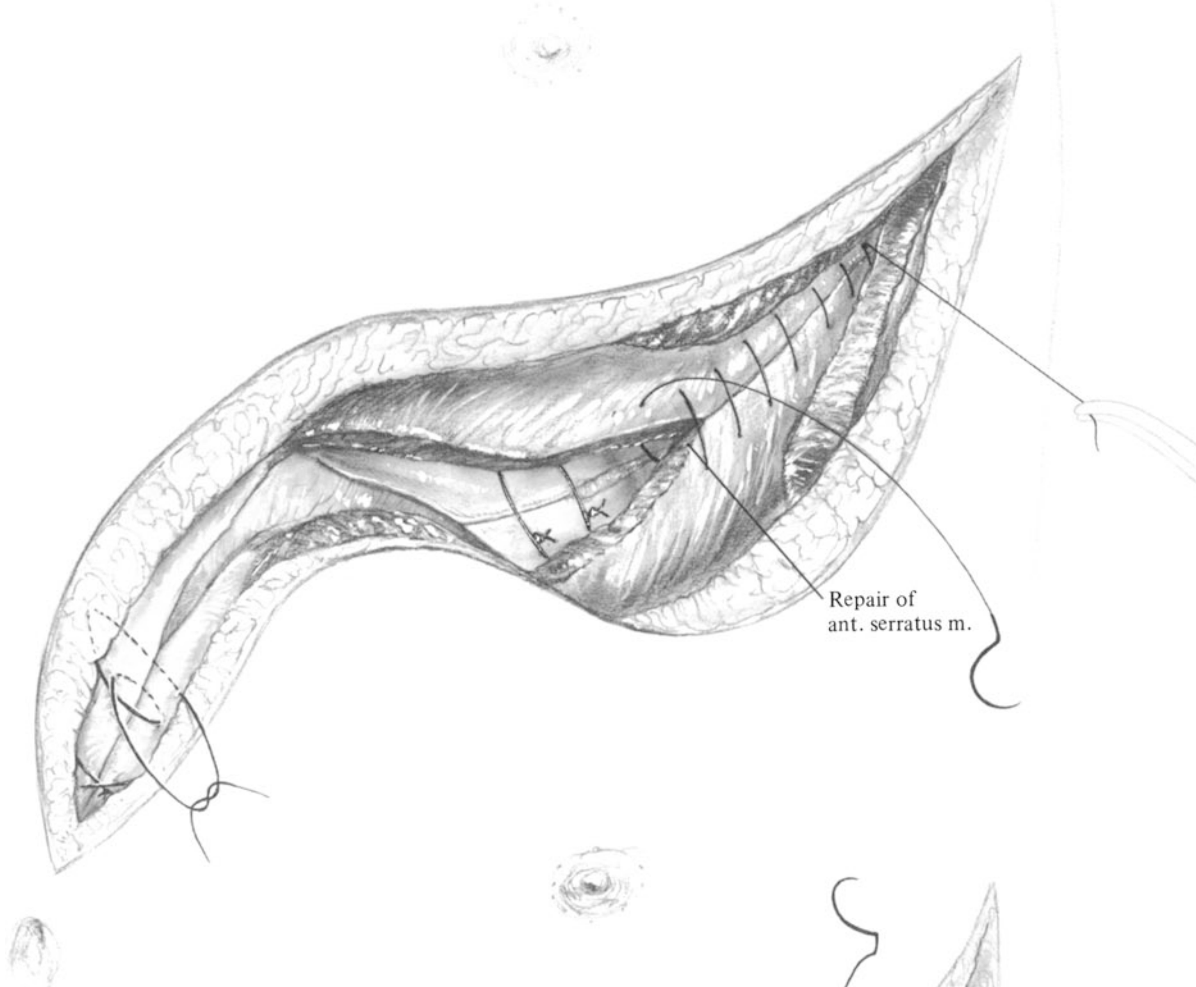


Fig. 8–43

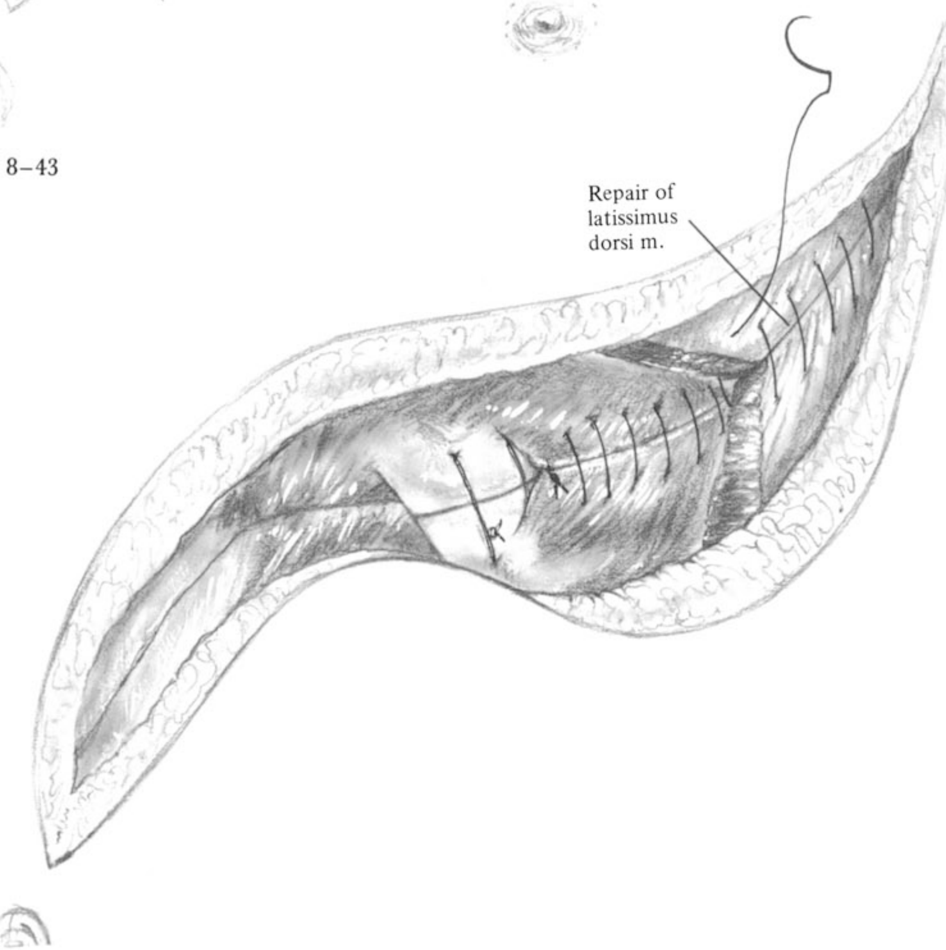


Fig. 8–44

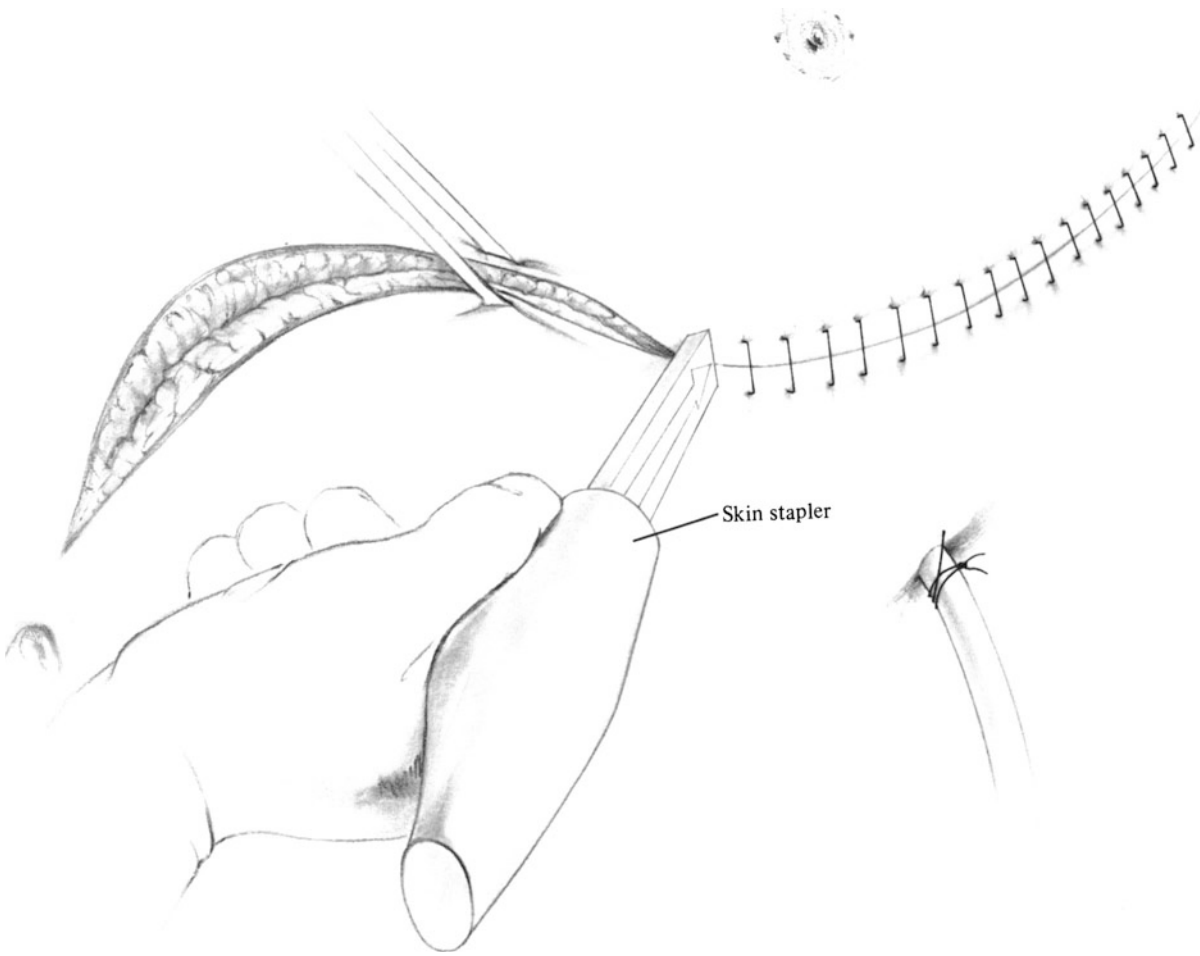


Fig. 8–45

leaks from the lung are noted, pass a second chest catheter anterior to the lung up to the apex of the thorax. Tie the pericostal sutures and close the nuscles in two layers with a continuous 2–0 PG atraumatic suture in each (**Figs. 8–43 and 8–44**).

Close the abdominal portion of the incision with interrupted No. 1 PDS Smead-Jones sutures as described in Chap. 5. Use staples or a subcuticular suture to close the skin (**Fig. 8–45**). No drains should be needed in the abdominal cavity.

Postoperative Care

(See Chap. 7.)

Complications

(See Chap. 7.)

References

Chassin JL. Esophagogastrectomy: Data favoring end-to-side anastomosis. Ann Surg 1978;188:22.

Chassin JL. Stapling technic for esophagogastrostomy after esophagogastric resection. Am J Surg 1978; 136:399.

Fisher RD et al. Esophagogastrostomy in the treatment of carcinoma of the distal two-thirds of the esophagus. Ann Thorac Surg 1972;14:658.

Muehrcke DD, Donnelly RJ. Complications after esophagogastrectomy using stapling instruments. Ann Thorac Surg 1989;48:257–262.

9 Operations to Replace or Bypass the Esophagus: Colon or Jejunum Interposition; Transhiatal Esophagectomy with Gastric Pull-Up

Concept: To Replace or to Bypass the Esophagus

Colon Interposition or Bypass

Using the colon (or jejunum) to replace resected segment of the esophagus permits the surgeon to preserve intact a functioning stomach. Performing the cologastric anastomosis 10 cm down from the gastric cardia will generally minimize gastrocolic reflux. Achieving a sufficient length of viable colon is, with rare exceptions, feasible. One drawback to using the colon as a substitute esophagus is the risk of impairing the venous blood flow either by injuring the veins in the colon mesentery or impairing venous return by leaving an inadequate aperture in the diaphragm or at the apex of the thorax for the colon and its mesentery. Under these conditions venous infarction can occur. Following careful surgery, this complication should be quite rare. Belsey experienced one colon infarct in 92 left colon interposition operations. This complication appears to be more common when the right colon is used as opposed to the left colon (Wilkins). When performed for benign disease, the left colon interposition is a safe operation. Belsey reported a 4.3% mortality, but no anastomotic leaks. Skinner, in discussing a paper by Mansour, Hansen, Hersh, Miller, and others, stated that they had had no hospital deaths in 40 consecutive operations for colon interposition after the resection of nondilatable benign strictures of the esophagus. Also, Skinner's long-term functional results following the use of the left colon interposition have been good. Belsey, after following his patients for 1–6 years, reported 81% good and 17% satisfactory results. Wilkins followed a group of 21 patients for 5–24 years and reported excellent functional results. Glasgow, Cannon, and Elkins also reported good or excellent results and no operative deaths following 17 left and 1 right colon interposition operations for benign esophageal disease. These patients had been followed for 1–6.5 years. Good results following colon interposition in children were reported by Kelly, Shackelford, and Roper, and, in adults, by DeMeester et al. and Curet-Scott, Ferguson, Little and Skinner.

Gastrocolic regurgitation has rarely been symptomatic, although some patients have noted a slow transit time for a bolus of food to pass from the colon into the stomach.

The major objection to using the colon as an esophageal substitute has been the fact that more time is required to perform three anastomoses, as compared to the single esophagogastric anastomosis that is required following a gastric pull-up in the neck. With modern stapling techniques, the colocolonic and the cologastric anastomosis can each be accomplished in a matter of a very few minutes, and the colon can be mobilized rapidly *by an experienced colon surgeon.* We do not feel that there is a significant difference in the time or the complexity of surgery when one compares the colon with the gastric esophageal substitute, provided that the surgeon is equally experienced and skilled in both areas.

Jejunum Interposition

For patients requiring the replacement of a relatively short segment of the esophagus, interposing a segment of jejunum is extremely effective in preventing further reflux. Polk noted no evidence nor any symptoms of reflux following 28 such operations in patients who had previously undergone many failed surgical procedures for the complications of reflux esophagitis. Polk's mortality was 4%. Moylan, Bell, Cantrell, and Merendino also reported very good functional results in 16 of 17 patients followed 10–17 years. Since peristalsis in the jejunum is considerably more vigorous than in the colon, it may well be that for patients who have had many failed operations for reflux esophagitis, interposing the jejunum may be more effective for a short segment replacement than the colon. However, mobilizing a 15–20 cm segment of jejunum with preservation of both venous and arterial circulation can sometimes be difficult and time consuming. The jejunum interposition is contraindicated if the segment of jejunum must reach above the level of the inferior pulmonary vein.

Gastric Pull-Up

It has long been recognized that resection of a peptic stricture of the lower esophagus followed by esophagogastrostomy is often followed by disastrous consequences (Belsey). This is true because even when the esophagogastric anastomosis is made end-to-side, postoperative gastroesophageal reflux may occur. In patients who undergo esophagogastrectomy for carcinoma of the esophagus, this may not be a prominent symptom because of their limited life expectancy. Orringer and Orringer (1982) recommended total thoracic esophagectomy with esophagogastric anastomosis in the neck for patients with benign esophageal diseases such as neuromotor disorders or strictures that have failed to respond to multiple previous operations. When the stomach is stretched to reach the neck, it becomes a tubular organ and the incidence of reflux esophagitis is said to be insignificant. Orringer claims that, following the gastric pull-up operation, the functional results are good. On the other hand, in 1977 Orringer, Kirsh, and Sloan stated:

> We believe that colonic interposition with isoperistaltic left colon based on the ascending branch of the left colic artery as described by Belsey, is currently the best method of esophageal reconstruction for benign disease in relatively healthy patients in the first four to five decades of life. The relative size, length, constancy of blood supply, and ease of mobilization of the left colon and transverse colon through a left thoracoabdominal incision make this segment of bowel ideal for either one stage esophagectomy and reconstruction or for substernal bypass.

Skinner; Wilkins; DeMeester; Glasgow, Cannon, and Elkins; and Belsey—as well as this author—agree with the above statement. However, Orringer and Orringer (1983) later changed this opinion so that they now believe "that transhiatal esophagectomy without thoracotomy is the preferred approach in virtually all patients requiring esophageal resection." Follow the esophagectomy with a gastric pull-up, these authors advise. Among the indications for which Orringer and Orringer (1982) utilize these operations are advanced achalasia, scleroderma, and even reflux esophagitis with complications that have not been relieved by previous operations. Morton, Karwande, and associates reported that following gastric pull-up operations, passage of food from the neck to the duodenum occurred more as a result of gravity than of gastric peristalsis. In this respect the gastric pull-up is similar to the colon interposition operation.

Reversed Gastric Tube

First reported in 1955 by Heimlich and also by Gavriliu, the reversed gastric tube has achieved a certain degree of acceptance as a substitute for the esophagus in adults as well as in children. Heimlich (1975) reported performing this operation in 67 patients with a 4.2% operative mortality and with good functional results. Nine of these patients had previously undergone colon or jejunum interposition operations that had failed. This operation requires the construction of a tube 30 cm by 2.5 cm in size from the greater curvature of the stomach, with its blood supply based on the left gastroepiploic artery and vein. This tube is generally anastomosed to the cervical esophagus. It can be brought to the neck by way of the bed of the resected thoracic esophagus, by the substernal route, or by the subcutaneous route, all with equally good results according to Heimlich. Anderson and Randolph noted satisfactory results with the gastric tube interposition in children.

Since we have no experience with this operation, and since there are few reports documenting its risks and end results, a description of the operative technique is not included in this volume.

Concept: To Preserve the Esophagus with a Bile Diversion Operation (See Chap. 14)

Reflux Esophagitis Following Esophagogastrectomy

When a proximal gastrectomy has been performed with removal of more than half the stomach, it may not be possible to perform an end-to-side esophagogastric anastomosis because the remaining pouch of antrum is too small. In these patients reflux esophagitis is likely to occur. When a proximal gastrectomy is performed for cancer, truncal vagotomy combined with hemigastrectomy will generally eliminate any significant amount of acid secretion; reflux esophagitis nevertheless occurs because bile often backs up into the esophagus through an incompetent pyloric sphincter. The reflux of bile produces more damage to the esophagus than is provoked by the reflux of acid. This situation may be remedied by performing a total gastrectomy with an esophagojejunostomy by the Roux-en-Y technique. However, this may be difficult as a secondary operation, requiring a thoracoabdominal incision. An acceptable alternative is to transect the duodenum about 2 cm beyond the pylorus. Close the duodenal stump. Then anastomose the proximal cut end of the duodenum to a Roux-en-Y segment, 60 cm in length. Since there is no significant amount of acid being secreted by the residual gastric pouch, and since bile reflux is eliminated by the Roux-en-Y operation, reflux esophagitis will subside. In performing this operation, be sure to *preserve the right gastric and right gastroepiploic blood supply* to the gastric remnant because these two vessels constitute its only blood supply (see Figs. 14–3 to 14–5).

When the patient has undergone an esophagogastrectomy for benign disease, and there is some doubt whether a complete vagotomy was performed, preoperative acid studies of the gastric pouch may be beneficial. Anastomosing a Roux-en-Y segment of jejunum to a gastric pouch that produces a significant amount of acid may produce a marginal ulcer. In this case the bile diversion operation is probably contraindicated unless a simultaneous vagotomy can be accomplished. Smith and Payne have reported success in relieving reflux esophagitis after esophagogastrectomy by the use of Roux-en-Y bile diversion.

Reflux Esophagitis Following Multiple Failed Antireflux Operations

Patients who have had multiple failed operations aimed at eliminating gastroesophageal reflux, may be helped by a Collis–Nissen operation (see Chap. 13). If they have a nondilatable stricture, a resection and jejunum or colon interposition will be necessary. However, approaching the esophagogastric junction after several previous operations can be a formidable as well as hazardous undertaking in some patients. In such cases, one can consider performing a *distal gastrectomy followed by closure of the duodenal stump and anastomosis of the gastric pouch to Roux-en-Y limb of jejunum.* Payne advocated performing truncal vagotomy in all of these patients. He reported a series of 15 cases, 6 of whom also suffered from strictures. Seven of the patients had acquired a short esophagus secondary to chronic esophagitis. Two of the patients suffered from scleroderma of the esophagus with esophagitis and stenosis. Both had previous failed surgery. Another three patients had severe esophagitis and strictures following treatment of achalasia. All of the patients achieved relief of their esophagitis and the strictures responded nicely to dilatations following distal gastrectomy and Roux-en-Y gastrojejunostomy. Payne pointed out that this operation did not relieve the problem of gastroesophageal regurgitation. Consequently, some of the patients suffered from regurgitation of a bland liquid into the mouth when stooping or recumbent. This regurgitation did not produce any irritation. For this reason bile diversion is not an ideal solution to the problem of recurrent esophageal reflux, but the operation, in some patients, will be much safer than a repeated attack upon the esophagogastric junction.

It is interesting that Royston, Dowling, and Spencer performed the same operation in eight patients with severe esophagitis and strictures of long duration, but they did not include vagotomy. All of their patients had excellent results over a follow-up period of 11–20 months. In fact, some of the patients with strictures showed spontaneous resolution and did not require dilatation. Apparently, performing an adequate distal gastrectomy may reduce the gastric acidity sufficiently for the patient to tolerate a Roux-en-Y anastomosis to the gastric pouch without producing a marginal ulcer. If a marginal ulcer does occur, a transthoracic vagotomy may be necessary, if the ulcer does not heal with medical therapy.

Indications

Short-Segment Interposition

Reflux esophagitis with nondilatable stricture

Repeated failed operations for reflux esophagitis

Total Replacement or Bypass of Thoracic Esophagus

Caustic burns of esophagus with permanent stricture

Failed operations for neuromotor disorders of the esophagus with reflux and permanent stricture

Resection of esophagus for post-emetic perforation or intrathoracic anastomotic leaks

(See also Table 9–1)

Preoperative Care

Nutritional rehabilitation whenever indicated

Perioperative antibiotics

If colon interposition is contemplated, preoperative barium colon X ray or colonoscopy and arteriography of the superior and inferior mesenteric vessels to delineate colon circulation

Routine bowel preparation if colon is to be employed

Operative Technique—Colon Interposition, Long Segment

Incision—Resection of Esophagus

In patients who have experienced irreversible strictures following a caustic burn of the esophagus, there are no quantitative data to determine whether removing the destroyed esophagus carries with it a

Table 9–1. Indications for Various Types of Esophageal Substitution

	Colon Interposition or Bypass	Jejunum Interposition	Gastric Pull-Up	Reverse Gastric Tube
Benign disease				
short lesion	Yes	Yes	No	No
long lesion—adult	Yes	No	No	Yes
Malignant disease[a]				
CA thoracic esophagus–subtotal esophagectomy	?	No	Yes	No
CA cervical esophagus–pharyngolaryngectomy	?	No	Yes	No

[a] CA = carcinoma of

greater risk than the risk of the patient developing esophageal carcinoma if the organ is left behind. In the young patient we would tend to remove the esophagus and replace it with a long segment of left colon using a 6th interspace left thoracoabdominal incision (see Figs. 8–3 to 8–8). Patients who have an irreversible stricture due to peptic esophagitis will require resection of the esophagus. Esophagectomy is also performed on patients who have undergone failed operations for neuromotor esophageal disorders or who have had diversion–exclusion operations (see Chap. 17) for esophageal perforations or for anastomotic leakage. Orringer and Orringer (1983) do not open the chest in most of these patients; instead, they perform a transhiatal esophagectomy from the abdominal and cervical approaches.

We prefer a 6th interspace left thoracoabdominal incision for most of these esophagectomies. Close the gastroesophageal junction in an area relatively free of disease using the TA-55 or TA-90 stapler on the stomach side. Also close the esophageal end with another application of the stapling device. Dissect the esophagus out of the mediastinum. If the esophagus is markedly fibrotic, this dissection may require a scalpel. After the esophagus has been freed to the arch of the aorta, dissect the esophagus out from beneath the arch of the aorta as illustrated in Fig. 8–27. Temporarily leave the esophagus in its bed until the colon has been liberated.

Colon Dissection

The initial step in preparing a long colon segment is to liberate the hepatic flexure as well as the entire transverse and descending colon. If necessary, extend the thoracoabdominal incision below the umbilicus. Also dissect the omentum away from the transverse colon and its mesentery, as illustrated in Figs. 28–5 and 28–6 and in Figs. 37–1 to 37–6.

With this accomplished, inspect the blood supply of the left and transverse colon. Preserving the left colic artery will in almost every case permit transection of the middle colic vessels close to the point of origin and will yield a segment of colon that could include a good portion of the descending colon as well as the entire transverse colon, if that should be necessary. We have not encountered any cases where the "marginal artery" did not continue unimpeded from the left colon around to the transverse colon. However, this should be checked by careful palpation of the marginal artery as well as transillumination of the mesentery. Apply bulldog vascular clamps along the marginal artery at the points selected for division and check the adequacy of the pulse in the vessels being retained to supply the transplanted segment.

In order to assure a vigorous blood supply to the proximal portion of the transverse colon, which will provide the length necessary to reach the cervical region, it will be necessary to divide and ligate the middle colic artery at a point well proximal to its bifurcation. This will allow the blood flow from the left colic artery to enter the left branch of the middle colic and continue along the right branch to nourish the right portion of the transverse colon. For this reason, it is critical that this division and ligature of

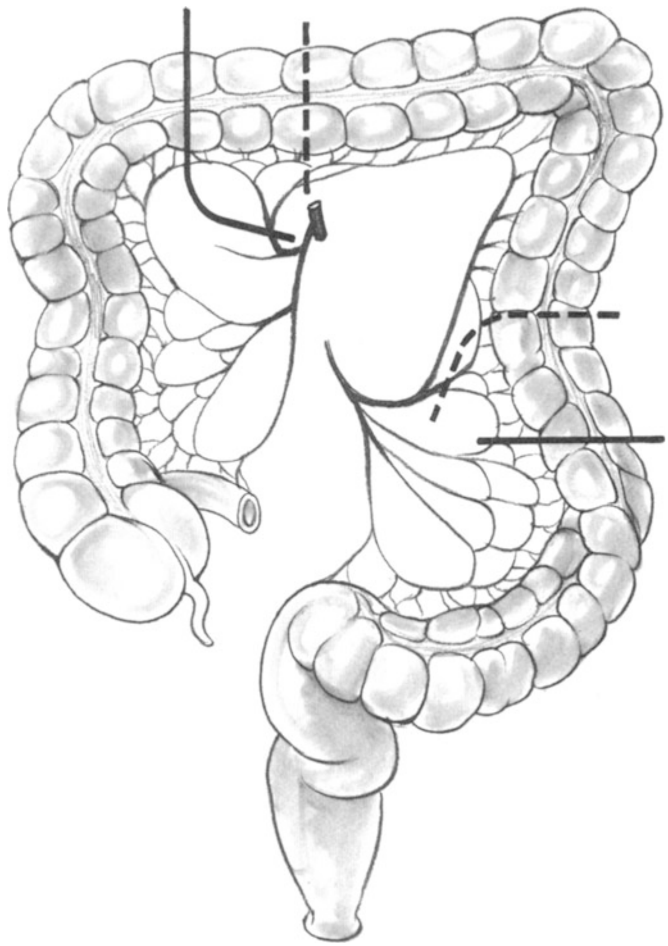


Fig. 9–1a

the middle colic artery and vein be done with great care (see line BB in **Fig. 9–1A**).

Estimating the Length of Colon Required to Reach the Neck

After the omentum has been dissected off the colon and after both the left and right colon segments have been freed from the posterior abdominal wall, grasp the splenic flexure at the point of termination of the left colic artery and draw this segment of colon in a cephalad direction towards the sternum. Then measure the distance from this point (point X in **Fig. 9–1B**) on the sternum to the neck. This distance will approximate the amount of colon that will be required going in a proximal direction from the termination of the left colic artery. Add about 4 or 5 cm to the estimate and insert a marking stitch in the right transverse colon at this point. In most cases the point that was marked will be to the right of the middle colic vessels. This indicates that division of the origin of the middle colic artery and vein will be required.

Transect the colon at the proximal margin of the segment selected for transplantation. Restore continuity to the colon by performing a stapled anastomosis as illustrated in Figs. 37–33 to 37–36. Close the proximal (right) margin of the colon transplant (temporarily) with a TA-55 stapler and leave the distal end of the colon segment open.

Cologastrostomy

Elevate the stomach with its attached omentum away from the pancreas. Divide the avascular attachments between the peritoneum overlying the pancreas and the back wall of the stomach. Also incise the avascular portion of the gastrohepatic omentum. Then draw the colon transplant with its mesentery in an isoperistaltic direction through the retrogastric plane and through the opening in the gastrohepatic omentum. Be certain not to twist the mesentery. Check to see that the colon does indeed reach the cervical esophagus without tension.

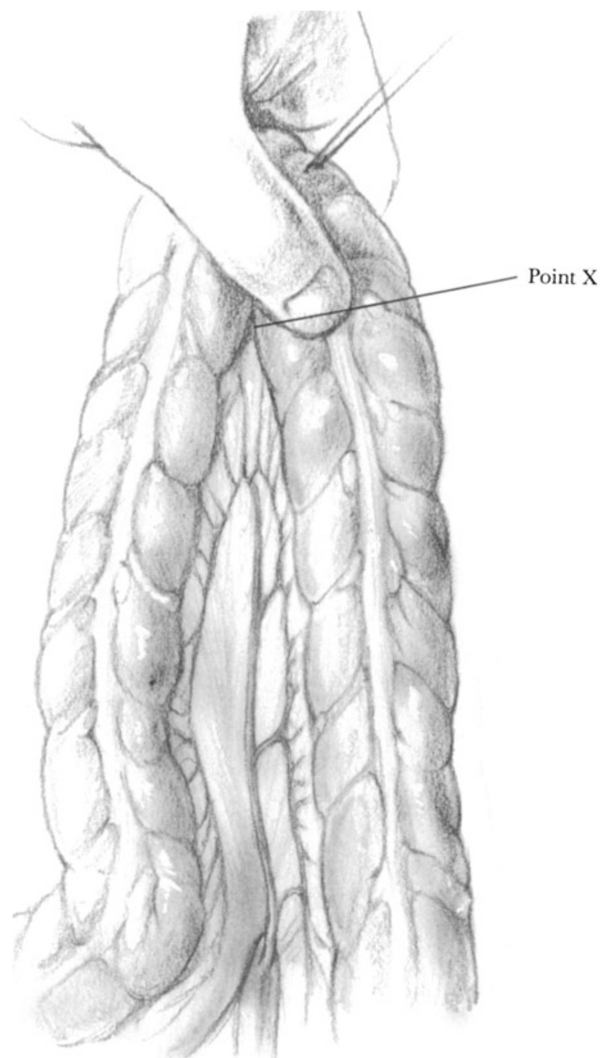


Fig. 9–1b

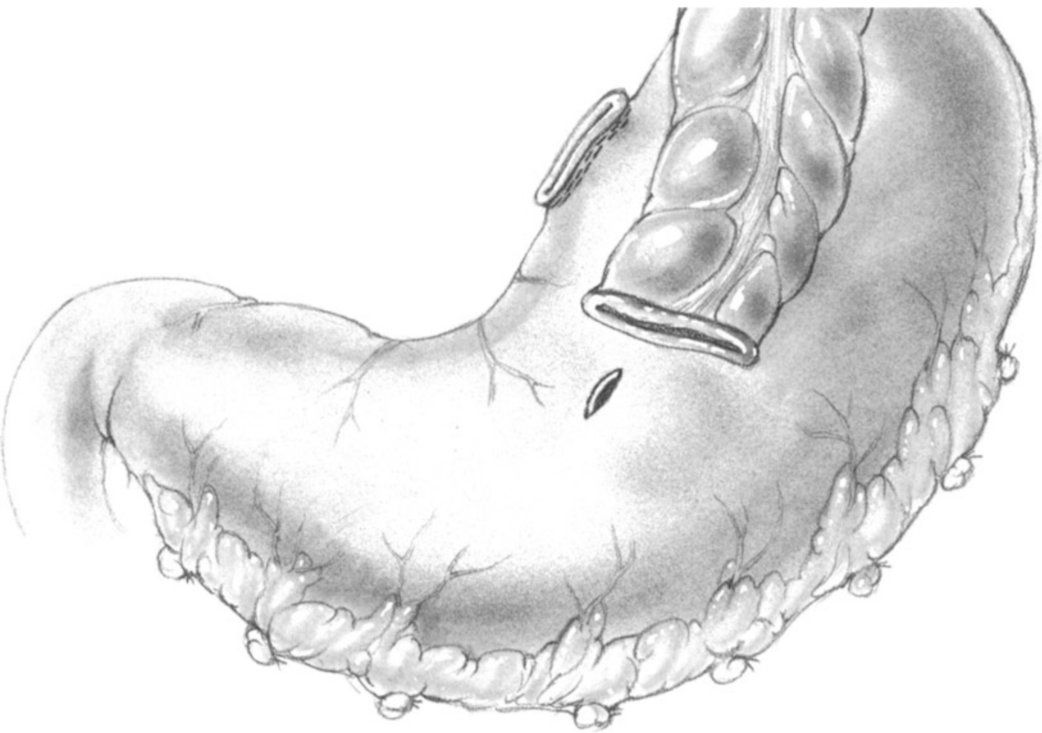


Fig. 9–2

Now prepare to anastomose the open end of the distal colon transplant to a point on the stomach approximately one-third of the distance down from the fundus to the pylorus. The anastomosis may be made on the anterior or the posterior side of the stomach. As illustrated in **Fig. 9–2**, make a 1.5-cm vertical incision in the stomach about one-third of the way down from the fundus. Then insert the GIA stapler, one fork in the stab wound of the stomach and one in the open lumen of the colon. Insert the GIA to a depth of 3 cm and lock the instrument (**Fig. 9–3**). Then fire the stapling device and remove it.

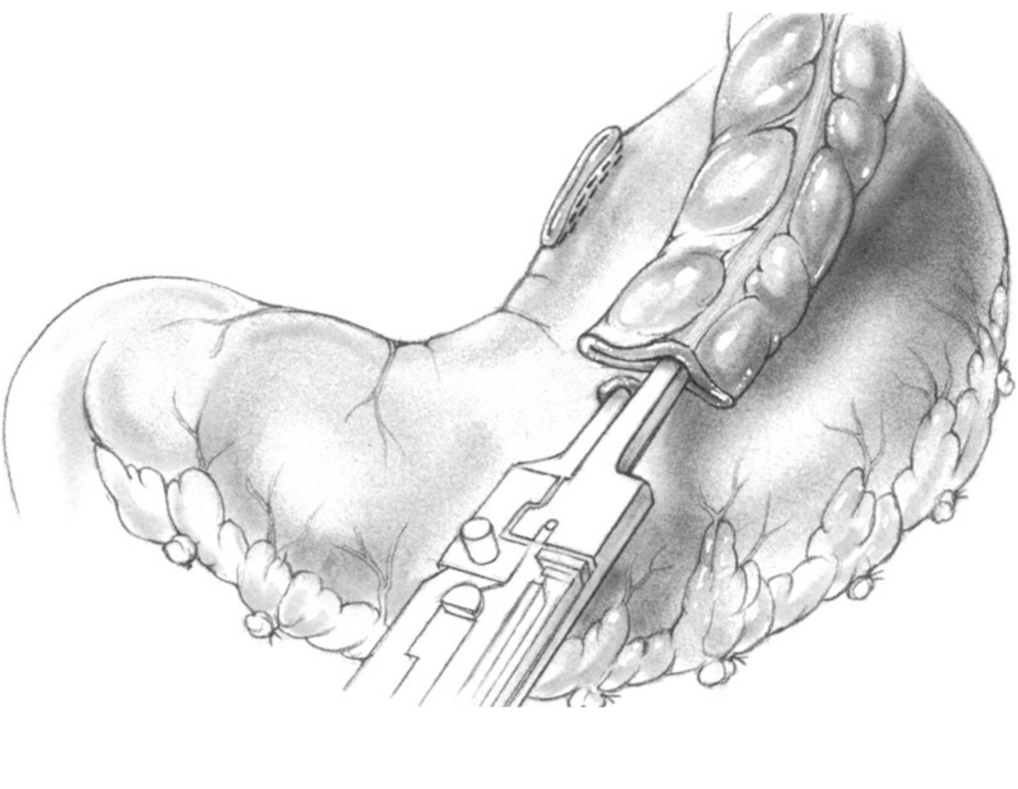


Fig. 9–3

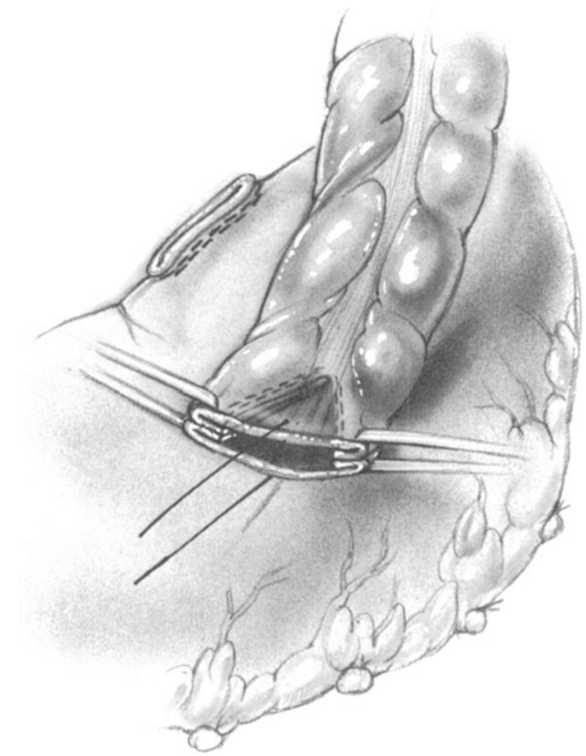


Fig. 9–4

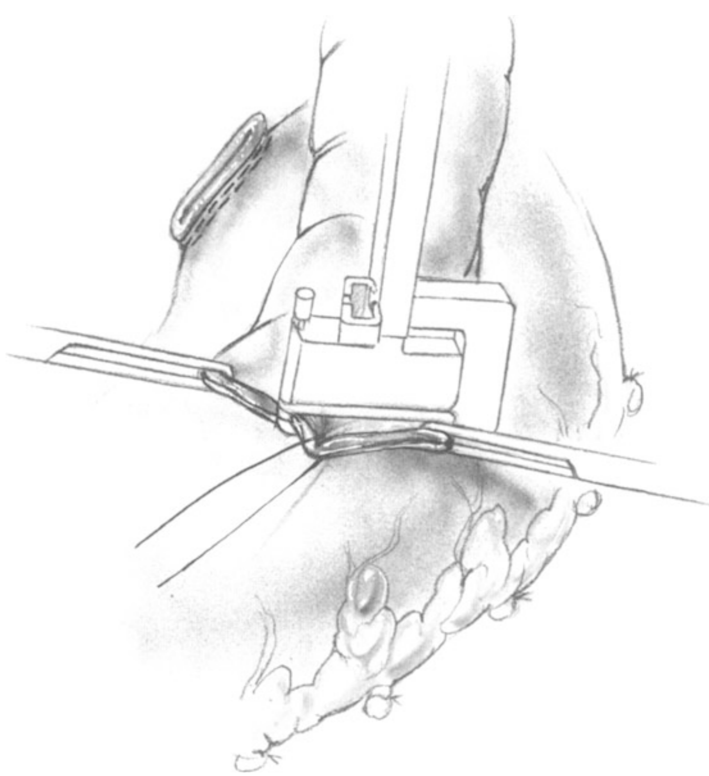


Fig. 9–5

Inspect the staple line for bleeding. Then apply one Allis clamp to the left extremity of the GIA staple line and another Allis clamp to the right termination of the GIA staples. Insert a guy suture through the midpoint of the stab wound of the stomach as illustrated in **Fig. 9–4**. Close the remaining defect by two applications of the TA-55 stapler. First, apply the stapler just deep to the Allis clamp and the guy suture to close the left half of the gap. After firing the stapling device (**Fig. 9–5**), excise the surplus tissue but preserve the guy suture. Lightly electrocoagulate the everted mucosa and remove the stapling device. Then reapply the stapler in similar fashion to close the remaining defect. Be sure to place the stapler deep to the Allis clamp and the guy suture. After firing the stapling device, cut away the surplus tissue and lightly electrocoagulate the mucosa. At the conclusion of these steps, there will have been created a fairly large anastomosis between the stomach and colon as illustrated in **Fig. 9–6**.

DeMeester has pointed out that it is possible to divide the descending colon as it comes down behind the stomach without simultaneously dividing the marginal artery of the descending colon. If the marginal artery is not divided, it provides an added avenue of blood flow to the colon that has been transplanted into the neck. By carefully transecting the colon behind the stomach and then dividing and ligating the end branches of the marginal artery close to the colon for a distance of about 4 cm, sufficient colon will have been liberated so that a cologastric anastomosis can be constructed to the posterior wall of the stomach while the distal segment of descending colon can be anastomosed to the remaining hepatic flexure. If the anastomosis is made at the junction between the upper third and the lower two-thirds of the stomach, it seems not to matter whether the cologastrostomy is constructed on the posterior wall or the anterior wall of the stomach. However, if one wishes to preserve the marginal artery of the descending colon, then it is necessary to place the cologastrostomy on the posterior wall of the stomach (**Fig. 9–7A**). The posterior cologastric anastomosis may be constructed by suturing, as illustrated here or by stapling as described in Figs. 9–3 to 9–6. In this manner the colocolostomy can also be performed

Fig. 9–6

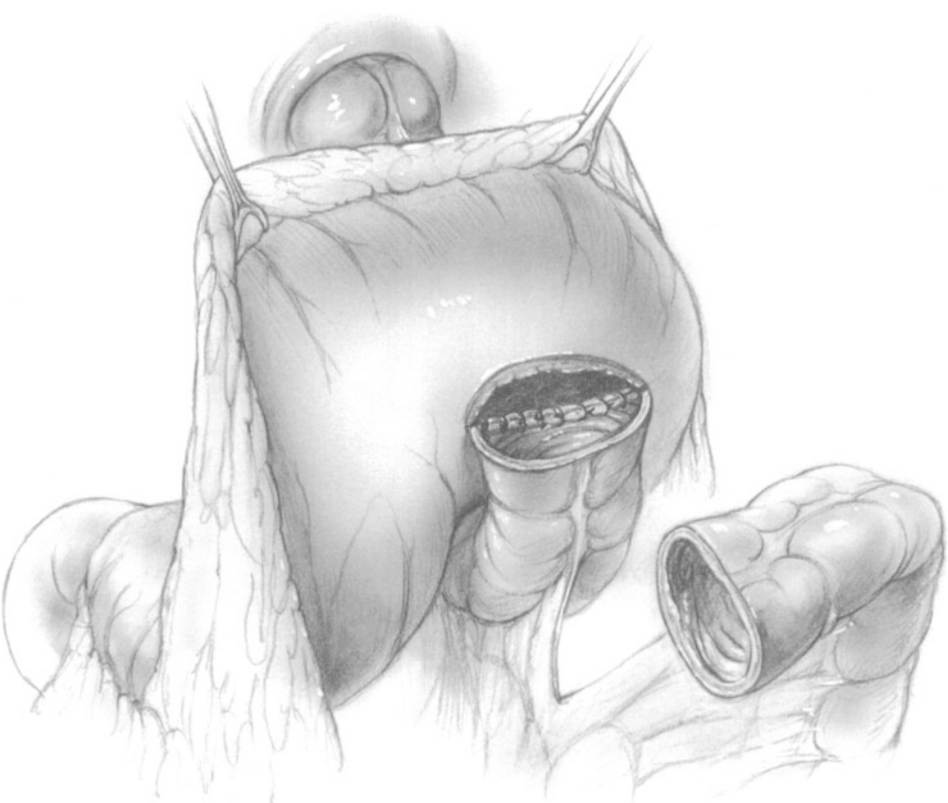


Fig. 9–7

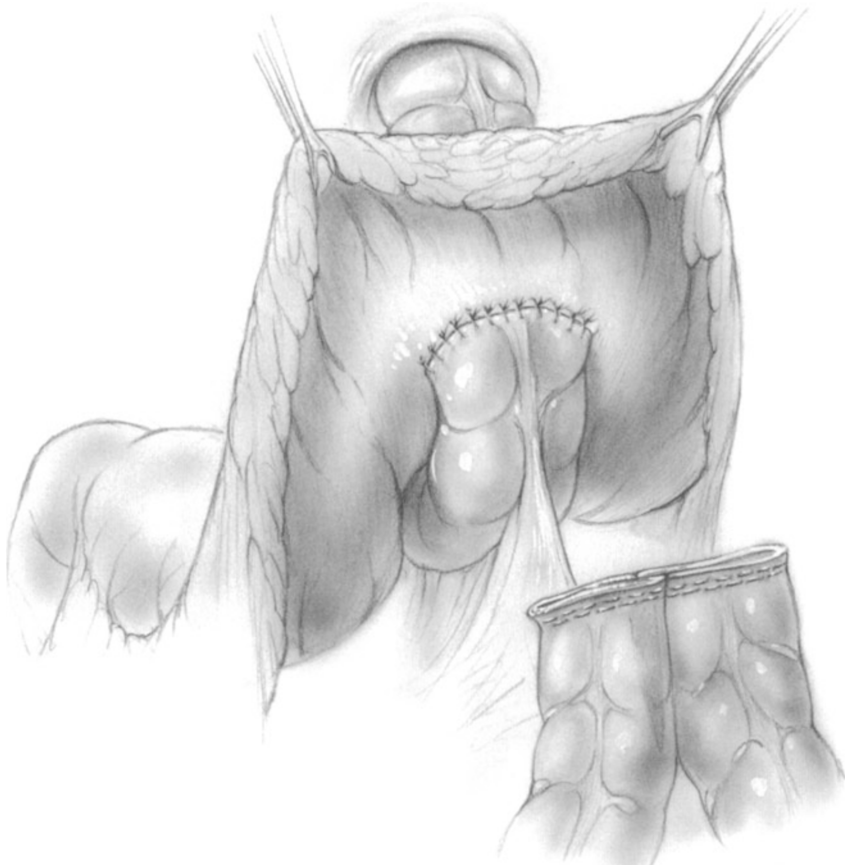


Fig. 9.7b

close by, thus preserving the marginal artery (**Fig. 9–7B**).

Pyloromyotomy

In most conditions for which a thoracic esophagectomy is being performed, the vagus nerves will be destroyed. This will impair gastric emptying to a fairly severe degree in about 20% of cases. In order to prevent this complication, a pyloromyotomy may be performed by the technique illustrated in Figs. 7–17 to 7–19.

Advancing the Colon Segment to the Neck

Be certain to enlarge the diaphragmatic hiatus (see Fig. 7–20) sufficiently so that the veins in the colon mesentery will not be compressed by the muscles of the hiatus. The most direct route to the neck is along the course of the original esophageal bed in the posterior mediastinum. This may be accomplished by placing several sutures between the proximal end of the colon transplant and the distal end of the esophagus; then draw the colon up into the neck by withdrawing the esophagus into the neck. This will bring the colon into the posterior mediastinum behind the arch of the aorta and into the neck posterior to the trachea. If there is no constriction in the chest along this route, the sternum and clavicle at the root of the neck are also not likely to compress the colon. On the other hand, if a substernal tunnel is selected for passing the colon up to the neck, it is generally necessary to resect the head of one clavicle and a 2-cm width of adjacent sternal manubrium in order to be certain that there will not be *any* obstruction at that point.

A good alternative method of transporting the colon up to the neck is to pass a 36F rubber catheter from the neck down into the abdominal cavity. Now obtain a sterile plastic sheath such as that which is used to cover the camera during laparoscopic cholecystectomy. Suture the end of this plastic cylinder to the termination of the rubber catheter. Then insert the proximal end of the colon into this plastic sheath and suture it lightly to the red rubber catheter. By withdrawing the catheter through the thoracic cavity into the neck, the colon with its delicate blood supply can be delivered into the neck without trauma.

Check to see that the tube of colon from the neck to the abdominal cavity lies in a straight line and that there is no surplus of colon in the chest. Leaving redundant colon in the thorax may produce a functional obstruction to the passage of food. After this item has been checked, suture the colon to the muscle of the diaphragmatic hiatus with interrupted sutures of atraumatic 4–0 Tevdek at intervals of about 2 cm around half the circumference of the colon. This will help maintain a direct passageway from the neck into the abdomen. Be sure not to pass the needle deep to the submucosa of the colon as colonic leaks have been reported from this error.

Dissecting the Cervical Esophagus

Change the position of the patient's left hand, which is suspended from the ether screen. Bring the left hand laterally and place it along the left side of the patient. Turn the head slightly to the right and make an incision along the anterior border of the left sternomastoid muscle and continue the dissection as described in Figs. 7–27 to 7–30. Be careful not to damage either the left or the right recurrent laryngeal nerve. After dissecting the esophagus free down into the superior mediastinum, extract the thoracic esophagus by applying gentle traction in the neck. In this way the thoracic esophagus and the attached colon interposition segment may be drawn gently into the neck. Divide the distal cervical esophagus and remove the thoracic esophagus. Inspect the end of the colon. This should not be cyanotic as this indicates venous obstruction. Also, there should be a good pulse in the marginal artery. Draw the closed stapled end of the colon transplant to a point about 6–7 cm above the cut end of the esophagus and, taking care not to penetrate the lumen of the colon, suture the colon to the prevertebral fascia with several interrupted 4–0 silk sutures.

Esophagocolonic Anastomosis

Perform an end-to-side esophagocolonic anastomosis at a point about 4 cm below the proximal end of the colon by using a technique similar to that described in Figs. 7–22 to 7–26 and by using interrupted 4–0 silk Cushing sutures for the outer layer and 5–0 Vicryl to the mucosal layer. Before closing the anterior portion of the anastomosis, ask the anesthesiologist to pass a nasogastric tube into the esophagus and guide this tube through the anastomosis into the colon.

During the course of this operation, whenever a hollow viscus is opened, irrigate the operative field with a dilute antibiotic solution.

Retrosternal Passage of Colon Transplant

When the posterior mediastinum is not a suitable pathway for the colon, or if the esophagus has not been removed, make a retrosternal tunnel to pass the colon up to the neck. If the left lobe of the liver is large, or if it appears to be exerting pressure on the posterior aspect of the colon transplant, liberate the left lobe by dividing the triangular ligament. This will permit the left lobe to fall in a posterior direction and thereby relieve this pressure. If the xiphoid process curves posteriorly and impinges on the colon, resect the xiphoid.

Enter the plane just posterior to the periosteum of the sternum. Start the dissection with Metzenbaum scissors. Then insert one or two fingers of the right hand; finally pass the entire hand just deep to the sternum up to the suprasternal notch. This is generally an avascular plane. Orient the colon segment so that the mesentery enters from the patient's left side. Resect the medial 3–4 cm of clavicle using a Gigli saw. Then rongeur away about 2 cm of adjacent sternal manubrium in order to be certain that the aperture at the root of the neck is sufficiently large to avoid any venous obstruction in the mesentery. Pass a long sponge-holder into the retrosternal tunnel from the neck down into the abdomen, and suture the proximal end of the colon segment to the tip of the sponge-holder. Gently pass the colon into the substernal tunnel while simultaneously drawing the sutures in a cephalad direction.

Orringer, Kirsh, and Sloan point out that there will be fewer symptoms from resection of the clavicular head if it is performed on the side opposite the dominant hand. Once it has been ascertained that the circulation to the colon segment is good, perform the esophagocolonic anastomosis as above. The final appearance of the colon interposition is depicted in a diagrammatic fashion in **Figs. 9–8 and 9–9**.

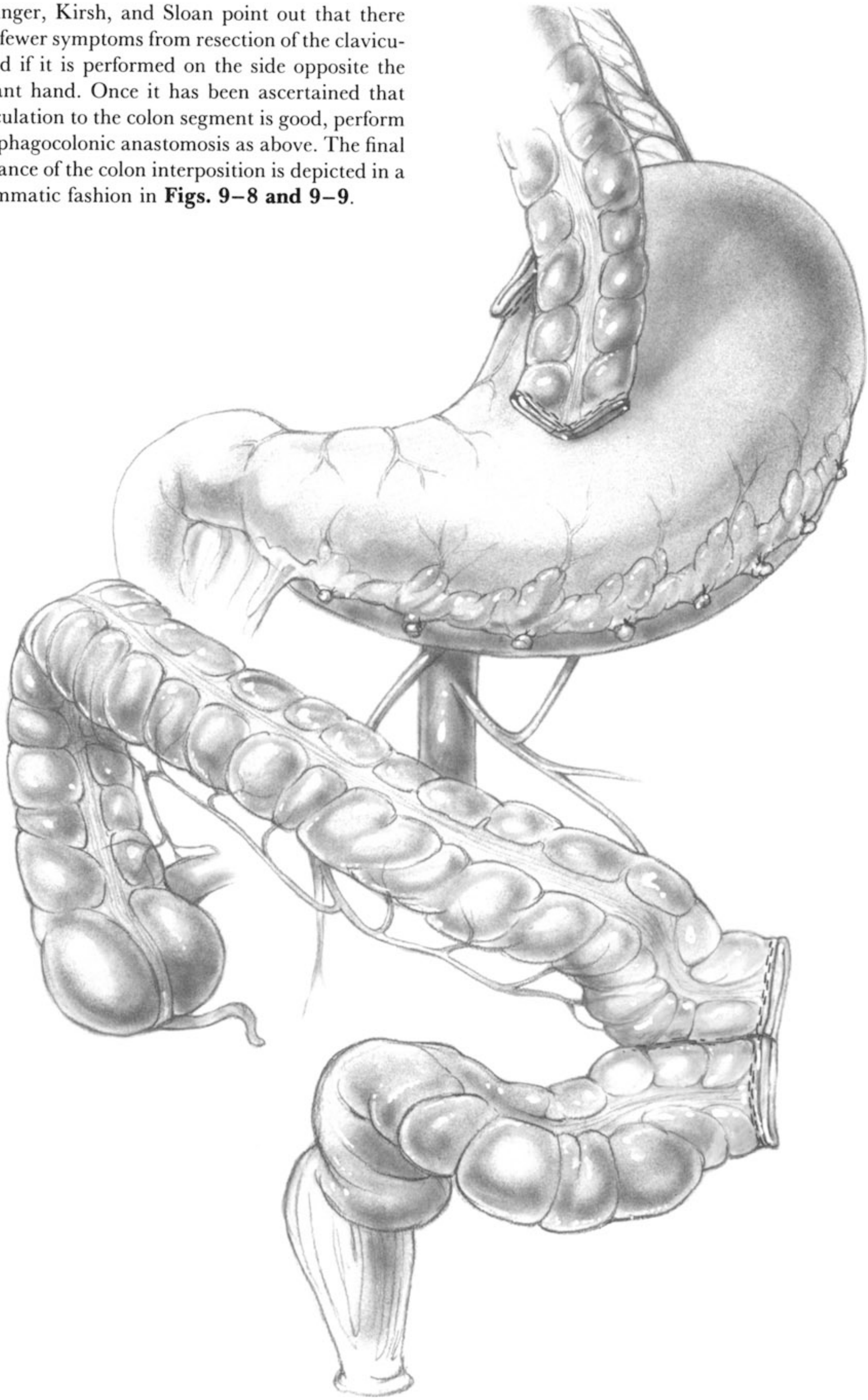


Fig. 9–8

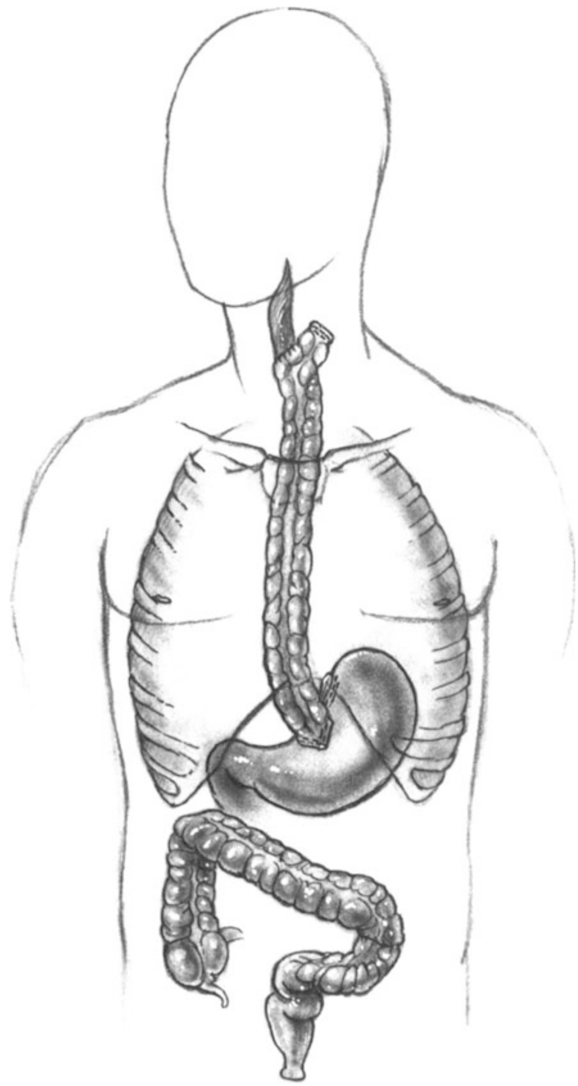


Fig. 9–9

Closure

Close the cervical incision in layers with interrupted 4–0 PG sutures. Insert one or two latex drains to the general vicinity of the anastomosis and leave these in place for 7–10 days. Close the skin in the usual fashion.

Close the thoracoabdominal incision as illustrated in Figs. 8–36 to 8–42.

Operative Technique—Colon Interposition, Short Segment

In rare cases with benign peptic strictures of the lower esophagus, it will not be possible to dilate the stricture, even in the operating room, without rupturing the esophagus. If there is no significant amount of disease above the level of the inferior pulmonary ligament, resect the diseased esophagus down to the esophagogastric junction and replace the missing esophagus with a short isoperistaltic segment of colon to extend from the divided esophagus to a point about one-third of the distance between the fundus and pylorus of the stomach. For a short-segment operation it is not necessary to divide the middle colic artery, and only the distal portion of the transverse colon and the splenic flexure need be employed. Otherwise, the operation is very much the same as described above. The cologastric anastomosis is identical. The esophagocolonic anastomosis may be sutured either in an end-to-end fashion, in an end-to-side fashion, or even by a stapling technique. The latter involves inserting a proper EEA cartridge (generally EEA-28 or EEA-25) into the open proximal end of the colon segment. The anastomosis is made between the end of the esophagus and the side of the colon by the EEA technique. Then, after disengaging the instrument, explore the anastomosis visually, and with a finger through the open end of the colon. If the exploràtion appears to be satisfactory, then close the opening in the colon about 1 cm away from the EEA anastomosis by using a TA-55 stapler. Excise the redundant tissue and remove the stapler.

Operative Technique—Jejunum Interposition

Incision and Mobilization

Although Polk advocates performing mobilization of the esophagogastric junction through an upper midline abdominal incision, we prefer the left 6th interspace thoracoabdominal incision with a vertical midline abdominal component. This is true because the jejunal interposition operation is performed primarily in patients who have had multiple failed previous operations for reflux esophagitis. The Collis-Nissen gastroplasty combined with dilatation of the esophageal stricture will suffice in most patients. This leaves a few of the most advanced cases that require either a colon (short-segment) or jejunum interposition. In order to make the esophagogastric dissection as safe as possible, the combined thoracoabdominal incision is much to be preferred over an abdominal approach or even using both a laparotomy and a separate thoracotomy incision. It should also be emphasized that creating a jejunal segment is much more difficult than the short-segment colon interposition. In performing the thoracoabdominal incision, incise the diaphragm with the electrocautery in a circumferential fashion as depicted in Fig. 8–8.

Now dissect the left lobe of the liver carefully away from the anterior wall of the stomach; in doing so, approach the dissection from the lesser curvature aspect of the stomach. At the same time, incise the gastrohepatic omentum by going up towards the hiatus. This may require division of the accessory left hepatic artery, provided this has not been done at a previous operation (see Fig. 12–4). It may also be difficult to free the upper stomach from its posterior attachments to the pancreas. Careful dissection with good exposure from the thoracoabdominal incision should make it possible to preserve the spleen from irreparable injury. At the conclusion of this dissection, the upper portion of the stomach and lower esophagus should be free. Freeing the esophagus in the upper abdomen may be expedited by first dissecting the esophagus out of its bed in the lower mediastinum.

Resection of Diseased Esophagus

After the esophagus has been freed from its fibrotic attachments in the mediastinum and upper stomach, select a point near the esophagogastric junction for resection. If the upper stomach has been perforated during this dissection and it can be included in the specimen, do so. If the upper stomach is not excessively thickened, apply a TA–55 or TA–90 stapling device with 4.8-mm staples and fire the stapling device. Transect the esophagogastric junction just above the stapling device. Lightly electrocoagulate the everted mucosa and remove the stapler. Deliver the transected esophagus into the chest and select the point of transection on the esophagus above the stricture. A mild degree of mucosal inflammation in the esophagus is acceptable at the point of transection. Remove the specimen.

If the point of division of the esophagus is not higher than the inferior pulmonary vein, a jejunal interposition is a good method of establishing continuity (Polk). If the esophagus must be transected at a higher level, use either a short segment of colon for the interposition, or remove the remainder of the thoracic esophagus and reestablish continuity either by means of a long-segment colon interposition from the neck to the stomach or by bringing the stomach up into the neck for this purpose as described below. The graft of jejunum may be lengthened safely if its circulation can be boosted by creating microvascular anastomoses from a thoracic artery and vein to the upper end of the graft.

Mobilizing the Jejunum Graft

Because the vascular anatomy of the proximal jejunum varies somewhat from patient to patient, it is necessary to individualize the dissection according to the conditions encountered. First, try to stretch the proximal jejunum in a cephalad direction in order to determine where the greatest mobility is located. Be certain to leave intact at least the first major jejunal artery to the proximal jejunum. The average length of jejunal segment to be transplanted varies between 12 and 20 cm, and the pedicle should consist of at least one major arcade vessel with careful preservation of the veins. Most jejunal grafts fail not because of poor arterial circulation but because the veins have been injured or compressed at some point in their course. Follow the principles illustrated in Fig. 28–11, and try to preserve a vascular pedicle containing two arcade vessels with their veins intact. In dividing an arcade vessel, be sure to place the point of transection sufficiently proximal to a bifurcation so that the continuity of the "marginal" artery and vein will not be interrupted. Divide the jejunum proximally and distally; preserve a segment measuring 15–20 cm for interposition. Close both proximal and distal segments of jejunum temporarily by applying a TA–55 stapler.

Now make an incision of the transverse mesocolon through its avascular portion just to the left of the middle colic vessels. Carefully pass the jejunal graft together with its vascular pedicle through this incision into the previously dissected lesser sac behind the stomach. Be absolutely certain that the incision in the mesentery does not constrict the veins of the vascular pedicle. Also be careful not to twist the pedicle. Pass the proximal portion of the jejunal segment through the hiatus into the chest. Be certain that the hiatus is large enough so that it does not compress the veins in the vascular pedicle.

Esophagojejunostomy

Establish an end-to-side esophagojejunal anastomosis on the antimesenteric border of the jejunum beginning about 1 cm distal to the staple line on the proximal closed end of the jejunal segment. A technique similar to that described in Figs. 28–12 to 28–22 using 4–0 atraumatic interrupted silk Cushing or Lembert sutures for the outer layer and interrupted or continuous 5–0 Vicryl for the mucosal layer may be employed. Pass the nasogastric tube through this anastomosis down to the lower end of the jejunal graft.

It is also possible to perform a stapled esophagojejunostomy by the technique described in Figs. 28–23 to 28–28.

Jejunogastrostomy

Place the jejunogastric anastomosis at a point 5–7 cm below the proximal margin of the stomach in an area of stomach that is relatively free of fibrosis and that

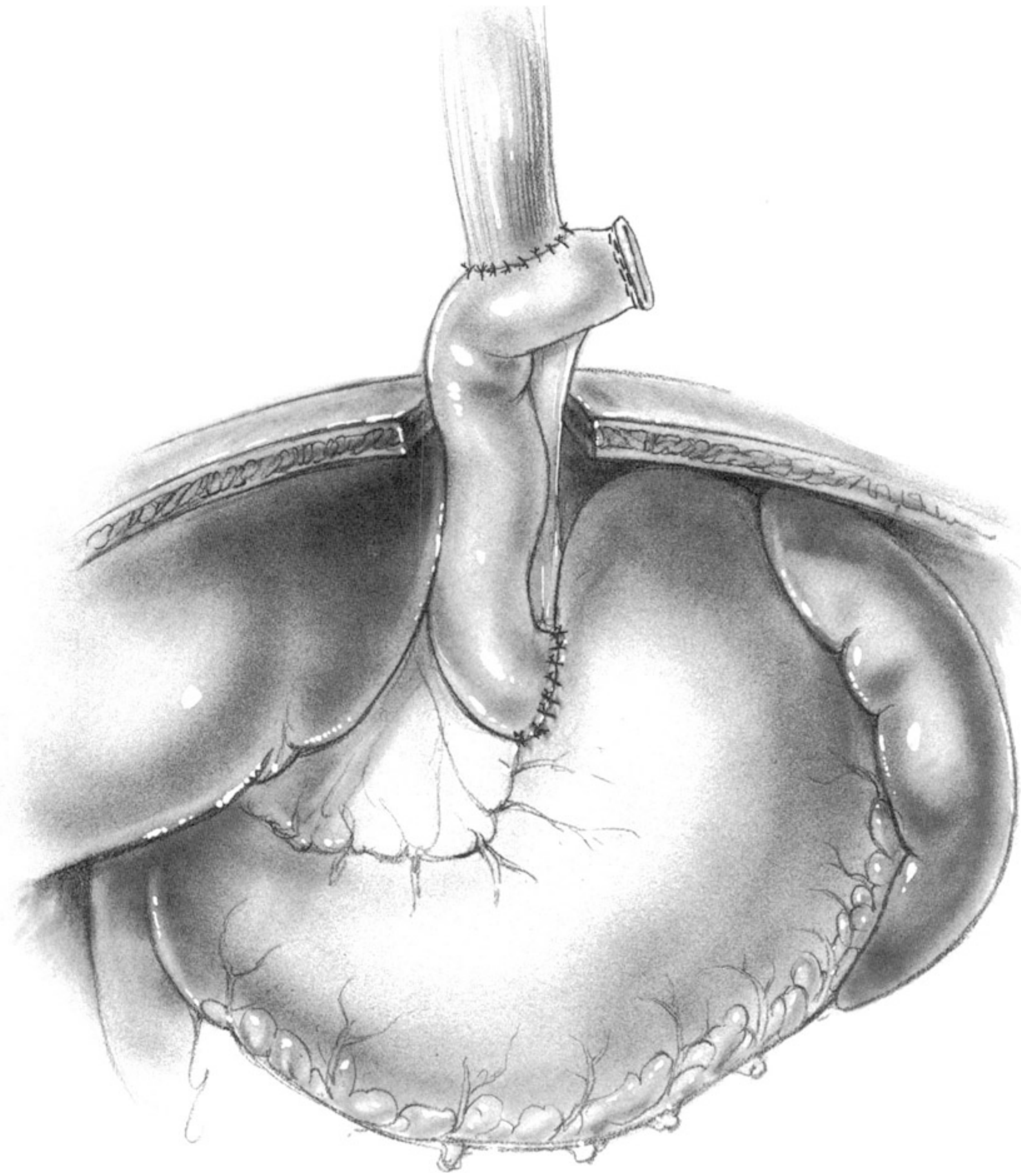


Fig. 9–10

permits the vascular pedicle to be free of tension. This may be done by the same suture technique as mentioned above (see Figs. 28–12 to 28–22), but if there is sufficient length of jejunum, it may also be performed by a stapled anastomosis similar to that described in Figs. 9–2 to 9–6. The appearance of the completed anastomosis is shown in **Fig. 9–10**.

Jejunojejunostomy

Reestablish the continuity of the jejunum by creating a functional end-to-end anastomosis using the stapling technique described in Figs. 30–12 to 30–16. Then carefully resuture the defect in the jejunal mesentery without compressing the vascular pedicle jejunal graft.

Use interrupted 4–0 Tevdek sutures to approximate the diaphragmatic hiatus to the seromuscular wall of the jejunum to avoid herniation of bowel through the hiatus. Be certain not to compress the vascular pedicle.

Gastrostomy; Pyloromyotomy

Although the nasogastric tube has been passed through the jejunal graft into the stomach in order to maintain the position of the graft, there is a risk that the nasogastric tube may be inadvertently removed before the patient's gastrointestinal tract has resumed function. For this reason, perform a Stamm gastrostomy as described in Figs. 26–1 to 26–5 and remove the nasogastric tube.

Most surgeons advocate performing a pyloromyotomy or pyloroplasty in this type of operation because it is assumed that the vagus nerves have been interrupted during the course of dissecting a heavily scarred esophagus out of the mediastinum. Polk stated that this step may not be necessary.

Closure

Repair the diaphragm and close the thoracoabdominal incision as illustrated in Figs. 8–39 to 8–45 after inserting a large catheter into the thorax. No abdominal drains are utilized. Intermittently during the operation, whenever a hollow viscus has been opened, irrigate the operative field with a dilute antibiotic solution.

Operative Technique—Transhiatal Esophagectomy without Thoracotomy; Gastric Pull-Up

Abdominal Incision

Removing the esophagus by dissecting through the diaphragmatic hiatus from below, and through the neck from above, is especially suitable for patients who have a reasonably normal esophagus. For instance, after pharyngolaryngectomy, removing the esophagus without a thoracotomy, followed by drawing the stomach into the neck for a pharyngogastrostomy can offer an expeditious method of replacing the esophagus. Orringer and Sloan (1978) warned that "if there is even the slightest amount of tension between the stomach and pharynx, we believe that colonic interposition should be performed, for . . . a pharyngogastric anastomotic disruption may ultimately result in a fatal carotid or innominate artery erosion." Orringer and Orringer (1983) have extended the indications of the transhiatal esophagectomy to include all patients with carcinoma of the thoracic or cervical esophagus on the assumption that all operations for esophageal carcinoma are only palliative and do not require a wide field excision. Although we still believe that early carcinoma of the esophagus may benefit by transthoracic wide excision, those patients with midthoracic carcinoma, who have positive nodes in the abdomen or a metastasis to the liver, would benefit from the esophagectomy without thoracotomy especially if they have limited pulmonary reserve.

All patients suffering from carcinoma of the middle third of the esophagus should undergo bronchoscopy prior to surgery. Invasion of the bronchus or trachea contraindicates this operation.

With the patient in the supine position, prepare the neck, the anterior chest, and the entire abdomen. Make a midline incision from the xiphoid to a point 5 cm below the umbilicus. Insert an Upper Hand or Thompson retractor and elevate the sternum strongly in a cephalad direction. Incise the peritoneum over the abdominal esophagus and encircle the esophagus with a latex drain. Identify the margins of the diaphragmatic hiatus. Enlarge the hiatus by making an incision in an anterior direction using the electrocautery. Divide and ligate the transverse phrenic vein that crosses over this incision.

Esophageal Dissection in the Mediastinum

Most of the dissection of the esophagus away from its attachments in the mediastinum, should be done accurately under direct vision. Exposure can be improved by inserting a narrow Harrington or Deaver retractor into the anterior margin of the hiatus. The surgeon would benefit from wearing a headlight to illuminate the mediastinum. Using a blunt Metzenbaum scissors and finger dissection it is possible to identify the blood vessels surrounding the esophagus and to occlude them with Hemoclips prior to transection. Divide the major vagal trunks while dissecting the esophagus from the pleura and the pericardium. This type of dissection can be pursued without difficulty in most patients up to the level of the carina. Do not attempt to include any surrounding soft tissue or lymph nodes in the specimen; rather, keep the dissection close to the wall of the esophagus. If tumor is encountered that cannot be easily separated from other mediastinal structures, abandon this dissection and perform a thoracotomy.

Cervical Dissection

Make an incision along the anterior border of the left sternomastoid muscle down to and across the sternal notch. Develop this dissection as illustrated in Figs. 7–28 to 7–30. Be careful not to apply traction to the recurrent laryngeal nerve. *Palsy of the recurrent nerve may occur after strong medial retraction of the trachea during* this dissection of the cervical esophagus. Gently encircle the cervical esophagus and use blunt dissection to free the esophagus from its attachments in the upper mediastinum. Be especially careful in dissecting the esophagus away from the membranous portion of the trachea. During this step in the dissection it is wise to ask the anesthesiologist to decompress the balloon of the endotracheal tube for a minute or two when the dissection is being conducted along the upper posterior trachea. Keep the fingers closely applied to the wall of the esophagus so that the dissection does not extend any distance away from the esophageal wall, especially in the region of the membranous trachea and carina. Surround the upper esophagus with a latex drain and apply mild traction. A small sponge grasped in a sponge-holder may be used to dissect the esophagus away from the tissues of the superior mediastinum (**Fig. 9–11**). There is a small area of dissection in the vicinity of the carina which is difficult to visualize, either from below or from above. Pass the right hand into the mediastinum from below and left hand from above. With this type of bimanual dissection, it should be possible to free the remaining attachments of the esophagus bluntly.

Apply a TA-55 stapling device across the esophagus very low in the neck and transect the esophagus above the stapling device. Then, remove the esophagus into the abdomen. Place several large moist gauze pads into the mediastinum while the gastric dissection is being conducted.

Mobilizing the Stomach

Complete the liberation of the upper stomach and divide the omentum as described in Figs. 7–10 to 7–12. Be certain not to damage any portion of the right gastroepiploic arcade as this constitutes the major remaining blood supply to the stomach. If necessary, leave 5–10 cm of omentum lateral to the gastroepiploic arcade attached to the greater curvature. Elevate the stomach and identify and divide the coronary vein and left gastric artery (see Fig. 7–13). Perform an extensive Kocher maneuver as illustrated in Figs. 7–14 to 7–16. Then perform a pyloromyotomy (see Figs. 7–17 to 7–19). The stomach should now be free of all attachments. The Kocher maneuver should permit the pylorus to come close to the diaphragmatic hiatus without tension.

Perform a pyloromyotomy (see Figs. 7–17 to 7–19).

According to Akiyama, the most important step in preparing the stomach for an anastomosis in the neck is to apply traction to the highest point on the gastric fundus as determined by the stretchability of the remaining stomach. He then advocates removing the lesser curvature, for two reasons: (1) the vascularity of the lesser curvature portion of the stomach following division of the left gastric artery is reduced; (2) with the upper 50%–60% of lesser curvature removed, the fundus can be stretched further into

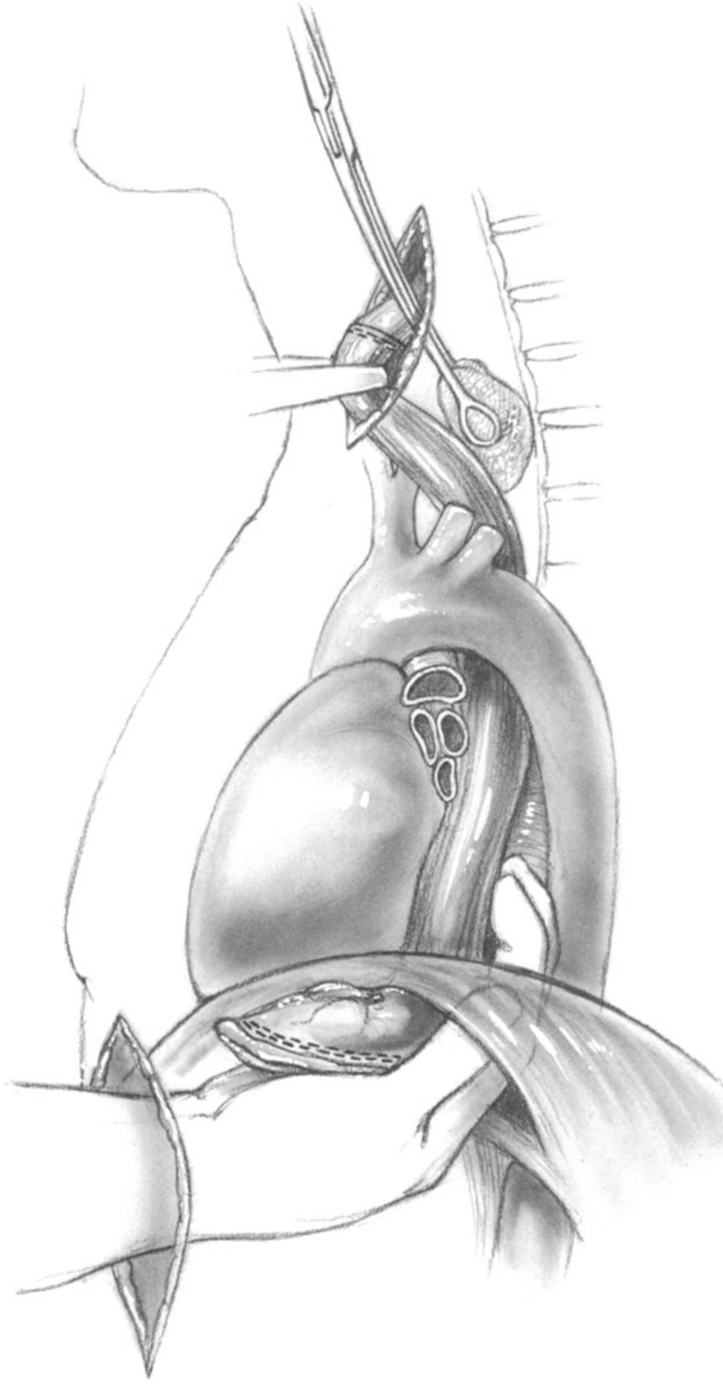


Fig. 9–11

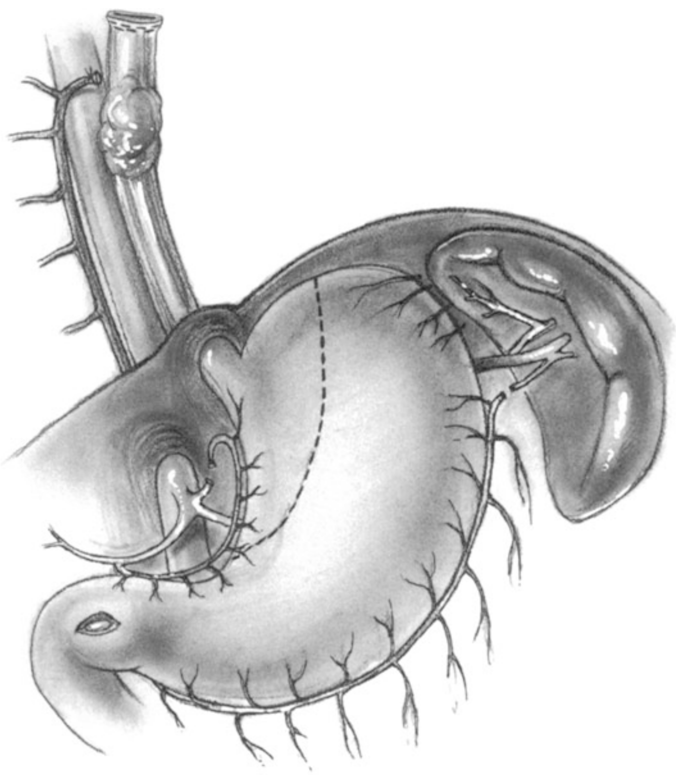


Fig. 9–12

Advancing the Stomach to the Neck

Akiyama prefers to use the substernal route for the stomach's course to the neck if the patient has carcinoma of the thoracic esophagus because he fears that recurrent carcinoma in the mediastinum may invade and occlude the gastric tube. Transect the sternal origins of the left sternohyoid and sterno-

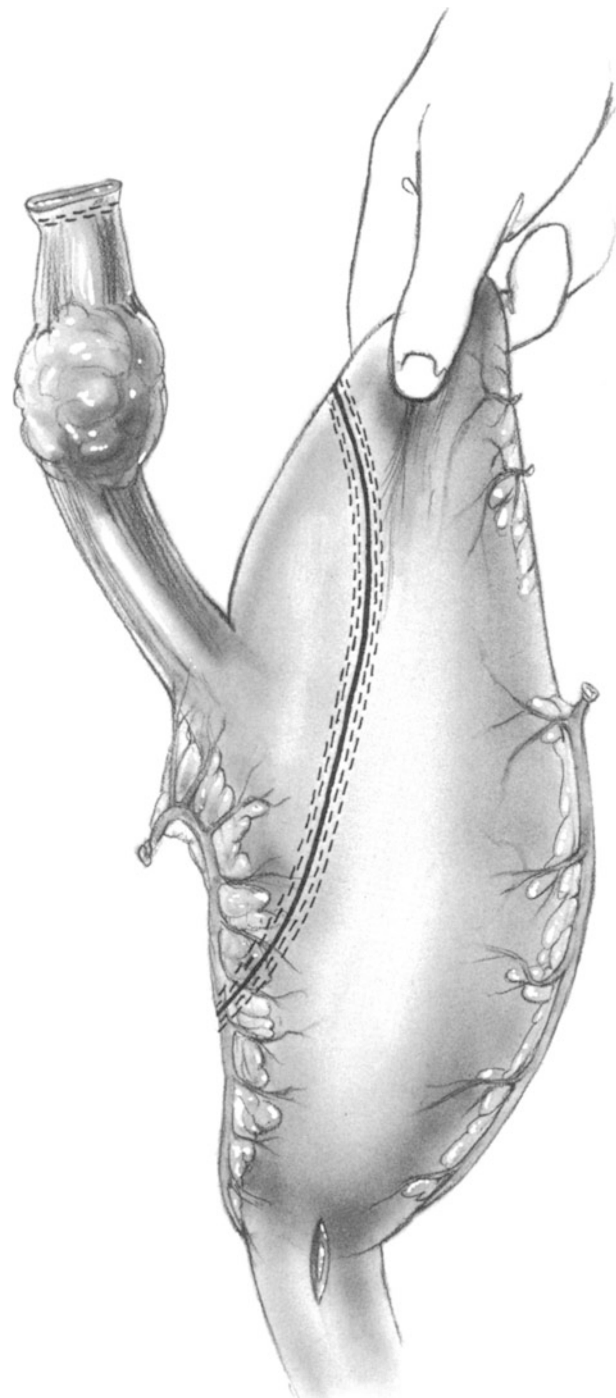


Fig. 9–13

the neck without excessive tension. Although the illustration in **Fig. 9–12** relates to a patient with esophageal carcinoma, even patients with benign disease would benefit from removing almost the same amount of stomach along the lesser curvature. This also tends to convert the stomach into a tubular structure rather than a reservoir. If staples are used along the lesser curvature, as recommended by Akiyama, *be certain to fire the staples only while considerable cephalad traction is being applied to the gastric fundus* at its highest point (**Fig. 9–13**). Most surgeons use the GIA stapler by serial application to divide the stomach along its lesser curve. Since this device employs small staples, the width to which the stomach tissues are compressed may be too narrow to preserve their viability. Consequently, the GIA suture lines require inversion by oversewing with a continuous Lembert suture. If the Ethicon 75-mm Linear Cutter is used to staple and divide the lesser curve, oversewing the staple line does not seem to be necessary because the staples in this device have a leg length of 4.8 mm. After being fired, these staples do not compress the two thicknesses of stomach to the degree that prevents capillary blood flow to the tissues being compressed. The GIA 80 mm with 4.8-mm staples also accomplishes this end.

thyroid muscles. If the substernal route to the neck has been selected for the gastric tube, excise the medial 3–4 cm of the clavicle using a Gigli saw. Avoid damaging the underlying subclavian vein. Also resect the lateral 2 cm of manubrium with a power sternal saw, preserving the internal mammary vessels. If this step is not accomplished, the passage of food into the substernal gastric tube may be obstructed by the sternoclavicular junction.

Apply the Linear Cutter to the lesser curve of stomach beginning at the level just below the fourth branch of the left gastric artery. More than one application of the stapling device will be necessary. For the next application of the device, be certain that it crosses the prior staple line to prevent any gap in the closure. Remember that the surgeon must apply cephalad traction on the gastric fundus in order to create a gastric tube of sufficient length to reach the neck without tension. Lightly electrocoagulate the exposed mucosa along the staple line. Carefully check that all staples have been properly closed in the shape of "B." If in doubt, oversew the staple line with a continuous 4–0 Lembert PDS suture. Orringer and Orringer (1983) advocate passing the stomach through the original esophageal bed in the posterior mediastinum behind the arch of the aorta because this is the most direct route and does not require any dissection at the root of the neck nor resection of the clavicle.

Remove the gauze packing from the mediastinum. Pass the right hand through the hiatus up into the neck to confirm that there is free passage. Then gently direct the gastric tube along this route and bring it out in the neck. It should reach the hypopharynx without tension. *Check to see that the hiatus is large enough so that it does not exert pressure on the epiploic veins.*

A better method of transporting the stomach up to the neck is to pass a 36F rubber catheter from the neck down through the posterior mediastinum into the abdominal cavity. Now acquire a sterile plastic sheath such as that which is used to cover the camera during laparoscopic cholecystectomy. Suture the end of this plastic cylinder to the termination of the rubber catheter. Then insert the proximal end of the stomach into this plastic sheath and suture it lightly to the red rubber catheter. By withdrawing the catheter through the thoracic cavity into the neck, the stomach with its delicate blood supply along the greater curvature can be delivered into the neck without trauma.

Suture the upper portion of the gastric fundus to the prevertebral fascia as high as possible in the neck. Use interrupted 4–0 Tevdek sutures. Then anastomose the esophagus to the anterior wall of the gastric tube at a point about 5–6 cm beyond its apex. A one-layer anastomosis between the end of the esophagus and the front of the gastric tube sutured with interrupted 4–0 Vicryl may be used (**Fig. 9–14**). When transecting the cervical esophagus, do so in such fashion that the anterior distal margin of esophagus is at least 1 cm longer than the posterior margin (see Figs. 7–23 and 7–24). This

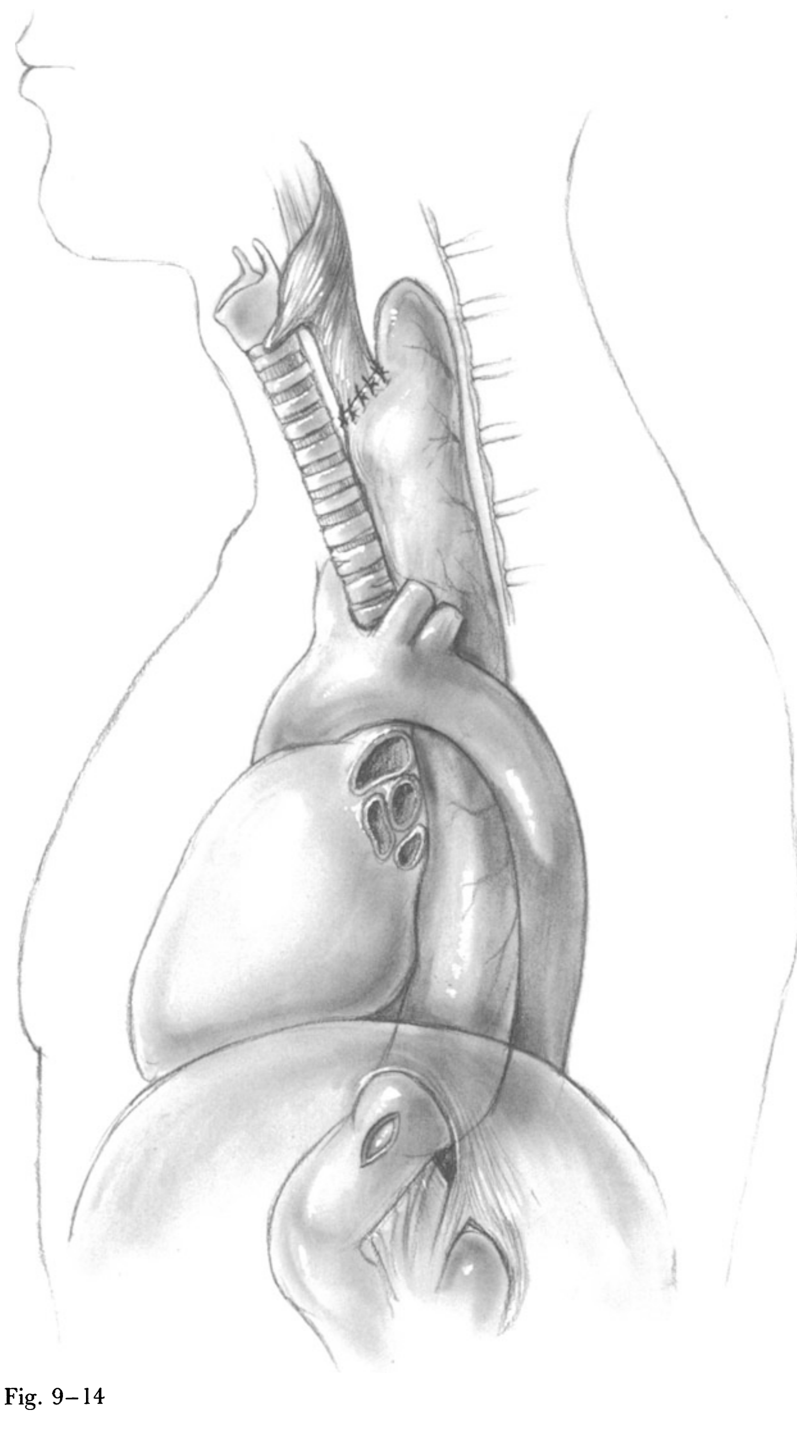


Fig. 9–14

will permit you to make the incision in the gastric tube longer than the diameter of the esophagus and thus accomplish a larger anastomosis, in the shape of an ellipse rather than a circle.

Orringer and Stirling advocate excising a 2-cm circle of stomach rather than simply making a linear incision in the gastric tube for the esophagogastric anastomosis. An alternative two-layer method is depicted in Figs. 7–31, 7–32, and 7–24 to 7–26. Pass the nasogastric tube across the anastomosis into the thoracic portion of the gastric tube.

Closure

Close the cervical incision in layers with interrupted 4–0 PG, after inserting a 1.5 cm latex drain down to a point near the anastomosis. Construct a needle-catheter jejunostomy after a gastric pull-up, or a jejunal or a colon interposition operation. Close the abdominal cavity without drainage by using the modified Smead-Jones closure described in Chap. 5 and No. 1 PDS sutures. Close the skin with interrupted fine nylon, a subcuticular continuous 4–0 PG, or staples.

Intermittently during the operation, when a hollow viscus has been opened, irrigate the operative field with a dilute antibiotic solution.

Because there is potential for blood loss during the phase of the thoracic dissection that is performed bluntly, these patients should have a pressure monitor in the radial artery and in the poor-risk patient, another monitor to measure pulmonary artery wedge pressure.

Postoperative Care

If the patient develops signs of postoperative sepsis, keep a high index of suspicion that the colon bypass may have become infarcted. Because this is a fatal complication, do not hesitate to explore the neck (long-segment bypass) or the chest (short-segment bypass) whenever a serious suspicion exists that colon infarction has occurred.

Continue nasogastric suction for 4–5 days.

Maintain the chest catheter on some type of underwater drainage for 4–5 days, or until the volume of drainage becomes insignificant.

In patients with anastomoses of the cervical esophagus, leave the drain in place for 7–10 days.

Postoperative Complications

Venous infarction of colon or jejunum

Anastomotic leak, especially in cases of anastomoses involving the cervical esophagus

Stricture of the cervical anastomosis, especially after leaks

Intestinal obstruction due to adhesions

Trauma to recurrent laryngeal nerve during dissection of cervical esophagus

Pneumothorax and intraoperative or postoperative hemorrhage, which may occur with transhiatal esophagectomy. Insert a large drainage tube into the right and/or left hemithorax if a pneumothorax has been produced by the transhiatal dissection. Inspection of the mediastinum will reveal most gaps in the mediastinal pleura.

Chylothorax following transhiatal esophagectomy.

Orringer, Bluett, and Deeb reported a 3% incidence of postoperative chylothorax after 320 transhiatal esophagectomy operations. The diagnosis of this complication was confirmed by administering cream into the jejunostomy feeding tube that was inserted routinely during each transhiatal esophagectomy. In a patient suffering from chylothorax, the chest tube drainage changes from serous to opalescent. Chylothorax should be suspected whenever the chest tube drainage exceeds 800 ml per day after the third postoperative day.

These authors emphasize that "early recognition of a chylothorax after transhiatal esophagectomy with prompt transthoracic ligation of the injured duct results in a shorter overall hospitalization and lower morbidity and mortality from this complication" when compared with traditional conservative management.

To make it simple for the surgeon to identify the leaking thoracic duct at reoperation, Orringer et al. inject cream into the jejunostomy feeding tube at a rate of 60 to 90 ml per hour for 4 to 6 hours prior to reoperation for duct ligation. A limited fifth interspace posterolateral thoracotomy under one-lung anesthesia was the approach these authors employed for the reoperation.

References

Akiyama H. Surgery for carcinoma for the esophagus. Curr Probl Surg 1980;17:56.

Anderson KD, Randolph JG. Gastric tube interposition: a satisfactory alternative to the colon for esophageal replacement in children. Ann Thorac Surg 1978;25:521.

Belsey R. Reconstruction of the esophagus with the left colon. J Thorac Cardiovasc Surg 1965;49:33.

Curet-Scott M, Ferguson MK, Little AG, Skinner DB et al. Colon interposition of benign esophageal disease. Surgery 1987;102:568.

DeMeester TR, Johansson K-E, Franze I et al. Indications, surgical technique, and long-term functional results of colon interposition and bypass. Ann Surg 1988;208:460–474.

Glasgow JG, Cannon JP, Elkins RC. Colon interposition for benign esophageal disease. Am J Surg 1979;137:175.

Heimlich HJ. Reversed gastric tube (RGT) esophagoplasty for failure of colon, jejunum and prosthetic interpositions. Ann Surg 1975;182:154.

Kelly JP, Shackelford GD, Roper CL. Esophageal replacement in children: functional results and long-term growth. Ann Thorac Surg 1983;36:634.

Mansour KA, Hansen HA II, Hersh T, Miller JI Jr et al. Colon interposition for advanced nonmalignant esophageal stricture: experience with 40 patients. Ann Thorac Surg 1981;32:584.

Morton KA, Karwande SV, Davis RK et al. Gastric emptying after gastric interposition for cancer of the esophagus or hypopharynx. Ann Thorac Surg 1991;51: 759–763.

Moylan JP Jr, Bell JW, Cantrell JR, Merendino KA. The jejunal interposition operation: a follow-up on seventeen patients followed 10–17 years. Ann Surg 1970; 172:205.

Orringer MB, Bluett M, Deeb GM. Aggressive treatment of chylothorax complicating transhiatal esophagectomy without thoracotomy. Surgery 1988;104:720.

Orringer MB, Kirsh MM, Sloan H. Esophageal reconstruction for benign disease: technical considerations. J Thorac Cardiovasc Surg 1977;73:807.

Orringer MB, Orringer JS. Esophagectomy. Definitive treatment for esophageal neuromotor dysfunction. Ann Thorac Surg 1982;34:237.

Orringer MB, Orringer JS. Esophagectomy without thoracotomy: a dangerous operation? J Thorac Cardiovasc Surg 1983;85:72.

Orringer MB, Sloan H. Esophagectomy without thoracotomy. J Thorac Cardiovasc Surg 1978;76:643.

Orringer MB, Stirling MC. Cervical esophagogastric anastomosis for benign disease; functional results. J Thorac Cardiovasc Surg 1988;96:887–893.

Payne WS. Surgical treatment of reflux esophagitis and stricture associated with permanent incompetence of the cardia. Mayo Clin Proc 1970;45:553.

Polk HC Jr. Jejunal interposition for reflux esophagitis and esophageal stricture unresponsive to valvuloplasty. World J Surg 1980;4:741.

Royston CMS, Dowling BL, Spencer J. Antrectomy with Roux-en-Y anastomosis in the treatment of peptic oesophagitis with stricture. Br J Surg 1975;62:605.

Smith J, Payne WS. Surgical technique for management of reflux esophagitis after esophagogastrectomy for malignancy. Further application of Roux-en-Y principle. Mayo Clin Proc 1975;50:588.

Wilkins EW Jr. Long-segment colon substitute for the esophagus. Ann Surg 1980;192:722.

10 Concept: Operations for Reflux Esophagitis, Stricture, Short Esophagus, and Paraesophageal Hernia

Parahiatal and Paraesophageal Hernia

Parahiatal Hernia

Most acquired diaphragmatic hernias enter the chest through the esophageal hiatus. In the typical case, this constitutes a sliding hernia of the esophagogastric junction up into the mediastinum, dragging a fold of peritoneum along with it, just as is the case with a sliding hernia of the cecum. When the abdominal esophagus remains properly attached to the preaortic fascia by means of the phrenoesophageal ligaments, a herniation of the fundus or body of the stomach through the diaphragmatic hiatus into the chest is termed a "paraesophageal" hernia.

MacDougall, Abbott, and Goodhand described five cases where the stomach entered the chest through a congenital defect in the diaphragm, which was situated a few centimeters to the right of the esophageal hiatus, a true *parahiatal* hernia. These authors attributed the defect in the diaphragm to the persistence of a right pneumatoenteric recess. Other authors (Hill and Tobias) state that they have never encountered a true parahiatal hernia that penetrated the diaphragm via any other pathway than the esophageal hiatus itself. In our own experience, we have encountered only one case where the hernia penetrated the left side of the diaphragmatic crus through a defect about 1.5 cm to the left of the normal hiatus. It seems clear that a true parahiatal hernia is extremely rare. A paraesophageal hernia, with a normally situated esophagogastric junction and a normal low esophageal sphincter, is also uncommon, constituting perhaps less than 2% of all acquired diaphragmatic hernias.

Differentiating Paraesophageal from Sliding Hiatus Hernia

By definition, the paraesophageal hernia requires that the esophagogastric junction be fixed to the area of the preaortic fascia and median arcuate ligament. These patients do not suffer from reflux esophagitis. If the paraesophageal hernia is freely reducible, the patients may experience no symptoms. Occasionally, they will suffer from a chronic anemia when a large portion of the stomach is herniated into the chest. This is probably secondary to chronic venous hypertension caused by the diaphragm constricting the stomach, resulting in chronic oozing of blood into the gastric lumen. In some cases gastric ulcer in a herniated stomach may occur because of partial obstruction and stasis.

Paraesophageal Hiatus Hernia with Gastric Volvulus, Obstruction, or Strangulation

The patient with a paraesophageal hernia may have a large portion of the stomach in the chest. Since both the esophagogastric junction and the duodenum are fixed in position, the result is a volvulus of the stomach. This may cause complete obstruction. Since one point of obstruction is at the esophagogastric junction, the patient may be unable to vomit. Generally, an incarcerated paraesophageal hernia produces severe substernal pain. In advanced cases, the blood supply to the herniated stomach is impaired, resulting in necrosis, perforation, empyema, septic shock, and death.

An X ray of the chest, demonstrating a mass in the posterior mediastinum with an air–fluid level, will confirm the diagnosis of a diaphragmatic hernia. Because of the danger that a paraesophageal hernia may strangulate, surgery is indicated in any good-risk patient even if he has no symptoms. All symptomatic patients require surgical repair as this disease results from a mechanical problem for which there is no medical therapy.

Some patients who appear to suffer from a typical paraesophageal hernia actually do have a sliding component. It is important to identify these patients because they may have an incompetent lower esophageal sphincter and will develop reflux esophagitis unless an antireflux procedure is combined with a repair aimed at correcting the paraesophageal hernia. In these cases the esophagogastric junction is not firmly attached to the area of the median arcuate ligament, a point that generally can be confirmed by X-ray studies.

Surgical Repair

If the neck of a *parahiatal* hernia is indeed surrounded by diaphragmatic muscle of good quality, the repair is simple. Remove the sac and close the defect in the diaphragm with several sutures of 0 or 2–0 Tevdek. Paraesophageal hernias can also generally be repaired through the abdominal approach. An attempt should be made gently to insert a nasogastric tube into the herniated portion of stomach prior to operation. After surgical exposure has been obtained, reduce the herniated stomach and omentum. Generally it is not difficult to tease the large hernial sac down from the mediastinum into the abdomen. Then excise the sac, making no attempt to close the remaining peritoneal defect. Narrow the enlarged hiatal opening by inserting interrupted 0 Tevdek sutures to approximate the crura behind the esophagus as described in the repair of a sliding hiatus hernia. With an 18F nasogastric tube in the esophagus, it should be possible for the surgeon to insert his index finger between the esophagus and the newly repaired hiatal orifice.

Now, if there is any suggestion that the esophagogastric junction is not firmly fixed to the median arcuate ligament, or that the patient may be susceptible to reflux esophagitis, perform a posterior gastropexy by the technique of Hill (see Chap. 12) or some modification of that operation.

Sometimes the herniated gastric pouch is the site of a chronic gastric ulcer due to compression by the muscle of the diaphragm. It is not necessary to resect the ulcer or any part of the stomach as simple repair of the hernia will result in satisfactory healing of the ulcer, unless there is some abnormality of gastric function in addition to the paraesophageal hernia.

Sliding Hiatus Hernia

When to Operate

Occasionally a patient may have a normal high pressure zone at the esophagogastric junction even though he has a sliding hernia with this junction high in the mediastinum. This patient will be free of symptoms and does not require surgery. Surgery is indicated for symptomatic reflux esophagitis and its complications when they cannot be successfully controlled by medical management. Patients who do not have any hiatus hernia also require an antireflux operation if the lower esophageal sphincter is incompetent and they suffer from reflux esophagitis that cannot be controlled. Among the serious complications of gastroesophageal reflux are ulceration, bleeding, stricture, and aspiration pneumonitis. Most physicians believe it is the acid that damages the esophagus, producing pain and other complications. However, bile, when it refluxes into the esophagus, also causes pain and stricture formation. Bile may be even more potent in this respect than the gastric acid.

It is generally agreed that medical management is the treatment of choice for mild reflux esophagitis. However, once a stricture has formed, surgery is necessary for long-term relief. Dilating the stricture, without performing an antireflux operation, results in recurrence of the stricture.

Spechler and associates in a randomized study of 247 patients confirmed that "surgery is significantly more effective than medical therapy in improving the symptoms and endoscopic signs of esophagitis for up to two years."

Operations for Preventing Reflux

Belsey Mark IV Procedure

Belsey's operation, described by Baue and Belsey and by Skinner and Belsey, was a great step forward in the surgery of hiatus hernia because it was aimed at preventing reflux as well as repairing the hernia. A long-term follow-up study has been reported by Orringer, Skinner, and Belsey indicating a recurrence rate of 14.7% after 10 years. The Belsey operation can be done only by the thoracic approach. This procedure is likely to fail if the esophagus is not long enough to descend into the abdominal cavity *without tension*. The tension will cause the sutures, which create the partial fundoplication, to pull out of the esophagus with collapse of the repair.

Hill Posterior Gastropexy

In this operation the surgeon narrows the lumen of the esophagogastric junction by turning in the tissues on the lesser curvature side with sutures. These same sutures are fixed to the median arcuate ligament. If this maneuver is successful, it guarantees that 4–7 cm of esophagus will be within the abdominal cavity. Also, the resting pressure at the esophagogastric junction is restored to the normal value.

The posterior gastropexy, described by Hill (1967 and 1977), is done transabdominally. Postoperative complications, such as the "gas bloat" syndrome, are rare. Hill's postoperative studies, including manometric and acid reflux measurement, have demonstrated excellent long-term results.

Although we have experienced good results with this operation, there are a few disadvantages. The operation is difficult to reproduce or to teach with precision because the pillars of adipose tissue and phrenoesophageal ligaments, which are sutured on the lesser curvature of the stomach, vary from patient to patient. Therefore, the amount of tissue inverted into the esophagogastric junction may vary also. Hill has attempted to rectify this drawback by measuring the intraesophageal pressure during the operation so that he can calibrate the degree of inversion according to the pressure being recorded. On the other hand, Orringer, Schneider, Williams, and Sloan reported that intraoperative pressure measurements were unreliable and not reproducible. Inexperienced surgeons find it difficult to identify and dissect out the median arcuate ligament, which is an essential step in this operation. There is also the possibility that the surgeon, not expert in Hill's technique, will injure the celiac artery while dissecting the median arcuate ligament.

Nissen Fundoplication

Nissen's operation involves a complete wrap of the lower esophagus by a segment of gastric fundus. This operation can be performed equally well in the abdomen or in the chest. Studies by DeMeester, Johnson, and Kent, by Dilling, Peyton, Cannon, and Kanaly, and by Skinner and DeMeester have suggested that the Nissen operation is superior to those of Belsey and of Hill when it comes to preventing gastroesophageal reflux. Woodward, Rayl, and Clarke reported a significant incidence of gastric bloating following the Nissen fundoplication as well as the inability to belch or even to vomit. However, Donahue and Bombeck demonstrated that using a loose wrap in making the fundoplication will avoid this complication in almost every case. This has also been our experience.

On the negative side, many complications have been reported to follow defective suturing in this operation. The gastric wrap may slip down so that it surrounds and obstructs the body of the stomach. If the hiatal opening is too large, the fundoplication may herniate into the chest and produce stasis in the herniated gastric pouch with gastric ulcer and bleeding, or even perforation. The Nissen operation may be impossible to perform if the patient has already undergone a high subtotal gastrectomy.

Angelchik Prosthesis

Angelchik and Cohen in 1979 introduced a device shaped like a doughnut with a small gap in its circumference. This device was designed to surround the lowermost esophagus, partially constricting it. It was claimed that the application of this device constituted a very simple operation to prevent gastroesophageal reflux. In the ensuing decade, thousands of these devices have been implanted. Although there have been few randomized studies of the efficacy and complications of this procedure, there were many anecdotal reports of complications such as erosion of the prosthesis into the stomach and migration elsewhere as well as severe dysphagia. The author's only experience with this device was in a patient in whom it was inserted elsewhere. The patient had intractable dysphagia. Gastroscopy disclosed that half of the prosthesis was in the stomach.

At exploration, most of the esophagogastric junction had been eroded. After removing the prosthesis, the esophagogastric junction could not be reconstructed except by the interposition of a segment of isoperistaltic jejunum between the esophagus and the stomach. While this produced an excellent result, the experience does not speak well of the Angelchik device.

A recent prospective randomized trial by Kmiot and associates including 50 patients, 25 undergoing Nissen fundoplication and 25, the Angelchik prosthesis. Five patients with an Angelchik prosthesis developed severe persistent dysphagia within 2 years. The dysphagia was serious enough to warrant removal of the prosthesis in three of these patients. By contrast, no patient who underwent Nissen fundoplication developed severe dysphagia or required reoperation. The authors terminated the trial at that point. Similar findings were noted in a prospective randomized trial reported by Stuart and associates. We believe that the Angelchik procedure is an unacceptable operation for gastroesophageal reflux at this time.

Personal Viewpoint

When the thoracic approach is used, we prefer Nissen's repair to Belsey's because it is simpler to perform and appears to be more effective in preventing reflux. Transabdominally, the Nissen and Hill repairs both are effective operations; the choice between them depends on the preference of the surgeon.

Operations for Esophageal Stricture Secondary to Reflux

Dilatation of Stricture with Transthoracic Nissen Repair

When the transthoracic approach is used, the anesthesiologist can pass Maloney bougies through the patient's mouth and dilate the stricture while the surgeon guides the bougie through the lumen. After this has been successfully completed, it is necessary to perform an operation to prevent further reflux. The Nissen operation is then performed. After completing this step, reduce the fundoplication into the abdomen and close the crura behind the esophagus.

Long-standing fibrotic strictures can cause foreshortening of the esophagus. In these cases, even dissection of the esophagus up to the arch of the aorta will not achieve significant lengthening and it is not possible to replace the esophagogastric junction into the abdominal cavity *without tension.* If tension is present and the repair is forced into the abdominal cavity, recurrence of both the hernia and the reflux will be common. Some surgeons (Woodward, Pennell) prefer to handle this problem by leaving the esophagogastric junction in the thoracic cavity after performing a Nissen fundoplication. In this case it is necessary to enlarge the hiatal opening to permit the body of the stomach to pass through *without constriction.* It is also necessary to carefully suture the gastric wall to the muscular ring of the hiatus or else bowel will herniate into the chest between the stomach and the hiatus. Many complications have been reported by Richardson, Larsen, and Polk and by Mansour, Burton, Miller, and Hatcher following an intrathoracic fundoplication. Some of these complications are gastric ulceration and perforation in the intrathoracic stomach, esophagopleurocutaneous and gastropleurocutaneous fistulas, and perigastric herniation of bowel into the chest.

Because of these complications, we restrict the use of the transthoracic Nissen fundoplication *only* to those patients whose esophagus is pliable and is *long enough to pass into the abdomen without tension.* Otherwise, we perform a Collis gastroplasty to lengthen the esophagus before creating an antireflux valve of the Nissen type (Stirling and Orringer 1988).

On the other hand, Collard and associates studied 31 patients suffering from reflux esophagitis accompanied by a short esophagus such that even after thoracic dissection, the hiatus hernia could not be reduced into the abdomen. Their first 16 cases were followed by acute perforations of the Nissen wrap in four patients and bronchogastric fistula in one case. After correcting their operative technique to allow for *significant* enlargement of the hiatus, together with loosening the Nissen wrap, as well as suturing the stomach to the circumference of the hiatal ring, they found the results to be satisfactory.

Although we still prefer the Collis–Nissen operation for patients with severe reflux who have a short esophagus, it is possible that the intrathoracic Nissen wrap will find a niche in certain poor-risk patients.

Dilatation of Stricture with Collis Gastroplasty and Antireflux Procedure

Whenever there is any question at all concerning the ease with which 5–7 cm of esophagus can be passed into the abdomen, we agree with Pearson and Henderson and with Urschel, Razzuk, Wood, and Galbraith that the esophagus should be lengthened by a Collis gastroplasty. Even if the esophagus is not short in length, when the distal end is rigid with fibrosis, trying to create a valve to prevent reflux will be ineffective because the rigid esophageal wall cannot be compressed. Rigidity of the distal esophagus is, therefore, a second indication for a Collis gastroplasty. The Collis operation is not difficult to perform in the chest, especially with the help of the GIA stapling device. When a fibrotic esophagus is baked into the mediastinum, sharp dissection is required to release it. Dissect the esophagus as far as the inferior pulmonary vein in these cases; further cephalad dissection does not achieve significant lengthening. Then the Collis gastroplasty will add another 5–9 cm to the length of the esophagus.

Following this lengthening procedure, Pearson and Henderson and Urschel and colleagues added a Belsey 270° fundoplication to prevent reflux. Orringer and Sloan (1977) and Henderson (1977) were unable to duplicate the successful antireflux effect of the Collis-Belsey operation reported by Pearson and by Urschel. They prefer to perform a modified Nissen fundoplication following the Collis gastroplasty. Although there has not been any randomized study comparing the Collis-Belsey and the Collis-Nissen operations, at this time we prefer the Collis-Nissen as described by Henderson (1979) and by Stirling and Orringer (1988) because it is simpler and appears to be more effective (Henderson 1977, Orringer and Sloan 1977, and Orringer and Orringer 1982).

Esophageal Resection with Colon or Jejunal Interposition (see Chap. 9)

On rare occasions, the esophageal fibrosis is so advanced that attempting to dilate the stricture will result in rupture of the esophagus. An esophageal laceration can sometimes be converted into an esophagoplasty with a Thal gastric patch (Woodward et al.). However, most of the time the traumatized lower esophagus will have to be resected. *Irreversible damage to the lower esophagus may also occur during an operation for severe esophagitis in a patient who has had several previous operations in this area.*

In repairing the defect that remains following resection of the lower esophagus, several requirements should be satisfied. First, the operation should be safe. Second, the reconstruction should prevent future reflux. Third, the repair should permit free passage of food from the mouth to the stomach. Two procedures seem to fulfill these requirements. In 1965 Belsey reported 92 cases in which the distal esophagus was replaced by a segment of colon whose blood supply was based on the left colic artery. The mortality rate was 4.3% when this procedure was performed for benign disease. Successful long-term results with the colon interposition operation were also reported by Glasgow, Cannon, and Elkins and by Wilkins. Merendino and Dillard suggested the interposition of an isoperistaltic segment of proximal jejunum between the distal esophagus and stomach. Polk found that the jejunal interposition operation was effective in preventing reflux. His mortality rate was 4%. Both the jejunum and the colon interposition operations need to be performed only under highly unusual circumstances. For this reason, there are not enough data to determine whether one is better than the other. If the esophagus must be resected above the level of the inferior pulmonary vein, the jejunal interposition is contraindicated (Polk), but the colon procedure is feasible.

Another procedure to replace the esophagus that has recently achieved attention is the cervical esophagogastrostomy as described by Akiyama (1980) and by Orringer (1985). Although this operation requires only one anastomosis, we prefer the colon interposition. We reduce the operating time by performing the colocolic and the cologastric anastomoses with stapling devices (see Figs. 37–33 to 37–36 and 9–2 to 9–7).

Esophagoplasty and Thal Patch

Thal described a method of repairing a lower esophageal stricture by making a longitudinal incision through the constricted area. He then sutured the fundus of the stomach into the defect created in the esophagus by this incision. Later modifications (Woodward et al.) included applying a split-thickness skin graft to the gastric wall to replace the defect in the esophageal mucosa, as well as creating a Nissen fundoplication around the repair. The repaired esophagus and the fundoplication are left in the thoracic cavity, a situation that is followed by many complications as discussed above. This procedure is possible only in strictures of the lower esophagus where adjacent gastric fundus is available for the repair. Although the operation appears to be straightforward, it has not gained widespread popularity. Woodward reported satisfactory results with the Thal operation, but we have not had any experience with this procedure. In most esophageal strictures, even when they are severe, gradual dilatation leads to a surprisingly high percentage of good results without requiring either an incision of the stricture or a resection of the esophagus. In each case dilatation of the stricture should be followed by an antireflux operation or the stricture will recur.

Operation for Barrett's Esophagus

In Barrett's esophagus, chronic reflux has produced metaplasia of the squamous epithelium of the esophagus distal to the stricture, so that the epithelium becomes columnar in nature. Some strictures in patients suffering from the Barrett esophagus may occur as high as the aortic arch. These patients can be treated by dilatation of the stricture followed by an antireflux operation. In the absence of further gastroesophageal reflux, the successfully dilated stricture will generally not recur.

It should be recognized that the incidence of malignancy (adenocarcinoma) in the Barrett esophagus is higher than when the esophagus is lined with squamous epithelium. For this reason, these patients should be followed by annual esophagoscopy.

Management of Patients with Failed Operations for Reflux Esophagitis

Recurrent Reflux Esophagitis after Transabdominal Operation

Some patients with a failed Nissen fundoplication or Hill posterior gastropexy operation can be successfully explored and repaired by a second abdominal procedure. However, Henderson and Marryatt (1981) warn that in *most* operations for recurrence the upper stomach will be densely adherent to both the liver and the spleen. They advocate the routine use of a thoracoabdominal incision for these cases and almost always employ a Collis-Nissen repair. After an average follow-up period of 2.5 years in 97% of 121 patients, they achieved excellent results in 94% of their operations for recurrent esophagitis; their advice is well worth following.

Roux-en-Y Bile Diversion for Recurrent Reflux Esophagitis Following Repeated Failed Operations

When a patient has undergone two or three failed surgical attempts to correct gastroesophageal reflux, Payne and also Royston, Dowling, and Spencer recommend a procedure that does not necessitate reexploring the esophagogastric junction. The procedure consists of vagotomy and antrectomy combined with a Roux-en-Y gastrojejunostomy (see Chap. 14). This operation is particularly appropriate in patients who have already had a vagotomy and antrectomy during one of their previous operations. It is especially suitable in poor-risk patients who may not be candidates for a thoracotomy and extensive reconstruction of the esophagogastric junction. The combination of vagotomy, antrectomy, and Roux-en-Y diversion prevents the reflux of either acid or bile into the esophagus, with relief of symptoms. In the good-risk patient with many failed operations for reflux, one might prefer to perform a jejunal interposition operation, rather than the biliary diversion procedure, but there are inadequate data at this time to enable the surgeon to choose between these two options on a scientific basis. In several critical situations we have had successful results with Payne's operation.

The concept that following a failed operation to stop gastroesophageal reflux, further surgery on the esophagogastric junction is ineffective, especially in patients with short esophagus or severe stricture, is supported by the study of Fekete and Pateron. They performed truncal vagotomy, antrectomy, and Roux-en-Y gastrojejunostomy in 83 patients suffering from severe reflux esophagitis despite previous surgery for reflux. These authors considered their postoperative results in these patients to be superior to those to be expected from repeat operations to prevent reflux.

Reflux Esophagitis Following Esophagogastrectomy

After esophagogastrectomy for lesions of the distal esophagus or proximal stomach, an *end-to-side* esophagogastric anastomosis will generally prevent gastroesophageal reflux. When the surgeon has erroneously performed this anastomosis in an end-to-end fashion, he should anticipate a high incidence of serious reflux esophagitis. When this esophagitis will not respond to conservative management, a biliary diversion may be of benefit (Smith and Payne). In these cases, vagotomy has invariably been performed during the esophagogastrectomy. Generally, a significant portion of the acid-secreting gastric mucosa has been resected, so that it is the bile rather than the acid which is causing damage to the esophagus. In this situation, dividing the duodenum 2–3 cm beyond the pylorus and anastomosing it to jejunum by the Roux-en-Y technique (see Chap. 14) will eliminate the reflux of bile. Before electing to perform the Roux-en-Y procedure, one should ascertain that it is indeed bile that is refluxing into the esophagus by performing an esophagoscopy or a radionuclide scan.

Whenever more than 50%–60% of the stomach has to be removed for a proximal gastric tumor, it is preferable to perform a total gastrectomy with an esophagojejunal anastomosis by the Roux-en-Y technique than to do an end-to-end esophagogastrostomy. If this policy is followed, postoperative reflux esophagitis will not be a problem.

Operation for Schatzki's Ring

Schatzki's ring is a thin diaphragmlike membrane across the lower esophagus. This generally occurs in patients with hiatus hernia and an incompetent sphincter. The lumen of the Schatzki ring is rarely less than 1 cm in diameter so that it does not produce obstructive symptoms very often, although a large piece of meat can occasionally occlude its lumen.

When a patient who has a tight Schatzki ring is undergoing surgery for reflux esophagitis, the Schatzki ring may be dilated from above by the anesthesiologist with Maloney bougies or by the surgeon via a small gastrotomy incision with Hegar's dilators from below. It is not generally necessary to perform surgery for the Schatzki ring in the absence of reflux esophagitis.

Thoracic, Abdominal, or Thoracoabdominal Incision?

In patients who have had no previous operations in the area of the esophagogastric junction, the abdominal incision is preferred. With the help of a Thompson or Upper Hand retractor, the exposure for an antireflux operation is generally quite good. Additionally, other diseases, such as cholelithiasis and duodenal ulcer, can be treated surgically at the same time that the hiatus hernia is being repaired. The abdominal approach is *contraindicated* if there is evidence that the esophagus is short. In many patients the esophagus appears to be foreshortened because of the sliding nature of the hiatus hernia. However, in the absence of significant esophageal fibrosis the esophagogastric junction can be brought back into the abdominal cavity without tension. On the other hand, during esophagoscopy it may be evident that there is a thick fibrotic stricture or that the lower esophagus appears to be fixed in the mediastinum. Under these conditions a transthoracic approach is preferable. Attempts at transabdominal dissection of the lower esophagus are fraught with the danger of traumatizing both the esophagus and the vagus nerves. Also, many of these patients will require a Collis gastroplasty to lengthen the esophagus. This operation is much easier to perform through the chest than through the abdomen.

When a patient is undergoing the second or third operation for recurrent gastroesophageal reflux, he should always be positioned on the operating table so that the initial approach can be extended by making a left thoracoabdominal incision (see Figs. 8–3 to 8–7). Although some surgeons prefer to achieve additional exposure by making separate laparotomy and thoracic incisions, thus avoiding division of the costal margin, we have never hesitated to combine the thoracic and the abdominal incisions because division of the costal margin creates no disability if the cartilage is repaired with one or two nonabsorbable sutures. The exposure provided by the thoracoabdominal incision surpasses that of any other combination of incisions. In performing the thoracoabdominal incision for recurrent hiatus hernia, do not make a radial incision from the esophageal hiatus to the costal margin because this will disrupt the function of the diaphragm by cutting the phrenic nerve. A 12 cm incision in the periphery of the diaphragm offers excellent exposure without cutting any branches of the phrenic nerve.

Secondary operations for esophageal reflux are difficult procedures that carry a significant mortality rate. Zucker, Peskin, and Saik reported that 3 of 17 patients (17.6%) undergoing such operations died and 46% developed a complication. All of the fatal cases had been performed by an exclusively transabdominal approach.

References

Akiyama H. Surgery for carcinoma of the esophagus. Curr Probl Surg 1980;17:56.

Angelchik JP, Cohen R. A new surgical procedure for the treatment of gastroesophageal reflux and hiatal hernia. Surg Gynecol Obstet 1979;148:246–248.

Baue AE, Belsey R. The treatment of sliding hiatus hernia and reflux esophagitis by the Mark IV technique. Surgery 1967;62:396.

Belsey R. Reconstruction of the esophagus with left colon. J Thorac Cardiovasc Surg 1965;49:33.

Collard J-M, DeKoninck XJ, Otte JB et al. Intrathoracic Nissen fundoplication: Long-term clinical and pH-monitoring evaluation. Ann Thorac Surg 1991; 51:34–38.

DeMeester TR, Johnson LF, Kent AH. Evaluation of current operations for the prevention of gastroesophageal reflux. Ann Surg 1974;180:511.

Dilling EW, Peyton MD, Cannon JP, Kanaly PJ et al. Comparison of Nissen fundoplication and Belsey Mark IV in the management of gastroesophageal reflux. Am J Surg 1977;134:730.

Donahue PC, Bombeck CT. The modified Nissen fundoplication-reflux prevention without gas bloat. Chir Gastroenterol 1977;11:15.

Fekete F, Pateron D. What is the place of antrectomy with Roux-en-Y in the treatment of reflux disease? Experience with 83 total diversions. World J Surg 1992; 16:349–354.

Glasgow JC, Cannon JP, Elkins RC. Colon interposition for benign esophageal disease. Am J Surg 1979;137:175.

Henderson RD. Reflux control following gastroplasty. Ann Thorac Surg 1977;24:206.

Henderson RD. Nissen hiatal hernia repair: problems of recurrence and continued symptoms. Ann Thorac Surg 1979;28:587.

Henderson RD, Marryatt G. Recurrent hiatal hernia: management by thoracoabdominal total fundoplication gastroplasty. Can J Surg 1981;24:151.

Hill LD. An effective operation for hiatal hernia: an eight year appraisal. Ann Surg 1967;166:681.

Hill LD. Progress in the surgical management of hiatal hernia. World J Surg 1977;1:425.

Kmiot WA, Kirby RM, Akinola A et al. Prospective randomized trial of Nissen fundoplication and Angelchik prosthesis in the surgical treatment of medically refractory gastroesophageal reflux disease. Br J Surg 1991;78:1181–1184.

MacDougall JI, Abbott AC, Goodhand TK. Herniation through congenital diaphragmatic defects in adults. Can J Surg 1963;6:301.

Mansour KA, Burton HG, Miller JI Jr, Hatcher CR Jr. Complications of intrathoracic Nissen fundoplication. Ann Thorac Surg 1981;32:173.

Merendino KA, Dillard DH. The concept of sphincter substitution by an interposed jejunal segment for anatomic and physiological abnormalities at the esophagogastric junction. Ann Surg 1955;142:486.

Orringer MB. Transhiatal esophagectomy for benign disease. J Thorac Cardiovasc Surg 1985;90:649.

Orringer MB, Orringer JS. The combined Collis-Nissen operation: early assessment of reflux control. Ann Thorac Surg 1982;33:543.

Orringer MB, Schneider R, Williams GW, Sloan H. Intraoperative esophageal manometry: is it valid? Ann Thorac Surg 1980;30:13.

Orringer MB, Skinner DB, Belsey RHR. Long-term results of the Mark IV operation for hiatal hernia and analyses of recurrences and their treatment. J Thorac Cardiovasc Surg 1972;63:25.

Orringer MB, Sloan H. Complications and failings of the combined Collis-Belsey operation. J Thorac Cardiovasc Surg 1977;74:726.

Orringer MB, Sloan H. Combined Collis-Nissen reconstruction of the esophagogastric junction. Ann Thorac Surg 1978;25:16.

Payne WS. Surgical treatment of reflux esophagitis and stricture associated with permanent incompetence of the cardia. Mayo Clin Proc 1970;45:553.

Pearson FG, Henderson RD. Experimental and clinical studies of gastroplasty in the management of acquired short esophagus. Surg Gynecol Obstet 1973;136:737.

Pennell TC. Supradiaphragmatic correction of esophageal reflux strictures. Ann Surg 1981;193;655.

Polk HC Jr. Jejunal interposition for reflux esophagitis and esophageal stricture unresponsive to valvuloplasty. World J Surg 1980;4:731.

Richardson JD, Larson GM, Polk HC Jr. Intrathoracic fundoplication for shortened esophagus. Am J Surg 1982;143:29.

Royston CMS, Dowling BL, Spencer J. Antrectomy with Roux-en-Y anastomosis in the treatment of peptic esophagitis with stricture. Br J Surg 1975;62:605.

Skinner DB, Belsey R. Surgical management of esophageal reflux and hiatus hernia. J Thorac Cardiovasc Surg 1967;53:33.

Skinner DB, DeMeester TR. Gastroesophageal reflux. Curr Probl Surg 1976;13:1.

Smith J, Payne WS. Surgical technique for management of reflux esophagitis after esophagogastrectomy for malignancy; further application of the Roux-en-Y principle. Mayo Clin Proc 1975;50:588.

Spechler SJ and the V.A. Gastroesophageal Reflux Disease Study Group. Comparison of medical and surgical therapy for complicated gastroesophageal reflux disease in veterans. N Engl J Med 1992;326;786–792.

Stirling MC, Orringer MB. The combined Collis-Nissen operation for esophageal reflux strictures. Ann Thorac Surg 1988;45:148–157.

Stirling MC, Orringer MB. Continued assessment of the combined Collis-Nissen operation. Ann Thorac Surg 1989;47:224–230.

Stuart RC, Dawson K, Keeling P et al. A prospective randomised trial of Angelchik prosthesis versus Nissen fundoplication. Br J Surg 1989;76:86–89.

Urschel HC, Razzuk MA, Wood RE, Galbraith NF et al. An improved surgical technique for the complicated hiatal hernia with gastroesophageal reflux. Ann Thorac Surg 1973;15:443.

Wilkins EW Jr. Long-segment colon substitution for the esophagus. Ann Surg 1980;192:722.

Woodward ER, Rayl JE, Clarke JM. Esophageal hiatus hernia. Curr Probl Surg 1970;7:1.

Zucker K, Peskin GW, Saik RP. Recurrent hiatal hernia repair; a potential surgical dilemma. Arch Surg 1982; 117:413.

11 Transabdominal Fundoplication (Nissen)

Indications

Reflux esophagitis without good response to medical therapy, whether or not an anatomical hiatus hernia is present. If a previous operation has been performed at the esophagogastric junction for reflux, a transthoracic or thoracoabdominal approach is preferred. Stein and DeMeester summarize their indications for an antireflux operation as follows:

1) Persistent or recurrent symptoms and/or complications after 8 to 12 weeks of intensive acid suppression therapy, and
2) Increased esophageal exposure to gastric juice on 24 hour esophageal pH monitoring, and
3) Documentation of a mechanically defective lower esophageal sphincter on manometry.

These authors also feel that the development of a stricture in a patient with a defective lower esophageal sphincter is an indication for surgery, as is the presence of a Barrett's esophagus. They note that patients who, in addition to the symptoms of reflux, complained of epigastric pain, nausea, bilious vomiting, and loss of appetite were often found to be suffering from duodenogastric reflux. These patients, who constituted 28% of their population of gastroesophageal reflux patients, could be diagnosed by noting periods of high pH during the 24 hour esophageal pH monitoring. If this condition is severe, a bile diversion operation (see Chap. 14) may be indicated in addition to the antireflux operation.

When these indications for surgery were observed in 100 patients followed over a 10-year period, the actuarial success rate for the control of reflux symptoms was 91% with the Nissen operation. (For a discussion of alternative operations for reflux esophagitis, see Chap. 10.)

Preoperative Care

Preoperative esophagoscopy to confirm the presence of reflux esophagitis

Barium esophagram and gastrointestinal X-ray series; check for disordered gastric emptying

Perioperative antibiotics

Manometric studies of esophageal motility in cases where diffuse esophageal spasm, scleroderma, or achalasia is suspected

A 24-hour continuous recording of lower esophageal pH is useful in deciding whether a patient's pain is indeed coincident with reflux of gastric juice into the esophagus.

Pass a nasogastric tube prior to or during operation.

Pitfalls and Danger Points

Inadequate mobilization of gastric fundus and abdominal esophagus

Injury to spleen or to vagus nerves

Fundoplication wrap too tight or too wide

Inadequate fundoplication suturing

Undiagnosed esophageal motility disorders, such as achalasia, diffuse spasm, aperistalsis, or scleroderma

Hiatal closure too tight, causing obstruction of esophagus

Hiatal closure too loose, permitting postoperative paraesophageal herniation

Injury to left hepatic vein or vena cava when incising triangular ligament to liberate left lobe of liver

Operative Strategy

Mobilizing the Gastric Fundus

In order to perform a hiatus hernia repair efficiently, it is essential that the lower 5–7 cm of esophagus and the entire gastric fundus from the gastroesophageal junction down to the upper short gastric vessel be completely mobilized from all attachments to the diaphragm and the posterior abdominal wall. To accomplish this, use the Thompson or Upper Hand retractor to elevate the sternum. Identify the gastrophrenic ligament by passing the left hand behind the stomach so that the fingertips will identify this avascular ligament, which attaches the greater curvature to the diaphragm. The ligament extends from the gastroesophageal junction down to the first short gastric vessel. It is simple to divide once it has been stretched by the surgeon's left hand behind the stomach. Although in a few cases no short gastric vessels need to be divided, there should be no hesitation to divide 1–3 proximal short gastric vessels so that the fundoplication wrap can be applied loosely.

On the lesser curvature aspect of the gastroesophageal junction, it is necessary to divide the proximal portion of the gastrohepatic ligament. This ligament generally contains an accessory left hepatic artery arising from the left gastric artery and going to the left lobe of the liver as well as the hepatic branch of the left vagus nerve. Division of the accessory left hepatic artery has, in our experience, not proved harmful. Do not divide the left gastric artery itself. Preserving the left gastric artery and the hepatic branch of the vagus nerve helps to prevent the fundoplication from slipping in a caudal direction (Polk). The lower esophagus is freed by incising the overlying peritoneum and phrenoesophageal ligaments; continue this incision in a semicircular fashion so that the muscular margins of the diaphragmatic crura are exposed down to the median arcuate ligament. During all of this mobilization, look for the major branches of the anterior and posterior vagus nerves and preserve them.

If the esophagus is foreshortened by esophagitis and fibrosis, a simple fundoplication is an inadequate operation. Unless 5–7 cm of esophagus can be brought without tension into the abdomen, do not perform fundoplication without also creating a Collis gastroplasty (see Chap. 13).

Preventing Injury to Spleen

Splenic trauma is reported to be a common complication of the Nissen operation. Rogers, Herrington, and Morton noted that 26% of their series of fundoplication operations underwent splenectomy because of operative trauma. Injury to the spleen is generally a preventable complication. With the use of the Thompson or Upper Hand retractor there is no reason for any retractor to come into contact with the spleen. Most often the mechanism of splenic injury is traction upon the body of the stomach toward the patient's right. This maneuver avulses a portion of the splenic capsule where it is attached to the omentum or to the gastrosplenic ligament. Early in the operation, make it a point to look at the anterior surface of the spleen. Note where the omentum may be adherent to the splenic capsule. If necessary, divide these attachments under direct vision. Otherwise, simply apply a moist gauze pad over the spleen and avoid lateral traction upon the stomach. Traction on the gastroesophageal junction in a caudal direction along the *lesser* curve of the stomach does not generally cause any injury to the spleen.

If a portion of the splenic capsule has been avulsed, this can almost always be managed by applying a sheet of Surgicel or powdered Avitene followed by 10 minutes of pressure. Other splenic injuries can be repaired by suturing with 2–0 chromic catgut (see Chap. 79). Extensive disruption of the spleen at its hilus is an indication for splenectomy.

How Tight Should the Fundoplication Be?

The Nissen operation produces a high pressure zone in the lower esophagus but not because the seromuscular sutures themselves reduce the lumen of the esophagus. Rather, the gastric air bubble rises to the area of the plication and transmits sufficient pressure to keep the esophagus partially occluded. This pressure is not sufficient to prevent the passage of food, however. For this reason, it is not necessary that the fundoplication be tight enough actually to constrict the esophagus. A loose wrap seems to accomplish an effective antireflux effect without causing the inability to vomit or belch and without giving the patient the "gas bloat" syndrome. Most surgeons perform the plication with a 40F bougie in place to avoid too tight a wrap. Whether or not the indwelling bougie is used, it is possible to judge the tightness of the wrap by applying Babcock clamps to each side of the gastric fundus and tentatively bringing them together in front of the esophagus. This will mimic the effect of the sutures. The surgeon should be able to pass one or two fingers between the wrap and the esophagus without difficulty with an 18F nasogastric tube in place. Otherwise readjust the fundoplication so that it is loose enough for this maneuver to be accomplished.

Even though the fundoplication wrap seems somewhat loose, the postoperative barium esophagram will show a narrow tapering of the distal esophagus.

How Wide Should the Fundoplication Be?

One cause of postoperative dysphagia is making the fundoplication wrap too wide. In the usual Nissen operation, do not wrap more than 2–3 cm of esophagus.

When they perform a fundoplication to prevent reflux simultaneously with an extensive esophageal myotomy for diffuse esophageal spasm, Henderson and Ryder utilize a one-stitch wrap, 0.5 cm wide. These authors also use a 0.5-cm wrap when they perform the Collis–Nissen operation in patients with scleroderma who have severe reflux esophagitis.

Henderson and Marryatt (1983) employ a Nissen fundoplication wrap only 1.0 cm in width (three stitches) together with a Collis gastroplasty in patients with severe reflux esophagitis who do not suffer any disorder of esophageal motility.

Avoiding Fundoplication Suture Line Disruption

Polk and other authors have noted that an important cause of failure after Nissen fundoplication has been disruption of the plication because the sutures broke. For this reason, use 2–0 sutures. Generally the sutures that were found to have broken were silk. We have used 2–0 Tevdek because it retains its tensile strength for many years while silk gradually degenerates in the tissues. It is also important not to pass the suture into the lumen of the stomach or esophagus. If this error is committed, tying the suture too tight will cause strangulation and possible leakage. Some insurance against the latter complication may be obtained if the major fundoplication sutures are turned in with a layer of continuous 4–0 Prolene seromuscular Lembert sutures as recommended by Orringer and Sloan.

Avoiding Postoperative Dysphagia

Transient mild dysphagia during the first 2–3 weeks following operation is common and probably is secondary to local edema. However, some patients have difficulty in swallowing for many months after a hiatus hernia operation. There are several possible causes for this dysphagia. (1) It is possible to make the fundoplication wrap so tight or so wide that permanent dysphagia may ensue. (2) The defect in the hiatus may be sutured so tightly that the hiatus impinges on the lumen of the esophagus and prevents the passage of food. With an 18F nasogastric tube in place, after the crural sutures have been tied to repair the defect in the hiatus, the surgeon should still be able to insert his index finger without difficulty between the esophagus and the margins of the hiatus. There is no virtue in closing the hiatus snugly around the esophagus. (3) A final cause of dysphagia in patients who have experienced this symptom as one of their preoperative complaints is the presence of an esophageal motility disorder like achalasia or aperistalsis. Patients who present to the surgeon with reflux esophagitis and who also complain of dysphagia should have preoperative esophageal manometry to rule out motility disorders that may require surgery either in addition to the antireflux procedure or instead of this operation.

Failure to Bring the Esophagogastric Junction into the Abdomen

If the surgeon cannot mobilize the esophagogastric junction from the mediastinum and bring it into the abdomen while performing a transabdominal repair of a hiatus hernia, he can infer that fibrosis has been sufficient in the esophagus to have foreshortened it. This can generally be suspected prior to operation by the fact that the lower esophagus is strictured. In our opinion, these patients require a transthoracic Collis-Nissen operation. Although it is possible to perform the Collis-Nissen procedure in the abdomen, this is quite difficult. If it cannot be accomplished transabdominally, it will be necessary to open the chest either through a separate incision or through a thoracoabdominal extension and to perform the Collis–Nissen operation, which appears to be the best long-term insurance against recurrent reflux esophagitis in these patients (see Chap. 13).

Unsettled Questions of Technique

Combining Nissen Operation with Posterior Gastropexy

Cordiano, Rovere, Agugiaro, and Mazzilli and Kaminski, Codd, and Sigmund have advocated that the Nissen fundoplication be sutured to the median arcuate ligament in order to prevent any possibility of the fundoplication herniating through the hiatus into the chest postoperatively. They accomplish this by passing the two lowermost fundoplication sutures through the median arcuate ligament before tying them. Although this may appear to be a rational extension of the Nissen operation, there are as yet no follow-up studies to validate the efficacy of this modification. Also, there is the danger that attaching the Nissen sutures to the median arcuate ligament may cause the wrap to slip downward on the stomach.

Dividing Short Gastric Vessels

Although Polk states that he rarely has to divide the short gastric vessels, we find that dividing several of the proximal short gastric arteries and veins does facilitate mobilizing enough of the fundus to permit a loose fundoplication wrap without tension. Since it is easy to pass the fundus behind the esophagus in a tentative fashion, one can estimate in each case whether there will be sufficient mobility of the fundus without dividing the short gastric vessels or whether further dissection is necessary. It is essential to achieve adequate mobility of the fundus.

Dividing Triangular Ligament of Liver

In many descriptions of the technique for transabdominal repair of a hiatus hernia, division of the triangular ligament is routinely performed to free the left lobe of the liver and to help to expose the hiatus. In most cases of hiatus herniorrhaphy, excellent exposure of the hiatus can be obtained by using a Thompson or Weinberg retractor on the left lobe of the liver and elevating it. If the lobe does have to be mobilized and the triangular ligament divided, remember that this ligament leads directly to the junction of the left hepatic vein and the vena cava. If the avascular triangular ligament is divided without paying close attention, the incision can easily continue into the vena cava. An injury at the junction of the left hepatic vein and the inferior vena cava can be serious because these two large veins are surrounded by liver at this point. Consequently, the control of a venous laceration here is extremely difficult.

Keeping the Fundoplication from Slipping by Inserting Additional Esophagogastric Sutures

Various methods have been advocated to keep the fundoplication from sliding in a caudal direction, where it will constrict the middle of the stomach instead of the esophagus and produce an "hourglass" stomach with partial obstruction. The most important means of preventing this caudal displacement of the wrap is to include the wall of the esophagus in each of the fundoplication sutures. Also, catch the wall of the stomach *just* below the gastroesophageal junction within the lowermost suture. This suture will anchor the lower portion of the wrap (see Fig. 11–10). Leonardi, Crozier, and Ellis advocate an additional suture line between the upper margin of the gastric wrap and the adjacent esophagus.

Operative Technique

Incision

Elevate the head of the operating table 10°–15°. Make a midline incision beginning at the xiphoid and continue about 2–3 cm beyond the umbilicus (**Fig. 11–1**). Explore the abdomen. Insert a Thompson or Upper Hand retractor to elevate the lower portion of the sternum. Reduce the hiatus hernia by traction along the anterior wall of the stomach. Look at the anterior surface of the spleen to determine whether there are omental adhesions to

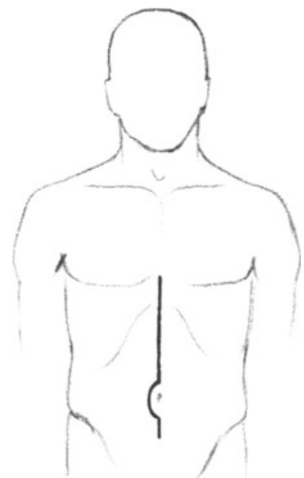


Fig. 11–1

the capsule that may result in avulsing the capsule later in the operation. Place a moist gauze pad over the spleen. In most cases it is not necessary to free the left lobe of the liver; simply elevate the left lobe with a Weinberg retractor in order to expose the diaphragmatic hiatus.

Mobilizing Esophagus and Gastric Fundus

Make a transverse incision in the peritoneum overlying the abdominal esophagus (**Fig. 11–2**) and continue this incision into the peritoneum overlying the right margin of the crus. Then divide the peritoneum overlying the left margin of the diaphragmatic hiatus. Separate the hiatal musculature from the esophagus using a peanut dissector until *most of the circumference of the esophagus has been exposed.* Then pass the index finger *gently* behind the esophagus and encircle it with a latex drain (**Fig. 11–3**). Enclose both the right and left vagus nerves in the latex drain and divide all the phrenoesophageal attachments behind the esophagus. If the right (posterior) vagus trunk courses at a distance from the esophagus, it is easier to dissect the nerve away from the upper stomach and to exclude the right vagus from the fundoplication wrap. Some authors (Herrington; Jordan) exclude both vagus trunks from the wrap. Before the complete circumference of the hiatus can be visualized, it will be necessary to divide not only the phrenoesophageal ligaments but also the

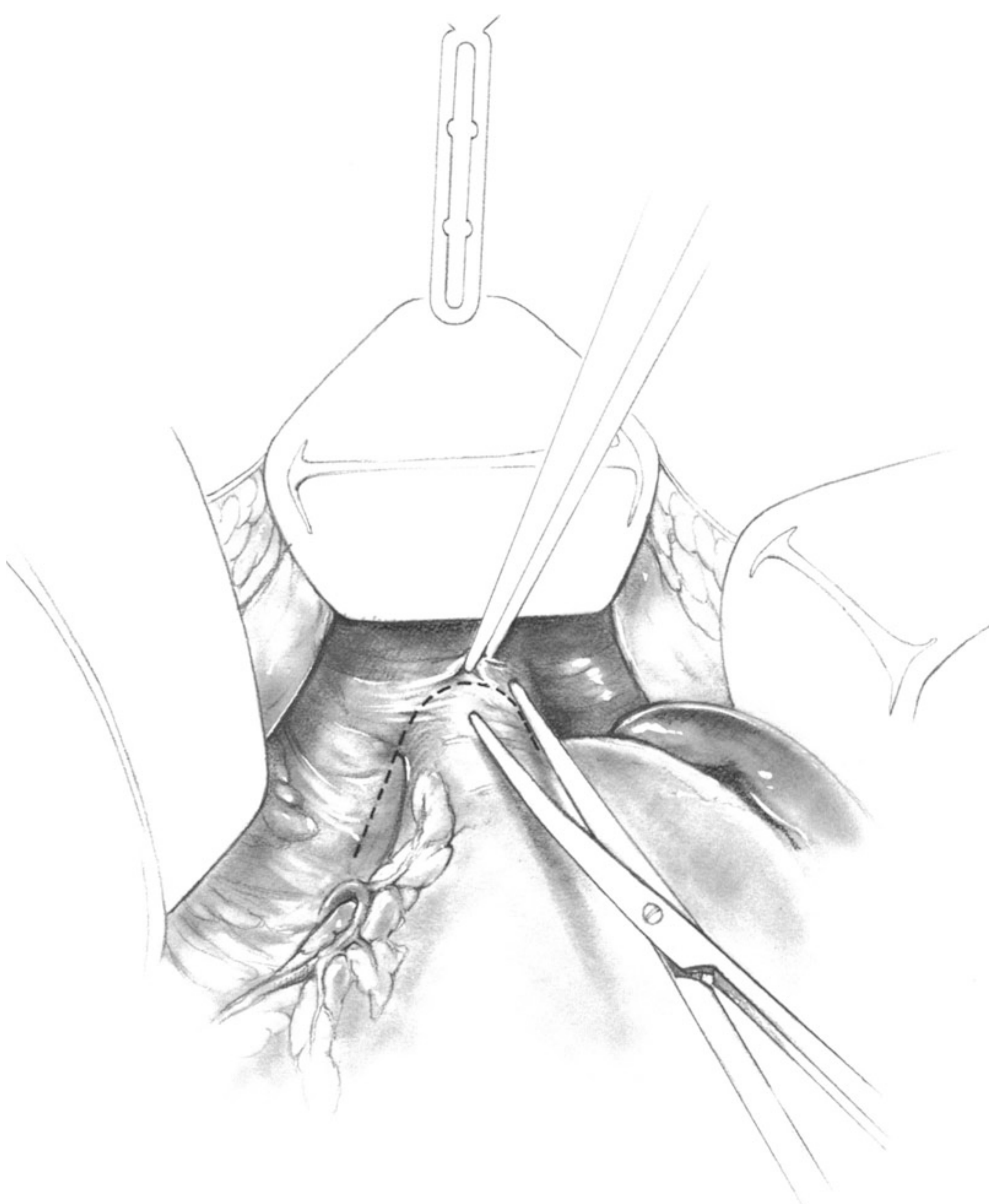


Fig. 11–2

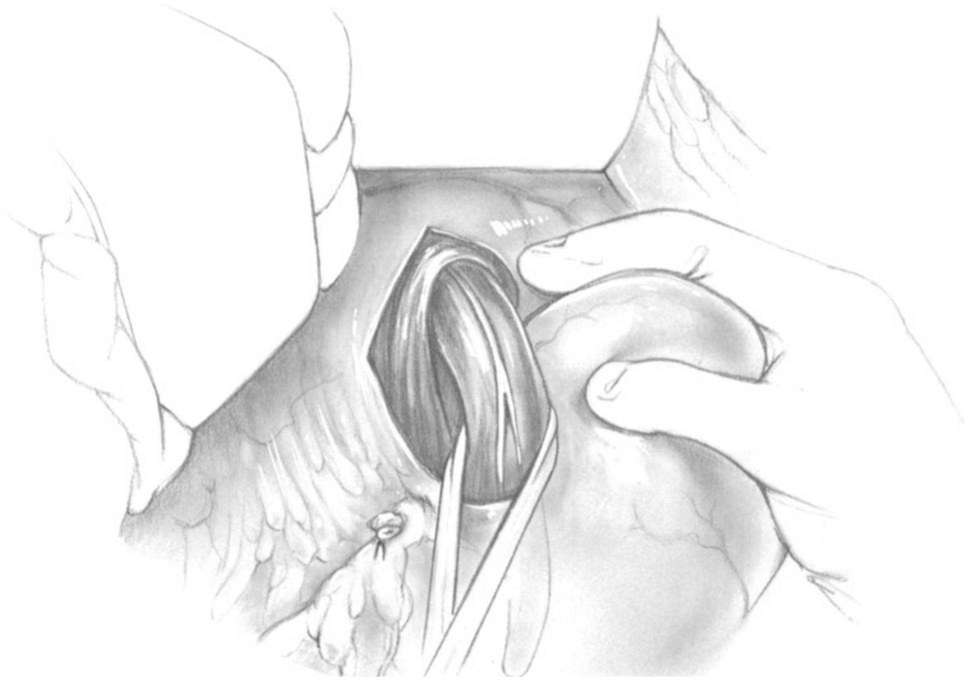


Fig. 11–3

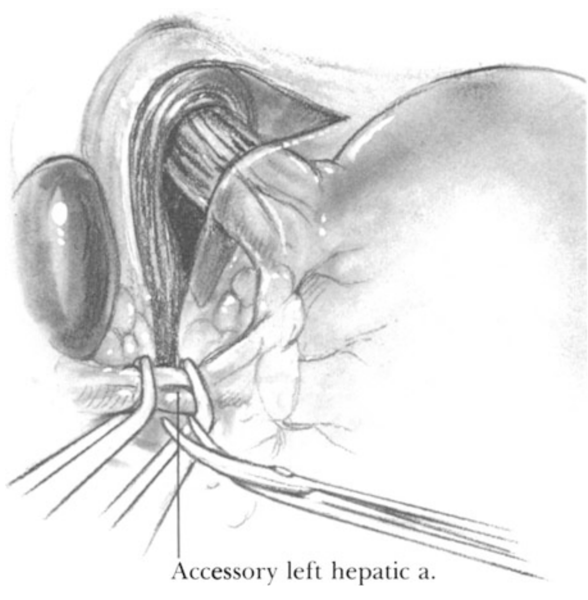


Fig. 11–4

cephalad portion of the gastrohepatic ligament, which often contains an accessory left hepatic artery that may be divided (**Fig. 11–4**). The exposure at the conclusion of this maneuver is seen in **Fig. 11–5**. Now pass the left hand behind the esophagus and behind the gastric fundus to identify the gastro-

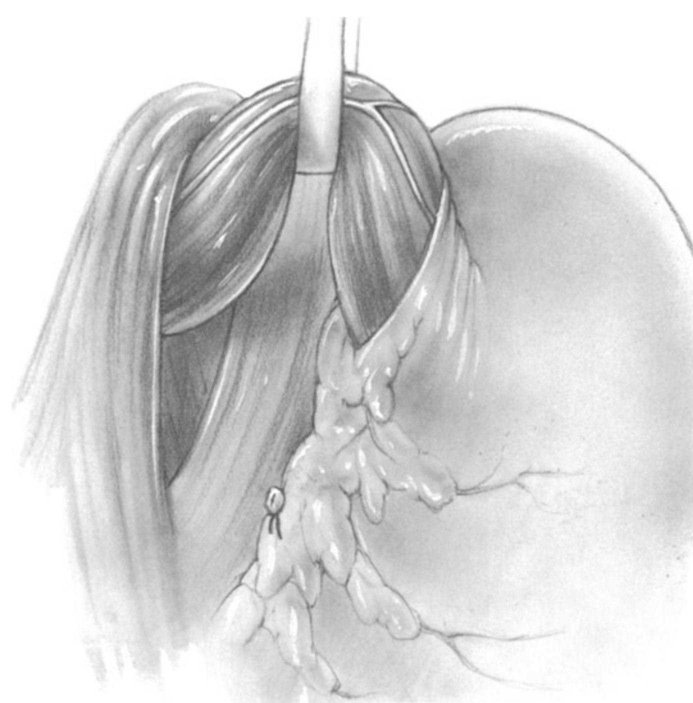


Fig. 11–5

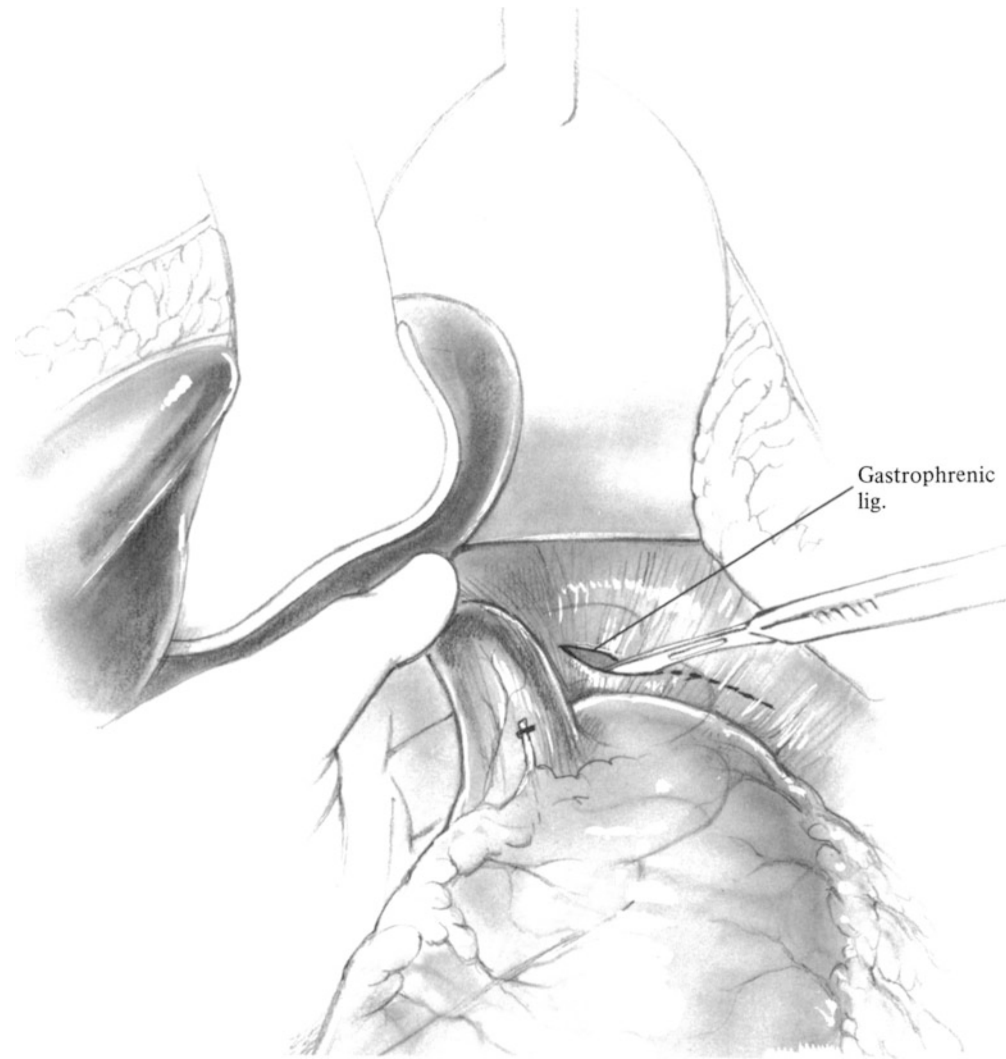


Fig. 11–6

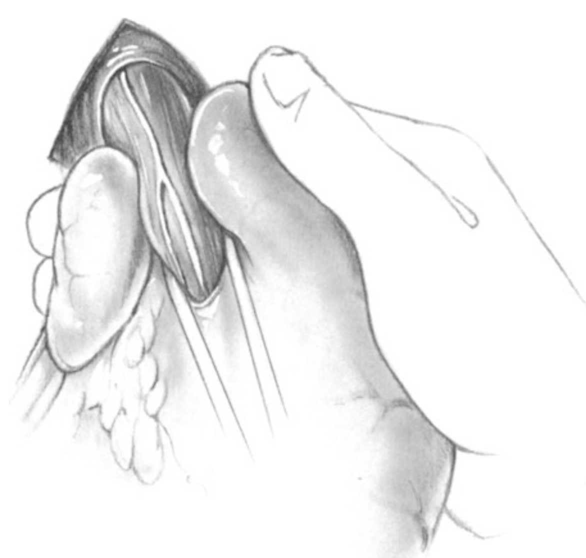


Fig. 11–7

phrenic ligament. Divide this carefully down to the proximal short gastric vessel (**Fig. 11–6**).

While the assistant is placing traction on the rubber tape to draw the esophagus in a caudal direction, pass the right hand so as to deliver the gastric fundus behind the esophagus (**Fig. 11–7**). Apply Babcock clamps to the two points on the stomach where the first fundoplication suture will be inserted and bring these two Babcock clamps together tentatively to assess whether the fundus has been mobilized sufficiently to accomplish the fundoplication without tension. **Fig. 11–8**, a cross-section view, demonstrates how the gastric fundus surrounds the lower esophagus and the vagus nerves.

Generally there will be inadequate mobility of the gastric fundus unless one divides the proximal 1–3 short gastric vessels. Ligate each with 2–0 silk.

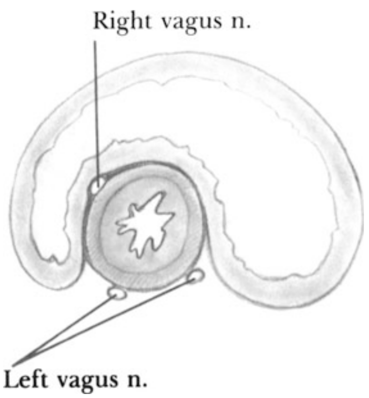


Fig. 11–8

On the greater curvature aspect of the esophagogastric junction there is usually a small fat pad. Excising the fat pad will improve the adhesion of the gastric wrap to the esophagus.

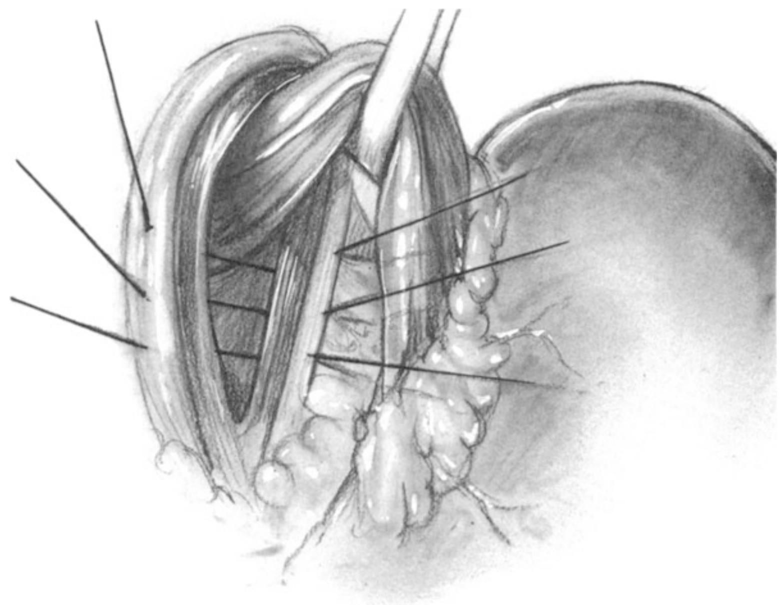


Fig. 11–9

Repairing the Hiatal Defect

Using 0 Tevdek sutures on a large atraumatic needle, start at the posterior margin of the hiatal defect and take a bite, 1.5–2.0 cm in width, of the crus and its overlying peritoneum on each side of the hiatus. Insert the next suture about 1.0–1.2 cm cephalad and continue this process until the index finger can just be inserted *comfortably* between the esophagus and the margin of the hiatus (**Fig. 11–9**).

Suturing the Fundoplication

Ask the anesthesiologist to pass a 40F Maloney dilator into the stomach. Insert the first fundoplication suture by taking a bite of the fundus on the patient's left using 2–0 atraumatic Tevdek. Pass the needle through the seromuscular surface of the gastric lesser curve just distal to the esophagogastric junction and then take a final bite of the fundus on the patient's right. Attach a hemostat to tag this stitch but do not tie it. Each bite should contain 5–6 mm of tissue including submucosa, but it should not penetrate the lumen. Do not pierce any of the vagus nerves with a stitch. In order to perform a fundoplication without tension, it is necessary to insert the gastric sutures a sufficient distance lateral to the esophagogastric junction. Place additional sutures, as illustrated in **Fig. 11–10**, at intervals of about 1 cm. Each suture should contain one bite of fundus, then esophagus, and then the opposite side of the fundus. No more than 2–3 cm of esophagus should be encircled by the fundoplication. Now tie all of these sutures (**Fig. 11–11**). It should be possible to insert one or two fingers between the

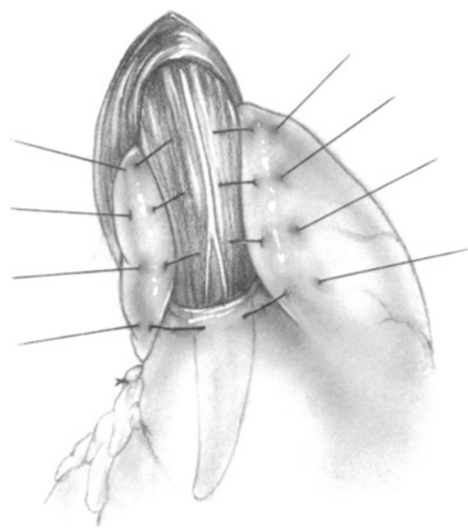


Fig. 11–10

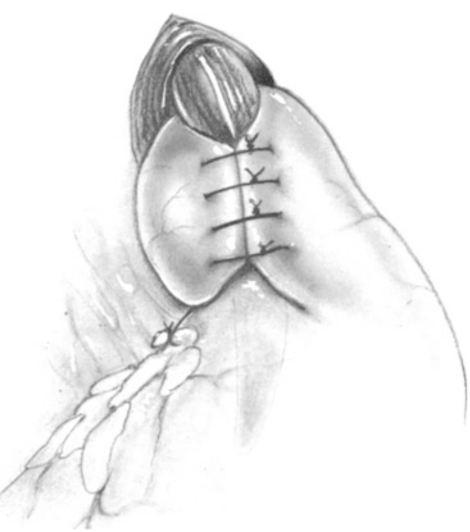


Fig. 11–11

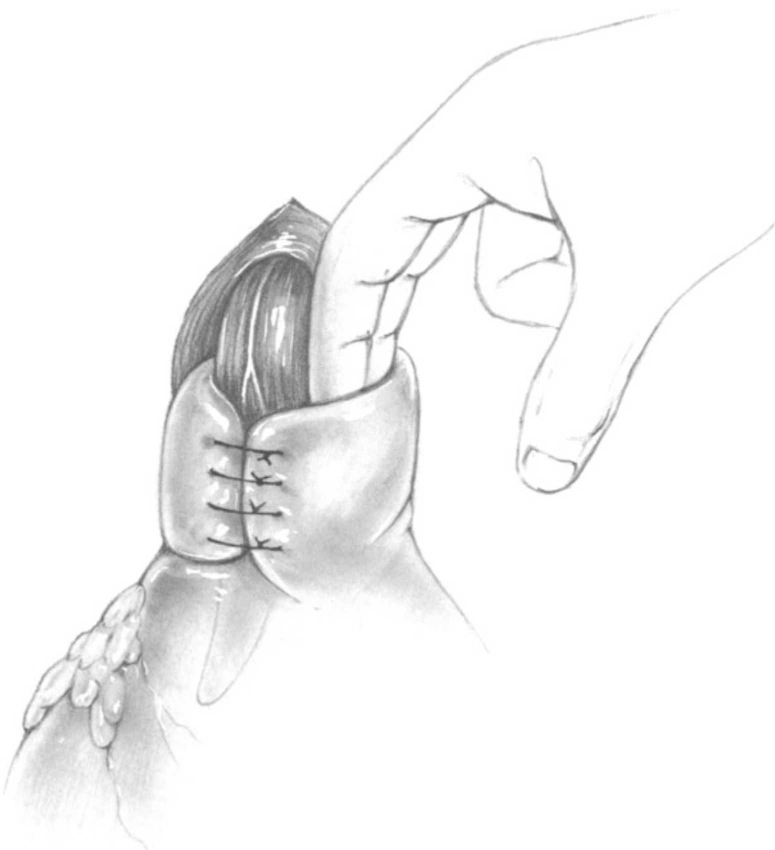


Fig. 11–12

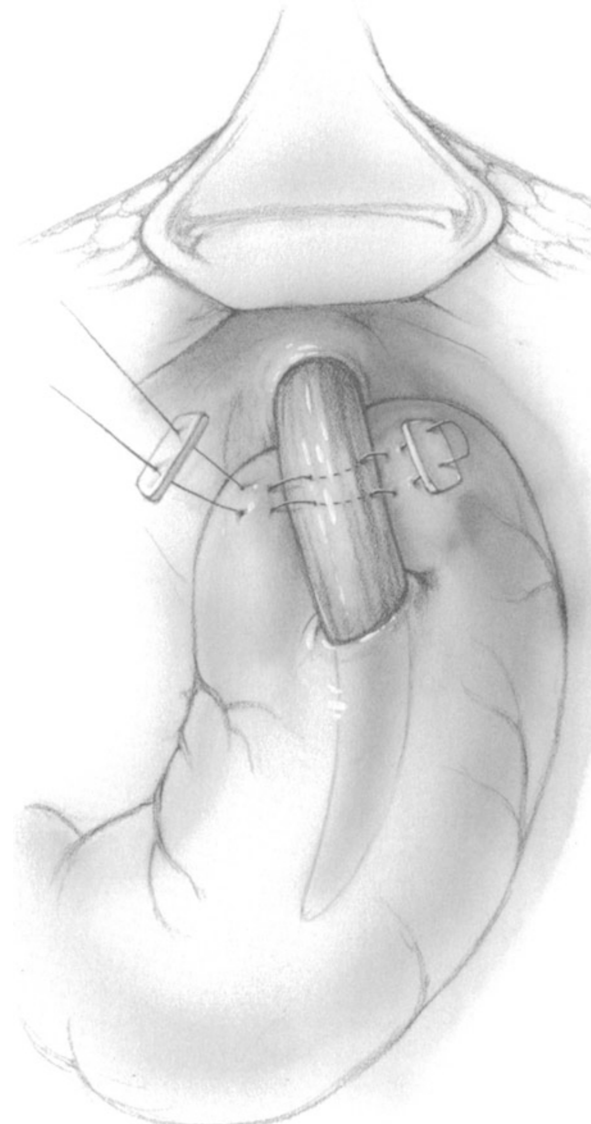


Fig. 11–13

esophagus and the Nissen wrap (**Fig. 11–12**). If this cannot be done the wrap is too tight.

A number of authors place sutures fixing the upper margin of the Nissen wrap to the esophagus in order to prevent the entire wrap from sliding downward and constricting the stomach in the shape of an hourglass.

More recently DeMeester and Stein after a considerable experience advocated a Nissen wrap measuring, only 1 cm in length, claiming that longer wraps produce postoperative dysphagia in a number of patients. Even with a 60F Maloney bougie in the esophagus, a 1-cm wrap has effectuated excellent control of reflux. They construct this wrap employing one horizontal mattress suture of 2–0 Prolene buttressed with Teflon pledgets (see **Figs. 11–13 and 11–14**). In this they agree with Henderson and Marryatt, as discussed above in "Operative Strategy."

Optionally, at this point one may invert the layer of fundoplication sutures by inserting a continuous seromuscular layer of 4–0 Prolene Lembert sutures. (This layer is not illustrated.)

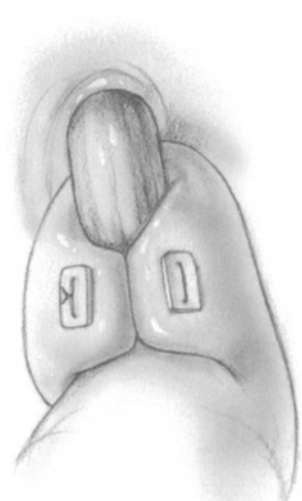


Fig. 11–14

Testing Antireflux Valve

Ask the anesthesiologist to inject 300–400 ml saline solution into the nasogastric tube. Then have him withdraw the tube into the esophagus. Now try to expel the saline by compressing the stomach. If the saline cannot be forced into the esophagus by moderate manual compression of the stomach, the fundoplication has been demonstrated to comprise a competent antireflux valve.

Abdominal Closure

Irrigate the abdomen and the subcutaneous tissues with a dilute antibiotic solution. Then close the abdomen without drainage in routine fashion.

Postoperative Care

Continue nasogastric suction for 1–2 days. Then initiate oral feeding.

Order a barium esophagram before the patient is discharged. If a satisfactory repair has been accomplished, a 3–4 cm length of distal esophagus will become progressively more narrow, tapering to a point at the gastroesophageal junction. If this tapering effect is not noted, it suggests that the wrap may be too loose. Successful antireflux procedures, whether by the Nissen, the Hill, the Belsey, or the Collis-Nissen technique, all show a similar narrowing of the distal esophagus on the postoperative esophagram. A typical postoperative barium esophagram is shown in **Fig. 11–15**.

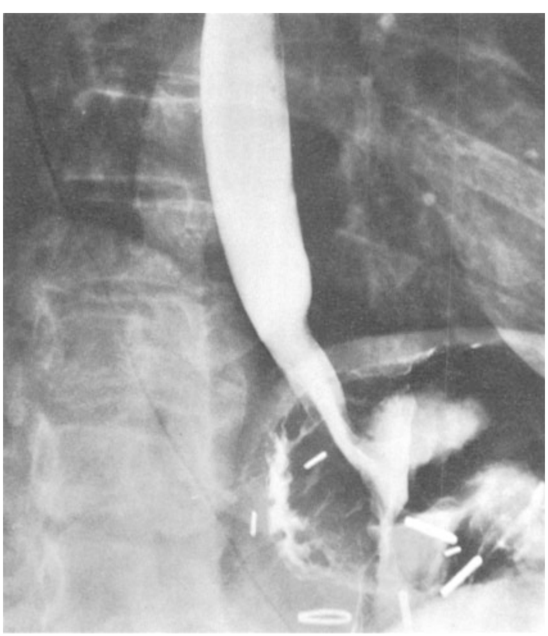


Fig. 11–15

Postoperative Complications

Dysphagia, usually transient

"Gas bloat" (rare)

Disruption of fundoplication

Slipping downward of fundoplication with obstruction

Postoperative paraesophageal hernia (Leonardi et al.) if hiatal defect was not properly closed

Herniation of fundoplication into thorax

Esophageal or gastric perforation by deep necrosing sutures

Persistent gastroesophageal reflux

References

Cordiano C, Rovere GQD, Agugiaro S, Mazzilli G. Technical modification of the Nissen fundoplication procedure. Surg Gynecol Obstet 1976;143:977.

DeMeester TR, Stein JH. Minimizing the side effects of antireflux surgery. World J Surg 1992;16:335–336.

Henderson RD, Marryatt G. Total fundoplication gastroplasty; long-term follow-up in 500 patients. J Thorac Cardiovasc Surg 1983;85:81.

Henderson RD, Ryder DE. Reflux control following myotomy in diffuse esophageal spasm. Ann Thorac Surg 1982;34:230.

Herrington JR Jr. Treatment of combined sliding and paraesophageal hiatal hernia; emphasis on protection of the vagus nerves. Contemp Surg 1983;22:19.

Jordan PH Jr. Parietal cell vagotomy facilitates fundoplication in the treatment of reflux esophagitis. Surg Gynecol Obstet 1978;147:593.

Kaminski DL, Codd JE, Sigmund CJ. Evaluation of the use of the median arcuate ligament in fundoplication for reflux esophagitis. Am J Surg 1977;134:724.

Leonardi HK, Crozier RE, Ellis FH. Reoperation for complications of the Nissen fundoplication. J Thorac Cardiovasc Surg 1981;81:50.

Orringer MB, Sloan H. Combined Collis-Nissen reconstruction of the esophagogastric junction. Ann Thorac Surg 1978;25:16.

Polk HC Jr. Fundoplication for reflux esophagitis: misadventures with the operation of choice. Ann Surg 1976;183:645.

Rogers DM, Herrington JL, Morton C. Incidental splenectomy associated with Nissen fundoplication. Ann Surg 1980;191:153.

Stein HJ, DeMeester TR. Who benefits from antireflux surgery? World J Surg 1992;16:313–319.

12 Posterior Gastropexy (Hill)

Indications (See Chap. 11.)

Hiatus hernia with severe reflux esophagitis resistant to conservative management is a clear indication. Successful execution of this operation requires that the esophagus be long enough to suture the esophagogastric junction to the level of the median arcuate ligament without tension (5–7 cm of intra-abdominal esophagus).

Preoperative Care

Esophagoscopy

X rays of the esophagus and upper gastrointestinal tract

Esophageal manometry, if there is any suspicion of diffuse esophageal spasm, achalasia, or scleroderma

Passage of 18F nasogastric tube the morning of or during the operation

Twenty-four-hour esophageal pH monitoring in selected patients

Pitfalls and Danger Points

Hemorrhage from laceration of celiac or inferior phrenic artery

Injury to spleen

Improper calibration of lumen of lower esophageal sphincter

Excessive narrowing of diaphragmatic hiatus

Failure to identify the median arcuate ligament

Injury to left hepatic vein or vena cava when incising triangular ligament to liberate left lobe of liver

Operative Strategy

Dissecting the Median Arcuate Ligament

The median arcuate ligament constitutes the anterior portion of the aortic hiatus, the aperture in the diaphragm through which the aorta passes. This ligament, a condensation of preaortic fascia, arches over the anterior surface of the aorta just cephalad to the origin of the celiac artery and joins the right crus of the diaphragm at its insertion onto the vertebral column. This band of fibrous tissue covers about 3 cm of the aorta above the celiac axis and is in turn covered by crural muscle fibers. It can be identified by exposing the celiac artery and pushing this vessel posteriorly with the finger at the inferior rim of the median arcuate ligament. In Hill's operation, the surgeon dissects the celiac artery and the celiac ganglion away from the overlying median arcuate ligament in the midline, avoiding the two inferior phrenic arteries that arise from the aorta just to the right and just to the left of the midline. Nerve fibers from the celiac ganglion must be cut to liberate the median arcuate ligament.

An alternative method of identifying the median arcuate ligament is to visualize the anterior surface of the aorta above the aortic hiatus. A few fibers of preaortic fascia may have to be incised. Then with the left index fingernail pushing the anterior wall of the aorta posteriorly, pass the fingertip in a caudal direction. The fingertip will pass behind a strong layer of preaortic fascia and median arcuate ligament. Blocking further passage of the fingertip, at a point about 2–3 cm caudal to the upper margin of the preaortic fascia, is the attachment of the inferior border of the median arcuate ligament to the aorta at the origin of the celiac artery. The pulsation of the celiac artery is easily palpated by the fingertip, which is lodged between the aorta and the overlying ligament. Vansant, Baker, and Ross believe that the foregoing maneuver constitutes sufficient mobilization of the median arcuate ligament and that the ligament need not be dissected free from the celiac artery and ganglion to perform a posterior gastropexy. We believe that a surgeon who has not had considerable experience in liberating the median arcuate ligament from the celiac artery may find Vansant's modification to be safer than Hill's approach. If one succeeds in catching a good bite of the preaortic fascia and median arcuate ligament by Vansant's technique, the end result should be satisfactory. Hill himself has recommended that the inexperienced surgeon adopt Vansant's modification (see Herrington, Skinner, Sawyers, Hill et al., 1978, p. 52). If, in the course of performing the Hill operation, the celiac artery or aorta is lacerated, do not hesitate to divide the median arcuate ligament and preaortic fascia in the midline since this step may be necessary to expose the full length of the laceration.

Calibrating the Esophagocardiac Orifice

In addition to fixing the esophagocardiac junction to the median arcuate ligament, the Hill operation serves to narrow the entrance of the lower esophagus into the stomach by partially turning in the lesser curvature aspect of the esophagogastric junction. Calibration of this turn-in is important if reflux is to be prevented without, at the same time, causing chronic obstruction. Hill (1977) uses intraoperative manometry to measure the pressure at the esophagocardiac junction before and after completing the gastropexy. He believes that a pressure of 50–55 mm Hg will assure that the calibration is proper. Orringer, Schneider, Williams, and Sloan reported that intraoperative pressures did not correlate at all with pressures obtained at postoperative manometry, perhaps because of the variable influence of preoperative medication and anesthetic agents.

If intraoperative manometry is not used, then the adequacy of the repair should be tested by invaginating the anterior wall of the stomach along the indwelling nasogastric tube upward into the esophagogastric junction. Prior to the repair, the index finger will pass freely into the esophagus because of the incompetent lower esophageal sphincter. After the sutures have been placed and drawn together, but not tied, the tip of the index finger should be able to palpate the esophageal orifice but should not quite be able to enter the esophagus alongside the 18F nasogastric tube. This method of calibration has been successful in our hands.

Liberating Left Lobe of Liver

Although most authors who describe transabdominal repair of a hiatus hernia advocate dividing the triangular ligament in order to liberate the left lobe of the liver and improve exposure of the hiatus, we have often not found this step to be necessary, just as we have not found it necessary in performing truncal or proximal gastric vagotomy. By elevating the left lobe of the liver with a deep Harrington or Weinberg retractor, the anterior margin of the hiatus is generally easy to expose, making the division of the triangular ligament a superfluous maneuver.

Operative Technique

Incision and Exposure

With the patient in the supine position, elevate the head of the table about 10°–15° from the horizontal. Make a midline incision from the xiphoid to a point about 4 cm below the umbilicus (**Fig. 12–1**). Insert a Thompson or Upper Hand retractor to elevate the lower portion of the sternum and draw it forcefully in a cephalad direction. Explore the abdomen for incidental pathology such as duodenal ulcer, cholelithiasis, chronic pancreatitis, or colon disease.

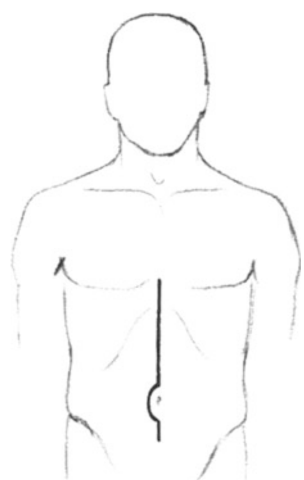


Fig. 12–1

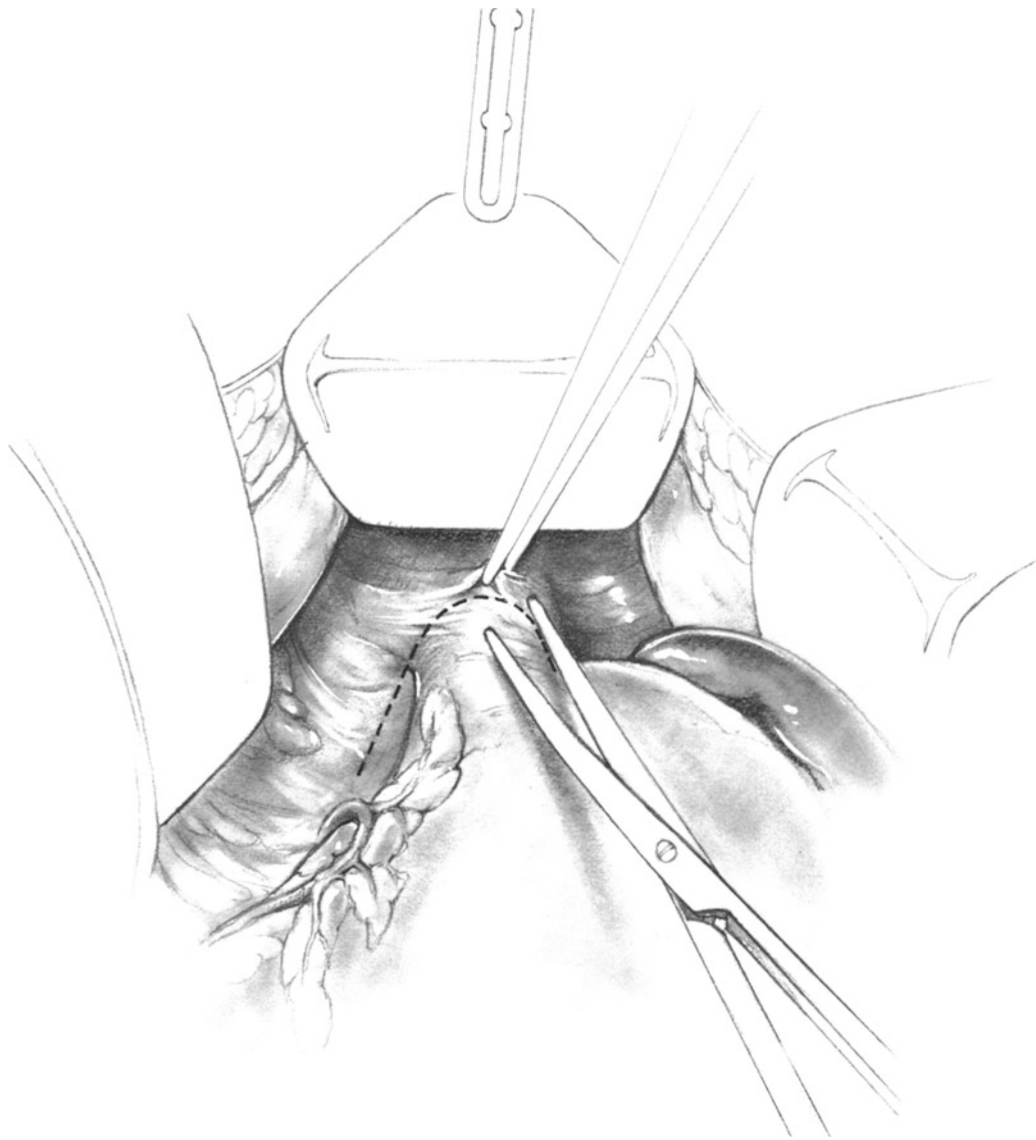


Fig. 12–2

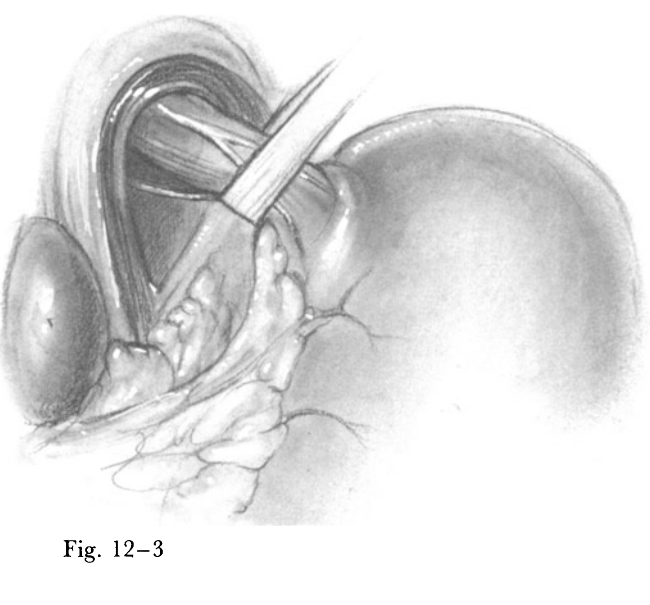


Fig. 12–3

Mobilizing the Esophagogastric Junction

Identify the peritoneum overlying the abdominal esophagus by palpating the indwelling nasogastric tube. Divide this peritoneum with a Metzenbaum scissors and continue the incision over the right and left branches of the crus (**Fig. 12–2**). After exposing the crus, elevate this muscle by inserting a peanut sponge dissector between the crus and the esophagus, first on the right and then on the left. Then insert the left index finger to encircle the esophagus by *gentle* dissection. If the esophagus is inflamed owing to inadequately treated esophagitis, it will be easy to perforate it by rough finger dissection. Identify and protect both the right and left vagus nerves. Then encircle the esophagus with a latex drain and free it from posterior attachments by dividing the phrenoesophageal ligaments (**Fig. 12–3**).

Make an incision in the avascular portion of the gastrohepatic ligament. Continue this incision in a cephalad direction toward the right side of the hiatus. In the course of dividing the gastrohepatic ligament, it is often necessary to divide an accessory left hepatic branch of the left gastric artery (**Fig. 12–4**). At the conclusion of this step, the muscular portion of the crura surrounding the hiatus should be clearly visible throughout the circumference of the hiatus.

The only structure binding the gastric fundus to the posterior abdominal wall now is the gastrophrenic ligament. The best way to divide this ligament is to insert the left hand behind the esophagogastric junction; then bring the left index finger between the esophagogastric junction and the diaphragm. This will place the ligament on stretch. Divide this avascular ligament (**Fig. 12–5**) from the

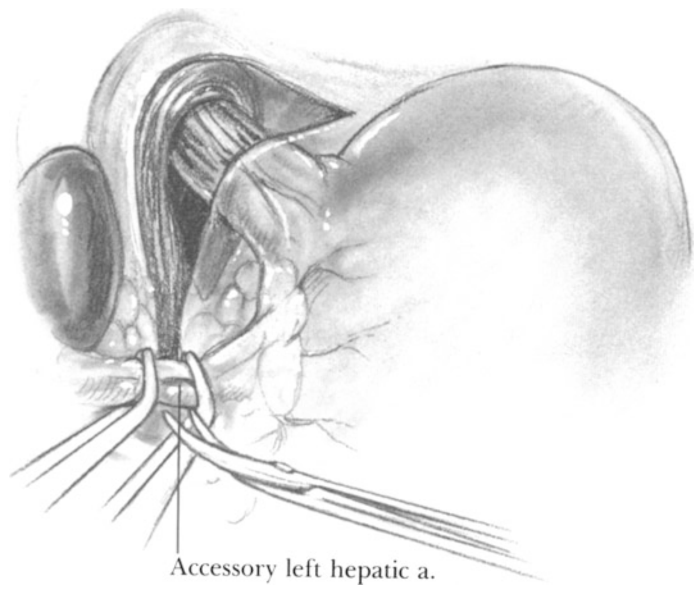


Fig. 12–4

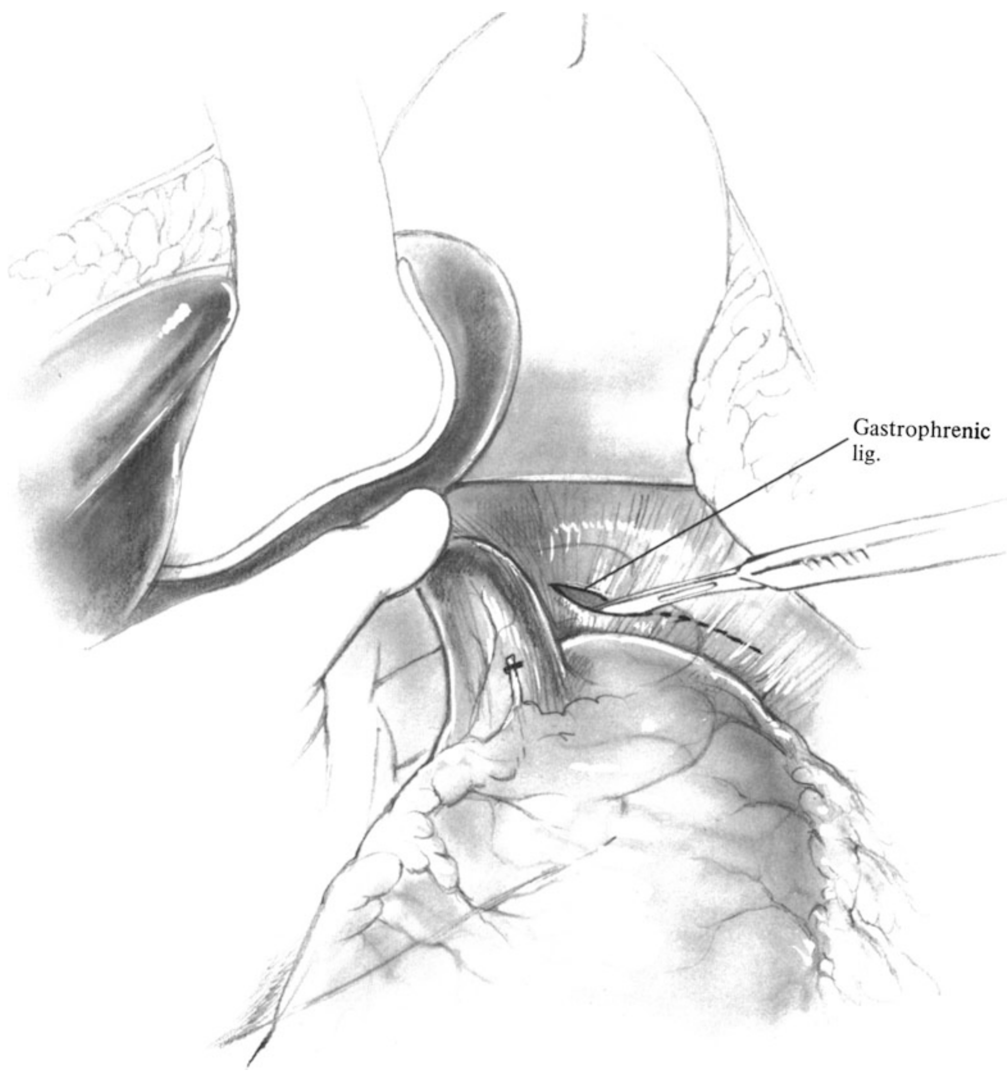


Fig. 12–5

esophagogastric junction along the greater curvature down to the first short gastric artery. It is often necessary to divide the first two short gastric vessels to achieve proper mobilization. This may be done by applying a Hemoclip to the splenic side and a 2–0 silk ligature to the gastric side of the short gastric vessel.

Avoid injuring the spleen by carefully inspecting the anterior surface of this organ prior to dissecting in this region. Divide any attachments between the omentum and the splenic capsule since traction on the omentum would otherwise cause avulsion of the capsule and bleeding.

Inserting the Crural Sutures

Ask the first assistant to retract the esophagus toward the patient's left. Then narrow the aperture of the hiatus by approximating the crural bundles behind the esophagus. Use 0 Tevdek atraumatic sutures on a substantial needle. Take a bite of 1.5–2.0 cm of crus on the left and then a similar bite on the right. Include the overlying peritoneum together with the crural muscle (**Fig. 12–6**). Do not tie these sutures at this time but tag each with a small hemostat. It is sometimes helpful to grasp the left side of the crus with a long Babcock or Allis clamp. Do not apply excessive traction with these clamps or with the sutures as the crural musculature will tend to split along the line of the muscle fibers. Insert 3–4 sutures of this type as necessary. Then tentatively draw the sutures together and insert the index finger into the remaining hiatal aperture. It should be possible to insert a fingertip into the remaining aperture alongside the esophagus with its indwelling nasogastric tube. Narrowing the hiatal aperture more than this may cause permanent dysphagia and will not help reduce reflux. Do not tie the crural sutures at this point.

Identifying the Median Arcuate Ligament

Hill's Method

After the lower esophagus and proximal stomach have been completely freed, identify the celiac artery and use the left index finger to press it posteriorly into the aorta. If the index finger slides in a cephalad direction, its tip will meet the lower border of the median arcuate ligament. Between the aorta and median arcuate ligament there are branches of the celiac ganglion as well as the right and left inferior phrenic arteries, which arise from the aorta in this vicinity. It is necessary to divide some of the nerve fibers, but once the inferior margin of the ligament is freed from the aorta in the midline, it is possible to pass an instrument in a cephalad direction without encountering any further resistance. Hill passes a Goodell cervical dilator between the median arcuate ligament and the aorta to protect the aorta while sutures are being inserted into the lower border of the ligament. He states that if a small diaphragmatic branch of the aorta is disrupted, the bleeding will often subside with pressure. However, it is possible for the inexperienced surgeon to induce major

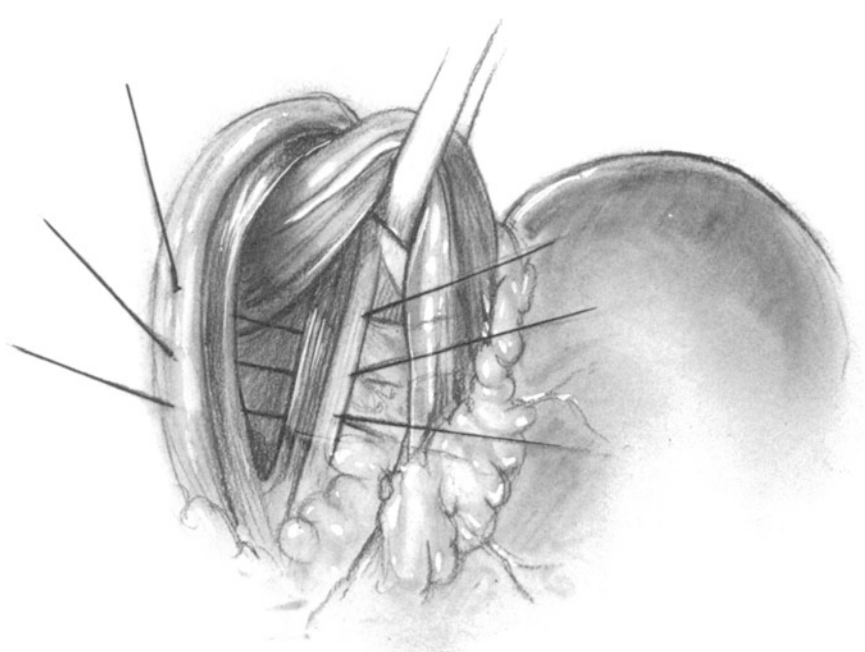


Fig. 12–6

hemorrhage by traumatizing the arteries in this vicinity. Caution is indicated.

Vansant's Method

Vansant, Baker, and Ross described another technique of identifying and liberating the median arcuate ligament by approaching it from its superior margin. In order to do this, identify the anterior surface of the aorta in the hiatal aperture between the right and left branches of the crus. Occasionally, it will be necessary to dissect away some areolar tissue. With the left index fingernail pressing posteriorly against the aorta about 4 cm cephalad to the diaphragm, slide the index finger in a caudal direction. Deep behind the confluence of the diaphragmatic crura, the tip of the index finger will pass behind a dense band of preaortic fascia that crosses over the aorta as the aorta passes through the aortic hiatus in the posterior diaphragm. The width of this band is variable but averages perhaps 3 cm. At the lower margin of this band the fingertip will encounter the pulsation of the celiac artery, which arises from the anterior wall of the aorta at the inferior margin of the median arcuate ligament. The median arcuate ligament lies between the fingertip and a thin layer of muscle fibers representing the caudal confluence of the diaphragmatic crura. With the index finger in place, Vansant and associates insert three interrupted atraumatic sutures of No. 1 braided silk into the median arcuate ligament. Tag each suture with a hemostat, leaving each needle attached for later use in suturing the posterior gastropexy.

Suturing Posterior Gastropexy

Hill's Method

Rotate the esophagogastric junction so that the lesser curvature surface faces anteriorly and the posterior phrenoesophageal fascial bundle and the gastric wall adjacent to it are visible to the surgeon. Demonstrate the anterior and posterior vagal trunks to avoid piercing them by a suture. Apply Babcock clamps, one to the posterior and one to the anterior phrenoesophageal bundle. Hill then places one anchoring suture to fix the posterior phrenoesophageal bundle to the left border of the median arcuate ligament. Tie this suture. Then insert 4–5 gastropexy sutures taking first a bite of the anterior phrenoesophageal bundle, then the posterior phrenoesophageal bundle and, finally, the inferior border of the median arcuate ligament. The cephalad gastropexy suture is the key suture with respect to calibrating the diameter of the esophageal lumen at the lower esophageal sphincter. Hill tentatively ties the upper suture and then measures the intraluminal pressure with an indwelling intraesophageal manometer catheter. He aims at an intraluminal pressure of 50–55 mm Hg. If the pressure is significantly below 50 mm Hg he takes additional sutures until the pressure has been raised to the proper level. A reading of 60 mm Hg or more indicates that the sphincter will be too tight. After tying all of the gastropexy sutures, take a final measurement of the intraluminal pressure.

Vansant's Method

Vansant and colleagues identify the median ligament by the technique described above. With an index finger in place between the preaortic fascia and the aorta, they insert three interrupted atraumatic sutures of No. 1 braided silk and tag each suture with a hemostat, leaving each needle attached. Then they close the hiatus with several interrupted sutures and insert the requisite sutures, approximating the anterior and posterior phrenoesophageal bundles. The phrenoesophageal sutures are tied. Then, they use the three preplaced No. 1 braided silk sutures to fix the phrenoesophageal bundles to the median arcuate ligament by passing each of these sutures through the phrenoesophageal bundles.

Author's Technique

Rotate the esophagogastric junction so that the lesser curvature aspect of the stomach faces anteriorly. Then place a large Babcock clamp on the anterior and another clamp on the posterior phrenoesophageal bundle. Between these two bundles, the longitudinal muscle fibers of the esophagus can be seen as they join the lesser curvature of the stomach. Where to place the proximal suture is an important consideration. Placing it too high will cause excessive narrowing of the esophageal lumen; placing it too low will not adequately increase the intraluminal pressure in the lower esophageal sphincter area. We use 2–0 atraumatic Tevdek and include a few millimeters of adjacent gastric wall together with the phrenoesophageal bundle in order to insure that the submucosa has been included in the suture. After placing the upper suture, cross the two ends or insert the first throw of a tie. Then estimate the lumen of the esophagastric junction by invaginating the stomach with the index finger along the indwelling nasogastric tube. If this maneuver is attempted before tying down the suture, the finger will pass easily into the lumen of the esophagus in patients who have an incompetent lower esophageal sphincter. After the first suture is tentatively closed, only the very tip of the index finger should be able to enter the esophagus. In the absence of intraoperative esophageal manometry, this is the best method of calibrating the proper placement of the gastropexy sutures.

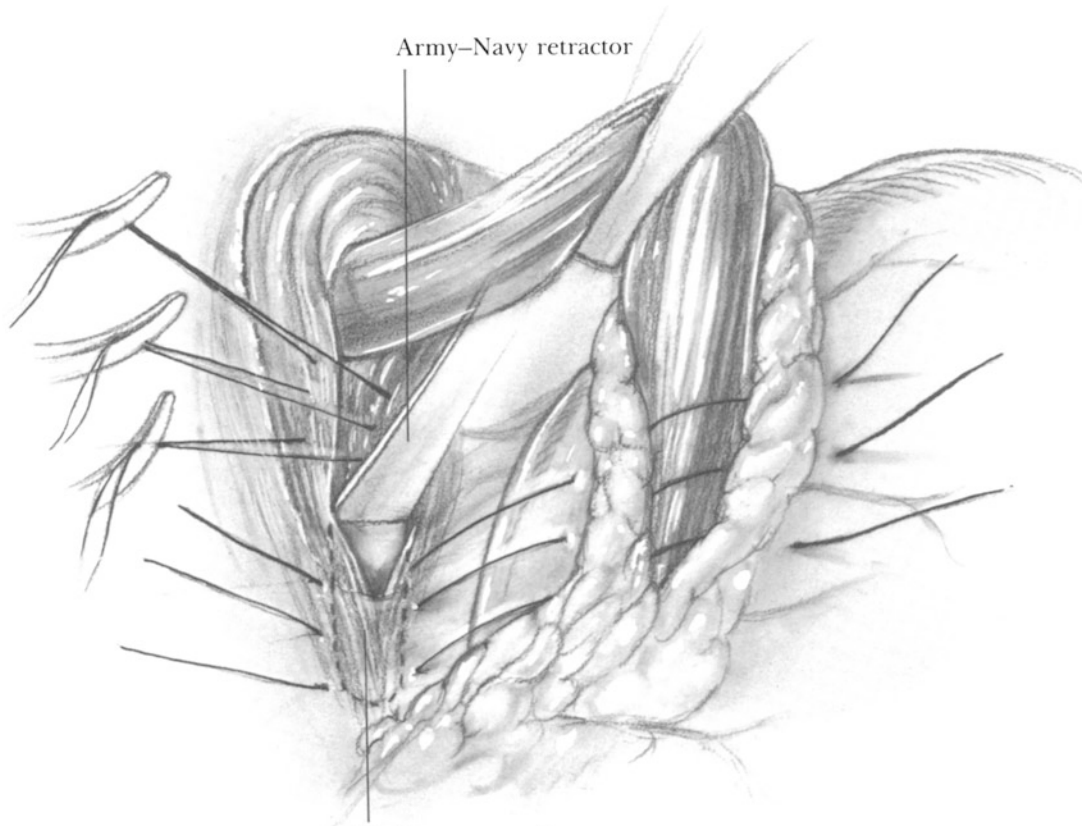


Fig. 12–7

If the first suture has been judged to be properly placed, tag it with a hemostat and insert 3 additional sutures of atraumatic 2–0 Tevdek into the phreno-esophageal bundles at intervals of about 1 cm, caudal to the first suture. Place a hemostat on each suture as a tag. After all the sutures have been placed, tighten them all and again use the index finger to calibrate the lumen of the esophagogastric junction once more. If this is satisfactory, expose the anterior wall of the aorta in the hiatal aperture behind the esophagus. With the index fingernail closely applied to the anterior wall of the aorta, pass the fingertip in a caudal direction beneath the preaortic fascia and median arcuate ligament down to the point where the fingertip palpates the pulsation of the celiac artery. Then, remove the index finger and replace it with a narrow right-angled retractor such as the Army-Navy retractor (**Fig. 12–7**). Be certain that the retractor is indeed deep to the median arcuate ligament. This retractor will serve to protect the aorta while the gastropexy sutures are being inserted through the preaortic fascia.

Now identify the proximal suture that has already been placed in the phrenoesophageal bundles. Pass this suture through the preaortic fascia. Be sure to take a substantial bite of the tissue anterior to the Army-Navy retractor. Pass the needle deep enough so that it makes contact with the metal retractor. Otherwise, only some overlying crural muscle fibers may be included in the stitch. This will not be strong enough to assure a long-term successful result. After the first stitch has been passed through the preaortic fascia, tag it with a hemostat and pass each of the remaining phrenoesophageal sutures through the preaortic fascia by the same technique and tag each with a hemostat (see Fig. 12–7).

Another good method of expediting the suturing of the median arcuate ligament is to use a large right-angle bronchus clamp. Insert the tip of the clamp behind the median arcuate ligament instead of the Army-Navy retractor. Use the clamp to vigorously draw the median arcuate ligament anteriorly. Pass the needle with the suture through the median arcuate ligament just deep to the clamp. This assures that a large bite of ligament is included in each stitch. Be certain not to injure the underlying aorta with the needle.

At this point, check the entire area for hemostasis. Then tie the previously placed crural sutures (Fig. 12–6), thus narrowing the aperture of the hiatus.

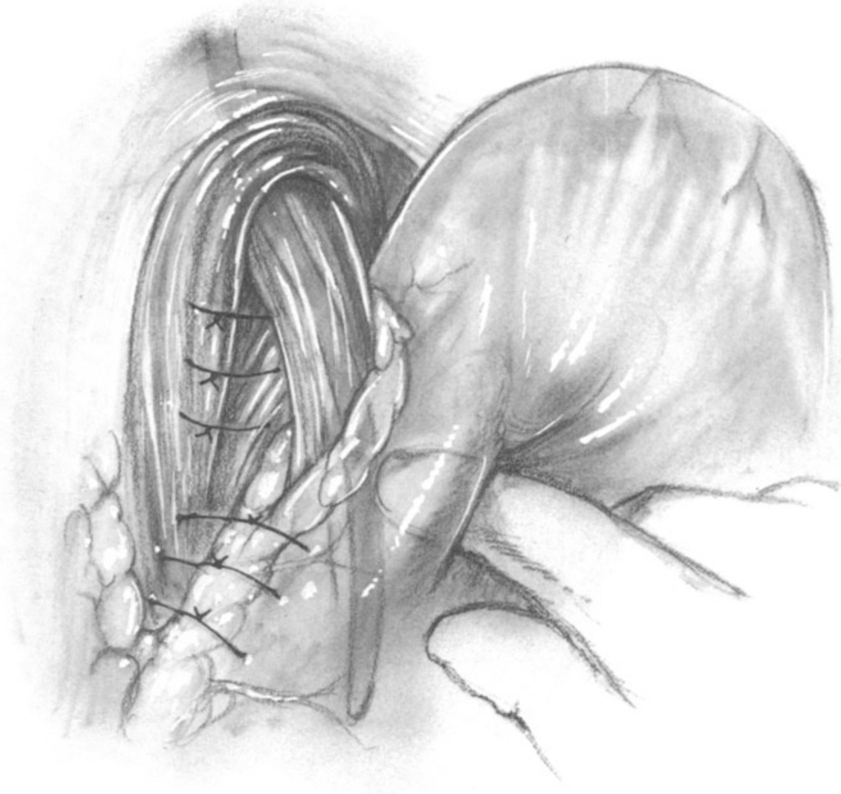


Fig. 12–8

After these sutures have been tied, the index finger should pass freely into the hiatal aperture with an indwelling 18F nasogastric tube in the esophagus. If this is not the case, replace the proximal crural suture as necessary.

Now tie each of the previously placed *gastropexy* sutures and cut all of the ends (**Fig. 12–8**).

Testing the Antireflux Valve

A simple method of testing the efficacy of the antireflux valve is to have the anesthesiologist inject about 500 ml of saline into the nasogastric tube. Then ask him to withdraw the tube to a point above the esophagogastric junction. In the presence of a competent antireflux valve, compressing the saline-filled stomach will fail to force the saline into the esophagus.

Abdominal Closure

Irrigate the abdomen and the subcutaneous tissues with saline or a dilute antibiotic solution. Close the abdomen without drainage in routine fashion.

Postoperative Care

Continue nasogastric suction for 1–2 days.

X ray the esophagogastric junction with a barium swallow before the patient is discharged from the hospital.

Postoperative Complications

Dysphagia (usually transient)

Persistence or recurrence of gastroesophageal reflux. This, as well as other complications following the Hill operation, are uncommon.

References

Herrington JL, Skinner D, Sawyers J, Hill LD et al. Surgical management of reflux esophagitis. Contemp Surg 1978;12:42.

Hill LD. An effective operation for hiatal hernia; an eight year appraisal. Ann Surg 1967;166:681.

Hill LD. Progress in the surgical management of hiatal hernia. World J Surg 1977;1:425.

Orringer MB, Schneider R, Williams GW, Sloan H. Intraoperative esophageal manometry: is it valid? Ann Thorac Surg 1980;30:13.

Vansant JH, Baker JW, Ross DG. Modification of the Hill technique for repair of hiatal hernia. Surg Gynecol Obstet 1976;143:637.

13 Transthoracic Gastroplasty (Collis) and Nissen Fundoplication

Indications

As discussed in the previous chapters (see esp. Chap. 10), this operation is indicated in patients with reflux esophagitis that has caused a significant degree of fibrosis, constriction, and *shortening of the esophagus*. In some patients without much esophageal shortening, advanced fibrosis itself will interfere with the antireflux efficiency of a fundoplication because the rigid esophageal walls will not be compressed by the fundoplication. For this reason, Pearson and Henderson; Urschel, Razzuk, Wood, Galbraith et al.; and Orringer and colleagues (see Chap. 10) believe that almost every esophageal stricture caused by reflux should be treated by a Collis gastroplasty and an antireflux procedure. A previous subtotal gastrectomy generally contraindicates a Collis gastroplasty. Most patients with recurrent reflux esophagitis after a previous operation will require a thoracoabdominal Collis–Nissen operation. This operation is indicated whenever the esophagogastric junction cannot *without tension* be brought down to the level of the median arcuate ligament.

Preoperative Care

Esophagram and upper gastrointestinal X-ray series

Esophagoscopy with biopsy of stricture

Esophageal manometric study

Dilate the esophageal stricture up to size 40F. This can generally be done with Maloney dilators.

Insert a nasogastric tube down to the stricture on the morning of the operation.

If the patient has severe fibrosis and an advanced stricture, he may be one of the rare cases whose stricture cannot be dilated and thus requires resection and possible colon interposition. In such a case, perform a preoperative barium colon enema and routine bowel preparation. Among those patients who should receive preoperative bowel preparation are those whose strictures cannot be dilated to the size of a 40F bougie. An angiogram of the colonic blood supply may also be helpful.

When esophagoscopy reveals severe acute ulcerative esophagitis with inflammation and bleeding, a 2–3 week period of preoperative treatment with cimetidine and/or omeperazole will reduce the inflammation and lessen the risk of intraoperative perforation of the esophagus.

Pitfalls and Danger Points

Esophageal perforation

Hemorrhage resulting from traumatizing or avulsing the accessory left hepatic artery, the inferior phrenic artery, the ascending branch of the left gastric artery, a short gastric vessel, or the inferior pulmonary vein

Laceration of spleen

Inadvertent vagotomy

Inadequate suturing, permitting the fundoplication to slip postoperatively

Operative Strategy

Performing an Adequate Gastroplasty

The object of performing a gastroplasty is to lengthen a shortened esophagus for an extent sufficient to prevent any tension whatever from being exerted on the antireflux operation and hernia repair. This newly constructed esophagus ("neoesophagus") consists of a tube made from the lesser curvature of the stomach. The anesthesiologist passes a 56F Maloney dilator into the stomach and the tube is constructed by applying a GIA 80 stapling device with 4.8 mm staples precisely at the esophagogastric junction parallel to and snug up alongside the Maloney dilator. When the GIA device is fired, the esophageal tube will be lengthened by as much as 7 cm. If the GIA has been placed snug against the esophagogastric junction, there will be no irregularities or outpouching at this point. Rarely, it may be necessary to apply the GIA a second time to construct the neoesophagus.

Check to see that the staples have been shaped into the form of a proper "B." Then oversew the GIA staple line on the stomach with a 4–0 continuous Prolene suture.

Mobilizing Esophagus and Stomach

Not only is it important to completely mobilize the distal esophagus, at least as far up as the inferior pulmonary vein, but the proximal stomach must be entirely free of attachments, just as is the case when a Nissen fundoplication is being performed through an abdominal approach. Only with full mobilization can this operation be accomplished without tension. This requires dividing the phrenoesophageal and the gastrophrenic ligaments, freeing the hiatus throughout is complete circumference from any attachments to the stomach or lower esophagus, as well as dividing an accessory left hepatic artery, which courses from the left gastric artery across the proximal gastrohepatic ligament to help supply the left lobe of the liver. After mobilization has been accomplished, the remaining maneuvers in the Collis–Nissen operation are not difficult.

If the esophagus is inadvertently perforated during the dissection, it will require careful judgment by the surgeon in deciding whether it is safe to suture the esophageal laceration or whether a resection and colon or jejunum interposition is necessary. If it is elected to suture the laceration, try to cover the suture line with a flap of parietal pleura (see Figs. 17–1 to 17–3).

Avoiding Hemorrhage

Avoiding unnecessary bleeding in any operation requires careful dissection and a knowledge of vascular anatomy. This is especially important when mobilizing the stomach through a thoracic approach, because losing control of the accessory left hepatic, a short gastric, or an inferior phrenic artery causes the proximal bleeding arterial stump to retract deep into the abdomen. Controlling these retracted vessels will be difficult and may require a laparotomy, or at least a peripheral incision in the diaphragm. Preventing this complication is not difficult if the dissection is orderly and the surgeon is aware of the anatomical location of these vessels.

Similarly, careful dissection and avoidance of traction along the greater curvature of the stomach will help prevent damaging the spleen.

Avoiding Esophageal Perforation

When the distal esophagus is baked into a fibrotic mediastinum, sharp scalpel dissection is safer than blunt dissection if injury to the esophagus and the vagus nerves is to be avoided. Sometimes the fibrosis terminates 8–9 cm above the diaphragm. If so, the esophagus and the vagus nerves can easily be encircled at this point. This will provide a plane for the subsequent dissection of the distal esophagus.

Operative Technique

Incision

With the patient under one-lung anesthesia in the lateral position, left side up, make a skin incision in the sixth intercostal space from the costal margin to the tip of the scapula (**Fig. 13–1**). Then identify the latissimus dorsi muscle and insert the index finger beneath it. Transect this muscle with the electrocoagulating device. Then divide the underlying anterior serratus muscle in similar fashion

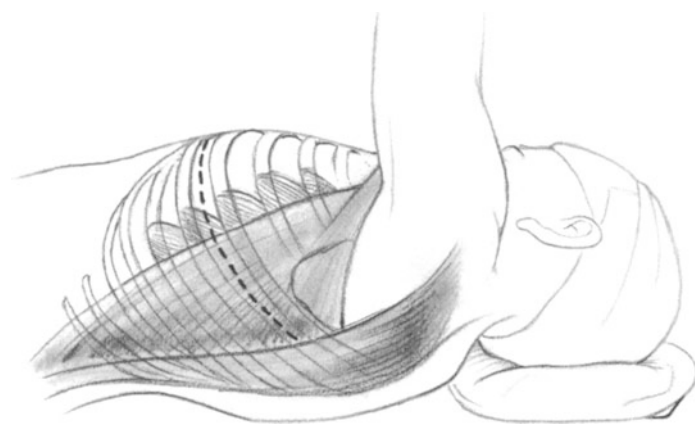


Fig. 13–1

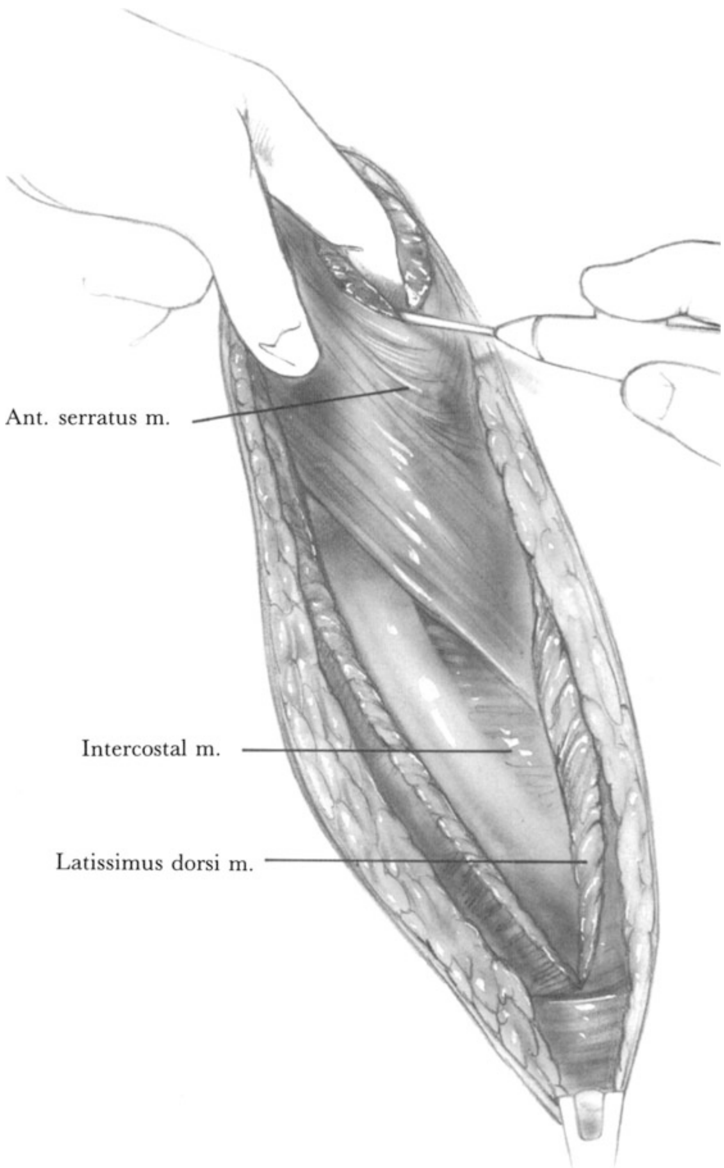


Fig. 13–2

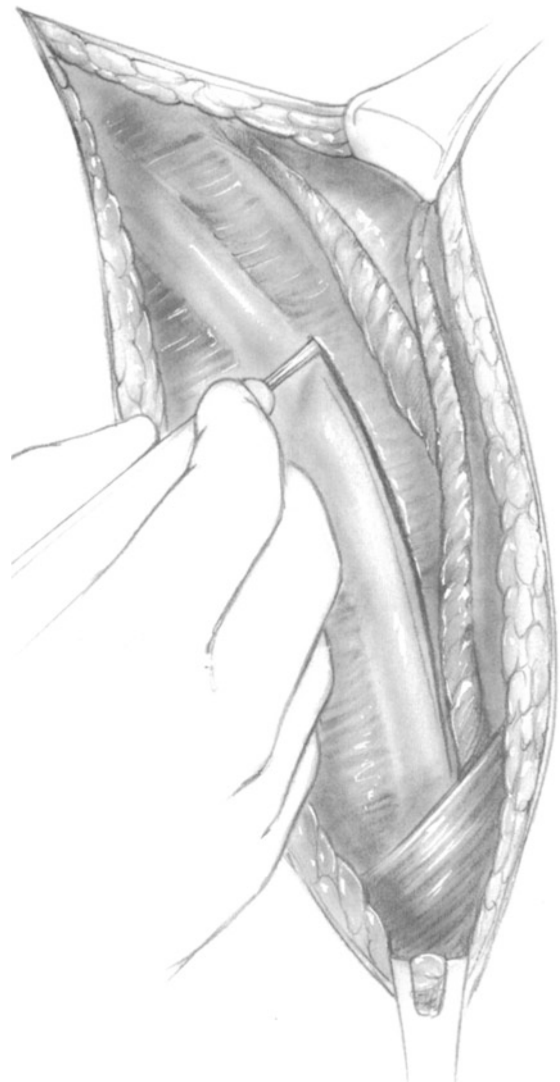


Fig. 13–3

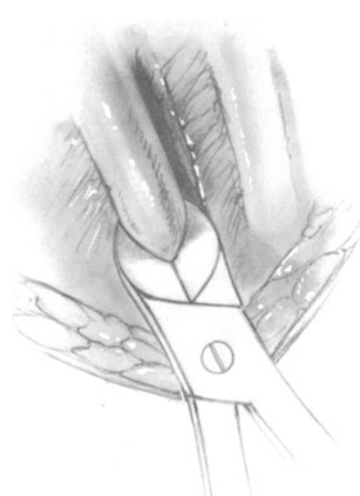


Fig. 13–4

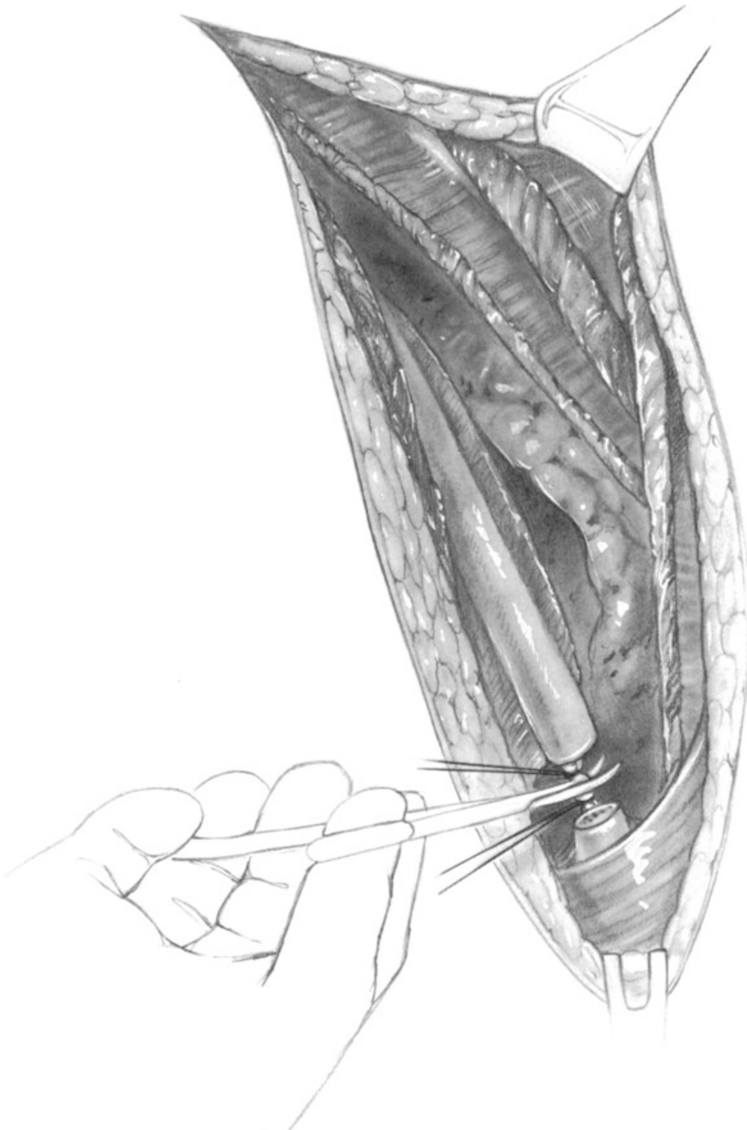


Fig. 13–5

(**Fig. 13–2**). In both cases it is preferable to divide these muscles somewhat caudal to the skin incision. This will help to preserve muscle function.

Then use the electrocautery to divide the intercostal muscles along the upper border of the seventh rib (**Fig. 13–3**) and open the pleura. Complete this opening from the costal margin to the region of the lateral spinal muscles. Separate the periosteum and surrounding tissues from a 1-cm segment of the posterior portion of the seventh rib lateral to the spinal muscles. Excise a 1-cm segment of this rib (**Fig. 13–4**). Then divide the intercostal neurovascular bundle that runs along the inferior border of this rib (**Fig. 13–5**).

Insert a Finochietto retractor into the incision and gradually increase the distance between the blades of the retractor over a 10-minute period to avoid causing rib fractures.

In patients who have undergone previous surgery of the distal esophagus or proximal stomach, do not hesitate to continue this incision across the costal margin, converting it into a thoracoabdominal incision to facilitate dissection on the abdominal aspect of the diaphragmatic hiatus (see Figs. 8–6 to 8–7).

Liberating the Esophagus

Incise the inferior pulmonary ligament with the electrocoagulator and then compress the lung and retract it in both an anterior and cephalad direction by using moist gauze pads and Harrington

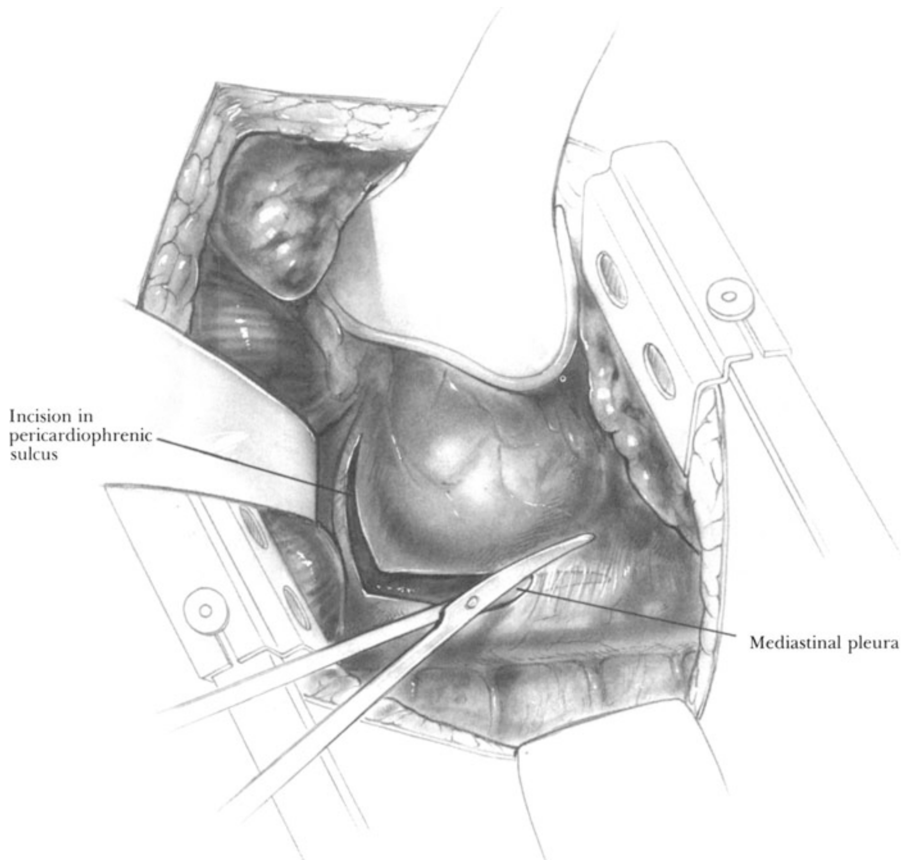


Fig. 13–6

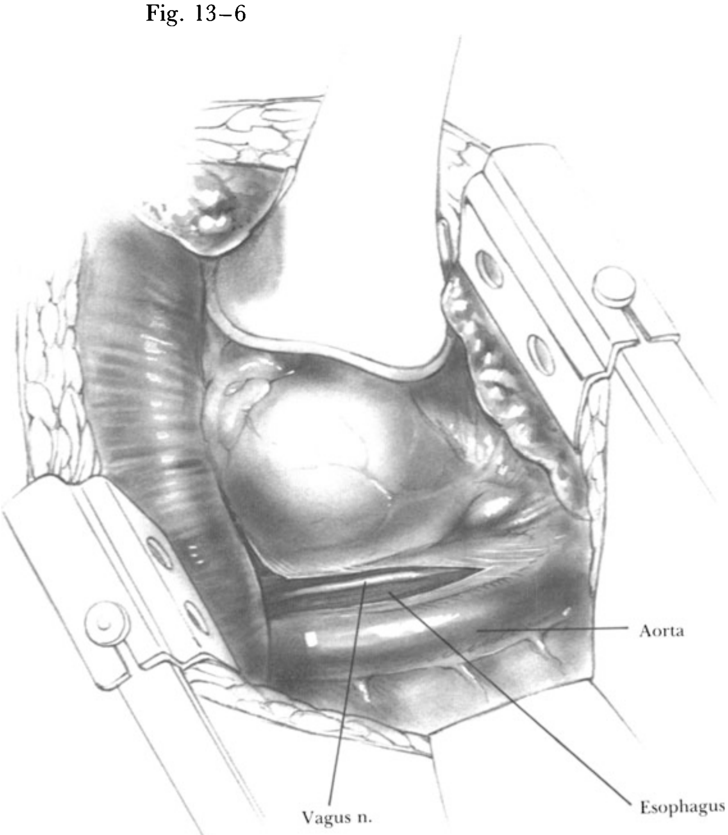


Fig. 13–7

retractors. Incise the mediastinal pleura just medial to the aorta (**Figs. 13–6 and 13–7**). Encircle the esophagus with the index finger using the indwelling nasogastric tube as a guide. If this cannot easily be done, it may be necessary to initiate sharp dissection at a somewhat higher level where the fibrosis may be less advanced. Encircle the esophagus and the vagus nerves with a latex drain. Continue the dissection of the esophagus from the inferior pulmonary vein down to the diaphragmatic hiatus. After the mediastinal pleura has been incised down to the hiatus, continue the incision anteriorly and divide the pleura of the pericardiophrenic sulcus (see Fig. 13–6). Otherwise, the medial aspect of the hiatal ring will not be visible.

If the right pleural cavity has been inadvertently entered, simply place a moist gauze pad over the rent in the pleura to prevent excessive seepage of blood into the right chest and continue the dissection.

Excising the Hernial Sac

Identify the point where the left branch of the crus of the diaphragm meets the hernial sac. By applying traction to the diaphragm, some attenuated fibers of the phrenoesophageal ligament and preperitoneal fat will be encountered. Incise these tissues as well as the underlying peritoneum (**Fig. 13–8**). Continue the incision in the peritoneum in a circumferential fashion, opening the lateral and anterior aspects of the hernial sac; expose the greater curvature of the stomach. Insert the left index finger into the sac and continue the incision along the medial (deep) margin of the hiatus using the finger as a guide (**Fig. 13–9**). A branch of the inferior phrenic artery may be noted posterolaterally near the left vagus nerve. This is divided, and ligated with 2–0 silk. In attempting to circumnavigate the proximal stomach, the index finger in the hernial sac will encounter an obstruction on the lesser curvature side of the esophagogastric junction. This represents the proximal margin of the gastrohepatic ligament, which often contains a 2–4 mm accessory left hepatic artery coming off the ascending left gastric artery. By hugging the lesser curvature side of the cardia with the index finger, this finger can be passed between the stomach and the gastrohepatic ligament, thus delivering the ligament into the chest, deep to the stomach. Identify the artery and ligate it proximally and distally with 2–0 silk. Divide it between the two ligatures (**Fig. 13–10**). After this step, it should be possible to pass the index finger around the entire circumference of the proximal stomach and encounter no attachments between the stomach and the hiatus. Throughout these maneuvers, repeatedly check on the location of the vagus nerves and preserve them.

Excise the peritoneum that constituted the hernial sac.

Dilating an Esophageal Stricture

Ascertain that the esophagus is lying in a straight line in the mediastinum. Ask the anesthesiologist or a surgical assistant to pass Maloney dilators into the esophagus through the mouth after removing the indwelling nasogastric tube. As the dilator is passed down the esophagus, guide it manually into the lumen of the stricture. Successively larger bougies are passed up to size 50–60F. This can be successfully accomplished in probably 95% of cases. Occasionally forceful dilatation of this type may cause the lower esophagus to burst in the presence of unyielding transmural fibrosis. In this case, resect the damaged esophagus and perform a colonic or jejunal interposition between the healthy esophagus and the stomach.

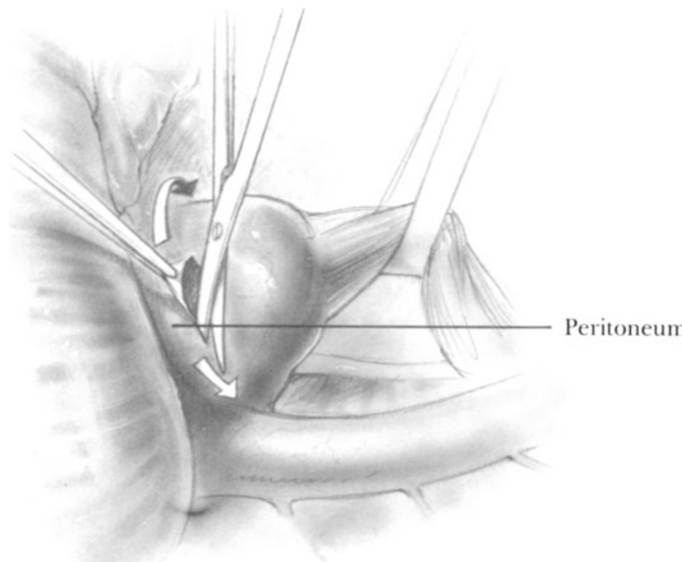


Fig. 13–8

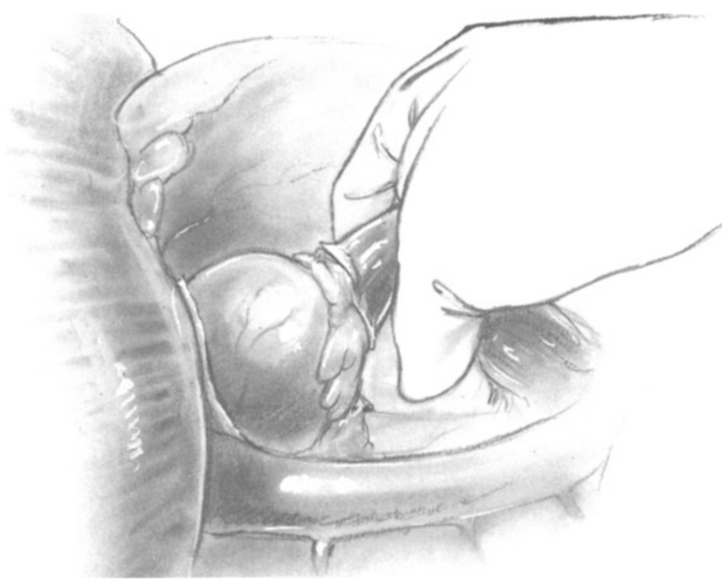


Fig. 13–9

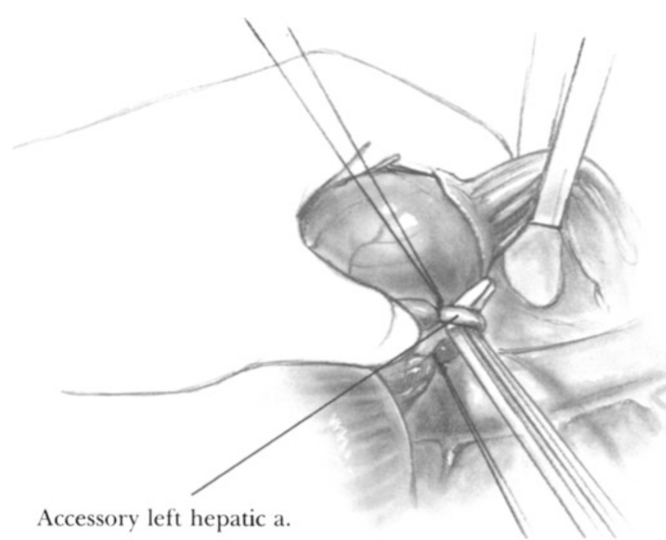


Fig. 13–10

Dividing the Short Gastric Vessels

Continue the dissection along the greater curvature of the stomach in an inferior direction until the first short gastric vessel is encountered. Use a long right-angled Mixter clamp to encircle this vessel with two 2–0 silk ligatures. Tie each ligature leaving at least 1 cm between them. Divide between ligatures. Continue this process until about five proximal short gastric vessels have been divided and about 12–15 cm of greater curvature has been mobilized.

Gastroplasty

Check that the esophagogastric junction has indeed been completely mobilized. Identify the point at which the greater curvature of the stomach meets the esophagus. Overlying this area is a thin fat pad perhaps 3 cm in diameter. Carefully dissect this fat pad away from the serosa of the stomach and the longitudinal muscle of the esophagus (**Fig. 13–11**). Avoid damaging the anterior vagus nerve.

Pass a 56–60F Maloney dilator into the stomach and position it along the lesser curvature. Then apply a GIA 80–4.8 or an Ethicon Linear Cutter 70–4.8 stapler parallel to and closely adjacent to the Maloney dilator while a Babcock clamp retracts the greater curvature of the stomach in a lateral direction (**Fig. 13–12**). Fire the stapler and remove it. Check to see that the staples have been shaped into an adequate "B" formation and that there are no leaks. Lightly electrocoagulate the everted mucosa. This maneuver will have lengthened the

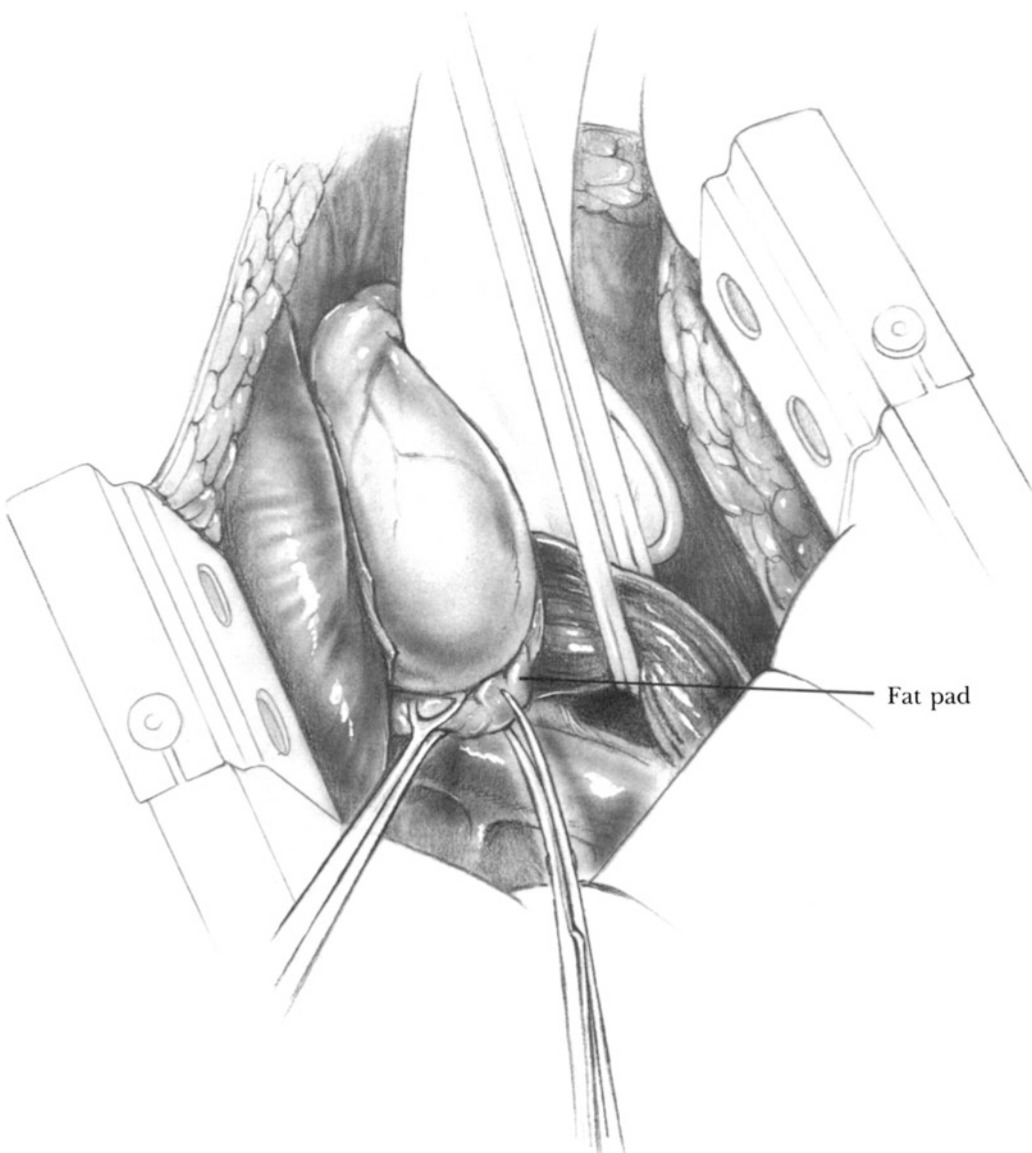


Fig. 13–11

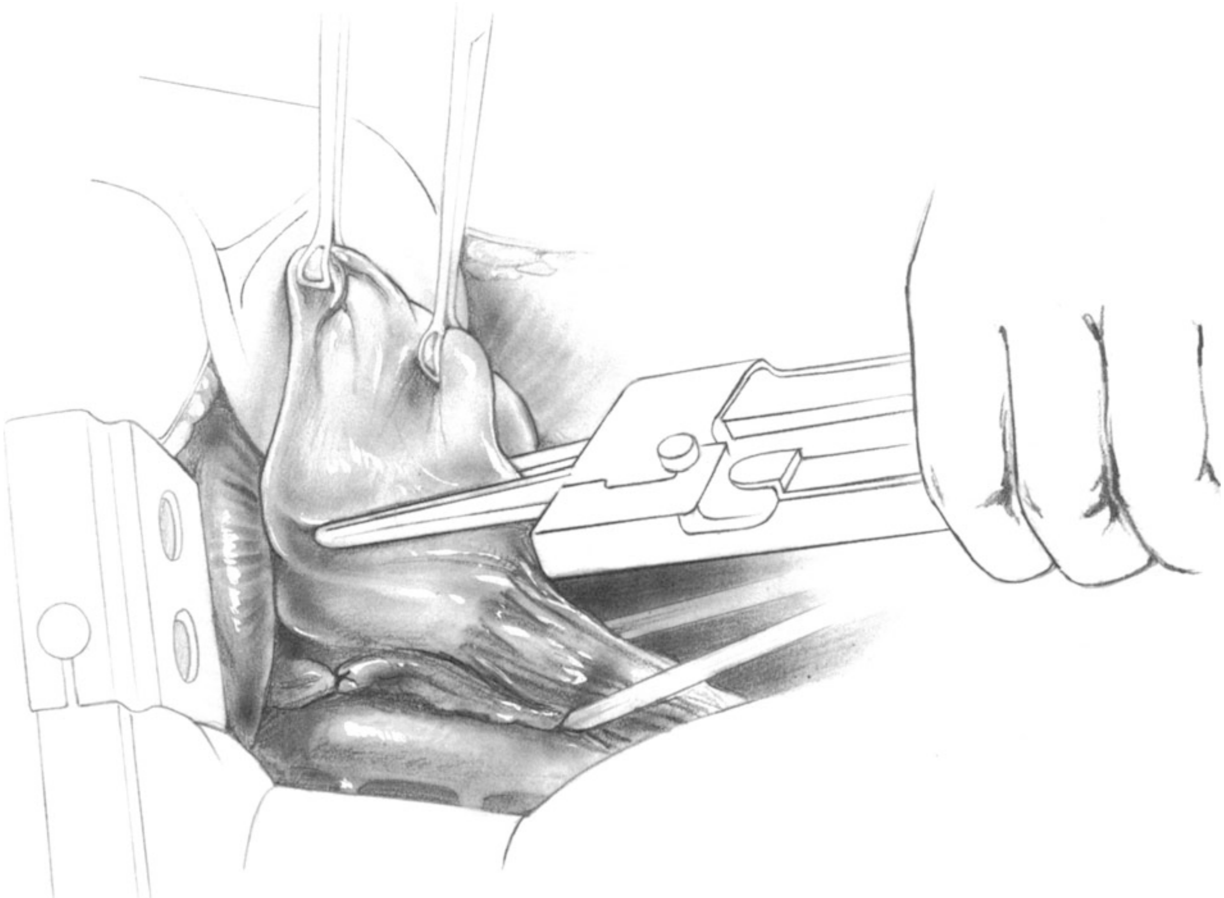


Fig. 13–12

esophagus by approximately 6–7 cm (**Fig. 13–13**). In most cases no additional length of neoesophagus will be necessary because of the greater lengths now available in the GIA devices. Although this step is not shown in the illustrations, it is wise as a precautionary measure to oversew the staple lines with two continuous Lembert sutures of either 4–0 Prolene or PDS suture material, one continuous suture to invert the staple line along the neoesophagus and the second continuous suture to invert the staple line along the gastric fundus. A continuous suture of the Lembert type is suitable, taking care not to turn in an excessive amount of tissue, as this will narrow the neoesophagus unnecessarily.

Performing a Modified Nissen Fundoplication

Since the neoesophagus has utilized a portion of the gastric fundus, there may not be sufficient remaining stomach to perform the Nissen fundoplication in the

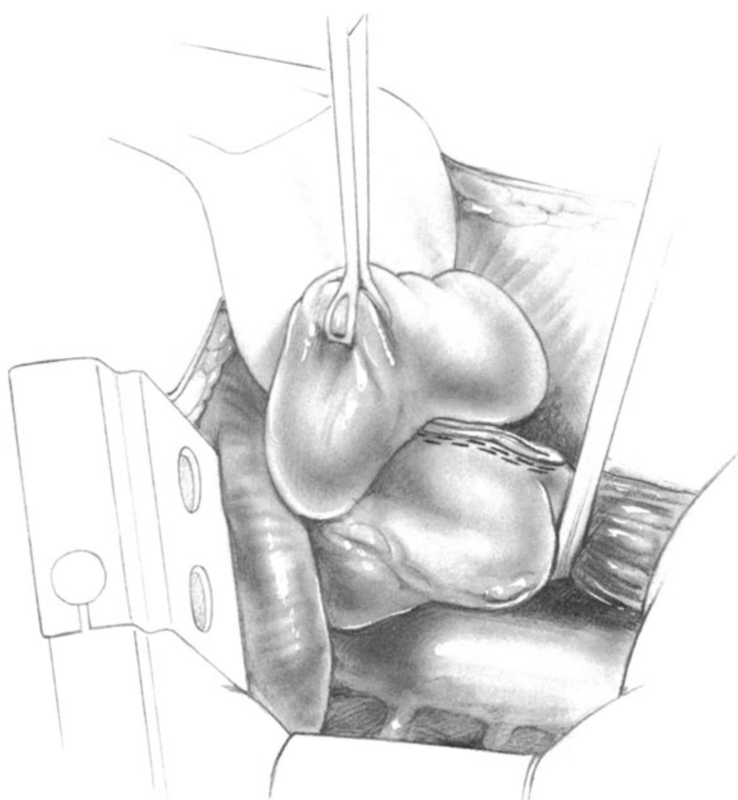


Fig. 13–13

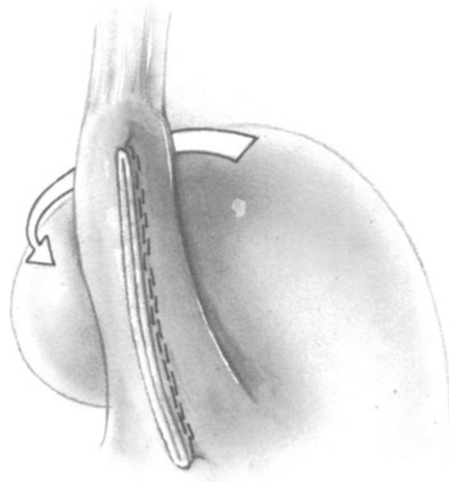


Fig. 13–14

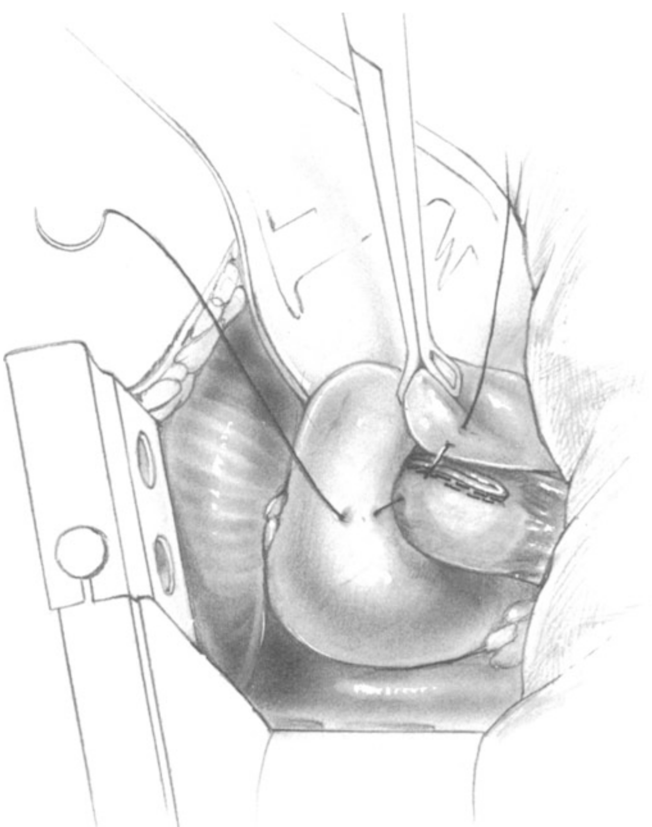


Fig. 13–15

classical manner. Instead, as seen in **Fig. 13–14**, the apex of the gastric fundus is wrapped around the neoesophagus in a counterclockwise fashion.

Before inserting any sutures, remove the indwelling large Maloney dilator and replace it with one sized 50F. Place a large Hemoclip at the site of the new esophagogastric junction (i.e., the junction of the neoesophagus with the stomach) as a radiographic marker. The fundoplication should encircle the neoesophagus in a loose wrap for a distance of 3 cm (**Fig. 13–15**).

Fig. 13–15 illustrates the insertion of the first Nissen fundoplication stitch including a 5–6 mm bite of gastric wall, then a bite of the neoesophagus, and finally a bite of the opposite wall of the gastric fundus. These bites should be deep to submucosa but not into the lumen of the stomach. Although Orringer uses 2–0 silk for this step, we prefer 2–0 Tevdek. A total of 3 or 4 fundoplication sutures are used at 1-cm intervals (**Figs. 13–16 and 13–17**). Now remove the Maloney dilator from the esophagus and replace it with a nasogastric tube. **Fig. 13–18** illustrates that the fundoplication wrap around the neoesophagus is loose enough to admit the fingertip. Orringer then inverts the layer of fundoplication sutures by oversewing it with a continuous Lembert seromuscular suture of 4–0 Prolene. This step is not illustrated.

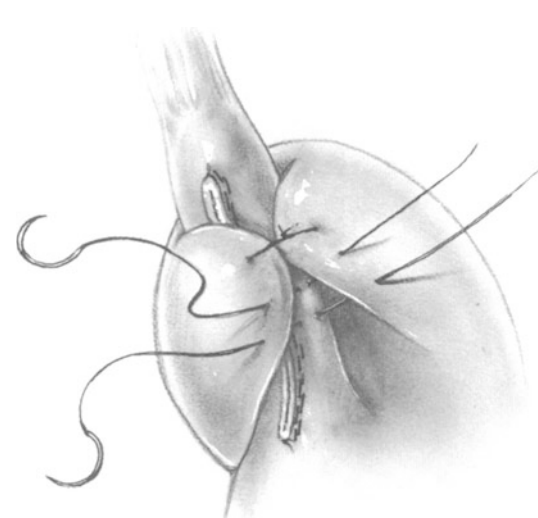


Fig. 13–16

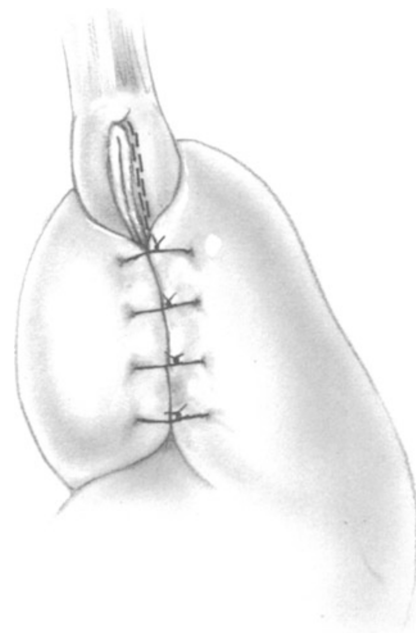


Fig. 13–17

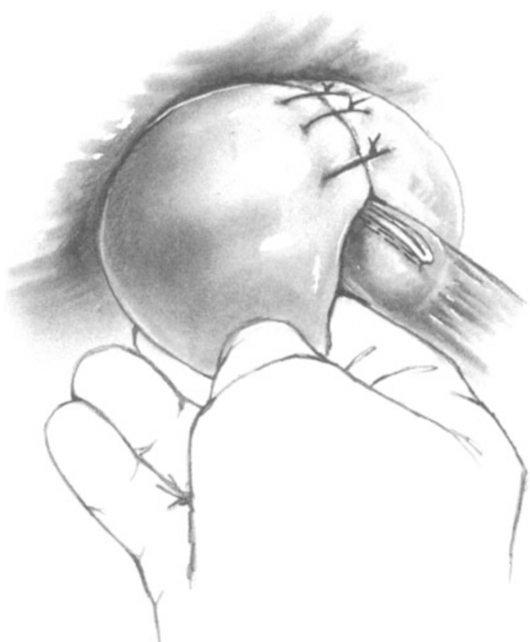


Fig. 13–18

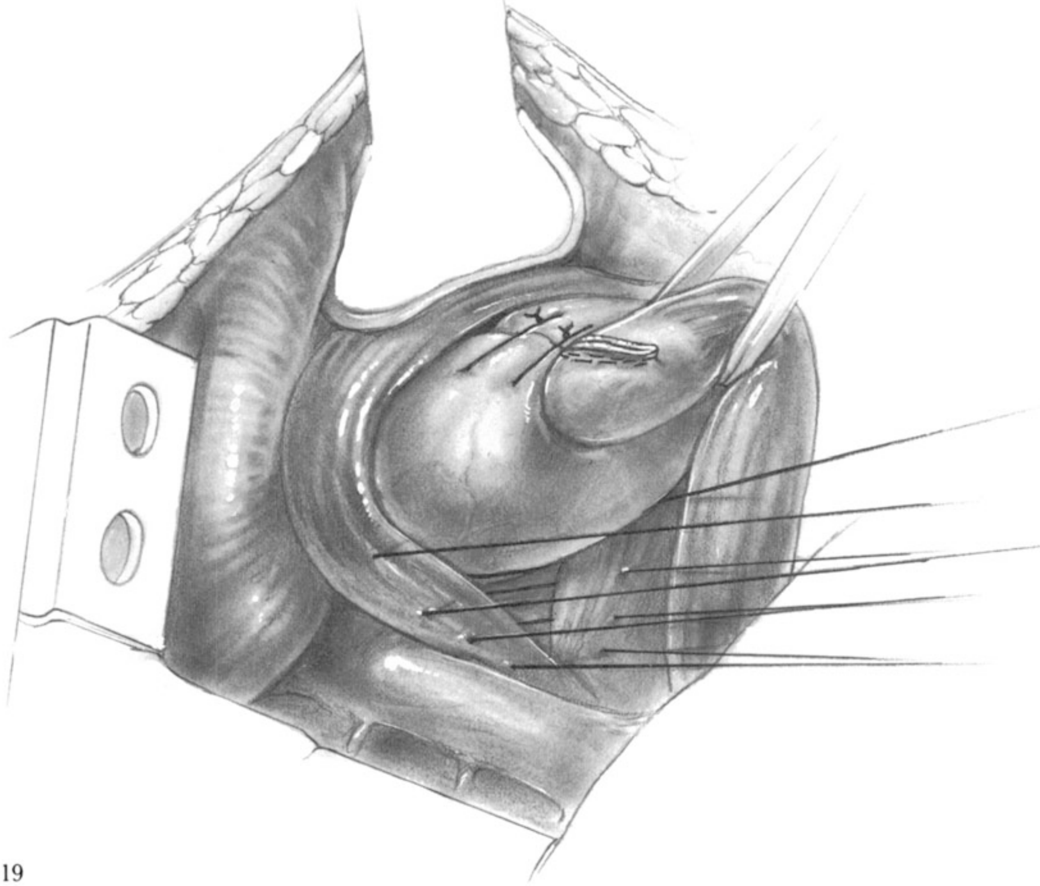


Fig. 13–19

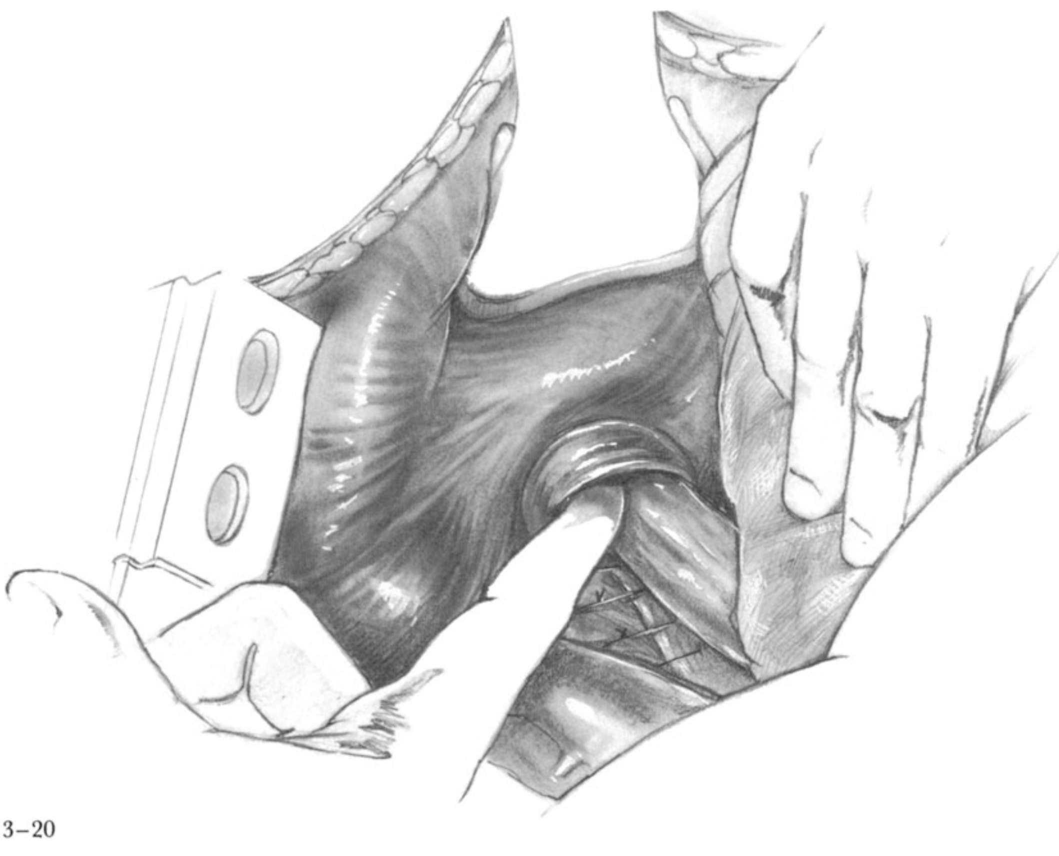


Fig. 13–20

Closing the Hiatal Defect

Close the defect in the posterior portion of the hiatus by inserting 0 Tevdek interrupted sutures through the right and left margins of the hiatus. Take a bite 1.5–2.0 cm in width and include overlying parietal pleura. After checking for hemostasis, reduce the fundoplication into the abdomen. This should slide down with ease. Then tie each of the sutures leaving space for the surgeon's fingertip alongside the esophagus or neoesophagus, with a nasogastric tube in place (**Figs. 13–19 and 13–20**). Place a Hemoclip at the edge of the hiatus as a marker. It is not necessary to resuture the incision in the mediastinal pleura.

Irrigate the mediastinum and thoracic cavity with warm saline and check for complete hemostasis. Insert a No. 36F plastic multiperforated intercostal drainage tube through a puncture wound below the level of the incision and bring the tube up the posterior gutter above the hilus of the lung. Insert 3–5 interrupted No. 2 PDS pericostal sutures and tie them to approximate the ribs. Close the overlying serratus and latissimus muscles in two layers with 2–0 PG continuous sutures. Close the skin with continuous or interrupted fine nylon sutures.

Postoperative Care

Continue nasogastric suction for 1–3 days.

Continue perioperative antibiotics for 24 hours.

Order a barium esophagram X ray on the 7th postoperative day.

Remove the chest drainage tube on the 3rd day unless drainage is excessive.

Postoperative Complications

Obstruction. Not rarely there will be a partial obstruction at the area of the fundoplication due to edema during the first 2 weeks following surgery. If the wrap is too tight, this obstruction may persist.

Recurrent gastroesophagel reflux. This is uncommon after the Collis–Nissen procedure unless the fundoplication suture line disrupts.

Leakage from the gastroplasty or fundoplication sutures. This complication is rare. If the fundoplication sutures are inserted into the lumen of the stomach and then the suture is tied with strangulating force, a leak is possible. The risk of this occurring may be reduced by oversewing the fundoplication sutures line with a continuous Lembert seromuscular suture.

Necrosis of the gastroplasty tube. This complication was reported by Orringer and Orringer in an operation for recurrent hiatus hernia. They warn that traumatizing the lesser curve of the stomach may doom a gastroplasty tube.

References

Orringer MB, Orringer JS. The combined Collis–Nissen operation: early assessment of reflux control. Ann Thorac Surg 1982;33:534.

Orringer MB, Sloan H. Combined Collis–Nissen reconstruction of the esophagogastric junction. Ann Thorac Surg 1978;25:16.

Pearson FG, Henderson RD. Experimental and clinical studies of gastroplasty in the management of acquired short esophagus. Surg Gynecol Obstet 1973;136:737.

Stirling MC, Orringer MB. Continued assessment of the combined Collis–Nissen operation. Ann Thorac Surg 1989;47:224–230.

Urschel HC, Razzuk MA, Wood RE, Galbraith NF et al. An improved surgical technique for the complicated hiatal hernia with gastroesophageal reflux. Ann Thorac Surg 1973;15:443.

14 Bile Diverting Operations in the Management of Reflux Esophagitis and Alkaline Reflux Gastritis

Concept and Indications

Esophagitis Following Repeated Failed Operations for Gastroesophageal Reflux: Bile Diversion by Antrectomy with Roux-en-Y Gastrojejunostomy

After one or more failed procedures for gastroesophageal reflux, one may elect to attack the esophagogastric junction another time by performing either a Collis–Nissen operation or a jejunal interposition procedure. If the patient is a poor-risk candidate for a formidable repeat dissection in the region of the esophagogastric junction, or if the technical difficulties are overwhelming, a possible alternative is a distal gastrectomy combined with a Roux-en-Y gastrojejunostomy. In 1970 Payne reported 15 patients who were suffering from "permanent incompetence of the cardia" and who were treated by vagotomy, hemigastrectomy, and Roux-en-Y gastrojejunostomy. All had severe esophagitis and six of the patients had serious strictures. Three patients suffered from achalasia and two from scleroderma of the esophagus. All of the patients had satisfactory results, although long-term follow-up has not been reported. Similar results were reported by Royston, Dowling, and Spencer in a series of eight patients, six of whom had undergone multiple previous operations at the esophagogastric junction. These authors stated that "none of the patients had any heartburn from the day of operation onwards." These good results persisted during a follow-up period of 11–20 months.

Fekete and Pateron performed this operation on 83 patients suffering from severe recurrent reflux esophagitis and reported good postoperative results.

Salo and associates reported on 11 patients with severe esophageal strictures due to reflux esophagitis treated with dilatation of the stricture, vagotomy, and partial gastrectomy with a Roux-en-Y gastrojejunostomy followed for an average of 4 years. Eight of the 11 patients were nonsymptomatic, while three had "slight transient dysphagia."

Reflux Esophagitis Following Esophagogastrectomy: Bile Diversion by Duodenojejunostomy Roux-en-Y Switch Operation

When the lower esophagus is resected, especially for a benign disease, and an anastomosis is made between the esophagus and the stomach in the lower chest, reflux esophagitis is a common complication. This is especially true if the anastomosis is made in an end-to-end fashion. The same complication does not occur as often after resection for cancer. However, since survival of patients with esophagogastric carcinoma is limited, the complications following gastroesophageal reflux in this group of patients have not received much attention.

One method of treating esophagitis following esophagogastrectomy is to reexplore the chest to interpose an intrathoracic short segment of isoperistaltic jejunum between the esophagus and the gastric pouch. Another option is to perform a total gastrectomy with a Roux-en-Y esophagojejunostomy. Both of the above operations are formidable undertakings, not without significant risk. A safer operation, suggested by Smith and Payne, is based on the presumption that the original esophagogastrectomy has almost invariably included a truncal vagotomy as well as the excision of a significant portion of the acid-secreting cells of the stomach. For this reason, in most of these patients the esophagitis is due to the reflux of bile. Smith and Payne recommend division of the proximal duodenum. This is followed by closing the duodenal stump and anastomosing the proximal end of the duodenum to a Roux-en-Y segment of jejunum, a procedure that will avoid any reflux of bile if the length of the Roux-en-Y segment is 60 cm. Although a large data base in support of this operation does not exist, we have had two excellent results using it, and the procedure is relatively simple and safe.

Bile Diversion by Duodenojejunostomy Roux-en-Y Switch Operation

In 1975 Smith and Payne recommended an operation for bile diversion subsequent to an esophagogastrectomy. In these cases, it was assumed that truncal vagotomy had been accomplished during the esophagectomy. These authors transected the duodenum about 3 cm beyond the pylorus and anastomosed the proximal cut end of duodenum to the end of a Roux-en-Y segment of jejunum, as illustrated in Figs. 14–4 and 14–5. However, in patients who had an intact stomach with intact vagus nerves, it was always feared that a duodenojejunostomy would permit the gastric acids to attack a jejunum that was unprotected by the biliary-pancreatic alkaline juices, thereby producing jejunal ulceration. DeMeester and associates (1987) reported the successful use of this same operation in patients who had an intact stomach and vagus nerves and who were suffering from severe duodenogastric reflux. In patients who did not have hyperacidity preoperatively, there was no problem with postoperative jejunal ulceration and the symptoms were relieved. DeMeester (1991) noted from his studies of 24-hour pH monitoring that a number of his patients with severe esophageal strictures or Barrett's esophagus experienced periods when the pH in the esophagus was low and other periods when the pH was quite high in the same patient, indicating intermittent gastroesophageal reflux of acid and at other times of bile and pancreatic juice. It was suspected that the biliary secretions might themselves be responsible for severe esophagitis and stricture. Naturally, in such cases, medical management aimed at lowering gastric acidity has no value. Symptoms that may indicate the presence of duodenogastric reflux include epigastric pain (especially when aggravated by eating), nausea, bilious vomiting, and loss of appetite.

Although many cases of delayed gastric emptying have been reported following the Roux-en-Y gastrojejunostomy operation, DeMeester and associates (1987) did not note any postoperative delayed emptying of the stomach in the 10 patients they reported who underwent Roux-en-Y duodenojejunostomy in the presence of an intact stomach. One explanation as to why their patients did not suffer delayed emptying may arise from the fact that in transecting the jejunum, they attempted to make the incision in the jejunal mesentery only 2 cm in length, thereby hoping to preserve the intestinal pacemaker.

Critchlow, Shapiro, and Silen in 1985 described the duodenojejunal bile diversion operation and applied it in three patients suffering from recurrent pancreatitis or cholangitis secondary to a duodenal diverticulum into which the ampulla of Vater entered. Their three patients had successful results with no jejunal ulcerations or significant problems of gastric emptying.

In patients who have severe esophagitis unresponsive to medical management as well as duodenogastric reflux, DeMeester and associates (1987) combine an antireflux operation with the duodenojejunostomy Roux-en-Y. DeMeester (1991) feels that otherwise the aspiration even of bland secretions would make the duodenojejunostomy operation unsatisfactory. Smith and Payne's patients, on the other hand, seemed to tolerate the reflux of the bland secretions satisfactorily.

Preoperative Care

In case of doubt whether a previous vagotomy has been done, perform appropriate studies of gastric acidity.

Perform esophagoscopy to evaluate the esophagus and to detect the presence of bile.

If bile reflux has not been demonstrated on esophagoscopy, obtain radionuclide studies for bile reflux.

Use of 24-hour esophageal pH monitoring is a good way to obtain evidence of biliary-pancreatic reflux.

Insert a nasogastric tube prior to operation.

Pitfalls and Danger Points

Incomplete vagotomy in patients with hyperacidity

Traumatizing liver, pancreas, or stomach

Operative Strategy

If transabdominal vagotomy does not appear to be feasible due to excessive scar tissue around the abdominal esophagus, one may make a transthoracic incision and perform a truncal vagotomy in the chest. Thoracoscopic vagotomy is another option.

Operative Technique—Vagotomy and Antrectomy with Bile Diversion

Incision and Exposure

Ordinarily a long midline incision from the xiphoid to a point about 5 cm below the umbilicus will be adequate for this operation. Divide the many adhesions and expose the stomach. Evaluate the difficulties of performing a hemigastrectomy, as opposed to the other available operations aimed at correcting the gastroesophageal reflux anatomically. Insert an Upper Hand or Thompson retractor and determine whether a transabdominal vagotomy is feasible.

Vagotomy

If it is feasible to perform an abdominal truncal vagotomy, follow the procedure described in Chap. 19. If dissecting the area of the esophagogastric junction appears to be too formidable a task, then it will be necessary to turn the patient to the lateral position and perform a left thoracotomy for a transthoracic vagotomy at the conclusion of the abdominal portion of this operation. Another possible alternative is to perform a high (70%) subtotal gastrectomy without a vagotomy.

Hemigastrectomy

Follow the procedure described in Chap. 24 for the performance of a Billroth II gastric resection. Close the duodenal stump either by stapling (see Fig. 24–46) or by suturing (see Figs. 24–23 to 24–25).

Roux-en-Y Gastrojejunostomy

Create a Roux-en-Y limb ofjejunum by the technique described in Fig. 28–11. Then perform an end-to-side gastrojejunostomy using either sutures (see Figs. 24–37 to 24–43) or staples (see Figs. 24–45 to 24–50). Position this anastomosis so that it sits about 1 cm proximal to the stapled closed end of the jejunum (see Fig. 24–52). Complete the construction of the Roux-en-Y segment by anastomosing the proximal cut end of jejunum near the ligament of Treitz to the side of the descending segment of jejunum at a point 60 cm distal to the gastrojejunostomy as shown in Figs. 28–33 to 28–37. Close the defect in the jejunal mesentery by means of interrupted sutures (**Figs. 14–1 and 14–2**).

Closure

Close the abdominal wall without drainage in the usual fashion.

Operative Technique—Bile Diversion Following Esophagogastrectomy

Incision and Exposure

Make a midline incision from the xiphoid to a point somewhat below the umbilicus. Divide the various adhesions subsequent to the previous surgery and expose the pyloroduodenal region. Due to the previ-

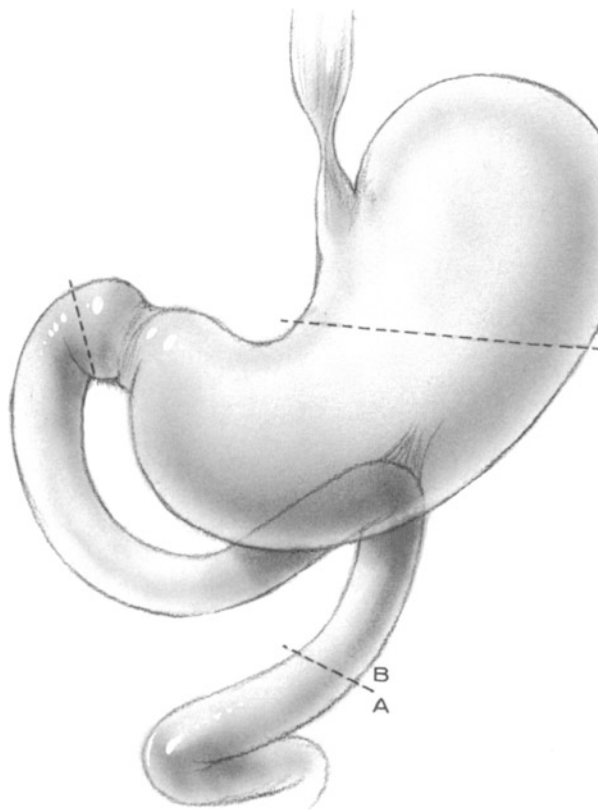


Fig. 14–1

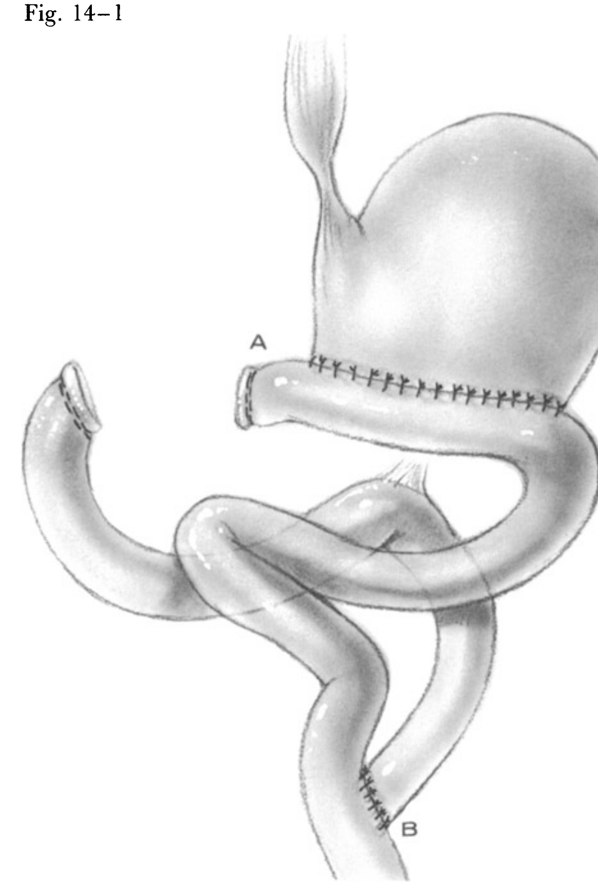


Fig. 14–2

ous surgery (esophagogastrectomy, **Fig. 14–3**), this area will now be located 5–8 cm from the diaphragmatic hiatus.

Dividing the Duodenum; Duodenojejunostomy, Roux-en-Y

Divide the duodenum at a point 2–3 cm beyond the pylorus. Be careful not to injure the right gastric or the right gastroepiploic vessels, as these constitute the entire blood supply of the residual gastric pouch. In order to divide the duodenum, first free the posterior wall of the duodenum from the pancreas for a short distance. If possible, pass one jaw of the TA–55 stapling device behind the duodenum, close the device, and fire the staples. Then divide the duodenum flush with the stapling device. Lightly electrocoagulate the everted mucosa and remove the stapler. This will leave the proximal duodenum open. Leave 1 cm of the posterior wall of the duodenum free (point A, **Fig. 14–4**) in order to construct an anastomosis with the jejunum.

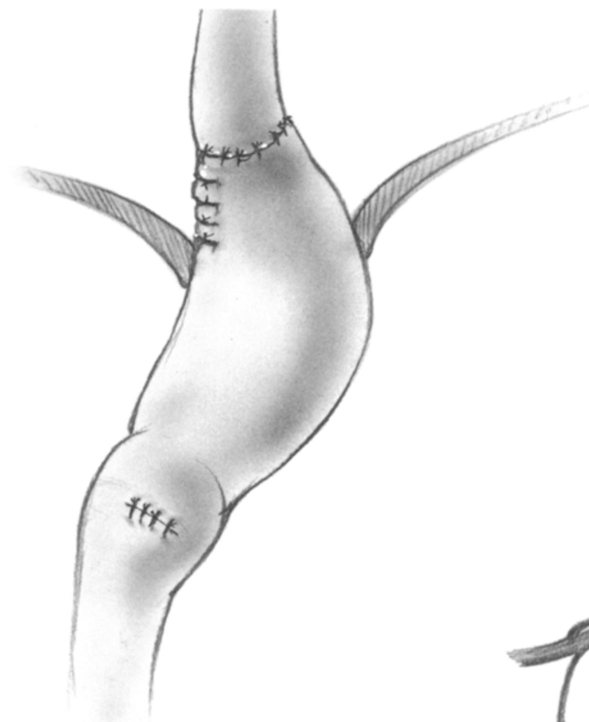


Fig. 14–3

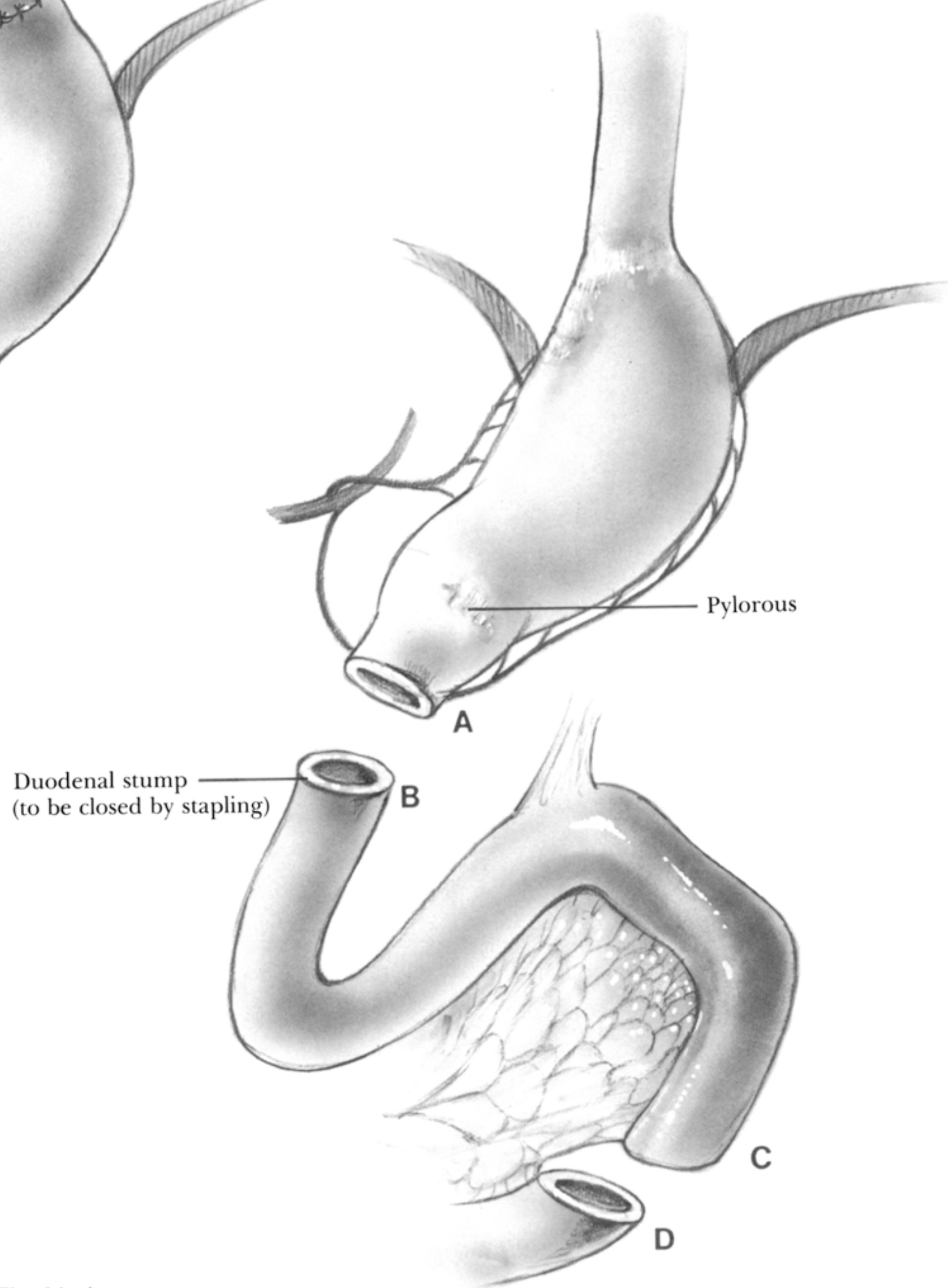


Fig. 14–4

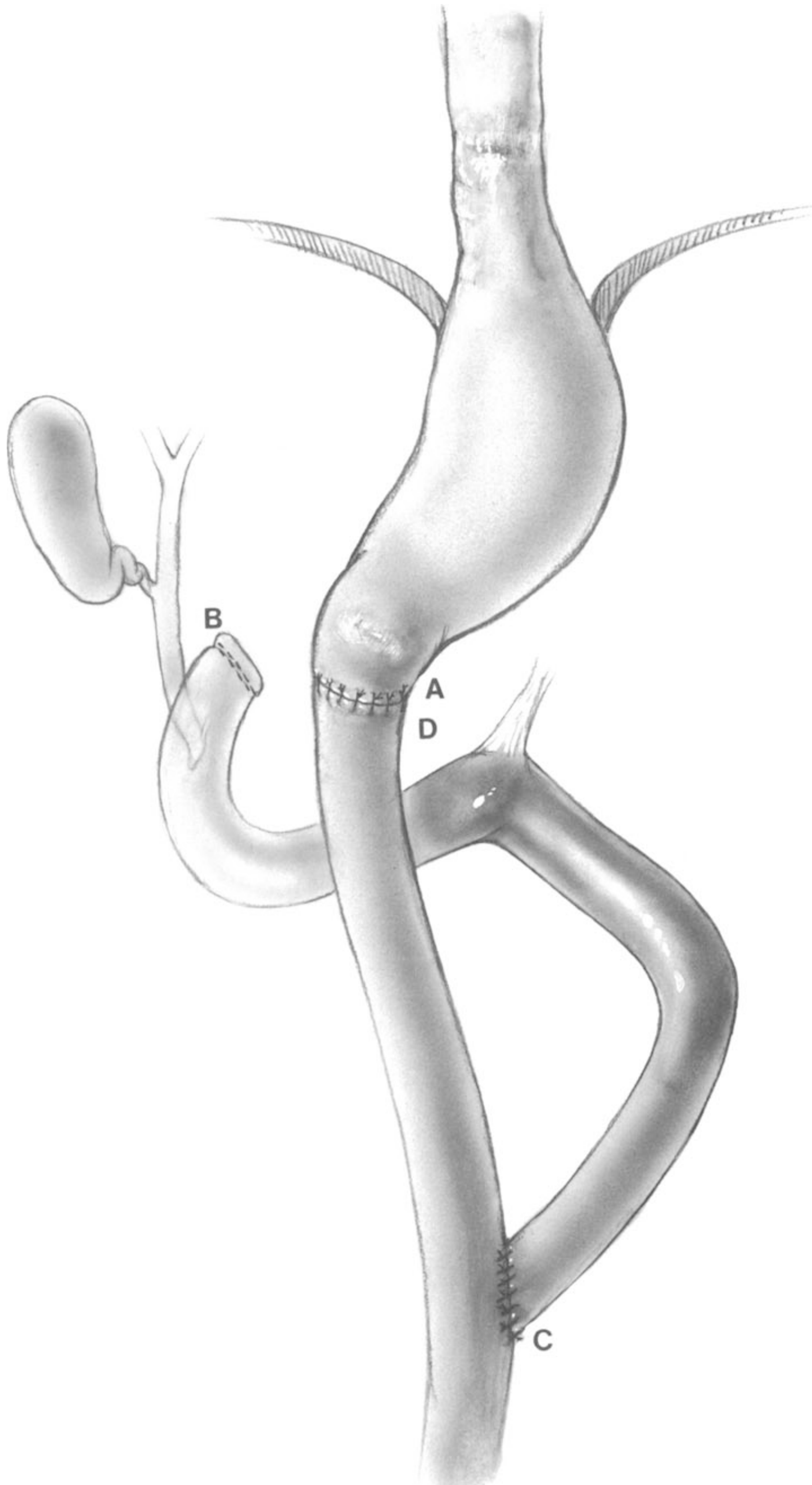


Fig. 14–5

Develop a Roux-en-Y limb of jejunum by the technique described in Fig. 28–11. Bring the open distal end of the divided jejunum (point D, Fig. 14–4) to the level of the duodenum either in an antecolonic fashion or, in some cases, it may be feasible to bring it through an incision in the mesocolon.

Establish an end-to-end duodenojejunostomy (point A to point D, **Fig. 14–5**) utilizing one layer of interrupted 4–0 silk for the seromuscular layer and continuous or interrupted sutures of atraumatic 5–0 Vicryl for the mucosal layer (see Figs. 30–2 to 30–10).

Complete the construction of the Roux-en-Y segment by creating an end-to-side jejunojejunostomy at a point 60 cm distal to the duodenojejunostomy using the technique shown in Figs. 28–33 to 28–37. Close the defect in the jejunal mesentery by means of interrupted sutures.

Closure

Close the abdominal wall without drainage in the usual fashion. Irrigate the operative field intermittently during the procedure with a dilute antibiotic solution.

Postoperative Care

If there is any suspicion that the patient has not had a complete vagotomy, give the patient an H_2 blocker postoperatively.

Continue nasogastric suction until bowel function resumes.

Postoperative Complications

Marginal ulcer may occur if a complete vagotomy has not been accomplished. Although in many cases a marginal ulcer may respond to conservative management, a transthoracic vagotomy may be necessary for long-term relief. This is true because the secretions in the Roux-en-Y segment of jejunum lack the buffering capacity of the diverted bile and pancreatic juice.

Bile Diversion by Duodenojejunostomy Roux-en-Y Switch Operation

Preoperative Care

Confirm the diagnosis of duodenogastric reflux by gastroscopy, mucosal biopsy, gastric analysis, serum gastrin levels, 24-hour esophageal and gastric pH monitoring, and DISIDA cholescintography.

Operative Technique

Incision and Exposure

Make a midline incision from the xiphoid to a point about 3–4 cm below the umbilicus.

Duodenojejunostomy

Perform a thorough Kocher maneuver, freeing the head of the pancreas and duodenum both anteriorly and posteriorly. Place a marking suture on the anterior wall of the duodenum precisely 3 cm distal to the pylorus. This represents the probable point at which the duodenum will be transected. Now approach the point where the duodenum and the pancreas meet. Divide and ligate carefully the numerous small vessels emerging from the area of the pancreas and entering the duodenum. Do this on both the anterior and posterior surfaces until a 2-cm area of the posterior wall of duodenum has been cleared. Do not dissect the proximal 2–3 cm of duodenum from its attachment to the pancreas. Dissecting the next 2 cm of duodenum free of the pancreas will provide enough length to allow stapled closure of the duodenal stump and a duodenojejunal end-to-end anastomosis. Be careful not to injure the pancreatic segment of the distal common bile duct or the duct of Santorini, which enters the duodenum at a point about 2 cm proximal to the papilla of Vater.

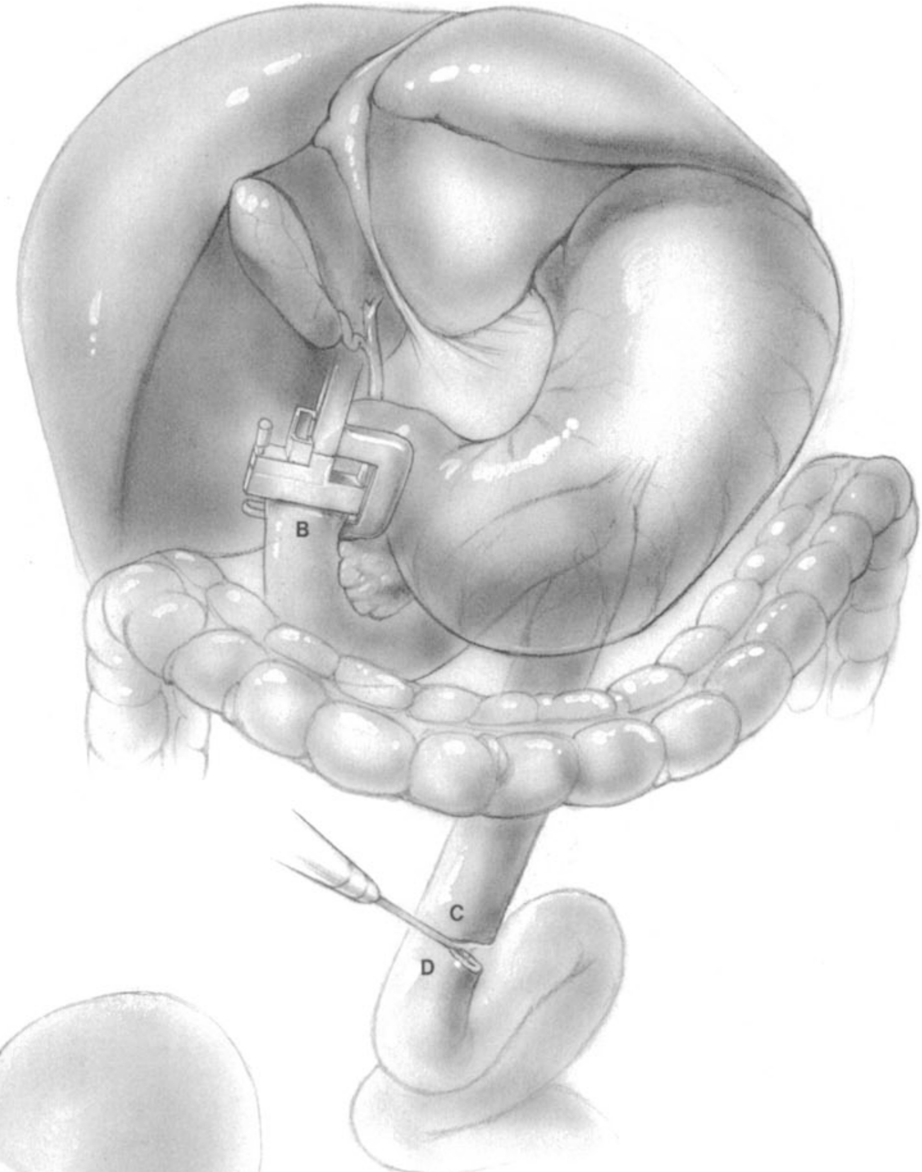


Fig. 14–6

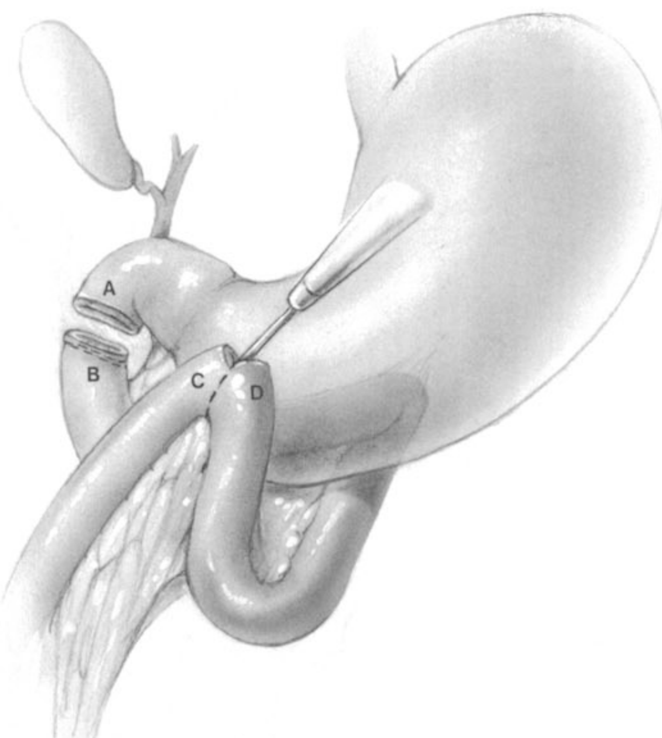


Fig. 14–7

After this has been completed, make a 2-cm transverse incision across the anterior wall of the duodenum near the marking suture (**Fig. 14–6**). Insert the index finger and palpate the ampulla. Confirm its location by compressing the gallbladder and liver. Observe the influx of bile into the distal duodenum. Now use a TA-55 stapler to occlude the duodenal stump just distal to the marking suture. Complete the transection of the duodenum after the stapler has been fired by cutting along the stapling device with a scalpel. Then electrocoagulate the mucosa and check for the proper formation of the staples.

At a point 20 cm distal to the ligament of Treitz, transect the jejunum and incise its mesentery down to, but not across, the arcade vessel (**Fig. 14–7C,D**).

Limiting the incision in the mesentery to 3 cm will help preserve the innervation of the intestinal pacemaker in the upper jejunal mesentery.

Bring the distal transected end of the jejunum through a small incision in the mesocolon and make an end-to-end anastomosis between the proximal transected duodenum to the jejunum using 4–0 interrupted silk sutures for the seromuscular layer and 5–0 Vicryl sutures for the mucosa (**Fig. 14–8A,C**).

Then perform an end-to-side jejunojejunostomy to the descending limb of jejunum (**Fig. 14–8**) at a point 60 cm distal to the duodenojejunostomy by the technique described in Figs. 28–33 to 28–37. Eliminate any defect in the mesocolon or the jejunal mesentery by suturing.

Irrigate the abdominal cavity and abdominal wound with a dilute antibiotic solution and close the abdomen in the usual fashion without drainage.

Postoperative Care

Nasogastric suction until bowel function resumes.

Administer H_2 blocker or omeperazole for the first two postoperative weeks.

Complications

Marginal jejunal ulcer

Anastomotic leak

Fig. 14–8

References

Critchlow JF, Shapiro ME, Silen W. Duodenojejunostomy for the pancreaticobiliary complications of duodenal diverticulum. Ann Surg 1985;202:56–58.

DeMeester TR. Invited letter concerning: peptic esophageal stricture. J Thorac Cardiovasc Surg 1991;101: 744–745.

DeMeester TR, Fuchs KH, Ball CS et al. Experimental and clinical results with proximal end-to-end duodenojejunostomy for pathological duodenogastric reflux. Ann Surg 1987;206:414–426.

Fekete F, Pateron D. What is the place of antrectomy with Roux-en-Y in the treatment of reflux disease? Experience with 83 total diversions. World J Surg 1992;16:349–354.

Payne WS. Surgical treatment of reflux esophagitis and stricture associated with permanent incompetence of the cardia. Mayo Clin Proc 1970;45:553.

Royston CMS, Dowling BL, Spencer J. Antrectomy with Roux-en-Y anastomosis in the treatment of peptic oesophagitis with stricture. Br J Surg 1975;62:605.

Salo JA, Ala-Kulju KV, Heikkinen LO. Treatment of severe peptic esophageal stricture with Roux-en-Y partial gastrectomy, vagotomy, and endoscopic dilation. J Thorac Cardiovasc Surg 1991;101:649–653.

Smith J, Payne WS. Surgical technique for management of reflux esophagitis after esophagogastrectomy for malignancy. Further application of Roux-en-Y principle. Mayo Clin Proc 1975;50:588.

Stein HJ, Barlow AP, DeMeester TR et al. Complications of gastroesophageal reflux disease: role of the lower esophageal sphincter, esophageal acid and acid/alkaline exposure, and duodenogastric reflux. Ann Surg 1992;216:35–43.

15 Cricopharyngeal Myotomy and Operation for Pharyngoesophageal (Zenker's) Diverticulum

Concept: When to Perform a Cricopharyngeal Myotomy

Physiology of Swallowing

Normal swallowing begins when the tongue thrusts a bolus of food from the mouth back into the pharynx. When food contacts the pharyngeal mucosa, it initiates afferent impulses to the swallowing center in the medulla. The swallowing center promptly sends an orderly sequence of impulses to the muscles of the pharynx, the esophagus, and the stomach. Forceful contraction of the pharyngeal musculature closes the passageway between the mouth and the nasopharynx to prevent regurgitation into the nose while at the same time the food is propelled forward. At this instant the cricopharyngeal sphincter must relax until the bolus of food has passed into the esophagus where sequential peristaltic contractions carry the food toward the stomach. At the lower end of the esophagus, the lower esophageal sphincter relaxes for a few seconds to permit the food to pass.

In the resting state both the cricopharyngeal and the lower esophageal sphincters are in a state of contraction. In the case of the lower esophageal sphincter, this state of contraction prevents gastroesophageal regurgitation. Since the pressure in the thoracic esophagus during inspiration is lower than it is in the atmosphere, there is a pressure gradient between the mouth and esophagus. In the absence of a closed cricopharyngeal sphincter, air could continuously enter the esophagus. It is notable that the pharyngeal constrictor, the cricopharyngeal, and the cervical esophageal musculature are striated in type. However, these muscles are voluntary only in the sense that a voluntary act of swallowing initiates an ordered series of impulses from the swallowing center to these muscles. It is also notable that the high pressure zone in the area of the cricopharyngeal sphincter measures about 4 cm, a distance which is considerably greater than the anatomical distribution of the cricopharyngeal muscle itself. When the term "cricopharyngeal sphincter" is used physiologically, it must be understood that the functional sphincter includes a few centimeters of the proximal esophagus. Ellis and Crozier prefer to use the term "upper esophageal sphincter" because the physiological sphincter is not in fact confined to the cricopharyngeal muscle.

Operation for Pharyngoesophageal (Zenker's) Diverticulum

For many years it had been theorized by authors like Belsey; Ellis, Schlegel, Lynch, and Payne; and Dohlman and Mattson, that the pharyngoesophageal (or Zenker's) diverticulum bursts through the space between the pharyngeal constrictor muscles and the cricopharyngeus because of "spasm" or achalasia of the cricopharyngeus. However, Ellis and Crozier emphasized that careful manometric studies of the upper esophageal sphincter in patients with pharyngoesophageal diverticula did not demonstrate achalasia (failure of relaxation). Nor did the studies elicit any evidence of spasm or increased pressure in this location. These authors did find, however, that there was an incoordination in the function of the upper esophageal sphincter in that the timing of the relaxation did not coincide with the peak of the pharyngeal contraction. This failure of coordination, they feel, produced repeated stress against the posterior hypopharynx in the weak area where the longitudinal muscles of the pharyngeal constrictors adjoin the transverse fibers of the cricopharyngeus. Repeated stress of this type may result in a pharyngoesophageal diverticulum.

For many years simple diverticulectomy was advocated for patients who had symptomatic pharyngoesophageal diverticula, and generally satisfactory results were reported (Welsh and Payne). However, there are a number of patients, especially those with smaller diverticula, whose dysphagia persisted without much improvement following simple diverticulectomy. While the postoperative X ray showed that the diverticulum was cured by the operation, the patient's symptomatology persisted. Persistence or recurrence of symptoms following diverticulectomy has been noted by a number of authors including Siewart and Blum; Worman; and Ellis and Crozier. Belsey emphasized that significant dysphagia often occurs in patients with small diverticula and that these symptoms can be relieved by performing only a myotomy of the upper esophageal sphincter without removing the diverticulum. Worman also noted that the size of the diverticulum is not often related to symptoms and that many patients with small diverticula experience severe dysphagia and aspiration. While primary operations for pharyngoesophageal diverticula are usually safe and straightforward procedures, Huang, Payne, and Cameron reported a 3.2% mortality and a 51.6% morbidity after surgical correction of *recurrent* diverticula.

In conclusion, it is not wise to perform a diverticulectomy without a concomitant cricopharyngeal and upper esophageal myotomy that is at least 4 cm in length.

Neuromotor Disturbances of the Cricopharyngeal Sphincter

From the above discussion it can be concluded that the pharyngoesophageal diverticulum is simply one manifestation of a functional disorder occurring in the upper esophageal sphincter. A number of observers have reported performing a cricopharyngeal myotomy for patients without any diverticula who suffer from dysphagia secondary to achalasia, delayed relaxation, or persistent elevation in the resting pressure of the cricopharyngeal–upper esophageal sphincter. Palmer and also Ellis and Crozier have published reports relevant to this problem. Palmer describes the dysphagia resulting from cricopharyngeal disorders as a sensation that a shelf forms in the throat every time a patient tries to swallow. The patient senses exactly where the dysphagia is located and points just below the larynx. The patient may state that the food catches on a shelf in the throat prior to his developing a choking sensation. Swallowing solid foods may be easier than liquids. The patient may become hoarse and acquire a persistent cough especially at night with some degree of aspiration. The fear of choking may lead to the patient refusing to eat, a fear that is often followed by undernutrition.

Some known causes of this type of dysphagia include extensive resections of oropharyngeal cancers, division of the superior or the recurrent laryngeal nerves, and bulbar palsy (e.g., amyotrophic lateral sclerosis, cerebral vascular accident). Excessively high pressure in the upper esophageal sphincter may be the cause of dysphagia in patients with globus hystericus in some cases. Myotomy of the truly hypertensive upper esophageal sphincter produces excellent results (Ellis and Crozier), when the diagnosis is confirmed by manometry.

The exact role of cricopharyngeal myotomy in the treatment of all of these functional disorders of the upper esophageal sphincter has not yet been delineated. Since the number of these cases is small, few surgeons have acquired any significant experience in managing them. At the present time, patients in this category should be subjected to careful manometric studies in a laboratory experienced in manometry of the cervical esophagus. Only if specific abnormalities, such as persistent elevation of the cricopharyngeal pressure or achalasia, are demonstrated, should a myotomy be performed for neuromotor disorders. Ellis and Crozier found that their patients with bulbar palsy did not respond well to myotomy.

Cricopharyngeal Dysphagia as a Complication of Reflux Esophagitis

It has long been known that perhaps 10% of patients with cricopharyngeal dysphagia also suffer from gastroesophageal reflux. In some cases, the severity of the cricopharyngeal dysphagia is far greater than that of the symptoms caused by the gastroesophageal reflux. Henderson and associates reported on 25 cases of severe cricopharyngeal dysphagia unresponsive to medical management that were encountered during the course of performing 1500 operations for gastroesophageal reflux. To correct this condition, they performed a long myotomy, beginning at the lower pharynx, and continuing down through the entire cervical esophagus and extending 1–2 cm into the thoracic esophagus. This operation gave good symptomatic relief to these patients. They performed the operation under local anesthesia. By having the patient swallow gelatin before and after the myotomy, they would often observe disappearance of the dysphagia. In those patients who did not have *severe* reflux esophagitis, no antireflux operation was performed. It is important that patients who have incompetence of both the lower esophageal and the upper esophageal sphincters remain in an erect or sitting position for a period of time after eating in order to avoid aspiration. It was interesting that following the myotomy operation, aspiration was not a serious problem.

Cricopharyngeal-esophageal myotomies in the neck should not be performed without precise preoperative manometric studies during the act of swallowing to confirm the diagnosis of either cricopharyngeal achalasia or uncoordination of the upper esophageal sphincter. Upper esophageal endoscopy and/or X rays of the cervical esophagus serve to rule out other types of pathology.

Indications

Pharyngoesophageal diverticulum, symptomatic

Selected cases with functional disorders of the upper esophageal sphincter

Preoperative Care

Patients suffering from pharyngoesophageal diverticula do not require any preoperative diagnostic study other than a barium swallow.

Patients with other functional disorders of the upper esophageal sphincter should have not only X rays but also precise manometric studies of the pharynx and the esophagus.

Pitfalls and Danger Points

Inadequate cricopharyngeal and upper esophageal myotomy

Inadequate closure of cervical esophagus following diverticulectomy with postoperative leak

Damage to recurrent laryngeal nerve

Operative Strategy

Adequate Myotomy

Performing a cricopharyngeal myotomy is not unlike performing a cardiomyotomy. In the first place, it must be recognized that the physiological upper esophageal sphincter is considerably wider than is the anatomical cricopharyngeus muscle. The transverse muscle fibers are only about 2.0–2.5 cm wide while the high pressure zone corresponding to the cricopharyngeus area can measure 4 cm in width. Consequently, a proper cricopharyngeal myotomy should not only transect all of the transverse fibers of the cricopharyngeus muscle but also 1–2 cm of the proximal esophagus so that the myotomy measures at least 4 cm in length. The incision in the muscle is carried down to the mucosa of the esophagus, which should bulge out through the myotomy after all of the muscle fibers have been divided. Additionally, free the mucosa from the overlying muscle over the posterior half of the esophagus.

Is Diverticulectomy Necessary?

If the pharyngoesophageal diverticulum is a small diffuse bulge measuring no more than 2–3 cm in diameter, we perform only a myotomy and make no attempt to excise any part of the diverticulum because after the myotomy there is only a gentle bulge of mucosa and no true diverticulum. On the other hand, longer, fingerlike projections of mucosa should be amputated because there have been a few case reports of recurrent symptoms due to the persistence of diverticula left behind in patients in whom an otherwise adequate myotomy had been done. Belsey advocated suturing the most dependent point of the diverticulum to the prevertebral fascia in the upper cervical region. This procedure effectively upends the diverticulum so that it can drain freely into the esophageal lumen by gravity. He used fine stainless steel wire for the diverticulopexy. We have preferred to amputate diverticula larger than 3 cm rather than to perform a diverticulopexy. With the application of a stapling device, amputation of the diverticulum takes only about 1 minute of additional operating time, and the results have been excellent.

Operative Technique

Incision and Exposure

With the patient's head turned somewhat toward his right, make an incision along the anterior border of the left sternomastoid muscle beginning at a point 2–3 cm above the clavicle (**Fig. 15–1**). Divide the platysma muscle. Electrocoagulate the bleeding points. Free the anterior border of the sternomastoid muscle and retract it laterally. This will expose the omohyoid muscle crossing the field from medial to lateral. Transect this muscle (**Fig. 15–2**). The diverticulum will be located deep to the omohyoid muscle. Identify the carotid sheath and the descending hypoglossal nerve. Retract these structures laterally. The thyroid gland will be seen in the medial portion of the operative field beneath the strap muscles. Retract the thyroid gland and the larynx in a medial direction. This will reveal, in most cases, a prominent middle thyroid vein (**Fig. 15–3**). Ligate and divide this vein.

Fig. 15–1

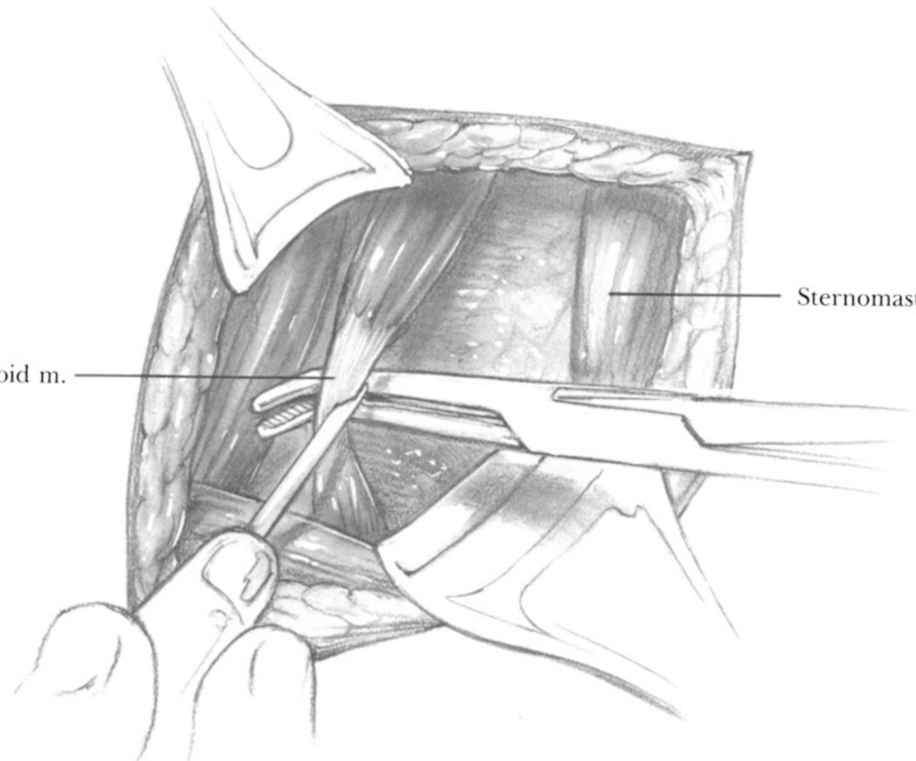


Fig. 15–2

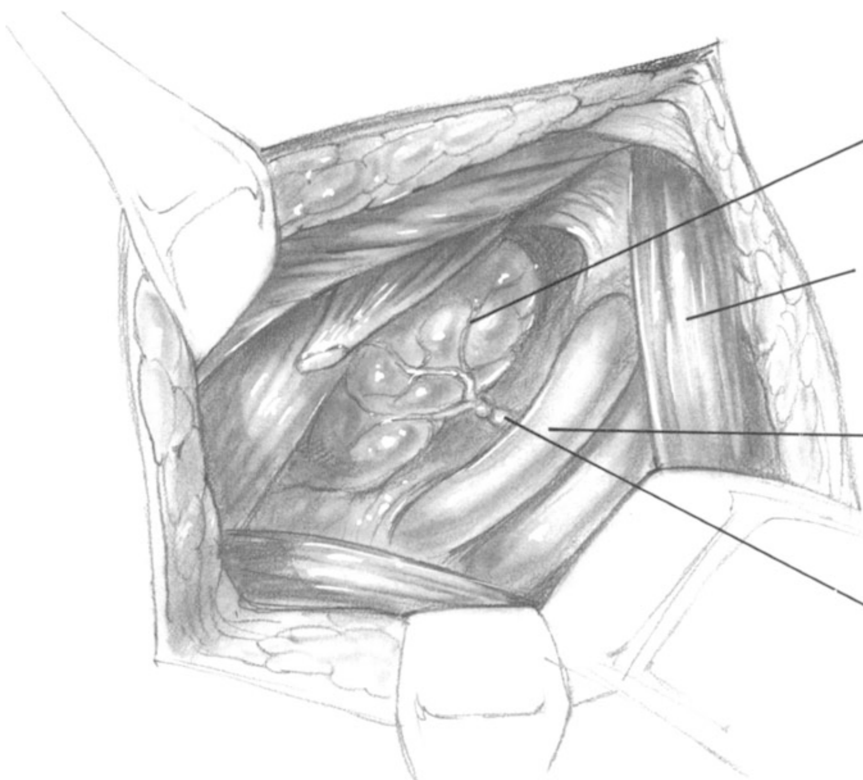


Fig. 15–3

Divide the areolar tissue anterior to the carotid artery and identify the inferior thyroid artery and the recurrent laryngeal nerve. In some patients there does not appear to be a true left inferior thyroid artery arising from the thyrocervical trunk. In these patients the lower thyroid is supplied by branches of the superior thyroid artery. In the majority of patients, with the inferior thyroid artery emerging from beneath the carotid artery and crossing the esophagus to supply the lower thyroid (see Figs. 96–10 and 96–11), divide and ligate this vessel after identifying the recurrent laryngeal nerve. After this step has been completed, retracting the larynx in an anteromedial direction and the carotid artery laterally will expose the lateral and posterior aspects of the cervical esophagus and the pharyngoesophageal junction. Often it is not necessary to divide the inferior thyroid artery or its branches to develop adequate exposure for diverticulectomy.

Dissecting the Pharyngoesophageal Diverticulum

The pharyngoesophageal diverticulum emerges posteriorly between the pharyngeal constrictor and the cricopharyngeus muscles. Its neck is at the level of the cricoid cartilage and the dependent portion of the diverticulum descends between the posterior wall of the esophagus and the prevertebral fascia overlying the bodies of the cervical vertebrae. Blunt dissection with the index finger or a peanut sponge will generally identify the most dependent portion of the diverticulum. Grasp this with a Babcock clamp and elevate the diverticulum in a cephalad direction. Mobilize the diverticulum by sharp and blunt dissection down to its neck. If there is any confusion about the anatomy, especially in patients who have had previous operations in this area, ask the anesthesiologist to pass a 40F Maloney bougie through

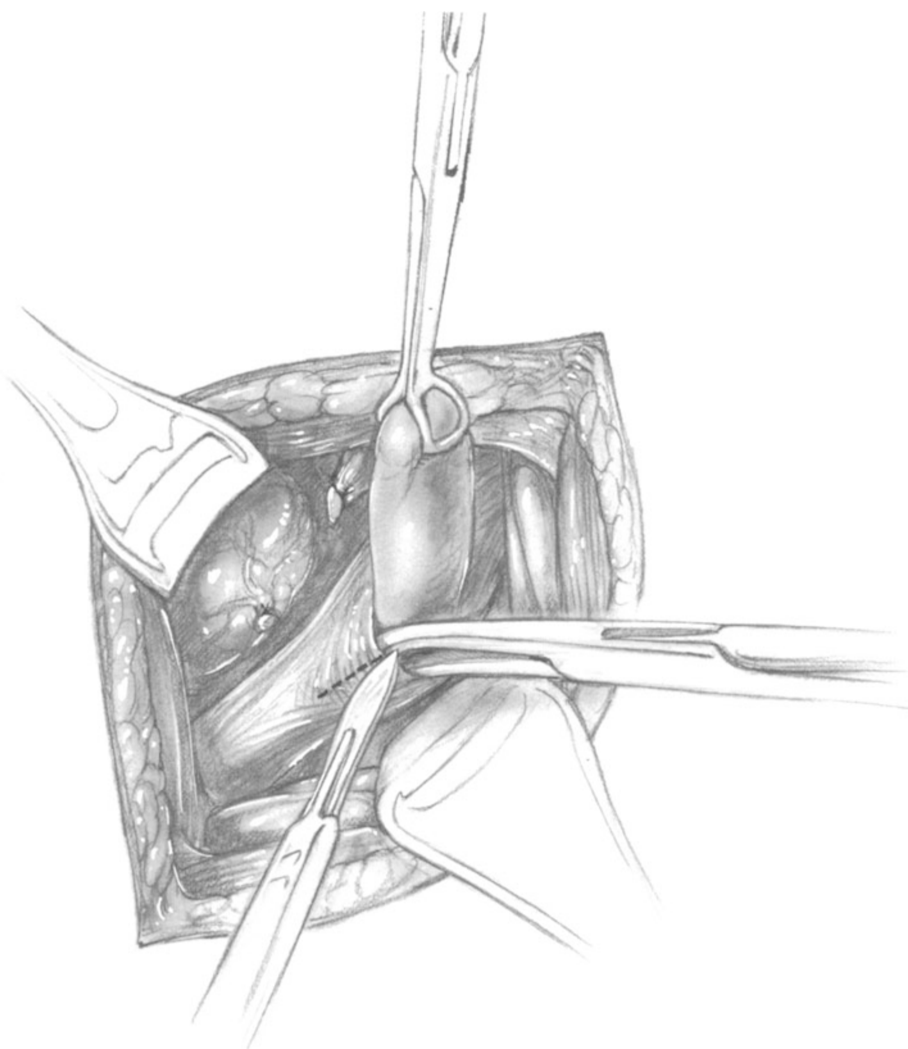


Fig. 15–4

the mouth into the cervical esophagus. Guide the tip of the bougie past the neck of the diverticulum so that it enters the esophagus. Now the exact location of the junction between the esophagus and the diverticulum can be identified. There is generally some fibrous tissue overlying the mucosa of the diverticulum. Lightly incise this with a scalpel near the neck of the sac down to the submucosa. At this point the transverse fibers of the cricopharyngeus muscle are easily identified.

Cricopharyngeal and Esophageal Myotomy

Insert a blunt-tipped right-angled hemostat between the mucosa and the transverse fibers of the cricopharyngeus muscle just distal to the neck of the diverticulum (**Fig. 15–4**). Elevate the hemostat in the posterior midline and incise the fibers of the cricopharyngeus muscle with a scalpel. Continue this dissection down the posterior wall of the esophagus for a total distance of about 5–6 cm. Now elevate the incised muscles of the cricopharyngeus and the upper esophagus from the underlying mucosal layer over the posterior half of the esophageal circumference by blunt dissection.

After the mucosa has been permitted to bulge out through the myotomy, make a determination as to whether the diverticulum is large enough to warrant resection. If so, apply a TA-30 or a TA-55 stapler with 3.5-mm staples across the neck of the diverticulum. Close the stapler. Fire the staples and amputate the diverticulum flush with the stapling device. Although the stapler is shown applied in a longitudinal direction in **Fig. 15–5**, Hoehn and Payne prefer to apply staples in a transverse direction. With a 40F Maloney dilator in the lumen of the esophagus, it will not be possible to excise so much mucosa as to cause constriction of the lumen. After removing the stapling device, carefully inspect the

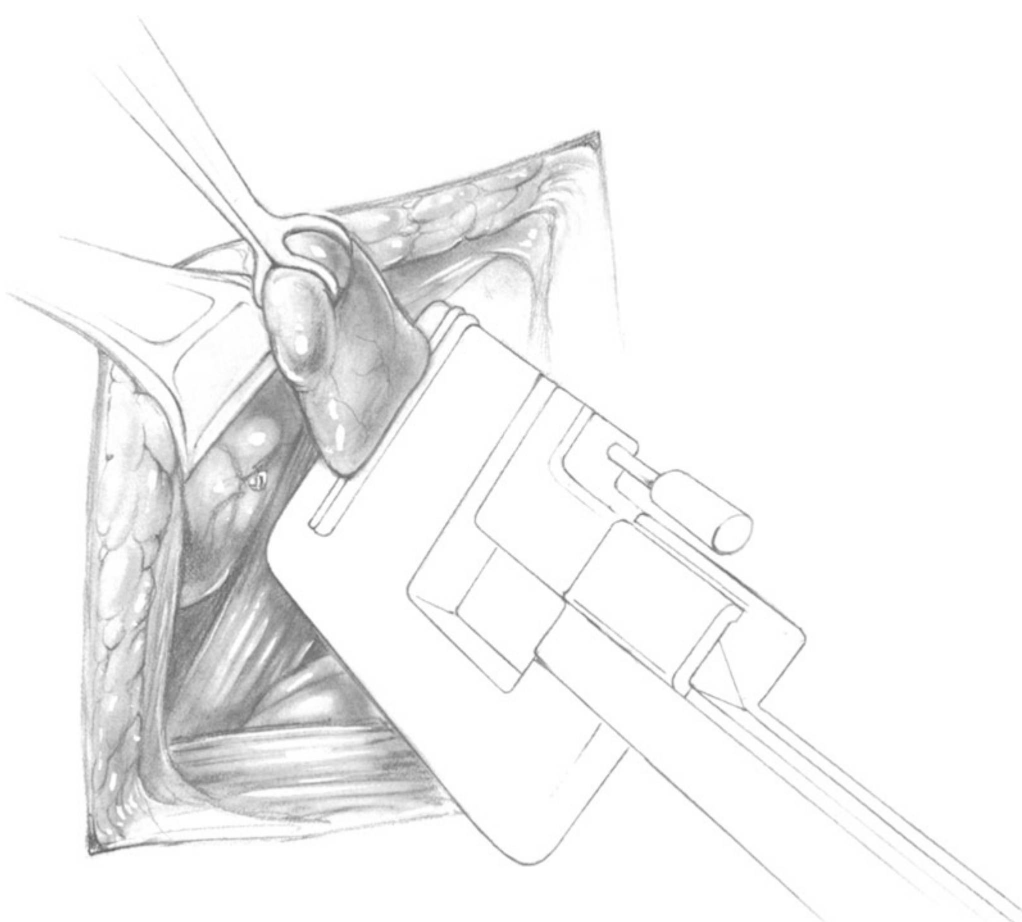


Fig. 15–5

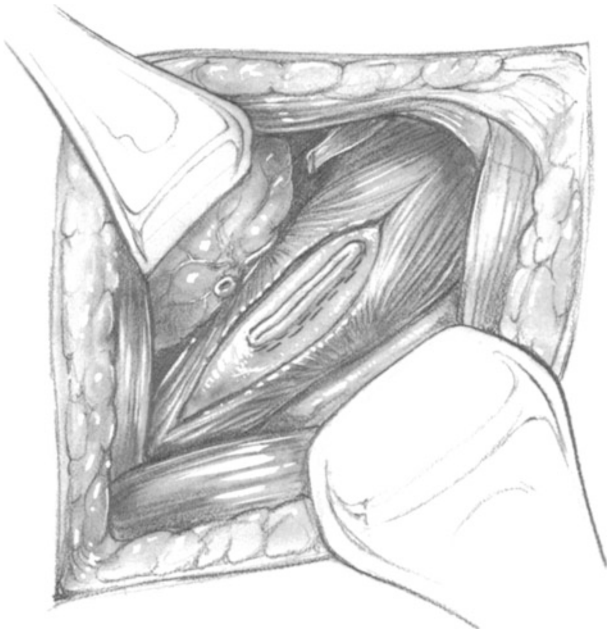


Fig. 15–6

Fig. 15–7

staple line and the staples for proper closure. Check for complete hemostasis (**Fig. 15–6**).

An alternative method for performing the myotomy is illustrated in **Fig. 15–7** where the incision is initiated 1 or 1.5 cm cephalad to the cricopharyngeus muscle, in the pharyngeal constrictor muscle. Then it is continued downward for 4–5 cm. The diverticulum is removed in the usual fashion.

Drainage and Closure

After carefully inspecting the area and assuring complete hemostasis, insert a medium-size latex rubber drain into the prevertebral space just below the area of the diverticulectomy. Bring the drain out through the lower pole of the incision.

Close the incision in layers with interrupted 4–0 PG sutures to the muscle fascia and platysma. Close the skin either by means of a continuous subcuticular suture of 4–0 PG, interrupted nylon sutures, or skin staples.

Postoperative Care

Remove the drain by the 4th postoperative day.

Initiate a liquid diet on the 1st postoperative day and progress to a full diet over the next 2–3 days.

Continue perioperative antibiotics for a second dose.

Postoperative Complications

Esophageal fistula (When the fistula is small and drains primarily saliva, it will generally close after a week of intravenous feeding if the patient's operative site has been drained as described above.)

Recurrent laryngeal nerve palsy, generally temporary, secondary to excessive traction on the thyroid cartilage or to direct trauma to the nerve

Persistent dysphagia due to inadequate myotomy

References

Belsey R. Functional disease of the esophagus. J Thorac Cardiovasc Surg 1966;52:164.

Dohlman G, Mattson O. The endoscopic operation for hypopharyngeal diverticula; a roentgenocinematographic study. Arch Otolaryngol 1960;71:744.

Ellis FH Jr, Crozier RE. Cervical esophageal dysphagia; indications for and results of cricopharyngeal myotomy. Ann Surg 1981;194:279.

Ellis FH Jr, Schlegel JF, Lynch VP, Payne WS. Cricopharyngeal myotomy for pharyngoesophageal diverticulum. Ann Surg 1969;170:340.

Henderson RD, Hanna WM, Henderson RF, Maryatt G. Myotomy for reflux-indiced cricopharyngeal dysphagia. J Thorac Cardiovasc Surg 1989;98:428–433.

Hoehn JG, Payne WS. Resection of pharyngoesophageal diverticulum using stapling device. Mayo Clin Proc 1969;44:738.

Huang B, Payne WS, Cameron AJ. Surgical management for recurrent pharyngoesophageal (Zenker's) diverticulum. Ann Thorac Surg 1984;37:189.

Palmer ED. Disorders of the cricopharyngeal muscle: a review. Gastroenterology 1976;71:510.

Siewart JR, Blum AL. The esophagus. Part I: surgery at the upper esophageal sphincter, tubular esophagus, and lower esophageal sphincter. Clin Gastroenterol 1979;8:271.

Welsh GF, Payne WS. The present status of one-stage pharyngoesophageal diverticulectomy. Surg Clin North Am 1973;53:953.

Worman LW. Pharyngoesophageal diverticulum—excision or incision? Surgery 1980;87:236.

16 Esophagomyotomy for Esophageal Achalasia and Diffuse Esophageal Spasm

Concept: Which Therapy for Achalasia and Esophageal Spasm?

Hydrostatic Dilatation versus Esophagomyotomy

In esophageal achalasia the body of the esophagus is unable to produce organized peristaltic contractions, and the lower esophageal sphincter fails to relax following the act of swallowing. This combination of events results in partial obstruction. The esophagus dilates. The patient suffers from dysphagia, regurgitation, tracheal aspiration, and pneumonitis in advanced cases. Long-term relief from the symptoms of achalasia requires either hydrostatic dilatation of the lower esophagus or an esophagomyotomy. Both procedures result in interrupting the continuity of the circular muscle surrounding the distal esophagus. Sanderson, Ellis, and Olsen report that hydrostatic dilatation has been successful in relieving symptoms in 81% of their cases, of which 3.2% required emergency surgery for esophageal perforation. There were no deaths. On the other hand, Ellis, Kiser, Schlegel, Earlam, and others (1967) feel that surgical esophagomyotomy is the treatment of choice for esophageal achalasia. They experienced one death from malignant hyperthermia in 269 operations. There was only a 3% incidence of symptomatic reflux esophagitis. An additional 3% of cases experienced poor results in the form of either persistent or recurrent symptoms of dysphagia not related to gastroesophageal reflux. A majority of the patients having poor results from esophagomyotomy had previously undergone unsuccessful treatment by hydrostatic dilatation or surgery. Using a similar technique of esophagomyotomy, Okike, Payne, and Newfeld also noted only a 3% incidence of postoperative reflux esophagitis in a study of 200 operations for achalasia done at the Mayo Clinic from 1967 to 1975. These authors report good or excellent results in 90% of their patients.

In the hands of an experienced gastroenterologist, hydrostatic dilatation may achieve satisfactory results. However, we agree with Ellis, that surgical division of the esophageal muscle is a safe and effective procedure for the primary treatment of esophageal achalasia.

Which Therapy for Patients with Sigmoid Megaesophagus or Failed Surgery for Achalasia?

Orringer and Stirling reported on 26 patients with failed esophagomyotomy operations for achalasia with sigmoid-shaped megaesophagus. They performed thoracic esophagectomy, mostly transhiatal, and cervical esophagogastrostomy in these patients, with no deaths but multiple complications. Except for a few patients with nocturnal regurgitation and others with dumping symptoms, the results have been satisfactory. On the other hand, Ellis follows a more conservative approach with this type of patient. He performs a resection of the lower esophagus with intrathoracic esophagogastrostomy, vagotomy, antrectomy, and Roux-en-Y gastrojejunostomy. His experience with this operation in 20 patients was highly gratifying.

Diffuse Esophageal Spasm

Patients with diffuse esophageal spasm suffer from attacks of severe substernal pain, not unlike angina pectoris, as well as from espisodic dysphagia. These symptoms are caused by a severe motor disorder that produces spasm and hypertrophy of the esophageal circular muscle, generally involving the lower two-thirds of the esophagus. The lower esophageal sphincter is usually normal and relaxes well in response to swallowing (Murray). Ellis and associates (Leonardi, Shea, Crozier, and Ellis) recommend a long esophagomyotomy sparing the lower esophageal sphincter if it is normal on manometry. The upper end of the myotomy may have to extend to the level of the aortic arch; the proximal margin of the myotomy is determined by the upper extent of the disordered spastic contractions as shown on preoperative manometric measurements.

If there is achalasia of the lower esophageal sphincter as well as diffuse spasm of the esophagus, then the esophagomyotomy will have to include the lower esophagus. In these cases, Henderson and Ryder perform a very narrow (0.5 cm) Nissen fundoplication to prevent reflux without creating a functional obstruction at the lower end of an esophagus that no longer is capable of any peristalsis.

Indications

Esophageal achalasia as demonstrated by typical symptoms and esophageal X rays

Diffuse esophageal spasm, confirmed by esophageal manometry, if severe and unresponsive to medication.

Preoperative Care

Do an esophagoscopy with biopsy of the narrowed portion of distal esophagus in patients diagnosed as suffering from achalasia.

Perform esophagram X rays.

In advanced cases, lavage the dilated esophagus with a Levine tube and warm saline for 1–2 days prior to operation to evacuate retained food particles. This should be combined with a liquid diet.

Pass a nasogastric tube into the esophagus the morning of operation. Administer perioperative antibiotics.

Preoperative esophageal manometry is indicated in patients who have achalasia and experience severe chest pain, since vigorous achalasia may be accompanied by diffuse esophageal spasm. This cannot be diagnosed by any means other than manometry. Simply dividing the lower esophageal musculature will not be adequate for those patients having diffuse esophageal spasm involving a long segment of the esophagus.

Pitfalls and Danger Points

Extending the myotomy too far on the stomach

Perforating the esophageal mucosa

Performing an inadequate circumferential liberation of the mucosa

Creating a hiatus hernia

Operative Strategy

Length of Myotomy for Achalasia

Ellis, Gibb, and Crozier (1980) attribute their low incidence of postoperative gastroesophageal regurgitation (3%) to the fact that the myotomy terminates only a few millimeters beyond the esophagogastric junction. At the esophagogastric junction, several veins run in a transverse direction just superficial to the esophageal mucosa. One does not encounter any other transverse vein of this size during the myotomy of the more proximal esophagus. Once these veins are encountered, terminate the myotomy. In no case should more than 1 cm of gastric musculature be divided. Continue the myotomy in a cephalad direction for 1–2 cm beyond the point at which the esophagus begins to dilate. In early cases, where no significant esophageal dilatation is evident, the length of the myotomy should be 5–8 cm.

Avoiding the Creation of a Hiatus Hernia

Perform the esophagomyotomy through a thoracotomy incision and do not dissect the esophagus away from the hiatus as this dissection will result in division of the phrenoesophageal ligaments. If the esophagogastric junction is liberated, a potential hiatus hernia will be created. If the esophagomyotomy is performed transabdominally, it is obvious that the phrenoesophageal ligaments will have to be transected to expose enough of the lower esophagus. This approach will increase the likelihood of producing a hiatus hernia. Those patients in whom a hiatus hernia is already present should undergo some type of repair of the hiatal defect. Special care must be taken to avoid obstructing the esophagus in patients with achalasia, since these patients do not have normal peristaltic propulsion of food.

Is an Antireflux Procedure Necessary?

While Ellis and associated experienced reflux esophagitis in only 3% of their patients following esophagomyotomy, Skinner advocates adding a modified (loose) Belsey Mark IV type of partial fundoplication. If this procedure is added to the operation for achalasia, the myotomy can be extended onto the stomach further than is shown in Fig. 16–4, a step that, he argues, will eliminate the persistence of achalasia after esophagomyotomy.

On the other hand, Murray, Battaglini, Keagy, Starek et al. advocate adding a fundoplication only in selected cases of achalasia, for example, patients with preexisting reflux esophagitis or hiatus hernia and patients who experienced mucosal perforations during esophagomyotomy. Patients requiring repeat myotomy for recurrent achalasia require extension of the myotomy well onto the gastric wall to provide a patulous opening into the stomach, followed by an antireflux procedure. In general, our views concur with those of Murray and associates.

When a Belsey fundoplication is added to the esophagomyotomy, Skinner emphasizes that it should be looser than usual and that it should encompass only 180° of esophagus.

Mucosal Perforation

In the series reported by Ellis and colleagues (1967), the mucosa was perforated in 10% of the cases during the performance of the esophagomyotomy. In each case, the perforation was closed by interrupted sutures. Empyema developed postoperatively in three patients, in only one of whom was a mucosal perforation recognized at the time of operation. It is advisable for the surgeon to test the integrity of the mucosal layer following myotomy by having the anesthesiologist insert 100–200 ml of a methylene blue solution through the nasogastric tube. When a mucosal perforation is identified during the operation, careful suturing of the mucosa will generally avoid further difficulty. It should be noted that Ellis routinely sutures the incision in the mediastinal pleura following the esophagomyotomy. This will buttress a sutured perforation of the mucosa with a flap of pleura (also see Figs. 17–1 to 17–3).

Operative Technique

Incision and Exposure

Position the patient so that he lies on his right side. Make a skin incision along the course of the 7th intercostal space. Incise the serratus and latissimus muscles with the electrocautery. Then make an incision along the upper border of the 8th rib through the intercostal musculature (see Figs. 13–1 to 13–3). Open the pleura for the length of the 8th rib. Insert a Finochietto retractor and gradually increase the space between the 7th and 8th ribs. Divide the inferior pulmonary ligament and retract the left lung in a cephalad and anterior direction using large moist gauze pads and Harrington retractors. Make an incision in the mediastinal pleura overlying the distal esophagus (**Fig. 16–1**). Then gently encircle the esophagus with the index finger. This is facilitated by the indwelling nasogastric tube. Encircle the esophagus with a latex drain. Be careful to identify and preserve the vagus nerves. Free the esophagus from surrounding structures down to the level of the diaphragm, but no lower (**Fig. 16–2**).

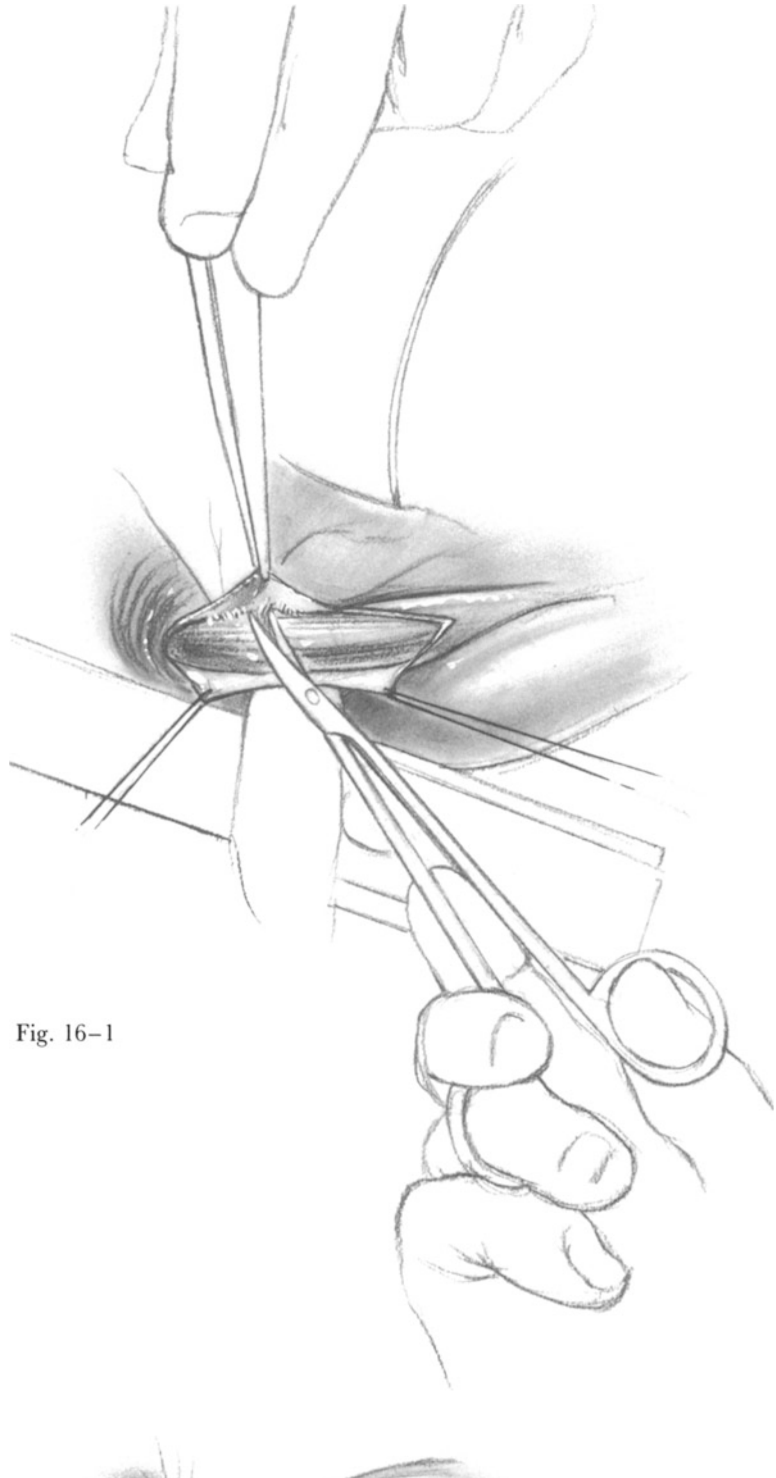


Fig. 16–1

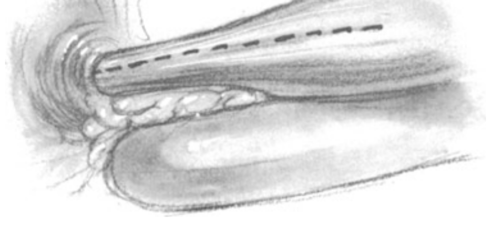


Fig. 16–2

Esophagomyotomy for Achalasia

Place the left index finger beneath the distal esophagus. Make a longitudinal incision through both the longitudinal and circular muscle layers of the esophagus until the muscosal surface is exposed (**Fig. 16–3**). Continue this incision in a cephalad direction for a distance of about 2 cm above the point where the esophagus begins to dilate, or at least 5–7 cm.

Continue the myotomy in a caudal direction as far as the esophagogastric junction (**Fig. 16–4**). This junction can be identified by noting one or two veins crossing transversely over the mucosa deep to the musculature. Do not continue the incision more than 1 cm into the gastric musculature. Another way of confirming the location of the esophagogastric junction is the fact that the gastric musculature differs from that of the esophagus.

In order to prevent the reuniting of the muscle fibers, it is important to free at least 50% of the circumference of the mucosa from its muscular coat. This may be accomplished by using the Metzenbaum scissors to elevate the circular muscle from the underlying mucosa going both medial and then lateral to the initial longitudinal myotomy until the mucosa bulges out as seen in cross section in **Fig. 16–5**. Achieve complete hemostasis by cautious electrocoagulation and fine suture-ligatures, especially in the incised esophageal muscle.

If the mucosa has been inadvertently incised, carefully repair the laceration with one or more 5–0 nonabsorbable sutures. At this point, ask the anesthesiologist to inject a solution of methylene blue into the esophagus in order to prove that there is no mucosal perforation.

Fig. 16–3

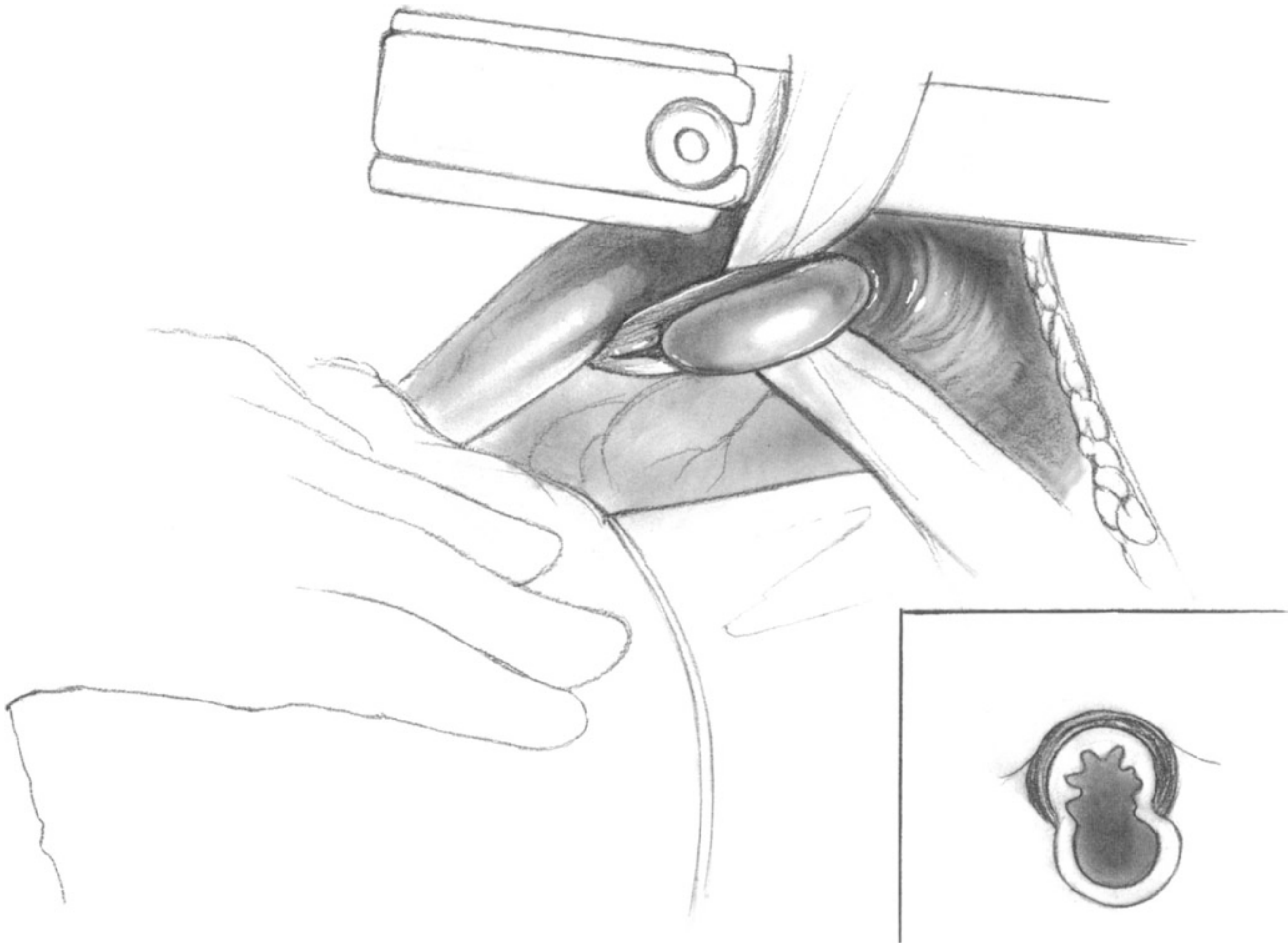


Fig. 16–4

Fig. 16–5

Esophagomyotomy for Diffuse Esophageal Spasm

The technique of performing a myotomy for diffuse spasm does not differ from that described for achalasia except in the length of the myotomy. If the lower esophageal sphincter can relax normally when swallowing occurs, then do not extend the myotomy down to the terminal esophagus. The preoperative manometric assessment of the patient's esophageal contractions will determine how far the esophagomyotomy should be extended.

Closure and Drainage

Bring a 30F plastic catheter out of the chest cavity through a stab wound in the ninth intercostal space in the anterior axillary line. Approximate the ribs with 2 or 3 pericostal sutures of No. 2 PDS. Close the remainder of the wound in layers as illustrated in Figs. 8–43 to 8–45.

Postoperative Care

Remove the nasogastric tube the day following surgery.

Initiate oral intake of liquids on the 1st or 2nd postoperative day, if tolerated.

Remove the thoracic drainage tube as soon as the drainage becomes minimal, about the 3rd or 4th postoperative day.

Postoperative Complications

Persistent Dysphagia. In some cases an inadequate myotomy for achalasia may fail to completely relieve the patient's dysphagia. In these cases, about 2 weeks following operation, the insertion of graduated Maloney dilators through the esophagogastric junction may relieve this complaint.

Recurrent Dysphagia Following Initial Relief of Symptoms. It is possible that in these cases there has been a reuniting of the muscular tissues. A trial of Maloney bougienage up to size 50F may prove successful. It should be noted that there appears to be an increased incidence of esophageal carcinoma in patients who have had long-standing esophageal achalasia. Consequently, patients with recurrent dysphagia following a symptom-free interval after esophagomyotomy should have complete study by X ray, esophagoscopy, and biopsy to rule out carcinoma.

Reflux Esophagitis. Although most patients with symptoms of reflux may be handled conservatively, an antireflux operation will be required in severe cases.

Diaphragmatic Hernia

Empyema

References

Ellis FH. Esophagectomy for achalasia: who, when, and how much? Ann Thorac Surg 1989;47:334–335.

Ellis FH Jr, Gibb SP, Crozier RE. Esophagomyotomy for achalasia of the esophagus. Ann Surg 1980;192:157.

Ellis FH Jr, Kiser JC, Schlegel JF, Earlam RJ et al. Esophagomyotomy for esophageal achalasia: experimental, clinical, and manometric aspects. Ann Surg 1967;166:640.

Henderson RD, Ryder DE. Reflux control following myotomy in diffuse esophageal spasm. Ann Thorac Surg 1982;34:230.

Leonardi HK, Shea JA, Crozier RE, Ellis FH Jr. Diffuse spasm of the esophagus: clinical, manometric, and surgical considerations. J Thorac Cardiovasc Surg 1977;74:736.

Murray GF. Operation for motor dysfunction of the esophagus. Ann Thorac Surg 1980;29:184.

Murray GF, Battaglini JW, Keagy BA, Starek PJK et al. Selective application of fundoplication in achalasia. Ann Thorac Surg 1984;37:185.

Okike N, Payne WS, Newfeld DM et al. Esophagomyotomy versus forceful dilatation for achalasia of the esophagus: results in 899 patients. Ann Thorac Surg 1979;28:119.

Orringer MB, Stirling MC. Esophageal resection for achalasia: indications and results. Ann Thorac Surg 1989;47:340–345.

Sanderson DR, Ellis FH Jr, Olsen AL. Achalasia of the esophagus: results of therapy by dilatation 1950–1967. Chest 1970;58:116.

Skinner DB. Myotomy and achalasia. Ann Thorac Surg 1984;37:183.

17 Operations for Esophageal Perforations and Anastomotic Leaks

Concept: Choice of Therapy

Options in Selecting Therapy

Conservative Management

Although several retrospective studies of esophageal perforations have identified groups of patients who survived with conservative therapy, it must be emphasized that these patients must be carefully selected. When a patient sustains a small perforation of the cervical esophagus following elective esophagoscopy and has minimal symptoms, both local and systemic, nonoperative management by means of antibiotics and intravenous feeding may prove successful. On the other hand, a spontaneous perforation of the thoracic esophagus following a bout of retching in a gourmand with a full stomach should always be treated by prompt operation. Otherwise, a fulminating necrotizing mediastinitis will develop because the chest has been flooded by the powerful digestive ferments of the stomach and duodenum. Nonoperative management is acceptable only in patients who have experienced a contained leak with minimal symptoms and no sign of systemic sepsis. In the thoracic esophagus the presence of fluid or air in the pleural cavity is a contraindication to conservative treatment.

Surgical Drainage

Proper drainage implies a surgical incision followed by the insertion of adequate drains down to the point of perforation, whether in the neck or in the thorax. This is accompanied by proximal decompression with nasogastric suction, antibiotics, and intravenous feeding.

Some surgeons have advocated inserting a large T-tube into the esophageal perforation, bringing the long end of the rubber tube out through the chest (Abbot, Mansour, Logan et al.). At least one instance of erosion of the thoracic aorta has occurred following the use of this method (Goldstein and Thompson).

Local drainage without suturing the opening is generally used in the cervical esophagus where the perforation may sometimes not be identified or may be located in an inaccessible position. Also, in operations performed after a delay of 12–24 hours the quality of the esophageal tissue may be such that suturing is not possible.

Suture Repair and Drainage

Ideally, when a perforation is diagnosed and explored within 8 hours of injury in the absence of a violent inflammatory response, accurate closure of the perforation with two layers of interrupted fine sutures may result in primary healing. In all cases, place a drain down to the vicinity of the repaired perforation. As above, utilize proximal nasogastric suction, antibiotics, and intravenous feeding or a needle catheter jejunostomy. Gastrostomy may be performed to accomplish the removal of gastric and duodenal secretions.

Suture Repair with Buttress

Grillo and Wilkins achieved excellent results when they wrapped their sutured thoracic esophageal perforations with a pedicle flap of parietal pleura. Other surgeons have advocated using pedicles of diaphragm or intercostal muscle to buttress the esophageal suture line. When a perforation of the *distal* esophagus has been repaired, it may be buttressed by performing a Nissen fundoplication or a Thal operation.

Early suture repair of an esophageal perforation, when the tissue is still viable without much edema, will prove successful in most cases. Otherwise, all sutured esophageal perforations should be supported by a buttress of viable tissue such as a flap of pleura, intercostal muscle, pericardium, diaphragm, or a Thal wrap of stomach around a lower esophageal repair. When Rosoff and White buttressed their repairs of 13 lower esophageal perforations, only two (15%) leaked. In 11 similar repairs without a buttress, eight (73%) leaked and four of the 11 patients died.

Gouge, Depan, and Spencer reported good results with pleural flap reinforcement in 14 patients, even though eight of these patients experienced a delay of more than 24 hours before surgery was performed. These authors believe that all primary suture repairs should be buttressed with autologous tissue. Pate and colleagues, after a review of their 30-year experience with this condition, also agree with this strategy.

Surgical Drainage with Proximal Diversion and Distal Occlusion

For patients with perforations of the thoracic esophagus accompanied by a serious degree of mediastinitis, Urschel advocated performing a cervical esophagostomy to accomplish the proximal diversion of saliva. He performed a thoracotomy both to provide adequate local drainage and to occlude the lower esophagus by means of a strip of Teflon felt. A gastrostomy was also performed. During the early postoperative period, the gastrostomy was used to evacuate digestive secretions. Later on, the same channel was employed for tube feeding.

Although in one retrospective review (Michel, Grillo, and Malt) the diversion-exclusion operation appeared to have a higher mortality rate than conservative management, it is obvious that diversion-exclusion is generally employed in the sickest patients. In many cases the thoracic esophagus will have to be sacrificed and replaced by means of a colon bypass from the neck to the stomach at a later date. Nevertheless, further progress in reducing the mortality from late esophageal perforations and leaks will come when the indications for a muscle pedicle or a pleural wrap and the diversion-exclusion operations have been expanded to include some of the patients who are now failures following more conservative methods of treatment.

The most effective method of assuring proximal diversion is to perform a total thoracic esophagectomy with an end cervical esophagostomy and a closure of the esophagogastric junction, combined with a gastrostomy.

Concept: Management of Esophageal Perforations at Various Anatomical Levels

Cervical Esophagus

The cervical esophagus may be perforated during endoscopy, endotracheal intubation, swallowing a foreign body, or by external trauma. Although endoscopic perforations accompanied by minimal symptoms and signs may be treated conservatively, patients who are febrile or have swelling and tenderness in the neck should have prompt exploration and drainage of the retroesophageal space, as well as suture repair of the perforation when possible.

Thoracic Esophagus

Perforation by Endoscopy or Bougienage

Esophageal perforation following endoscopy or instrumentation occurred in 0.15% of patients (mortality rate 0.02%) at the Massachusetts General Hospital (Michel et al.) and in 0.2% of 19,600 procedures (0.005%) at the Mayo Clinic (Sarr, Pemberton, and Payne). In an excellent review of 47 endoscopic or instrumental perforations Sarr and colleagues found that the fiberoptic endoscope had been used in 7 patients and the rigid scope in 12; 14 patients sustained perforations when the esophagus was being dilated through a rigid esophagoscope. Twelve patients experienced perforations during instrumental dilatation without endoscopy and one each during endotracheal intubation and instrumental dilatation of achalasia.

Pain was the most frequent complaint (95%) following esophageal perforation; fever and leukocytosis were noted in about two-thirds of the cases. In cervical perforations crepitation was noted in 63% by palpation and 95% on X ray. This finding usually required 4–12 hours to develop. Mediastinal emphysema was present in only 30%–40% of patients with disruptions of the thoracic esophagus, but extravasation of the contrast medium proved to be diagnostic in over 90% of X-ray esophagrams.

In selecting the proper treatment for a patient with an iatrogenic perforation of the thoracic esophagus diagnosed within a few hours of the accident, remember that the patient may look quite well during the first few hours and then collapse 24 hours later due to fulminating mediastinitis. We agree with Sarr and associates that when perforation becomes evident early, treatment should include primary surgical drainage with closure of the perforation. We would add a pleural or muscle pedicle flap to buttress the suture line in most cases. Sarr and associates experienced no hospital mortality in 13 cases treated by surgical closure of the perforation with drainage.

When a perforation of the thoracic esophagus is diagnosed later than 24 hours after the event and the patient meets the criteria for conservative management enunciated by Cameron, Keiffer, Hendrix, Mehigan, and others, nonoperative therapy may be acceptable. These authors identified a limited subgroup of patients with the following characteristics: (1) perforation of the thoracic esophagus, (2) late presentation, (3) minimal symptoms, (4) no signs of generalized sepsis, (5) all perforations contained locally within the mediastinum, (6) each perforation able to drain back into the esophagus, and (7) no communication with the pleural space. If the patient has minimal symptoms 24 hours after an intrathoracic perforation and the contrast esophagram demonstrates localization of the leak, the patient has probably passed the danger period during which he is susceptible to fulminating mediastinitis from the reflux of gastric and duodenal juices. In this group, treatment with proximal suction by means of a nasoesophageal tube combined with antibiotics and intravenous feeding was successful in all five patients reported on by Sarr and associates.

Performing a closed thoracostomy to provide drainage of a major thoracic esophageal perforation is an exercise in futility. Michel and associates reported three deaths in patients who were treated by closed thoracostomy after suffering esophageal perforations secondary to bougienage, passage of a Celestin tube, or passage of a Levine tube. They noted only one additional case who survived following this type of therapy, which brings the mortality rate from closed thoracostomy to 75%. The same authors had good results with primary suture repair and drainage of thoracic perforations, but they note that two additional patients, both of whom sustained esophageal perforation by a Sengstaken-Blakemore tube, died following persistent esophageal leakage after suture repair. It is possible that this type of perforation would fare better with a diversion-exclusion operation or an esophagectomy.

Perforations of the Obstructed Thoracic Esophagus

Perforations produced during endoscopy or dilatation of the obstructed esophagus require simultaneous relief of the obstruction or else a sutured repair is doomed to failure. In the case of an early operation following perforation of an esophagus obstructed by achalasia, it may be possible to combine suture of the perforation with an esophagomyotomy to relieve the obstruction, as advocated by McKinnon and Ochsner and by Skinner, Little, and DeMeester. On the other hand, in the report of Sarr and associates, six patients underwent distal esophagectomy with primary esophagogastric anastomosis for the removal of both the perforated esophagus and the obstructing lesion. Three of these patients died of complications related to anastomotic failure. Two of the three fatal cases came into the hospital with benign strictures and were operated upon more than 8 hours after perforation. Another patient in this series, with perforation of a distal esophageal stricture, underwent a total thoracic esophagectomy, an end cervical esophagostomy, closure of the esophagogastric junction, and a feeding gastrostomy. He was discharged in good health 13 days later. This patient underwent a successful colon interposition operation 2 months later. While it may be necessary to resect a perforated esophagus together with the obstructing lesion in some cases, a primary esophagogastric *anastomosis is contraindicated* in the presence of acute mediastinitis or any significant degree of inflammation of the organs being anastomosed. *Closing the upper end of the stomach and bringing normal esophagus out in the neck is a much safer procedure in the presence of severe inflammation.*

Postemetic Perforation (Boerhaave's Syndrome)

In general, postemetic perforations of the thoracic esophagus are dangerous because they often occur in a patient with a full stomach, which floods the mediastinum with food and digestive secretions. Fulminating mediastinitis occurs rapidly. Good results can be expected only if the operation is done within the first 8–24 hours. In the report of Michel and associates eight patients with Boerhaave's syndrome underwent primary sutured repairs with or without a pleural flap. All were successful except for one case. This patient had a primary repair buttressed by a pleural flap but operation was performed more than 24 hours after the perforation and the patient died. When operating upon a patient in whom the diagnosis is made late, and the mediastinal tissues are very inflamed, either a diversion-exclusion operation or a thoracic esophagectomy with cervical or anterior thoracic end esophagostomy is indicated.

Anastomotic Leaks Following Esophagogastrostomy

Patients who develop leaks following an esophagogastric anastomosis *in the neck* respond well to simple drainage, especially if the drain has been placed at the time of surgery. Although a stricture may appear at the site of the anastomosis secondary to the leak, systemic and mediastinal sepsis is unusual and recovery may be anticipated.

Small, contained nonsymptomatic leaks may be identified on the postoperative contrast X ray of the *thoracic* esophagus. These may resemble a perianastomotic diverticulum. Since they drain back into the lumen of the esophagus, the only required treatment is continued nasoesophageal suction and intravenous feeding if the patient has no sign of sepsis. Repeat esophageal X rays will generally show complete healing within a short period of time. We have generally resumed oral feeding if the patient remained nonsymptomatic for a period of 1 week after detecting the contained leak. None of this is meant to imply that a postoperative anastomotic leak is very often a minor complication. Triggiani and Belsey reported a 43% mortality rate from postoperative leaks following esophageal resection with intrathoracic anastomosis. Wilson, Stone, Scully, Ozeran, and others, in a review of leaks following esophagogastrectomy, stated that "anastomotic leaks cause a major portion of the morbidity after esophageal resection, accounting for up to three-fourths of the serious complications. Further, leaks are the most important cause of death: 54 to 100% of patients with anastomotic complications die." These authors reported 19 leaks (11.4%) and 4 deaths (2.4%) after 167 esophagogastrectomies. In their series there were 12 patients with serious anastomotic leaks accompanied by either an intrathoracic fluid collection, an esophagopleurocutaneous fistula, or an anastomotic dehiscence. Most of these patients were treated by continued nasogastric suction, total parenteral nutrition, and "aggressive and accurate replacement of the chest tube" by multiple closed thoracostomies. Chest X rays were obtained daily to be sure that there were no loculations. One patient underwent secondary thoracotomy to accomplish complete drainage of a mediastinal abscess; another patient, who developed anastomotic dehiscence, underwent a diversion-exclusion procedure successfully. Four of these 12 patients died because of uncontrolled sepsis 7–45 days postoperatively. Some of these deaths could probably have been prevented by the more aggressive employment of diversion-exclusion operations *or by total thoracic esophagectomy with end cervical esophagostomy and closure of the proximal end of the gastric pouch*, accompanied by tube gastrostomy. In some cases, septic collections of the pleural cavity or mediastinum may be amenable to drainage by percutaneous insertion of catheters under CT or ultrasound guidance (Maroney, Ring et al.). These authors treated some esophageal perforations by passing a nasoesophageal sump suction tube through the esophageal perforation into a mediastinal abscess, with successful outcomes, using CT guidance.

Recurrent Sepsis after Operation to Suture and Drain the Perforated Thoracic Esophagus

If a patient has undergone a thoracotomy for the closure of an esophageal perforation combined with drainage of the mediastinum and sepsis has persisted or recurred, this is a definite indication for another thoracotomy to improve the drainage and to accomplish diversion by cervical esophagostomy, with or without a total thoracic esophagectomy, and exclusion by closure of the upper stomach combined with tube gastrostomy.

It should be remembered that any abdominal or thoracoabdominal operation for gastric carcinoma produces some bacterial contamination of the peritoneal as well as the thoracic cavity. A left subphrenic abscess is not a rare complication of esophagogastrectomy for carcinoma. The possibility of a left subphrenic abscess should be kept in mind if sepsis occurs after surgery for gastric cancer. Most subphrenic abscesses may be successfully drained percutaneously with CT guidance.

Abdominal Esophagus

Perforation of the abdominal esophagus may occur following endoscopy or instrumental dilatation in patients with achalasia. Additionally, the esophagus may be perforated during the course of abdominal vagotomy or hiatus hernia repair. It is extremely important to identify this type of perforation during the course of the laparotomy so that prompt repair can be accomplished. An Upper Hand or Thompson retractor to elevate the sternum will provide adequate exposure in most cases. If the exposure is inadequate for a meticulous repair of the esophageal laceration, do not hesitate to extend the incision into the chest. If there is any question as to the adequacy of the repair, buttress the sutures with the gastric wall by performing a Nissen fundoplication or a Thal operation.

In the series reported by Michel and associates, one patient, who sustained a perforation of the lower esophagus during vagotomy, experienced a 24-hour delay before surgery. This patient died with a persistent esophageal leak, indicating the serious potential of this complication. In patients with advanced sepsis or a failed repair of a perforation of the abdominal esophagus, radical surgery will be necessary to salvage the patient. Divide and close the distal esophagus above the perforation. Close the upper stomach. Perform a Stamm gastrostomy and drain the left subhepatic space with sump and latex drains. Utilize a cervical esophagostomy for proximal diversion.

Any patient suspected of a perforated abdominal esophagus should have a prompt Hypaque contrast esophagram. If there is any leakage into the abdomen, prompt surgery is indicated.

Indications

(See discussion above under "Concept")

Preoperative Care

Confirm perforation with diagnostic studies: chest X ray; in suspected cervical perforations, lateral neck films in hyperextension; contrast esophageal X rays.

Administer nasoesophageal suction proximal to perforation of thoracic esophagus.

Maintain fluid resuscitation.

Administer appropriate systemic antibiotics.

Insert appropriate central venous or pulmonary artery pressure monitors.

Pitfalls and Danger Points

Delay in diagnosing the perforation

Inadequate surgery to control continuing contamination

Inadequate drainage

Depending on sutured closure of inflamed esophagus

Suturing a perforated esophagus proximal to an obstruction

Operative Strategy

Be certain to explore an esophageal perforation thoroughly. What appears to be a 1-cm perforation may prove to be three or four times that length after it is mobilized from the mediastinal pleura. Debride necrotic material around the perforation if suturing is anticipated. When the defect appears to be too large or the tissues too inflamed for suturing, it may be possible to apply a roof patch consisting of a flap of muscle pedicle, pleura, or pericardium that is sutured over the perforation. Otherwise, a diversion-exclusion operation or thoracic esophagectomy will be necessary.

Other points of strategy are discussed above under "Concept."

Operative Technique—Pleural Flap Repair of Thoracic Esophageal Perforation

Incision

Make an incision in the left or right thoracic cavity depending on which side the perforation appears to present on the contrast esophageal X ray. Generally, the lower half of the esophagus will be approached through a left 6th or 7th intercostal space thoracotomy. The uncommon perforations of the upper esophagus are better approached through the right chest.

Exposure; Locating the Perforation

Incise the mediastinal pleura above and below the area of suspected perforation. Otherwise, free the mediastinal pleura from the esophagus so that it may be elevated from its bed for thorough exploration. If the perforation is not immediately apparent, ask the anesthesiologist to instill a solution of methylene blue into the nasoesophageal tube. Sometimes the perforation is obscured by a layer of necrotic tissue. The area of perforation will generally be accurately identified by the methylene blue dye.

Repair

When operation is performed soon (8 hours) after perforation, it may be possible to debride the tissues around the esophagus if marked edema and inflammation have not yet occurred. Then close the mucosal layer with interrupted sutures of 5–0 Vicryl. Approximate the muscular layer with interrupted Lembert sutures of 4–0 silk or Prolene. Cover the suture line with a pleural flap. If the perforation is located in the lateral aspect of the esophagus, a simple rectangular flap of pleura is elevated and brought over the suture line. Use many interrupted 4–0 nonabsorbable sutures (Grillo and Wilkins used silk) to fix the pleural flap around the sutured perforation.

When the perforation is not suitable for a sutured closure due to marked edema and inflammation, employ a pleural flap, an intercostal muscle flap, or some other type of viable buttress as a roof patch over the open defect in the esophagus. First debride the obvious necrotic tissue around the perforation. When the esophagus is too inflamed to hold sutures, it is advisable to exclude the upper esophagus from the GI tract by one of the methods described below, to supplement the pleural roof patch. With an extensive defect in the esophagus or one that is located on the posterior surface, outline a large rectangular flap of pleura as illustrated in **Fig. 17–1**. In the presence

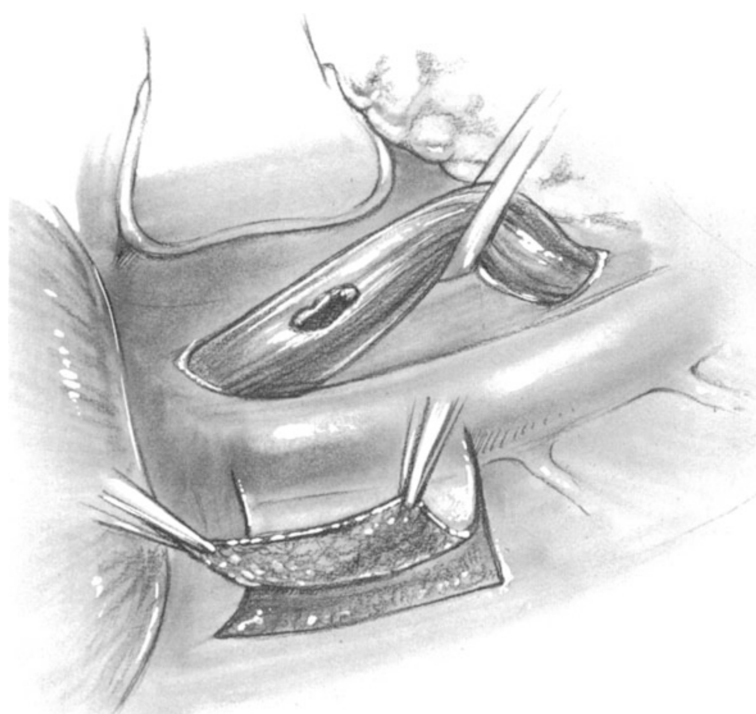


Fig. 17–1

Fig. 17–2

of mediastinitis, the pleura will be thickened and easy to mobilize from the posterior thoracic wall. Leave the base of the pedicle attached to the adjacent aorta. Slide the pedicle flap beneath the esophagus (**Fig. 17–2**) so as to surround the entire organ. Insert multiple 4–0 interrupted nonabsorbable sutures deep enough to catch the submucosa of

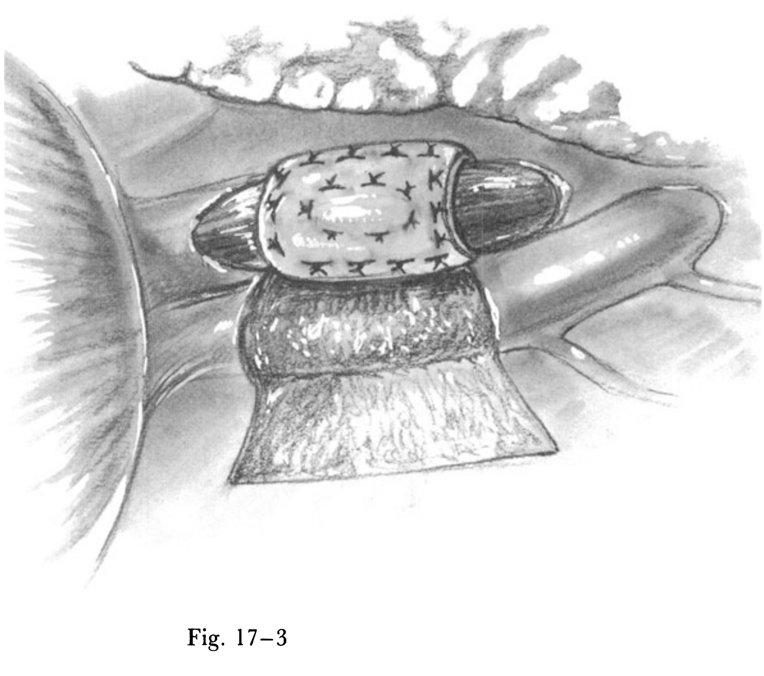


Fig. 17–3

the esophagus around the entire circumference of the perforation as well as the entire circumference of the esophagus above and below the perforation as illustrated in **Fig. 17–3**.

Whenever the esophageal perforation cannot be closed by sutures but requires a roof patch of either pleura or muscle pedicle, it is probably a good idea to *add an esophageal occlusion to the procedure by applying 4.8-mm absorbable staples* (Polysorb, U.S. Surgical Corp.) to the upper esophagus and also to the lowermost portion of the esophagus. Alternatively, a large PG ligature has been used for the same purpose.

Drainage

Place the tip of a 36F multiperforated drainage tube near the site of the esophageal perforation. Suture it to the mediastinal tissues with a catgut stitch. Bring this tube out through a small incision through the 9th or 10th interspace in the anterior axillary line. If desired, place a smaller multiperforated catheter in the posterior portion of the apex of the chest and bring this out through a second stab would. Attach both to some type of underwater drainage device.

Operative Technique—Intercostal Muscle Flap Repair of Esophageal Perforation

Another method of bringing viable tissue to the site of an esophageal perforation is to create a vascularized flap of the appropriate intercostal muscle with which to wrap the perforation of the esophagus. If the patient undergoes surgery within the first 8 hours after a perforation, minor debridement and primary suturing will generally remedy the situation. However, in perforations that have been leaking for a longer period of time before surgery is undertaken, debridement of necrotic tissue and primary suturing may not be adequate, and in these situations wrapping with a viable muscle flap may help to achieve primary healing. In cases where the perforation is too large for a suture closure, a roof patch consisting of viable intercostal muscle sutured to the intact esophagus around the perforation may be effective.

In order to achieve a viable muscle flap, care must be taken to preserve the intercostal vessels, which must be left attached to the muscle as it is being dissected away from the upper and lower rib borders.

Fig. 17–4 illustrates the dissection of the full thickness of the intercostal muscle from its attachments to the adjacent ribs. **Figs. 17–5, 17–6, and 17–7** illustrate the application of the intercostal

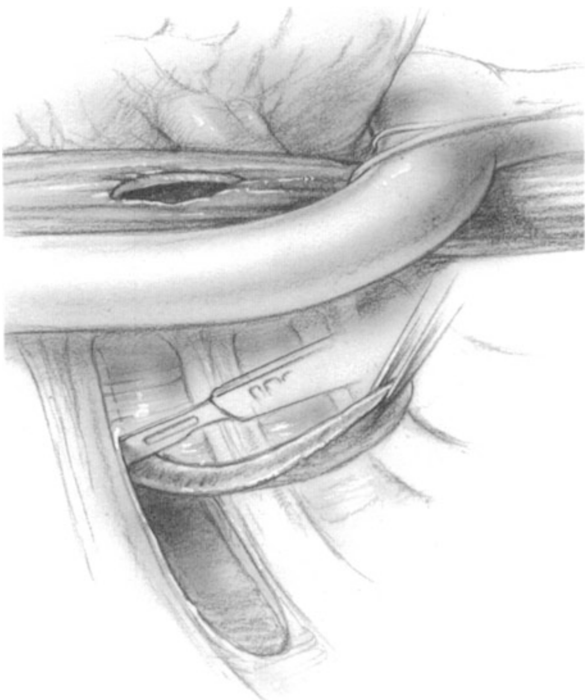


Fig. 17–4

muscle flap as a roof patch over a perforation that was not suitable for sutured closure. Large perforations that are longer than the width of the muscle flap may be difficult to repair by this technique.

Also accomplish drainage of the mediastinum and chest as described above.

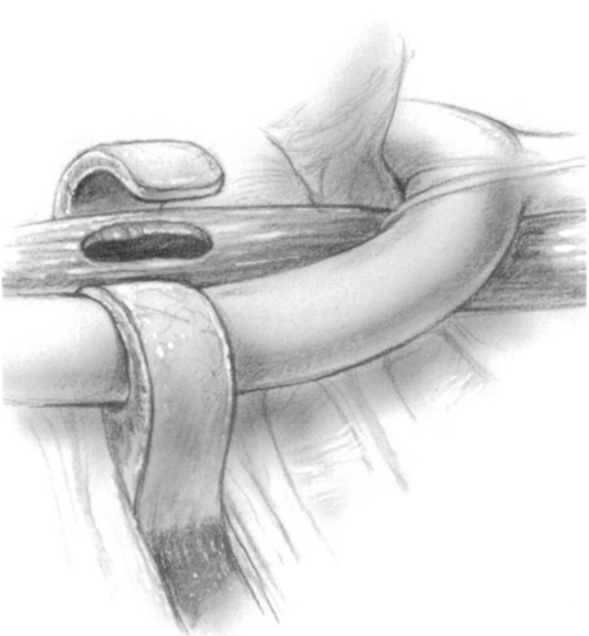


Fig. 17–5

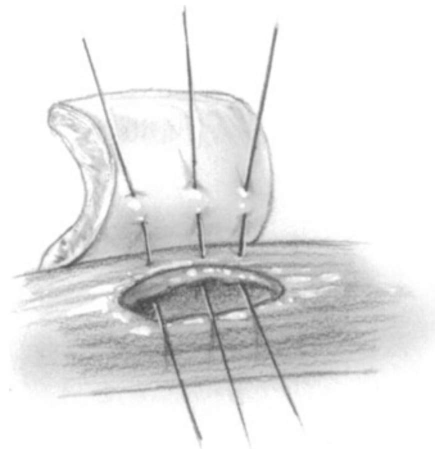


Fig. 17–6

If the repair proves to be of poor quality, do not hesitate to apply a temporary occlusion technique to the upper and lower portions of the esophagus, as described below.

Methods of Esophageal Occlusion without Cervical Esophagostomy

Often when cervical esophagostomy is used for diversion in the neck, it is difficult to reconstruct the esophagus after the perforation heals. This requires either a colon interposition or cervical esophagogastrostomy. On the other hand, Bardini and associates used absorbable staples (Auto Suture Polysorb 4.8-mm staples, U.S. Surgical Corp.) applied with the TA–55 stapler. These authors reported two cases with serious perforations of the thoracic esophagus treated by occluding the esophagus via a neck incision by applying the TA–55 stapler. A sump type nasoesophageal suction catheter was placed above the staple line. The lower esophagus

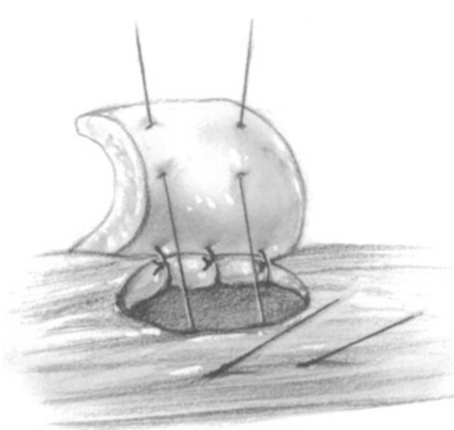


Fig. 17–7

was similarly occluded with Polysorb staples. A jejunostomy feeding tube was inserted to maintain nutrition. Patency of the esophagus returned spontaneously within 3 weeks when the staples resorbed. In both cases the esophagus healed and did not require any reconstruction.

Avoid capturing the vagus nerves when stapling the *lower* esophagus. It is possible to occlude the esophagus *above* a thoracic perforation through the exploratory chest incision if the thoracic esophagus above the perforation is healthy.

Operative Technique—Esophageal Diversion by Cervical Esophagostomy

Incision and Exposure

With the patient's head turned toward the right, make an incision along the anterior border of the sternomastoid muscle beginning 2–3 cm below the level of the mandibular angle and continuing down to the clavicle (see Fig. 7–27). Liberate the anterior border of the sternomastoid muscle. Divide the omohyoid muscle if it crosses the operative field. Retract the sternomastoid muscle and carotid sheath laterally and retract the prethyroid muscles medially, exposing the thyroid gland (see Fig. 7–29). Carefully divide the areolar tissue between the thyroid gland and the carotid sheath to expose the inferior thyroid artery and the recurrent laryngeal nerve. In some cases it may be necessary to divide the inferior thyroid artery. Preserve the recurrent nerve. Identify the tracheoesophageal groove. Then encircle the esophagus with the index finger, but keep the plane of dissection very close to the esophagus. Otherwise, it will be possible to traumatize the *opposite* recurrent laryngeal nerve. After the esophagus has been encircled, pass a latex drain around the esophagus for purposes of traction. Mobilize the esophagus from the level of the hypopharynx down to the upper mediastinum.

Suturing the Esophagostomy

After mobilization is satisfactory, suture the sternomastoid muscle back in place by means of several interrupted 4–0 Vicryl stitches. Close the platysma muscle with interrupted sutures of the same material, leaving sufficient space to suture the esophagostomy to the skin. Then insert interrupted 4–0 PG subcuticular sutures to close the skin leaving a 3–4 cm gap in the closure for the esophagostomy.

Now make a transverse incision across the anterior half of the circumference of the esophagus. Suture the full thickness of the esophagus to the subcuticular layer of skin with interrupted 4–0 Vicryl sutures (**Fig. 17–8**).

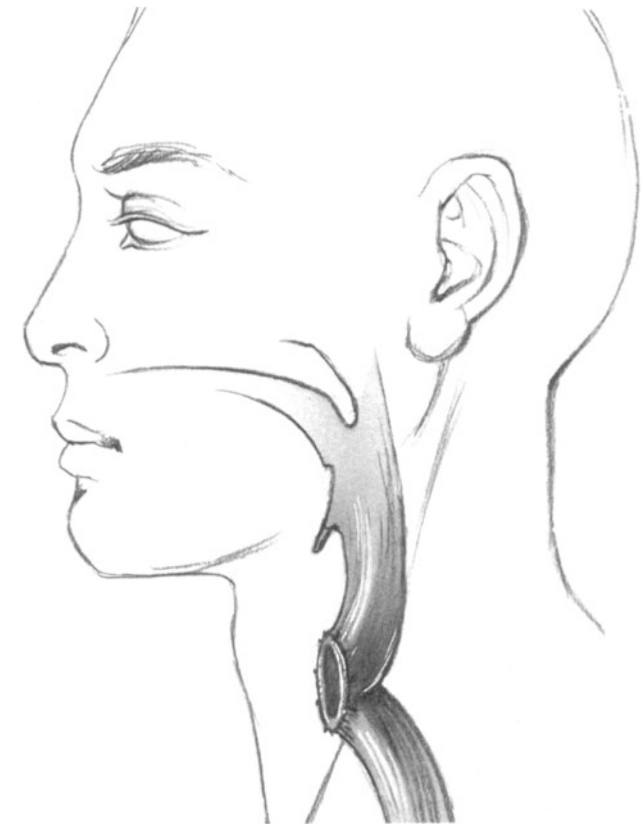


Fig. 17–8

In one case we found that despite thorough mobilization of the esophagus, the incised esophagus could not be sutured to the skin without tension. A subtotal thyroid lobectomy was carried out. Then the incised esophagus was sutured to the platysma muscle with interrupted sutures leaving the skin in this area open. This produced a satisfactory result.

Anterior Thoracic Esophagostomy

When a thoracic esophagectomy (Orringer and Stirling 1990) is carried out in these patients, an incision is made in the neck along the anterior border of the sternomastoid muscle. After the esophagus has been delivered through this incision, excise that segment which is nonviable. Then preserve all the viable esophagus. Make a subcutaneous tunnel from the incision in the neck over the anterior thorax. This tunnel should equal the length of the preserved esophagus. Make the esophagostomy on the anterior wall of the chest by making an incision in the skin and suturing the full thickness of the esophagus to the subcuticular layer of skin with interrupted 5–0 Vicryl sutures. It is much easier to apply stoma collection bags to the anterior chest than to a cervical esophageal stoma.

Operative Technique—Excluding the Esophagus from the GI Tract

Perform a thoracotomy as described for the pleural flap operation. Incise the mediastinal pleura and liberate the esophagus from its bed (**Fig. 17–9**). The perforation may be sutured or covered with a pleural flap (Fig. 17–3).

Then free the esophagus around its entire circumference distal to the perforation. Urschel, Razzuk, Wood, Galbraith, and others occluded the esophagus by surrounding it with a strip of Teflon that was sutured to itself to form a circumferential constricting band. Do not make this band so tight that it will strangulate the tissue. An umbilical tape may be passed around the Teflon band and tied to assure the proper degree of constriction. Try to avoid including the vagus nerves in the constricting band.

Alternative methods of occluding the lower esophagus include ligating it with a Silastic tube, such as the Jackson-Pratt catheter (**Figs. 17–10 and 17–11**). This material appears to be less irritating to the tissues than Teflon or umbilical tape.

Another alternative is to use the TA-55 stapling device *with 4.8 mm staples* to occlude the esophagus. When applying the staples, separate the vagus nerves from the esophagus so that they will not be trapped in the staple line. Use staples only if the esophagus is not markedly thickened or inflamed. Otherwise, the thickened tissues may be strangulated by the staples. After a period of 3–4 weeks, a gap will often appear in this staple line. This gap can often be dilated by the gentle passage of Maloney dilators. If the gap is quite small, the interventional radiologist can pass a guide wire over which dilating devices may be passed. The stapling technique can also be used to occlude the upper esophagus by applying the stapling device to the esophagus below a cervical esophagostomy. Polysorb (U.S. Surgical Corp.) 4.8 mm staples will resorb in 2 or 3 weeks spontaneously in the esophagus.

Another method of occluding the esophagus that has been reported is the passage of No. 2 chromic catgut or PG twice around the esophagus. This is then tied in a snug but not strangulating knot. The

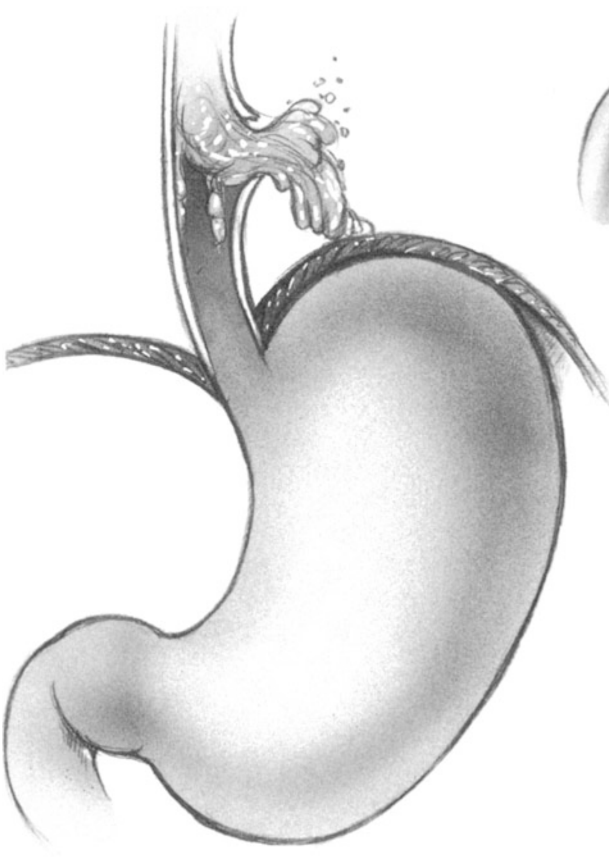


Fig. 17–9

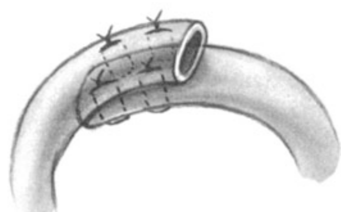


Fig. 17–10

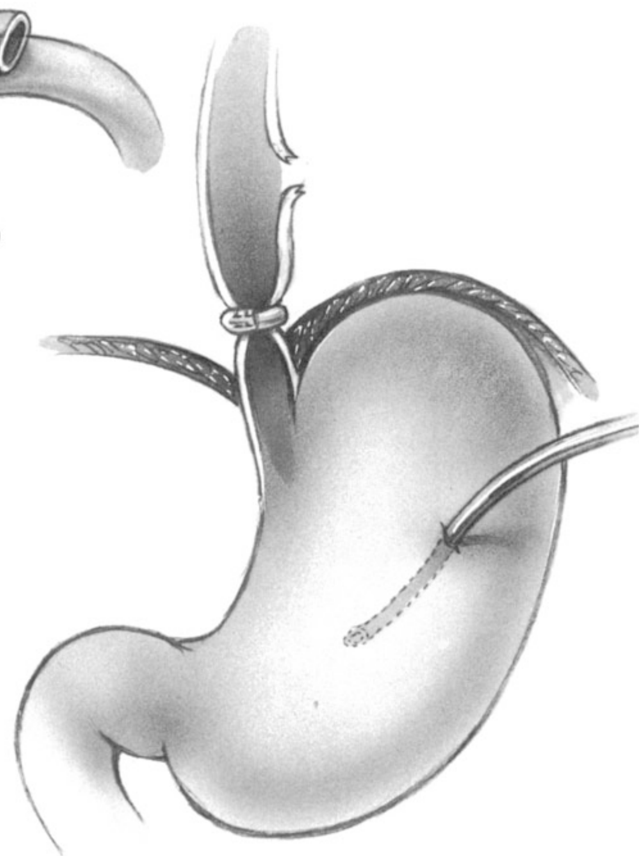


Fig. 17–11

esophagus should respond easily to dilatation by the end of 2–4 weeks. It has been reported that even in delayed operations in patients who suffered large lacerations of the thoracic esophagus, occasionally spontaneous healing will occur over a period of weeks, so that esophageal replacement with either colon or stomach is not necessary.

Also occlude the lowermost esophagus with staples or a PG ligature.

In order to decompress the stomach and prevent pressure against the esophageal closure, a Stamm gastrostomy is generally performed. Unlike the location shown in Fig. 17–11, it is wise to place this gastrostomy, if possible, near the lesser curvature of the stomach. In this way, if a gastric pull-up operation is to be performed to replace the esophagus, the gastrostomy defect can be included in that segment of the lesser curvature which is customarily excised in preparing the stomach for advancement into the neck.

Then place proper drainage tubes to the area of perforation and close the thoracic incision. At first, all of these patients require a tube gastrostomy to decompress the stomach; after the esophageal perforation has healed, the gastrostomy tube is used for purposes of feeding.

Postoperative Care

Most of these patients will require ventilatory support for several days as well as careful cardiodynamic monitoring.

Paste a small drainage bag or ileostomy bag over the esophagostomy to collect the saliva. In patients without an esophagostomy, maintain nasoesophageal sump suction postoperatively.

These patients will require intensive antibiotic treatment, depending on bacterial cultures of the mediastinum.

Do not remove the thoracotomy drainage tubes until drainage has ceased.

Total parenteral nutrition will be necessary until the gastrostomy tube can be used for feeding.

Perform frequent chest X rays or CT scans in the search for loculated collections of pus.

Postoperative Complications

Esophagocutaneous fistula

Uncontrolled sepsis including empyema or mediastinal abscess

Subphrenic abscess

Limited expansion of lung, requiring surgical decortication after active infection has subsided.

References

Abbott OA, Mansour KA, Logan WD Jr et al. Atraumatic so-called "spontaneous" rupture of the esophagus: a review of 47 personal cases with comments on a new method of surgical therapy. J Thorac Cardiovasc Surg 1970;59:67.

Bardini R, Bonavina L, Pavanello M. Temporary double exclusion of the perforated esophagus using absorbable staples. Ann Thorac Surg 1992;54:1165–1167.

Cameron JL, Keiffer RF, Hendrix TR, Mehigan DG et al. Selective nonoperative management of contained intrathoracic esophageal disruptions. Ann Thorac Surg 1979;27:404.

Goldstein LA, Thompson WR. Esophageal perforations: a 15 year experience. Am J Surg 1982;143:495.

Gouge TH, Depan HJ, Spencer F. Experience with the Grillo pleural wrap procedure in 18 patients with perforation of the thoracic esophagus. Ann Surg 1989; 209:612–619.

Grillo HC, Wilkins EW Jr. Esophageal repair following late diagnosis of intrathoracic perforation. Ann Thorac Surg 1975;20:387.

Maroney TP, Ring EJ, Gordon RL et al. Role of interventional radiology in the management of major esophageal leaks. Radiology 1989;170:1055–1057.

McKinnon WMP, Ochsner JL. Immediate closure and Heller procedure after Mosher bag rupture of the esophagus. Am J Surg 1974;127:115.

Michel L, Grillo HC, Malt RA. Operative and nonoperative management of esophageal perforations. Ann Surg 1981;194:57.

Orringer MB, Stirling MC. Esophagectomy for esophageal disruption. Ann Thorac Surg 1990;49:35–43.

Pate JW, Walker WA, Cole FH Jr et al. Spontaneous rupture of the esophagus: a 30-year experience. Ann Thorac Surg 1989;47:689–692.

Rosoff S, White T. Perforation of the esophagus. Am J Surg 1974;128:207–218.

Sarr MG, Pemberton JH, Payne WS. Management of instrumental perforations of the esophagus. J Thorac Cardiovasc Surg 1982;84:211.

Skinner DB, Little AG, DeMeester TR. Management of esophageal perforation. Am J Surg 1980;139:760.

Thal AP, Hatafuku T. Improved operation for esophageal rupture. JAMA 1964;188:826.

Triggiani E, Belsey R. Oesophageal trauma: incidence, diagnosis, and management. Thorax 1977;32:241.

Urschel HC Jr, Razzuk MA, Wood RE, Gailbraith N et al. Improved management of esophageal perforation: exclusion and diversion in continuity. Ann Surg 1974; 179:587.

Wilson SE, Stone R, Scully M, Ozeran L et al. Modern management of anastomotic leak after esophagogastrectomy. Am J Surg 1982;144:94.

Stomach and Duodenum

18 Operations for Peptic Ulcer

Concept: Selection of Operation for Duodenal Ulcer

Any peptic ulcer requires free acid to sustain it. Reducing the acid peptic content of gastric secretions cures the ulcer. This can be accomplished surgically by resecting three-quarters of the stomach to remove a large number of acid-secreting parietal cells. Unfortunately, such operations have produced a high incidence of undesirable postoperative symptoms. With the development of vagotomy, however, extensive resection of the stomach has become unnecessary. Vagotomy, then, should be routinely employed in surgery for duodenal ulcer. Which type of vagotomy, and which type of resection or drainage procedure should be employed, is a controversial question.

Antrectomy and Vagotomy

If removal of the gastrin-secreting antrum is combined with some form of gastric vagotomy, the postoperative secretion of free acid approaches zero levels. The chance of peptic ulcer recurring after this procedure is 0–2%. Counterbalancing this favorable aspect are studies by Goligher et al. (1979) and Herrington et al. that show an elective mortality rate of 0–2% when the patient is in expert hands, as well as a 3%–6% incidence of unsatisfactory results. Postgastrectomy fatalities generally follow a disruption of the duodenal suture line or acute necrotizing pancreatitis. Techniques aimed at preventing these two complications are discussed under "Operative Strategy" in Chap. 24.

Drainage Procedures and Vagotomy

According to Goligher et al. (1979), when pyloroplasty is combined with truncal vagotomy, the long-term recurrence rate of peptic ulcer is about 10% and the incidence of undesirable postoperative sequelae such as dumping or bile gastritis is not much different from that which follows antrectomy. On the other hand, the generally reported mortality rate for vagotomy and a drainage procedure performed under elective conditions is 0.5%. Because it is simple technically, this operation is often selected for the poor-risk patient, especially in cases of massive hemorrhage from a duodenal ulcer. Resection in these cases sometimes is difficult, and the reported operative mortality is high except when it is done by an expert.

Truncal versus Selective Vagotomy

The aim of selective vagotomy is to interrupt the vagal fibers going to the stomach while preserving the branches entering the liver and the celiac ganglion. The procedure was devised in the hope it would eliminate undesirable postvagotomy sequelae, such as diarrhea. The results of studies at Vanderbilt University by Sawyers et al. suggest that selective vagotomy reduces the incidence of incomplete gastric vagotomy. Since the incidence of significant post-vagotomy diarrhea has in our experience been minimal and since selective vagotomy requires considerable operating time as well as the devascularization of the lesser curvature of the gastric pouch, this procedure has not achieved widespread popularity. If the additional dissection required for selective vagotomy is to be performed, the surgeon might well choose a proximal gastric vagotomy without a drainage procedure. In any case, anyone undertaking to perform gastric surgery should master the art of performing some type of vagotomy in a *complete* fashion.

Choice of Drainage Procedure

Unless there is edema of the duodenal bulb or extreme fibrosis, pyloroplasty is simpler than gastrojejunostomy. The Mikulicz pyloroplasty, the simplest of drainage procedures, is suitable for 90% of the patients who require drainage. On occasions when a markedly fibrotic pyloroduodenal area must be incised to control bleeding, the Finney pyloroplasty may be indicated, as it can compensate for a certain degree of rigidity of the tissues, which may make the Mikulicz technique inapplicable. Some surgeons believe that the Finney pyloroplasty, with its large stoma, is the technique of choice. It is interesting that Goligher's group (1979) found fewer undesirable long-term sequelae after vagotomy and gastrojejunostomy than after vagotomy-pyloroplasty. As this part of their study was not done at random, its significance is not clear.

In comparing the Jaboulay gastroduodenostomy with the more traditional pyloroplasty techniques, there appear to be inadequate data to demonstrate any advantage.

Billroth I versus Billroth II Gastrectomy

There are now extensive data to demonstrate that the Billroth I operation, when combined with adequate vagotomy, produces as low an incidence of duodenal ulcer recurrence as the Billroth II. Billroth I has the advantage of eliminating afferent loop complications that occasionally follow the gastrojejunal type of reconstruction. Herrington, who has had vast experience with this procedure, believes that the gastroduodenal anastomosis is safe for most patients who suffer severe duodenal ulcer disease. In addition, White has pointed out that the incidence of postoperative steatorrhea is less after the Billroth I than after the Billroth II operation.

Proximal Gastric Vagotomy (Parietal Cell Vagotomy) without Drainage Procedure

History teaches us that early enthusiasm for new procedures in the treatment of duodenal ulcer is often followed by disappointment. Consequently, one must be skeptical until follow-up studies of 10–20 years' duration become available. Nevertheless, proximal gastric vagotomy is an operation that has many exciting features. First, it has the lowest mortality rate (0.3%) of all operations for duodenal ulcer, primarily because the gastrointestinal tract is not entered and there is no need for dissection in the region of the ulcer. While the incidence of recurrent ulcer is higher than that which follows vagotomy-antrectomy, experienced surgeons have noted that their recurrence rates were acceptable. For example, Jordan reported a 9.7% ulcer recurrence rate after a follow-up period of 2 to 16 years in 424 patients who underwent proximal gastric vagotomy.

Most recurrent ulcers that follow proximal gastric vagotomy respond to medication and do not require further definitive surgery for the recurrence.

Unquestionably, the extension of the operation to encompass the lower 5–7 cm of the esophagus and the esophagogastric junction has improved the rate of success. The only reported fatal operative complication has been necrosis of the lesser curvature, which seems to occur less than once in a thousand cases, leading to speculation that it may be secondary to excessive operative trauma or hematoma.

Of all the operations being done for duodenal ulcer, proximal gastric vagotomy has by far the fewest undesirable postoperative digestive sequelae.

Another attractive feature of this operation is that in cases of recurrent ulcer, secondary antrectomy offers no great difficulty technically unless a splenectomy has been performed. In this instance, the blood supply to the residual gastric pouch, following antrectomy, proximal gastric vagotomy, and splenectomy would be precarious, as is evident from a study of the blood supply of the stomach (see Fig. 24–1)

Summary

When done by an expert, vagotomy and antrectomy can be accomplished with low mortality and will provide a long-term cure for duodenal ulcer in 99% of the patients operated on. Less experienced surgeons should heed Goligher's (1979) advice to avoid gastrectomy in the deeply penetrating posterior ulcer because "vagotomy and gastroenterostomy yield overall results not greatly inferior to those of resection" and "it would be preferable to have several recurrent ulcers, for which one can reoperate with a good chance of success, than to incur a single operative death." The same statement could probably apply to proximal gastric vagotomy if the surgeon has mastered the technique.

One must be impressed by the 0% hospital mortality in 375 cases Goligher et al. subjected to gastrectomy (117), vagotomy-antrectomy (132), or vagotomy-gastrojejunostomy (126). They attribute the absence of fatalities among the 249 patients subjected to gastric resection to the good judgment exercised by the surgeons in rejecting for gastrectomy those patients for whom the duodenal dissection seemed hazardous. These patients underwent vagotomy and gastroenterostomy instead; they also had no mortality. Proximal gastric vagotomy is an equally safe operation.

Concept: Selection of Operation for Gastric Ulcer

Most patients who have a duodenal ulcer display increased acid output, while gastric ulcer is often accompanied by below-average measurements of gastric acid secretion. The etiology of gastric ulcer is related to gastric stasis, which allows the acid to remain in contact with the mucosa for an abnormally long period of time. This situation is obvious in patients who have a chronic duodenal ulcer and a partial obstruction and then develop a secondary gastric ulcer. Another hypothesis for the pathogenesis of gastric ulcer is impairment of the mucosal resistance to acid. This permits back diffusion of the acid, which produces tissue destruction. Patients who have both duodenal and gastric ulcers should be treated by an operation designed to cure the duodenal ulcer. Patients who have ulcers in the pyloric channel or the immediate prepyloric region should also receive the *same surgical management as is indicated for duodenal ulcer*.

Gastric ulcer patients who have low gastric acidity and who do not fit into the above categories respond very nicely to conservative resection of the lower 40%–50% of the stomach, followed by gastroduodenal anastomosis without vagotomy. Following this procedure the rate of ulcers recurring is less than 1% according to a report by Davis et al. from the Mayo Clinic. There are inadequate data to demonstrate the need to add vagotomy to the resection in these cases. Tanner encountered one case of recurrent ulcer in 1,000 gastrectomies he performed for gastric ulcer. In the absence of cancer, the Billroth I type gastrectomy is preferred.

Because there is always the possibility of a malignancy in a chronic gastric ulcer, if feasible the ulcer itself should be included in the area of stomach to be resected. Frozen section examination of all gastric ulcers should be performed because if a carcinoma is diagnosed, this is an indication for a more extensive resection than would be necessary for the cure of a benign ulcer.

Occasionally a chronic, deeply penetrating ulcer is situated high on the lesser curvature of the stomach. If this can easily be encompassed by a Schoemaker-Hoffmeister type gastric resection without impinging on the esophagogastric junction, then this is the preferred method of management. If the ulcer is large, is surrounded by edema, and impinges on the esophagogastric junction, multiple quadrant biopsies for frozen section analysis should be taken through a gastrotomy incision. If the biopsies are negative, a 40% gastrectomy, including antrum and pylorus (Madlener operation), should be carried out without further disturbing the ulcer. If the ulcer is benign it should be completely healed by both X ray and gastroscopy within 6 weeks after the Madlener operation.

Some surgeons advocate vagotomy and pyloroplasty for the definitive treatment of gastric ulcer if the biopsies are benign. Although good short-term results have been reported with this technique, and although it may be suitable for the extremely poor-risk patient, extensive data support partial gastrectomy. When performed for gastric ulcer, gastrectomy is almost as safe a procedure as vagotomy and pyloroplasy. The latter operation is followed by an excessive number of recurrent ulcers within 5–10 years.

Indications

Hemorrhage of massive proportions or recurrent hemorrhage while patient is under treatment in hospital.

Perforation of ulcer. Plication is the treatment of choice for perforated duodenal ulcer, but there are a number of exceptions. In patients who have a prior history of symptoms, whose perforation has not been of long duration, and in whom massive contamination has not occurred, a definitive operation aimed at curing the ulcer is indicated. In the case of gastric ulcer the perforation is frequently quite large or may be located on the posterior wall of the antrum where plication with omentum cannot be done satisfactorily. Under these conditions emergency gastrectomy is mandatory. Otherwise the incidence of reperforation will be frequent and often lethal. Because chronic gastric ulcer has a high recurrence rate, some surgeons believe that most gastric perforations should be resected, not plicated.

Gastric outlet obstruction. Definitive gastric surgery should be done following a period of nasogastric suction of sufficient duration to permit any edema in the hypertrophied gastric walls to recede. On the other hand a transient obstruction in a patient who does not have a previous history of ulcer may be managed by a trial of medical therapy.

Intractability. Medical management by means of frequent feedings, antacids, and cimetidine has been successful in managing over 90% of those patients who have duodenal ulcers. However, when a patient has experienced four or five recurrences of duodenal ulcer over a period of years, surgery is indicated. The recurrence rate of gastric ulcer following successful medical management is notoriously high. In a study by Littman, 42% of the patients suffering from gastric ulcers experienced a recurrence within 2 years of apparently successful medical management. Also, in the absence of duodenal pathology, the incidence of complications and fatalities following surgery for gastric ulcer is considerably lower than after surgery for duodenal ulcer. For these reasons definitive gastric ulcer surgery should be undertaken after only one or two recurrences.

Preoperative Preparation

Nasogastric suction for patients with pyloric obstruction; in other cases, passage of nasogastric tube morning of operation

Gastroscopy and biopsy of gastric ulcers

Serum gastrin determination in patients with manifestations of a severe peptic ulcer diathesis, atypical location of the ulcer, or a family history that suggests multiple endocrine adenopathy

References

Davis Z et al. The surgically treated chronic gastric ulcer: an extended followup. Ann Surg 1977;185:205.

Goligher JC et al. Controlled trial of vagotomy and gastroenterostomy, vagotomy and antrectomy and subtotal gastrectomy in elective treatment of duodenal ulcer: interim report. Br Med J 1964;1:455.

Goligher JC et al. Several standard elective operations for duodenal ulcer: ten to 16 year clinical results. Ann Surg 1979;189:18.

Herrington JL Jr et al. A 25 year experience with vagotomy-antrectomy. Arch Surg 1973;106:469.

Jordan PH Jr. Indications for parietal cell vagotomy in gastrointestinal surgery. Ann Surg 1989;210:29–41.

Littman A (ed) Veterans Administration cooperative study on gastric ulcer: healing, recurrence, cancer. Gastroenterology 1971;61:567.

Sawyers JL et al. Comparative studies of the clinical effects of truncal and selective gastric vagotomy. Am J Surg 1968;115:165.

Tanner NC. In: Harkins HN, Nyhus LM, Surgery of the stomach and duodenum. Boston: Little, Brown; 1962:133.

White TT, Harrison RC. Reoperative gastrointestinal surgery. Boston: Little, Brown; 1973.

19 Truncal Vagotomy

Indications

Patients who are having surgery for duodenal ulcer should generally undergo vagotomy as well (see also Chap. 18).

Preoperative Preparation

(See Chap. 18.)

Pitfalls and Danger Points

Esophageal trauma
Splenic trauma
Inadequate vagotomy
Disruption of esophageal hiatus with postoperative hiatal hernia; gastroesophageal reflux

Operative Strategy

Esophageal Trauma

The best way to avoid trauma to the esophagus is by performing most of the esophageal dissection under *direct vision*. Forceful, blind, finger dissection can be dangerous. After the peritoneum overlying the abdominal esophagus is incised (**Figs. 19–1, 19–2, and 19–3**), the crural musculature should be clearly exposed. The next vital step in this sequence is to develop a groove between the esophagus and the adjoining crux on each side. This should be done under direct vision, using a peanut dissector (**Fig. 19–4**). Only after the anterior two-thirds of the esophagus has been exposed is it permissible to insert the index finger for encircling the esophagus.

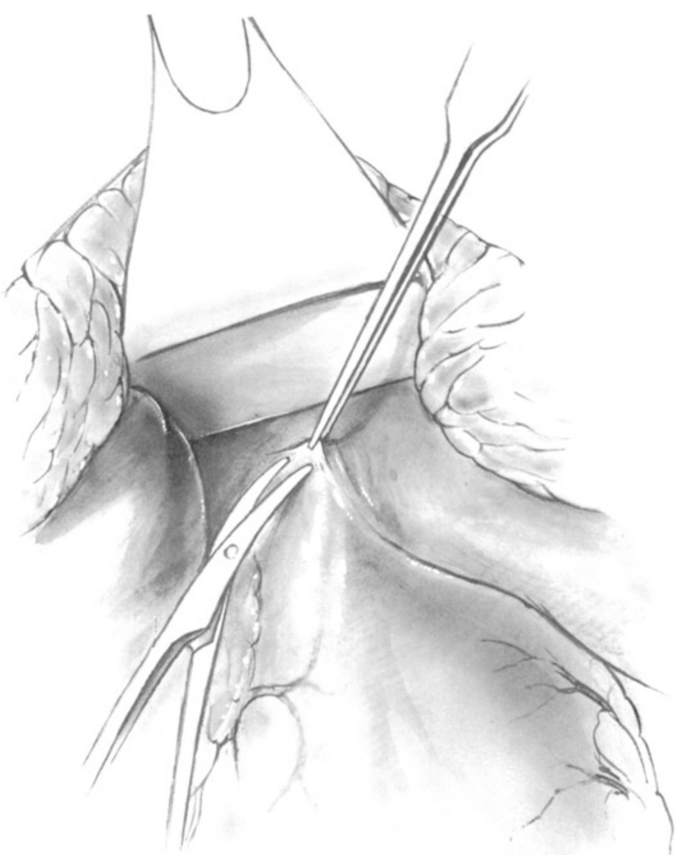


Fig. 19-1

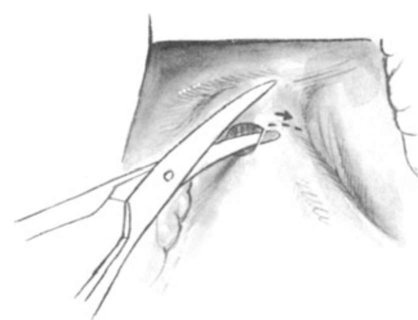


Fig. 19–2

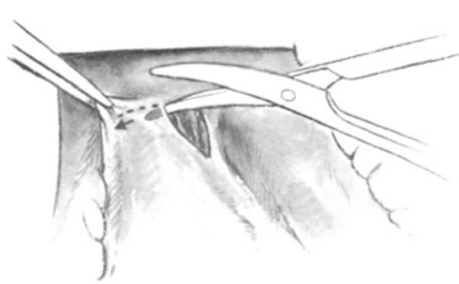


Fig. 19–3

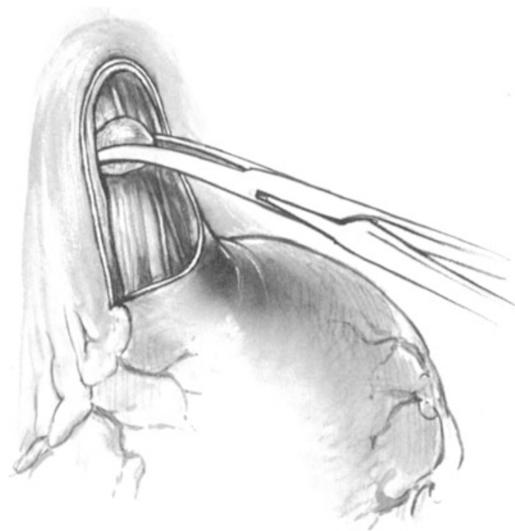


Fig. 19–4

Splenic Trauma

Splenic trauma can be prevented by avoiding any traction that will draw the stomach toward the patient's right. This traction may avulse the splenic capsule because of attachments between the omentum and the surface of the spleen. Consequently, all traction on the stomach should be applied on the lesser curvature side and directed toward the patient's feet. Avulsion of a portion of the splenic capsule, in the absence of gross disruption of the splenic pulp, does not require splenectomy. Application of Surgicel gauze, sutures, or in some cases Avitene powder may control bleeding satisfactorily.

Incomplete Vagotomy

In the majority of cases of recurrent marginal ulcer, it turns out the posterior vagal trunk has not been divided. This trunk is generally the largest encountered in the vagotomy operation. The surgeon's failure to locate the posterior vagus suggests an inadequate knowledge of the anatomy of the posterior vagus. The right (posterior) vagal trunk is frequently 2 cm or more distant from the right lateral wall of the esophagus. It is often not delivered into the field by the usual maneuver of encircling the esophagus with the index finger. If the technique described below is carefully followed, this trunk will rarely be overlooked.

To improve tissue-recognition skill the surgeon should place each nerve specimen removed from the vicinity of the esophagus into a separate bottle for histological examination. Each bottle should have a label indicating the anatomical area from which the nerve was removed. The pathological report that arrives several days after the operation will serve as a test of the surgeon's ability at visual nerve identification. The surgeon may be surprised to find that four or five separate specimens of nerve have been removed in a complete truncal vagotomy. Frozen section examination is helpful but not conclusive because it cannot prove that *all* the vagal nerve branches have been removed. The surgeon must gain sufficient skill at identifying nerve trunks in order to be certain that no significant nerve fiber remains.

Hiatus Hernia

Although significant hiatal hernia following vagotomy occurs in no more than 1%–2% of cases, this percentage can probably be reduced if the surgeon repairs any large defects seen in the hiatus after the dissection has been completed. It has been noted that the lower esophageal sphincter functions better when it rests upon a buttress of solid crural musculature. It may be weakened if there is a hiatal defect along its posterior margin.

Operative Technique

Incision and Exposure

Make a midline incision from the xiphoid to a point about 5 cm below the umbilicus. The incision can be extended into the xiphocostal junction if necessary. Elevate the sternum 8–10 cm by means of an Upper Hand or Thompson retractor. Elevate the upper half of the operating table about 10°. Retract the left lobe of the liver in a cephalad direction utilizing either Harrington or Weinberg retractors. In rare instances the triangular ligament has to be incised and the left lobe of the liver retracted to the patient's right for exposure.

Using long DeBakey forceps and long Metzenbaum scissors incise the peritoneum overlying the abdominal esophagus (Figs. 19–1, 19–2, and 19–3). Next, identify the muscles of the right and left branches of the crux. Use a peanut dissector to develop a groove between the esophagus and the adjacent crux, exposing the anterior two-thirds of the esophagus (Fig. 19–4). At this point insert the right index finger gently behind the esophagus and encircle it.

Left (Anterior) Vagal Trunks

In our experience, whereas the posterior trunk often exists as a single structure in the abdomen, the anterior vagus divides into two *or more* trunks in over 50% of the cases. The main left trunk generally runs along the anterior wall of the lower esophagus, and the other branches may be closely applied to the

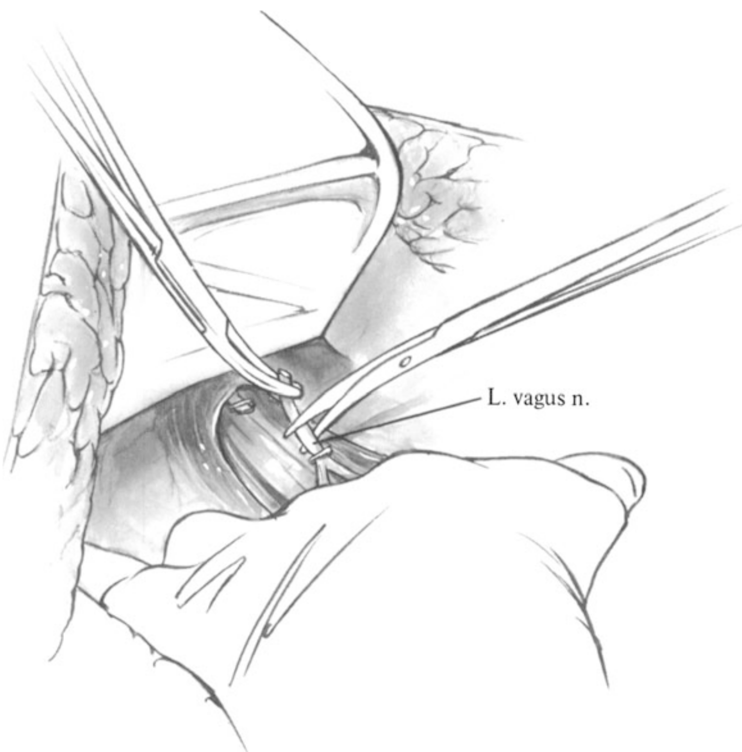


Fig. 19–5

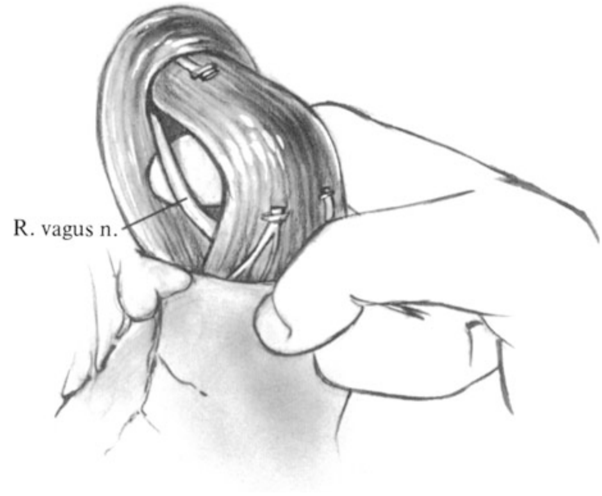


Fig. 19–6

longitudinal muscle of the anterior esophagus. The major nerve branches may be accentuated by caudal traction on the stomach, which will make the anterior nerves prominent against the esophagus. After applying Hemoclips remove segments from each of the anterior branches (**Fig. 19–5**). Any suspicious fibers should be removed with forceps and sent to the pathology laboratory for analysis.

Identification of the Right (Posterior) Vagus

The posterior vagal trunk often is situated 2 or 3 cm lateral and posterior to the right wall of the esophagus. Consequently, its identification requires that when the surgeon's right index finger encircles the lowermost esophagus, going from the patient's left to right, the fingernail should pass over the anterior aorta. The finger should then go a considerable distance toward the patient's right before the finger is flexed. Then the fingernail rolls against the *deep* aspect of the right branch of the crural muscle. When this maneuver is completed, the right trunk, a structure measuring 2–3 mm in diameter, is contained in the encircled finger to the right of the esophagus (**Fig. 19–6**). Its identification may be confirmed in two ways. First, look for a major branch going toward the celiac ganglion. Second, insert a finger above the left gastric artery near the lesser curvature of the stomach and draw the left gastric vessel in a caudal direction. This applies traction to the posterior vagus, which then stands out as a stout cord. The right trunk rarely divides in the abdomen above the level of the esophagogastric junction.

Apply a long Mixter clamp to the nerve; place Hemoclips above and below the clamp; remove a 2–3 cm segment of nerve and submit for histological study.

Rotate the esophagus and inspect the posterior wall. At the conclusion of this step the lower 5 cm of esophagus should be cleared of all nerve fibers. One should see only longitudinal muscle throughout its entire circumference (**Fig. 19–7**).

Fig. 19–7

Suture of Crural Musculature

At this time if the hiatus admits two or more fingers alongside the esophagus, one or two sutures of 0 Tevdek should be placed to approximate the muscle bundles behind the esophagus, taking care to leave a gap of one finger's breadth between the esophagus and the newly constructed hiatus. No attempt at fundoplication or any other antireflux procedure need be undertaken unless the patient had symptoms or other evidence of gastroesophageal reflux and esophagitis before the operation.

Hemostasis should be checked before going on to the gastric resection or drainage procedure.

Postoperative Care

(See Chap. 21.)

Complications

Operative perforations of the esophagus must be carefully repaired with two layers of interrupted sutures. If additional exposure is needed, do not hesitate to extend the abdominal incision into the left sixth or seventh intercostal space. For additional security, cover the suture line with gastric wall by performing a Nissen fundoplication when repairing a low esophageal tear.

Postoperative gastric stasis

20 Proximal Gastric Vagotomy

Indications

Intractable Duodenal Ulcer

As mentioned in Chap. 18, proximal gastric vagotomy without a drainage procedure has the smallest number of undesirable postoperative sequelae and the lowest mortality rate of any operation for duodenal ulcer. On the other hand, the incidence of recurrent ulcer after this procedure may reach 10% over the course of a 10-year follow-up period. Because many of the complications following drainage procedures and gastric resection can be extremely unpleasant—such as dumping, weight loss, and malabsorption—it may prove worthwhile to assume the risk of a 10% recurrence rate to avert all these complications.

Duodenal Ulcer with Hemorrhage

When bleeding from a duodenal ulcer can be controlled by suture through a duodenotomy incision that does not transect the pylorus, proximal gastric vagotomy is an acceptable alternative to truncal vagotomy combined with either antrectomy or pyloroplasty.

Duodenal Ulcer with Perforation

In cases of early perforation, which can be easily controlled by plication, the addition of proximal gastric vagotomy helps assure the long-term cure of the ulcer.

Contraindications

Duodenal Ulcer with Obstruction

Although some surgeons have treated obstructing duodenal ulcers by performing proximal gastric vagotomy combined with forceful dilatation of the stricture, there are as yet inadequate data to support this combined procedure.

Do not perform proximal gastric vagotomy for pyloric or *prepyloric* gastric ulcer, as 30% of these patients may experience problems with gastric emptying or recurrent ulcer after surgery (Jordan).

Preoperative Care

Gastrointestinal X rays
Gastric analysis
Gastroscopy when indicated
Nasogastric tube on morning of operation

Pitfalls and Danger Points

Hematoma of gastrohepatic ligament
Incomplete vagotomy
Damage to innervation of pyloric antrum
Injury to spleen

Operative Strategy

Exposure

Visibility of the area around the lower esophagus is greatly enhanced if either the Thompson or Upper Hand retractor is attached so that the blade underlying the lower border of the sternum elevates the sternum and also draws it in a cephalad direction.

Prevention of Hematoma and Injury to Gastric Lesser Curve

Hematomas in the region of the gastrohepatic ligament along the lesser curve of the stomach increase the difficulty of identifying the terminal branches of the nerve of Latarjet. Furthermore, rough dissection and hematomas in this area may damage the deserosalized muscle along the lesser curve to such an extent that necrosis may occur. Although this has been reported in less than 0.3% of the cases surveyed, it is probable that this complication, which is often fatal, can be prevented by gentle dissection and avoidance of hematomas. Resuturing the peritoneum produces inversion of the deserosalized portion of the lesser curve. This also helps prevent perforation in this region.

Preserving Innervation of Antrum

Both the anterior and posterior nerves of Latarjet terminate in a configuration resembling the foot of a crow. As described below, the crow's-foot portion of these nerves maintains the innervation of the antrum and pylorus and ensures adequate emptying of the stomach.

Adequacy of Proximal Vagotomy

Hallenbeck et al. demonstrated that the incidence of recurrent postoperative ulcer dropped markedly when they extended the dissection so that the lower esophagus was completely freed of any vagal innervation. This required meticulous removal of all nerve branches reaching the lower 5–7 cm of the esophagus and the proximal stomach. Grassi noted that one reason the proximal vagotomy technique fails is that surgeons sometimes overlook a branch leading from the posterior vagus nerve to the posterior wall of the upper stomach. He named this the "criminal nerve." If all the vagal nerve branches that enter the distal esophagus or proximal stomach are divided, interruption of the criminal nerve will be included in the dissection.

Postoperative Gastroesophageal Reflux

Sanker et al. and Temple and McFarland have observed that the lower esophageal sphincter may become incompetent following proximal gastric vagotomy because of the extensive dissection that must be done in the region of the esophagogastric junction. To prevent postoperative gastroesophageal reflux, Sanker has recommended that posterior gastropexy be done routinely with proximal gastric vagotomy. Although we have not *routinely* added a step to the proximal gastric vagotomy operation aimed at preventing reflux, this step should certainly be included for those patients who have shown *preoperative* evidence of gastroesophageal reflux. Whether this step should be the modified posterior gastropexy recommended by Sanker or the operation developed by Hill or by Nissen depends on the operative findings and the experience of the surgeon.

Operative Technique

Incision and Exposure

With the patient supine, elevate the head of the operating table 10°–15°. Make a midline incision from the xiphoid to a point 5 cm below the umbilicus. Insert an Upper Hand or Thompson retractor to elevate the lower sternum about 8–10 cm. Insert a self-retaining retractor of the Balfour type without excessive tension to separate the margins of the incision. Depending on the patient's body habitus, use either a Weinberg or Harrington retractor to elevate the left lobe of the liver above the esophageal hiatus. On rare occasions this exposure may not be adequate, and the triangular ligament of the left lobe of the liver may have to be divided, with the left lobe retracted to the patient's right.

Identification of Right and Left Vagal Trunks

Expose the peritoneum overlying the abdominal esophagus and transect it transversely, using a long Metzenbaum scissors and DeBakey forceps. Extend the peritoneal incision to uncover the muscular fibers of the crura surrounding the esophageal hiatus (see Figs. 19–1, 19–2, and 19–3). Separate the anterior two-thirds of the circumference of the esophagus from the adjacent right and left crux of the diaphragm, using scissors and peanut-sponge dissection under direct vision (see Fig. 19–4). Thereupon, encircle the esophagus with the right index finger.

Because the right (posterior) vagus nerve is frequently 2 cm or more away from the esophagus, a special maneuver should be employed to insure that the index finger includes this vagal trunk in its encircling motion. In order to accomplish this, pass the right index finger behind the esophagus, beginning in the groove between the left branch of the crux and the left margin of the esophagus. Then pass the fingernail along the anterior wall of the aorta and curve it anteriorly along the posterior aspect of the right side of the diaphragmatic crux. The fingertip then enters the operative field adjacent to the right crux. As a result of this maneuver, the index finger almost invariably will contain both vagal trunks in addition to the esophagus. The right vagus generally is considerably larger than the left and is almost always a single trunk. Encircle it with narrow umbilical tape to which a hemostat is attached. The left (anterior) vagus can be identified generally at the right anterior surface of the *lower* esophagus. Encircle it in a similar fashion with narrow umbilical tape.

Identification of Crow's Foot

Pass the left index and middle fingers through an avascular area of the gastrohepatic omentum and enter the lesser sac. This enables the nerves and blood vessels along the lesser curvature of the stomach to be elevated and put on stretch. The anterior nerve of Latarjet, which is the termination of the left vagus trunk as it innervates the anterior gastric wall, can be seen through the transparent peritoneum adjacent to the lesser curvature of the stomach. It intermingles with terminal branches of the left gastric artery, which also go to the lesser curvature.

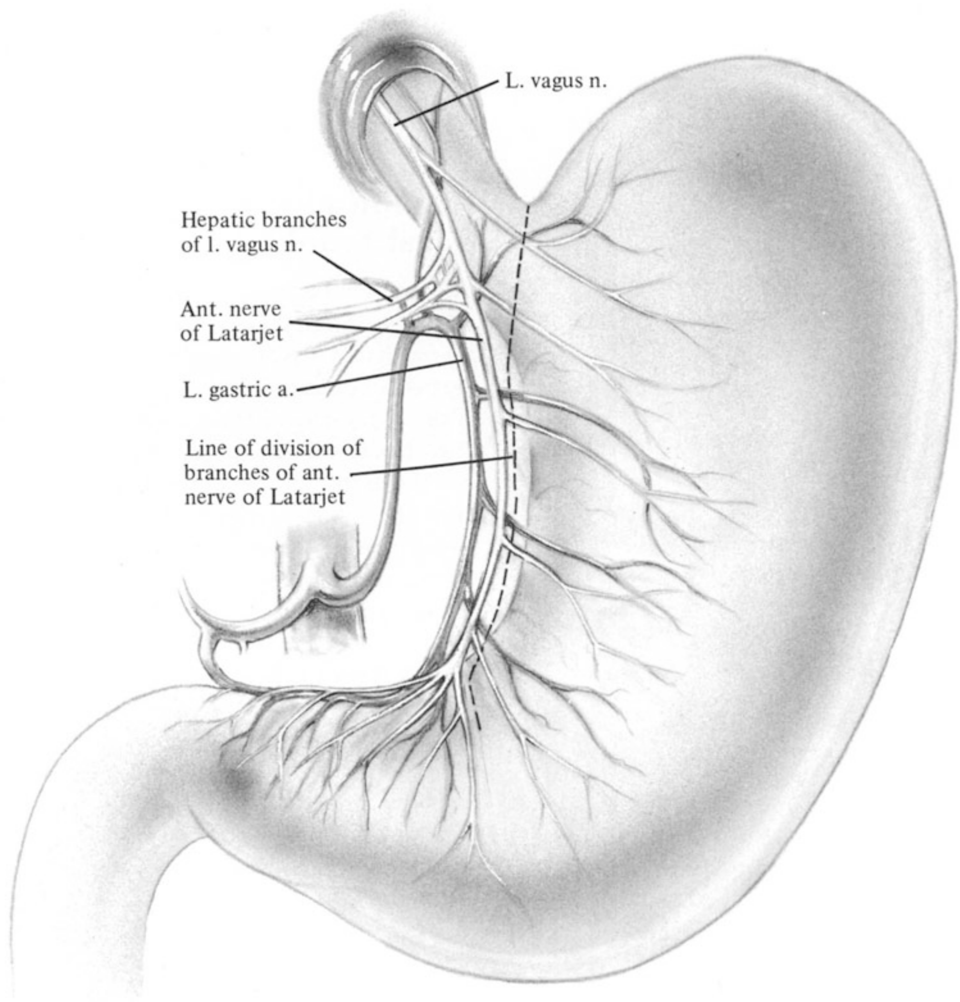


Fig. 20–1

As the nerve of Latarjet reaches its termination, it divides into four or five branches in a configuration that resembles a crow's foot. These terminal branches innervate the distal 6–7 cm of antrum and pylorus; they should be preserved (**Figs. 20–1 and 20–2a**).

Dissection of Anterior Nerve of Latarjet

After identifying the crow's foot, insert a Mixter right-angle clamp beneath the next cephalad branch of the nerve and the accompanying blood vessels (**Fig. 20–2b**). This branch is 6–7 cm cephalad to the pyloric muscle. After the clamp has broken through the peritoneum on both sides of these structures, divide them between Adson hemostats and carefully ligate with 4–0 silk (**Fig. 20–2c**). Alternatively, each branch may be doubly ligated before being divided. Repeat the same maneuver many times, ascending the lesser curvature of the stomach and taking care not to include more than one branch in each hemostat. In order to preserve the innervation of the antrum, the hemostats must be applied close to the gastric wall so as not to injure the main trunk of the nerve of Latarjet. Great care should be taken not to tear any of these small blood vessels, as they tend to retract and form hematomata in the gastrohepatic ligament, obscuring the field of dissection. This is a particular hazard in obese patients. Trauma to the musculature of the gastric wall should be avoided, as this area of lesser curvature is not protected by a layer of serosa.

Continue the dissection of the anterior layer of the gastrohepatic ligament until the main trunk of the left vagus nerve is reached. Retract this trunk toward the patient's right by means of the umbilical tape. At the conclusion of the dissection, the left vagus nerve

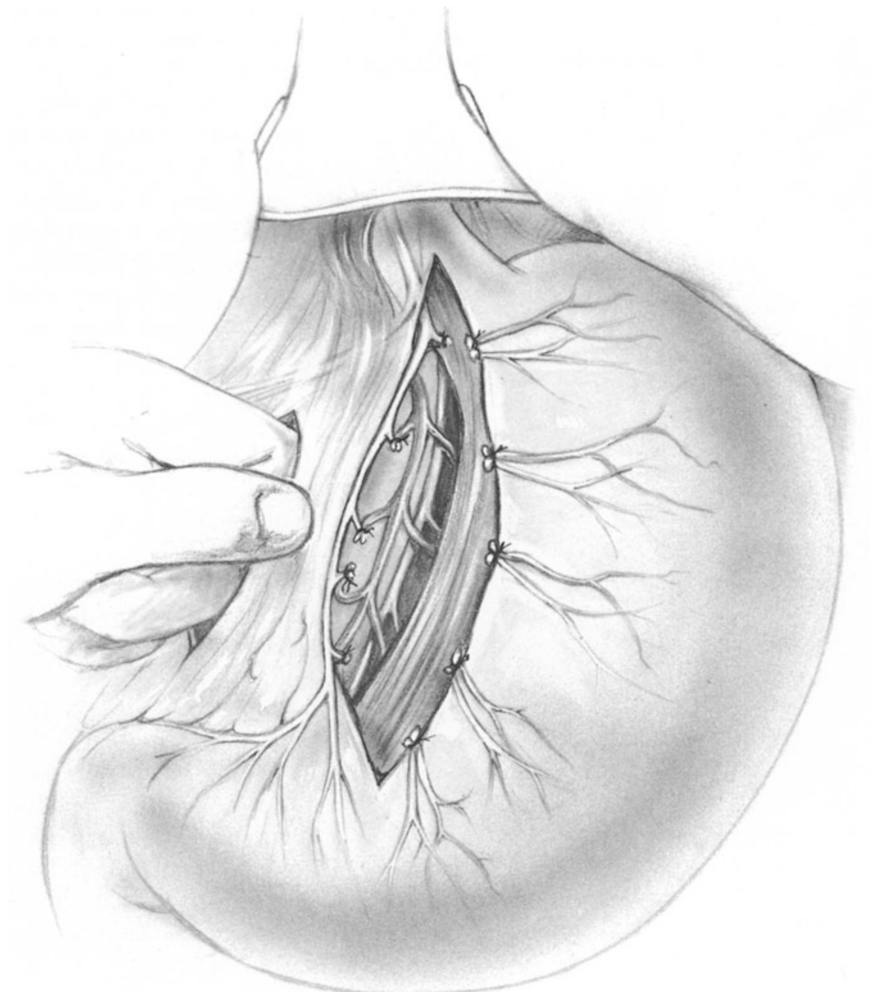


Fig. 20–2a

should be completely separated from the wall of the esophagus for a distance of 6–7 cm above the esophagogastric junction. Any small nerve branching from the vagus nerve to this portion of the esophagus should be divided. In this fashion all the branches from the left vagus to the stomach are interrupted, with the exception of those innervating the distal antrum and pylorus. Preserve the hepatic branch of the vagus trunk also, for it leaves the lei vagus and goes to the patient's right on its way to the liver.

Fig. 20–2b

Dissection of Posterior Nerve of Latarjet

Now delineate the posterior leaflet of the gastrohepatic omentum as it attaches to the posterior aspect of the lesser curvature of the stomach. Again, the crow's foot should be identified and preserved.

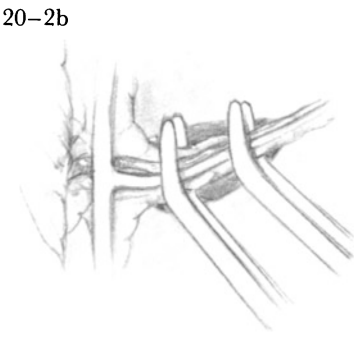


Fig. 20–2c

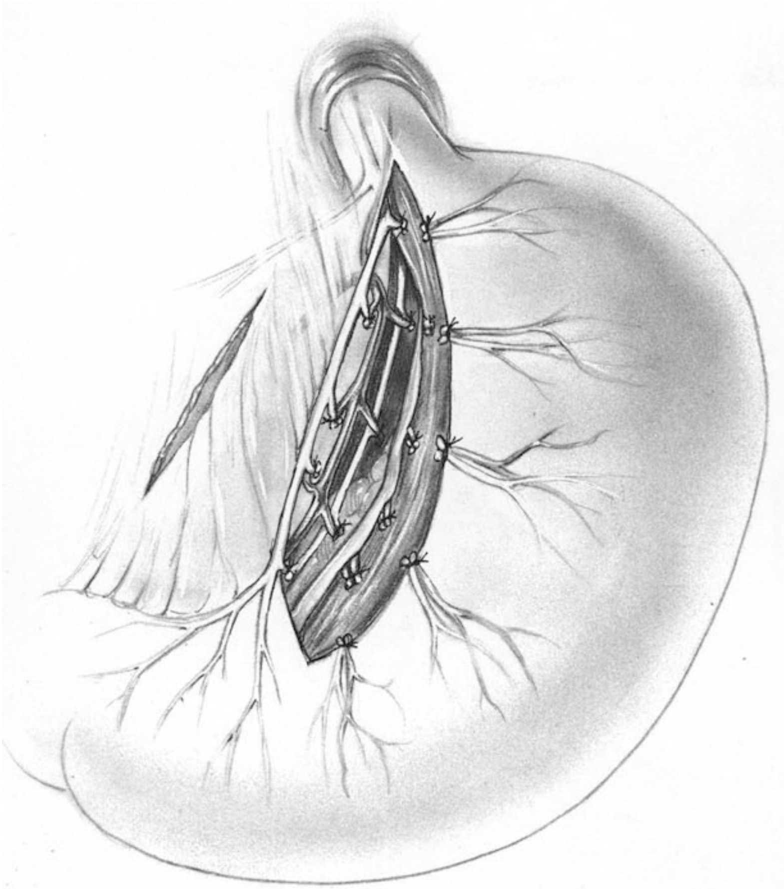


Fig. 20–3

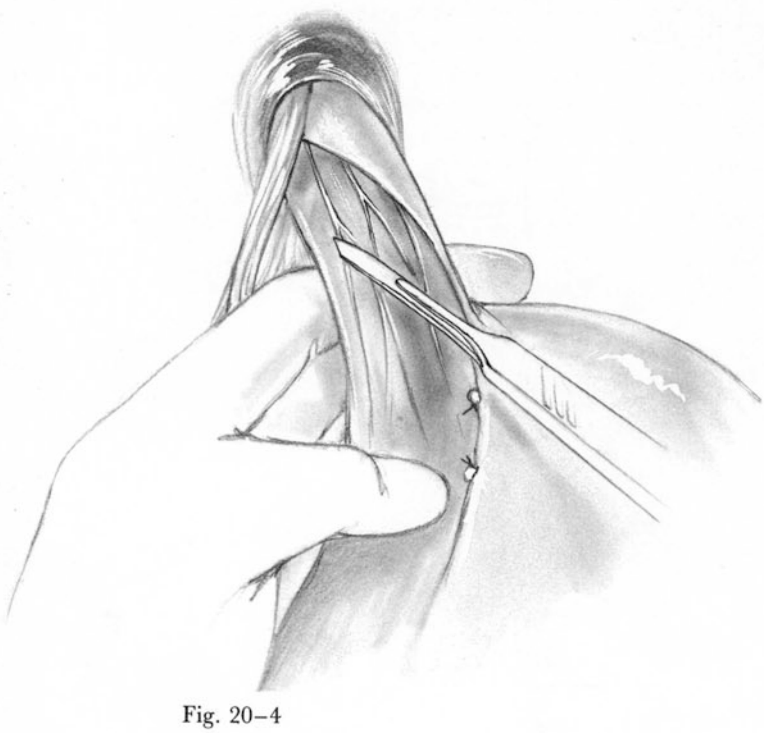


Fig. 20–4

Each branch of the left gastric artery and vein, together with each terminal branch of the *posterior* nerve of Latarjet, should be individually isolated, doubly clamped, divided, and ligated (**Fig. 20–3**). Take care to make this division close to the gastric wall in order to preserve the main nerve of Latarjet. Continue this dissection in a cephalad direction until the previously identified right vagal trunk can be seen alongside the distal esophagus. When this dissection has been properly completed, it will be evident that the right vagus nerve and the gastrohepatic ligament are situated far to the right of the completely bare lesser curvature. Now dissect away the posterior aspect of the esophagus from the posterior vagus nerve for a distance of 7 cm above the esophagogastric junction so that no branches from this trunk may reach the stomach by way of the distal esophagus.

Pay special attention to the criminal nerve described by Grassi, which is a branch of the posterior vagal trunk passing behind the esophagus to the posterior wall of the gastric cardia. If the surgeon's left hand can be passed between the freed vagal trunks and the distal esophagus as well as the gastric fundus, this would help insure that the extent of the dissection has been adequate. In addition, carefully inspect the longitudinal muscle fibers of the distal esophagus. Any tiny fibers resembling nerve tissue should be divided or avulsed from the musculature throughout the circumference of the lower 7 cm of esophagus (**Fig. 20–4**).

Repair of Lesser Curvature

Repair the deserosalized portion of the lesser curvature using interrupted 4–0 silk sutures to approximate the peritoneum over the denuded gastric musculature (**Fig. 20–5**).

Close the abdominal incision in the usual fashion, without drainage.

Postoperative Care

Continue nasogastric suction and intravenous fluids for 48 hours. At the end of this time the patient generally is able to tolerate the postgastrectomy type of diet. Usually the postoperative course is uneventful, and undesirable postoperative gastric sequelae, such as dumping, are distinctly uncommon.

Complications

One complication, which seems to be unique to proximal gastric vagotomy, is necrosis of the lesser curvature. Although this is quite rare (0.3% of all proximal gastric vagotomy operations), it is often

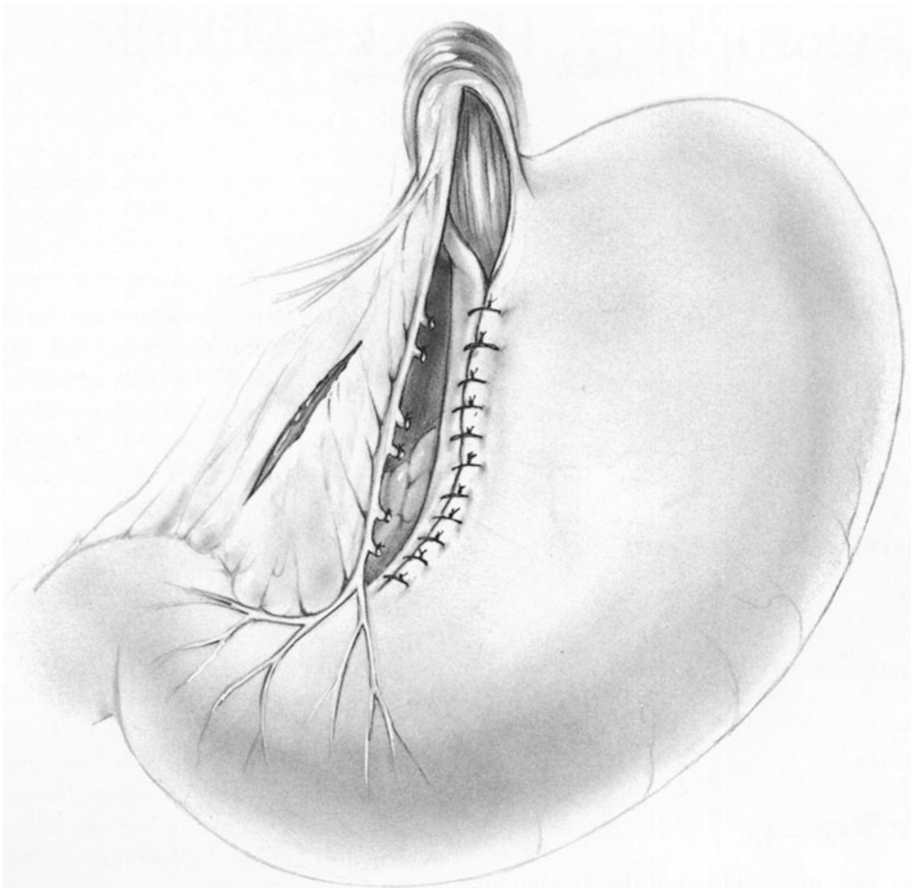


Fig. 20–5

fatal when it occurs. It probably results from trauma or hematoma of the gastric wall in an area that lacks serosa. Prevention requires accurate dissection. It is hoped that reperitonealization of the lesser curvature by suturing (Fig. 20–5) will also help avoid this complication. Treatment requires early diagnosis and resection.

References

Grassi G. In: Nyhus LM, Wastell C. Surgery of the stomach and duodenum. Boston: Little, Brown; 1977:61.

Hallenbeck GA et al. Proximal gastric vagotomy: effects of two operative techniques on clinical and gastric secretory results. Ann Surg 1976;184:435.

Jordan PH Jr. Indications for parietal cell vagotomy without drainage in gastrointestinal surgery. Ann Surg 1989;210:29–41.

Sanker MY et al. The advantages of combining posterior gastropexy with proximal gastrectomy. Chir Gastroent (Surg Gastroent) 1976;10:389.

Temple MB, McFarland J. Gastroesophageal reflux complicating highly selective vagotomy. Br J Surg 1975; 2:168.

21 Pyloroplasty, Heineke-Mikulicz

Indications

This operation is generally performed for the surgical treatment of duodenal ulcer in the poor-risk patient, especially one undergoing emergency surgery for massive hemorrhage (see Chap. 18).

Preoperative Preparation

(See Chap. 18.)

Pitfalls and Danger Points

Suture line leak
Inadequate lumen

Operative Strategy

Even if fibrosis and inflammation of the duodenum are present, as they may be in severe ulcer disease, in most cases a Heineke-Mikulicz pyloroplasty is feasible. When the duodenum appears too inflexible to allow the performance of this procedure, the Finney pyloroplasty or gastrojejunostomy should be elected. These latter two operations, although slightly more complicated than the Heineke-Mikulicz, give assurance of producing an adequate lumen for gastric drainage.

Another method of assuring an adequate lumen in the pyloroplasty is to use a one-layer suture line for the Heineke-Mikulicz pyloroplasty. This prevents the inversion of an excessive amount of tissue.

Covering the pyloroplasty suture line with omentum is important for two reasons: 1) This step helps prevent leakage from the one-layer suture line. 2) Adhesions between the suture line and the undersurface of the liver may cause angulation and partial obstruction unless omentum is used to separate these two structures.

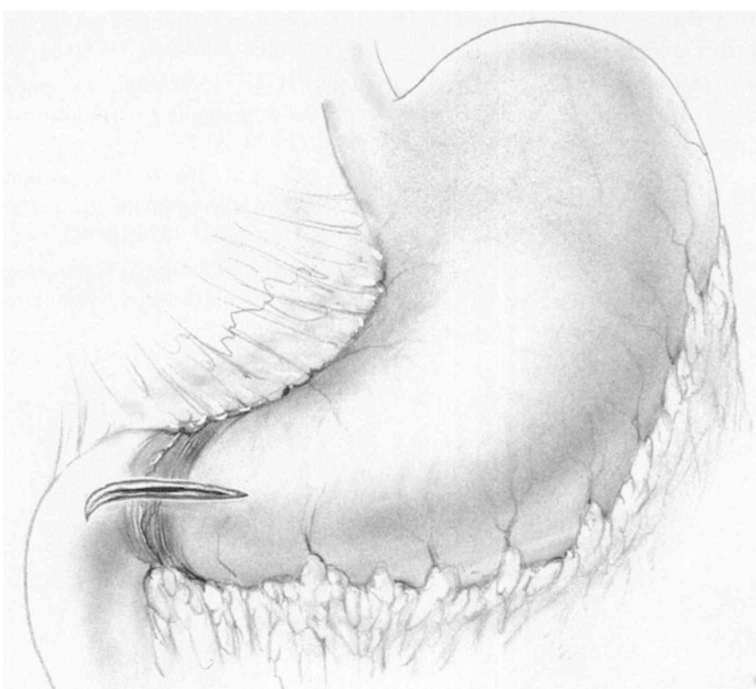


Fig. 21–1

Operative Technique

Kocher Maneuver

In the majority of cases a pyloroplasty requires a Kocher maneuver to provide maneuverability of the tissues. This is accomplished by grasping the peritoneum lateral to the duodenum with forceps and making an incision in this peritoneal layer. Alternatively, in many patients the surgeon's index finger may be insinuated behind the common bile duct and portal vein, pointing toward the ampulla of Vater. The finger then slides toward the patient's right. Overlying the fingertip is not only a thin layer of peritoneum but also an avascular lateral duodenal ligament that attaches the duodenum to the underlying retroperitoneal structures. Incise the peritoneal layer either with scissors or electrocautery, then stretch the lateral duodenal ligament with the fingertip and divide it similarly. It is rarely necessary to mobilize the hepatic flexure to perform a complete Kocher maneuver (see Figs. 7–14, 7–15, and 7–16).

Pyloroduodenal Incision

Make a 5-cm incision across the lower antrum, the pyloric sphincter, and the proximal duodenum, with the incision centered on the pyloric muscle (**Fig. 21–1**). Apply a Babcock clamp to the cephalad and one to the caudal cut ends of the pyloric sphincter and draw apart the two Babcock clamps. Transfix any bleeding points either with 4–0 chromic catgut suture-ligatures or with careful electrocoagulation. Close the incision transversely, which will provide a patulous lumen for gastric drainage.

Suture of Pyloroplasty

Use one layer of sutures to prevent excessive tissue inversion. Most techniques call for a through-and-through suture. As the gastric wall is much thicker than the duodenal, it is difficult with this type of technique to prevent eversion of mucosa between the sutures. Consequently, we prefer either a deep "seromucosal" (see Fig. B–16) or interrupted Lembert sutures of 4–0 silk. Insert the first suture at the midpoint of the suture line (**Fig. 21–2**). Proceed with the closure from one corner to the midpoint and then from the other corner to the midpoint, inverting just enough of the seromuscular coat to prevent any

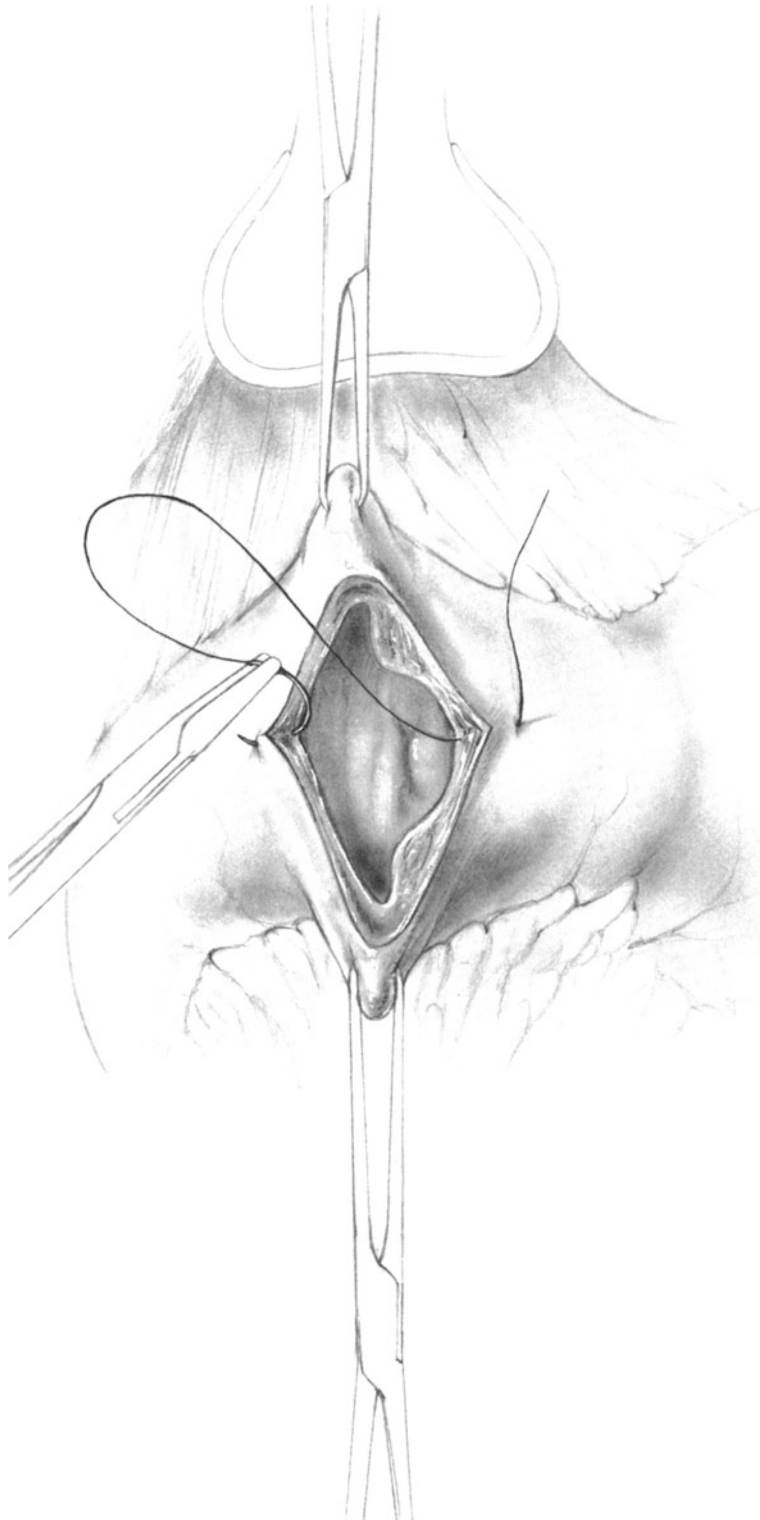


Fig. 21–2

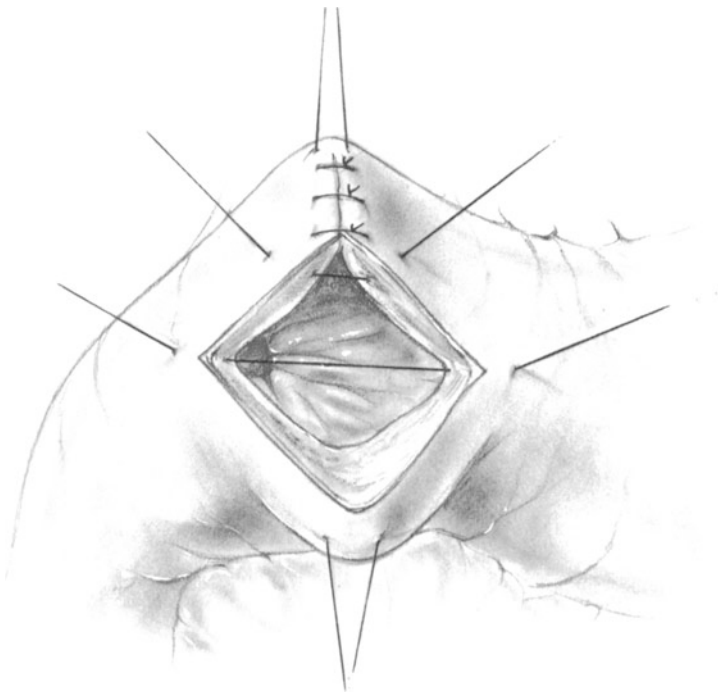


Fig. 21–3

outpouching of mucosa between the sutures (**Figs. 21–3 and 21–4**).

Then suture omentum loosely over the pyloroplasty to prevent adhesions to the undersurface of the liver.

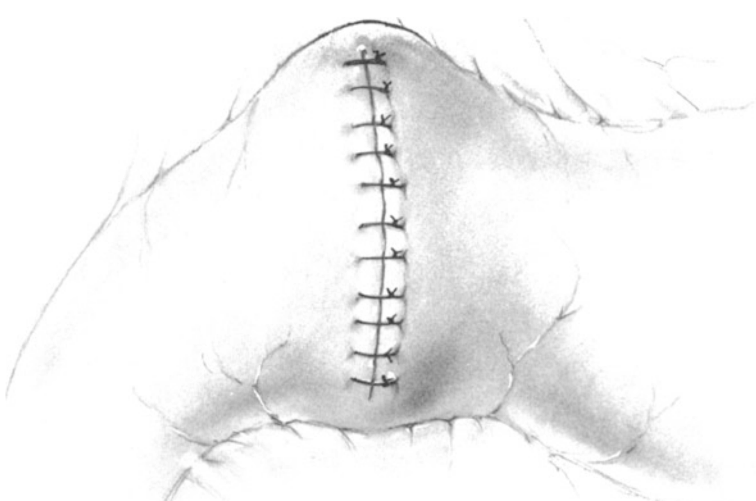


Fig. 21–4

Stapling of Pyloroplasty

Instead of suturing the pyloroplasty incision as described above, apply Allis clamps to the incision, approximating the tissues in eversion, mucosa to mucosa. Then apply the TA–55 device to the everted tissues just deep to the line of Allis clamps (**Fig. 21–5**). It should be loaded with 4.8-mm staples in most cases. Fire the staples. Excise redundant tissue with a scalpel and lightly electrocoagulate the everted mucosa, and remove the TA–55 instrument. Carefully inspect the staple line to be sure satisfactory "B" staple formation is carried out (**Fig. 21–6**). Bleeding points may be controlled by conservative electrocoagulation or sutures of 4–0 PG. Place omenthum over this stapled closure.

Postoperative Care

Administer nasogastric suction for 1–3 days.

Complications

Complications following this operation are rare, although delayed gastric emptying occurs occasionally, as does suture-line leakage. Dumping symptoms may occur.

Reversal of Pyloroplasty or Gastrojejunostomy

About 1% or 2% of patients who have undergone truncal vagotomy and pyloroplasty or gastrojejunostomy will develop severe symptoms of dumping, diarrhea, or bilious vomiting of such severity that surgical correction may be indicated. Animal experiments have demonstrated that the gastric motility defect resulting following vagotomy returns toward normal in 1 or 2 years' time. Martin and Kennedy described reconstruction of the pylorus in 9 patients who had a Heineke-Mikulicz pyloroplasty and 3 who had a Finney pyloroplasty. There was marked improvement in three-fourths of those patients whose complaint was dumping and diarrhea. Green et al. closed gastrojejunostomies in 19 patients. None of these patients suffered gastric retention following closure of the gastrojejunostomy, and 70% of them had good results.

Thus, it appears that one can surgically reverse a pyloroplasty by reopening the transverse incision, identifying both cut ends of the pyloric sphincter, reapproximating the sphincter by interrupted sutures, and then closing the incision in a longitudinal direction, thereby restoring the normal anatomy. In the case of gastrojejunostomies, surgical reversal requires that the attachment between the

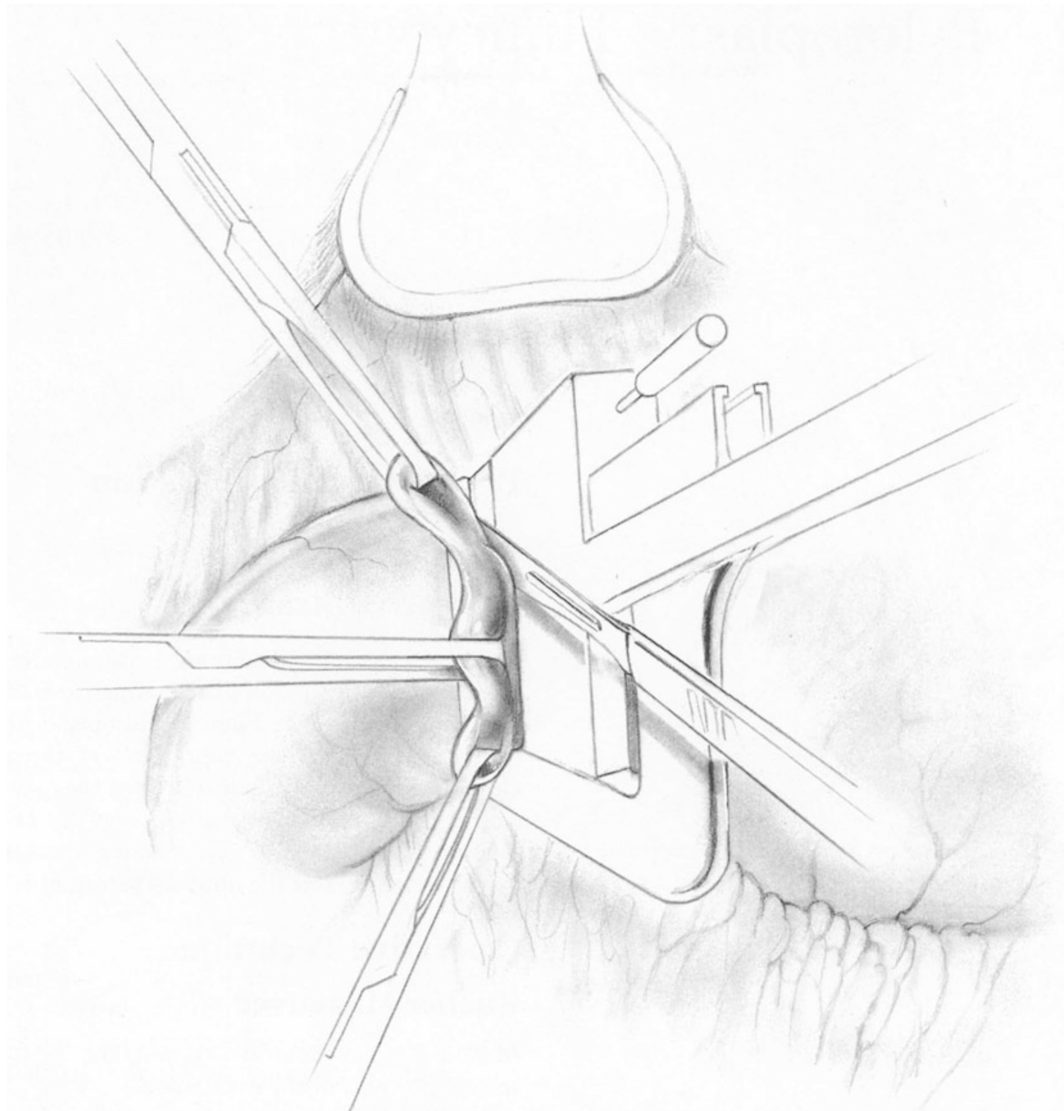


Fig. 21–5

stomach and the jejunum be transected. Then close the incisions in the greater curvature of the stomach and in the jejunum. Although we have had no occasion to perform this operation in our practice, it appears from the reports noted above that 1–2 years after the pyloroplasty or gastrojejunostomy and vagotomy have been performed, gastric motility is adequate to tolerate reversal of the drainage procedures.

References

Green R, Spencer A, Kennedy T. Closure of gastrojejunostomy for the relief of post-vagotomy symptoms. Br J Surg 1978;65:161–163.

Martin CJ, Kennedy T. Reconstruction of the pylorus. World J Surg 1982;6:221–225.

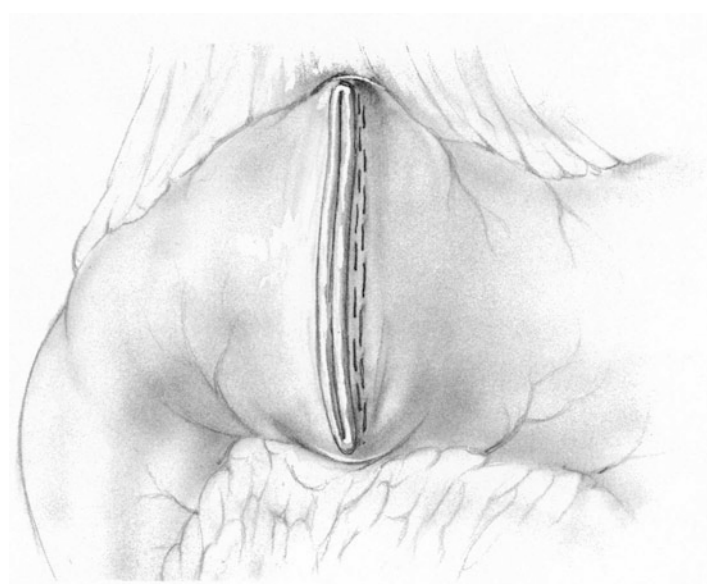


Fig. 21–6

22 Pyloroplasty, Finney

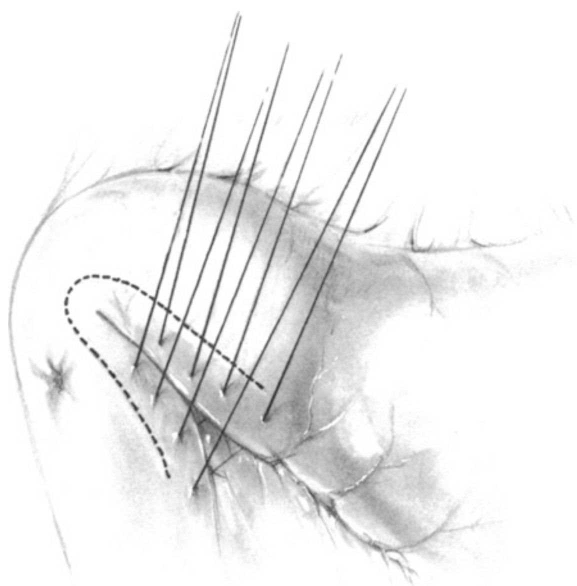


Fig. 22–1

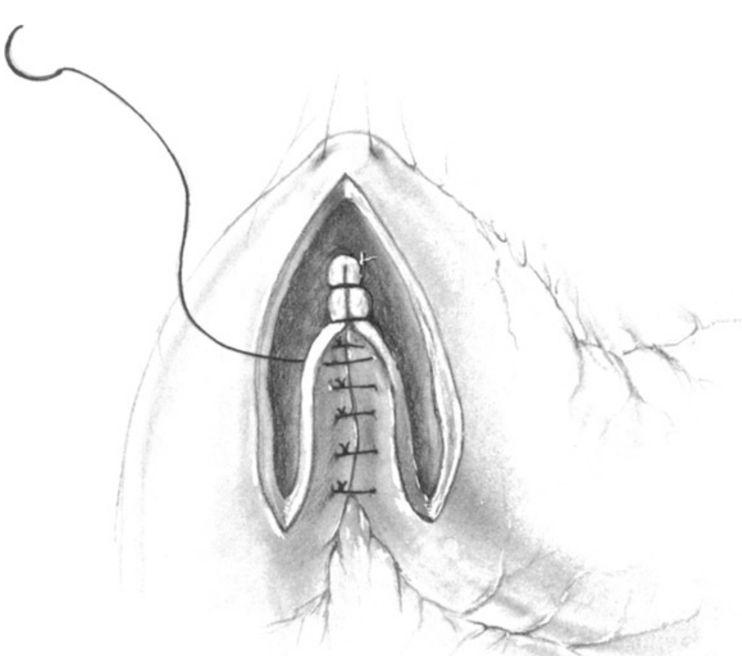


Fig. 22–2

Indications

Pyloroplasty is performed to provide gastric drainage following vagotomy.

Preoperative Preparation

(See Chap. 18.)

Operative Strategy

Unlike the gastroduodenotomy incision made for the Heineke-Mikulicz pyloroplasty, which is in the anterior midline, for the Finney pyloroplasty the gastroduodenal incision is kept close to the greater curvature side of the stomach and the pancreatic side of the proximal duodenum (Fig. 22–1). If the incision is not made in this manner, there will be excessive tension on the anterior suture line.

Operative Technique

Kocher Maneuver

Make a Kocher maneuver to mobilize the first and second portions of the duodenum.

Pyloroduodenal Incision

Insert a layer of interrupted 4–0 silk Lembert sutures to approximate the greater curvature of the stomach to the superior portion of the proximal duodenum. These sutures should be inserted fairly close to the greater curvature of the stomach and fairly close to the junction of the duodenum and pancreas. Continue this suture line for a distance of 5–6 cm from the pylorus (**Fig. 22–1**).

When the sutures have been tied, make an inverted "U"-shaped incision along a line 5–6 mm superficial to the suture line (Fig. 22–1). Carry this incision through the full thickness of the pyloric sphincter. After the incision has been made, the mucosal surface of both the gastric antrum and duodenum can easily be seen.

Completion of Suture Line

Begin the mucosal suture at the inferior surface of the divided pyloric sphincter. Pass a needle armed with 3–0 atraumatic PG through the full thickness of stomach and duodenum at the pyloric sphincter and tie it (**Fig. 22–2**). Continue the suture in a caudal direction as a continuous locked stitch until the lowermost portion of the incision is reached. Then pass the needle from inside out on the stomach side. Approximate the anterior mucosal layer by means of a continuous Connell or continuous Cushing suture (**Fig. 22–3**), which should be terminated when the cephalad end of the incision is reached. Close the anterior seromuscular layer by means of interrupted 4–0 silk Lembert sutures (**Fig. 22–4**). At the conclusion the lumen should admit two fingers.

Postoperative Care

Same as for Heineke-Mikulicz pyloroplasty (see Chap. 21).

Complications

Same as for Heineke-Mikulicz pyloroplasty (see Chap. 21).

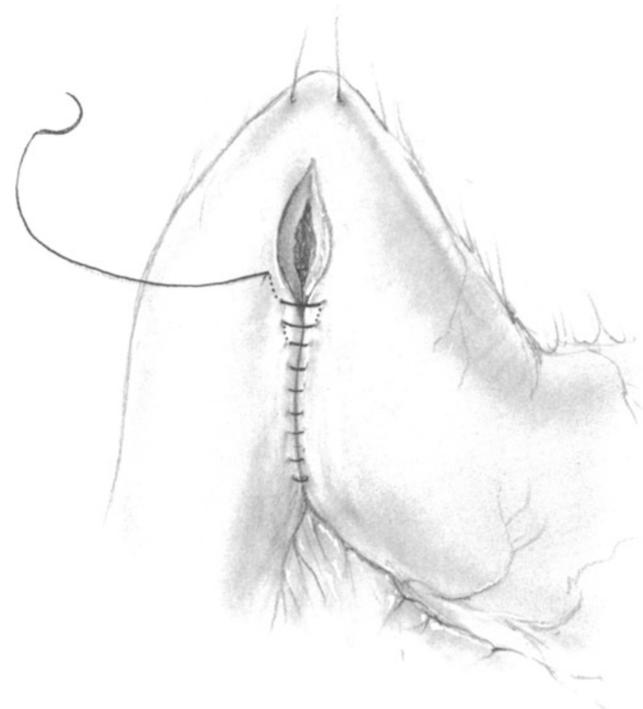


Fig. 22–3

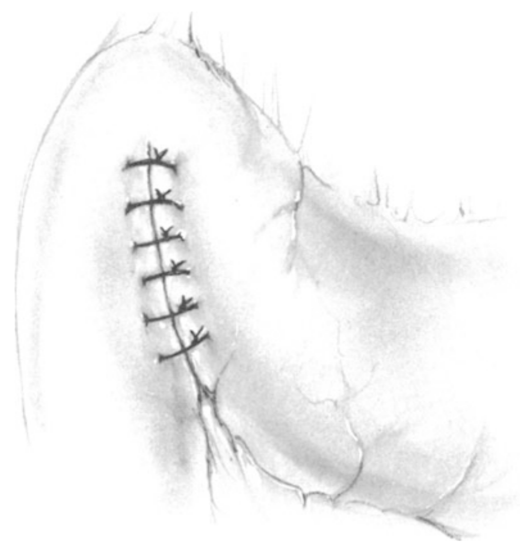


Fig. 22–4

23 Gastrojejunostomy

Indications

Gastrojejunostomy is performed to assure gastric drainage following vagotomy, when the duodenum is too inflamed or fibrotic to permit a pyloroplasty.

In patients who have inoperable carcinoma of the pancreas that occludes the duodenum, gastrojejunostomy will successfully bypass the obstruction. Routine vagotomy is not necessary, as these patients have a short life expectancy, and marginal ulcers do not often occur following gastrojejunostomy for pancreatic carcinoma.

Preoperative Preparation

(See Chap. 18.)

Pitfalls and Danger Points

Postoperative gastric bleeding
Anastomotic obstruction

Operative Strategy

Traditionally, gastrojejunal anastomoses have been placed on the posterior wall of the antrum in the hope they will improve drainage. Posterior drainage is dependent drainage only when the patient is lying in bed flat on his or her back. It is questionable, however, whether the average patient spends enough hours in this position during sleep to warrant the additional difficulty of placing the gastrojejunostomy in posterior location. We prefer to do an anterior gastrojejunostomy along the greater curvature of the antrum, situated no more than 5–7 cm from the pylorus.

Operative Technique

Incision

Make a midline incision from the xiphoid to the umbilicus. In cases of duodenal ulcer, carry out vagotomy as described above.

Freeing the Greater Curvature

Beginning at a point about 5 cm proximal to the pylorus, doubly clamp, divide, and individually ligate the branches of the gastroepiploic vessels on the greater curvature of the stomach, separating the greater omentum from the greater curvature of the stomach for a distance of 6–8 cm.

Gastrojejunal Anastomosis

Identify the ligament of Treitz and bring the jejunum in an antecolonic fashion, going from the patient's left to right. Make a longitudinal scratch mark with the back of a scalpel blade on the antimesenteric border of the jejunum, beginning at a point no more than 12–15 cm from the ligament of Treitz. The scratch mark should be 5 cm in length. This will mark the eventual incision into the jejunum for the anastomosis.

Because of the large size of the anastomosis, continuous suture material is quite satisfactory in this situation. After freeing a 6-cm segment of greater curvature from omentum, initiate (close to the greater curve) a continuous Lembert suture of atraumatic 3–0 PG on the left side of the anastomosis and approximate the seromuscular coats of the stomach and jejunum for a distance of about 5 cm (**Fig. 23–1**). Lock the last posterior Lembert suture. Then make incisions, 5 cm long, on the antimesenteric border of the jejunum and along the greater curvature of the stomach. Begin approximating the posterior mucosal layer at the midpoint of the incision, utilizing 3–0 PG doubly armed with straight needles. Insert and tie the first suture. Continue the suture toward the patient's left as a continuous locked suture, penetrating both mucosal and seromuscular coats. Terminate it at the left lateral margin of the incision. At this time with the second needle initiate a similar type stitch from the midpoint to the right lateral margin of the incision (**Fig. 23–2a**). Approximate the anterior mucosal layer by means of a continuous Connell or continuous Cushing-type stitch. The two sutures should meet

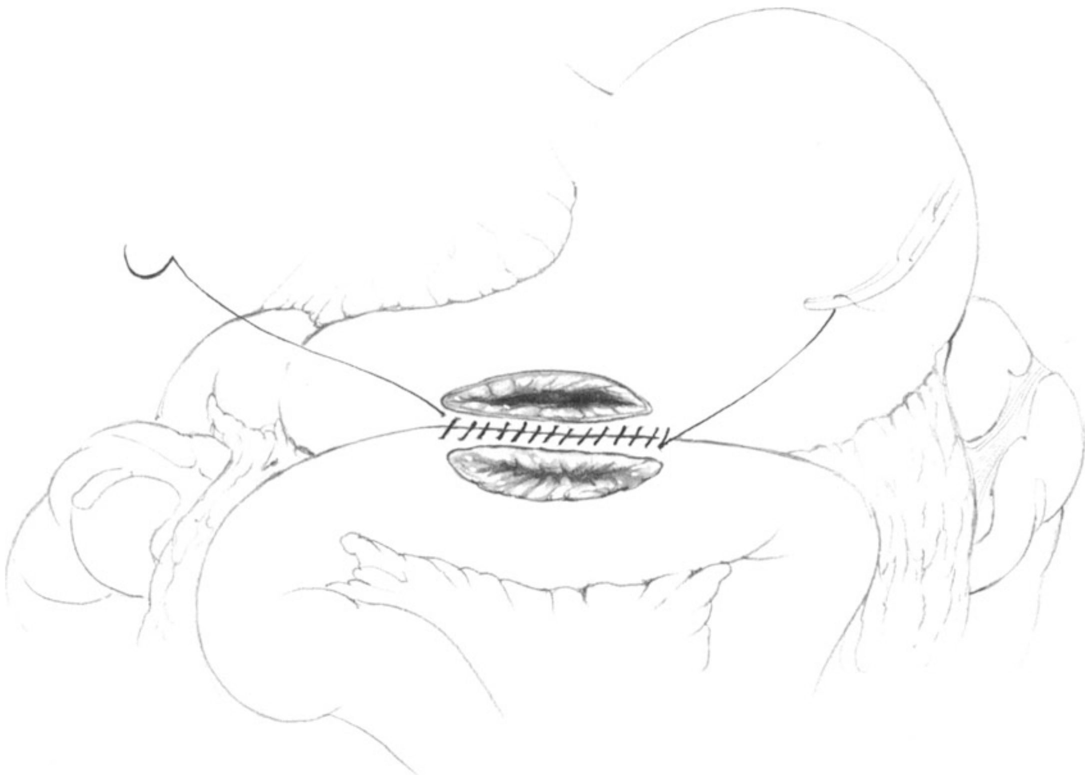


Fig. 23–1

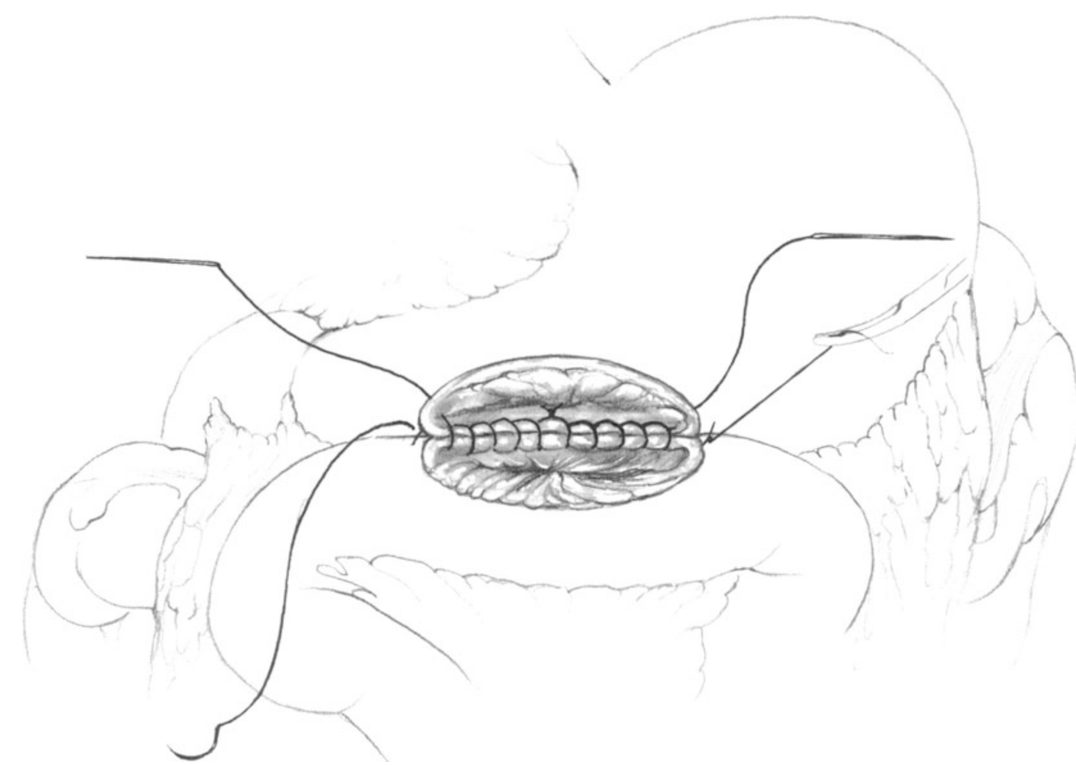


Fig. 23–2a

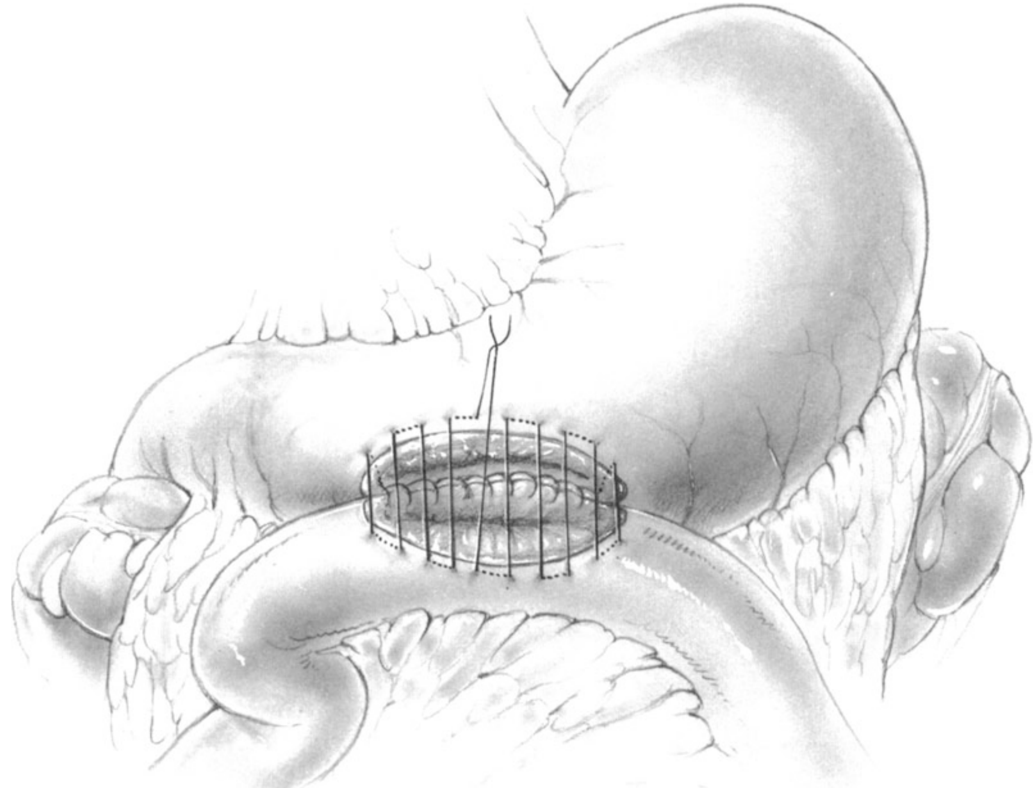


Fig. 23–2b

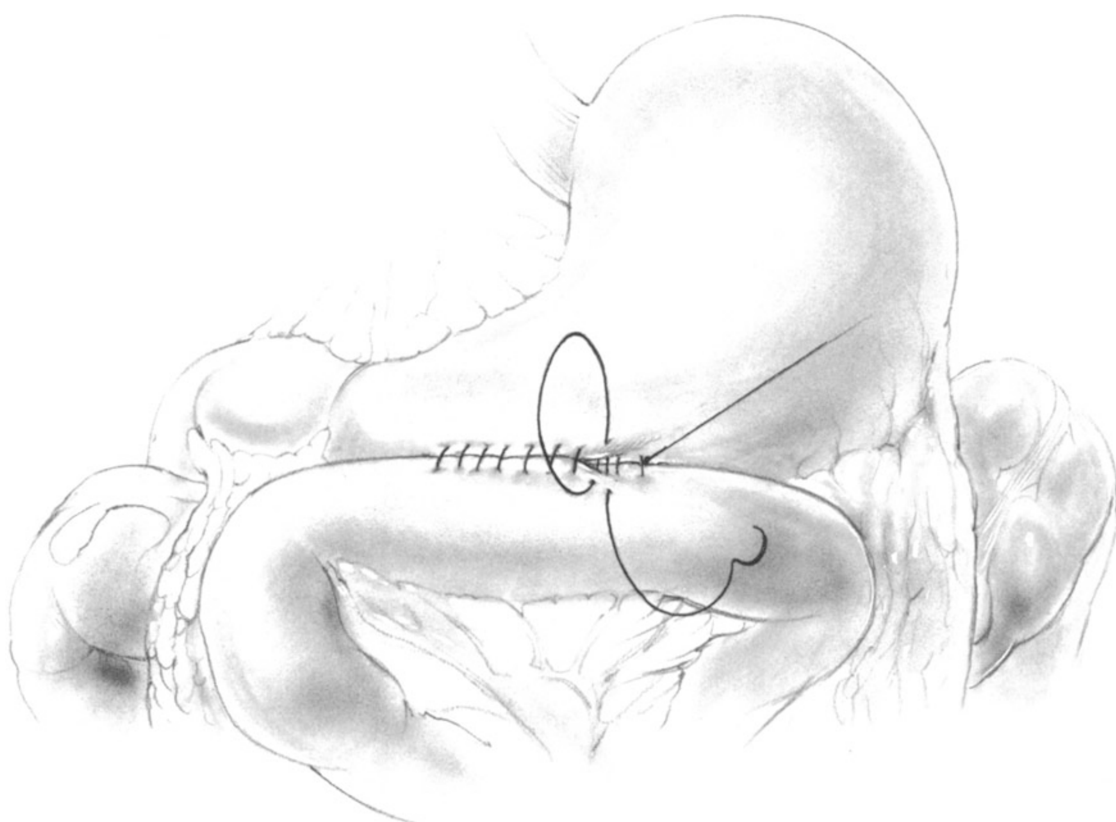


Fig. 23–3

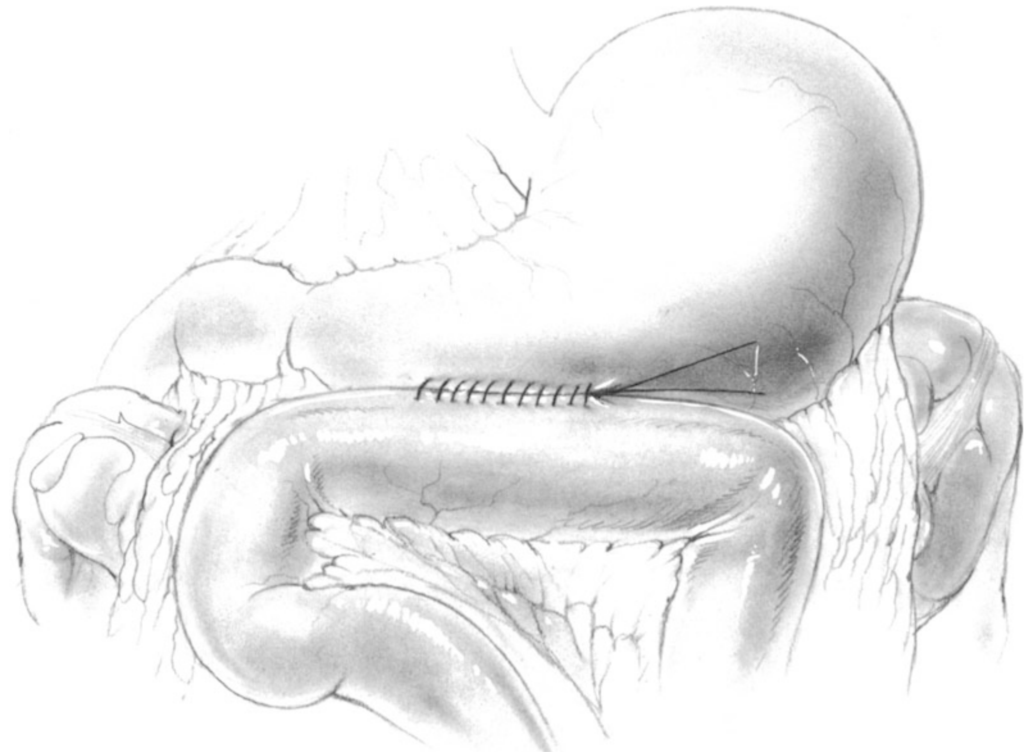


Fig. 23–4

anteriorly near the midline and be tied to each other (**Fig. 23–2b**).

Close the anterior seromuscular layer with the same curved needle that was utilized for the posterior layer. This should progress as a continuous Lembert suture (**Fig. 23–3**) from the right lateral margin of the anastomosis toward the left lateral margin. Terminate the suture by tying it to itself (**Fig. 23–4**). The anastomosis should admit two fingers.

Operative Technique: Gastrojejunostomy by Stapling

Clearing the Greater Curvature of the Stomach

Clear the greater curvature of the stomach by dissecting away the omentum as described above.

Application of the GIA

Identify the proximal jejunum and bring it to an antecolonic position as described above. With the electrocautery make a stab wound on the antimesenteric side of jejunum at a point 12–15 cm from the ligament of Treitz. Make a second stab wound along the greater curvature of the stomach at a point about 10 cm from the pylorus. Insert one fork of the GIA device into the jejunum and one fork into the stomach

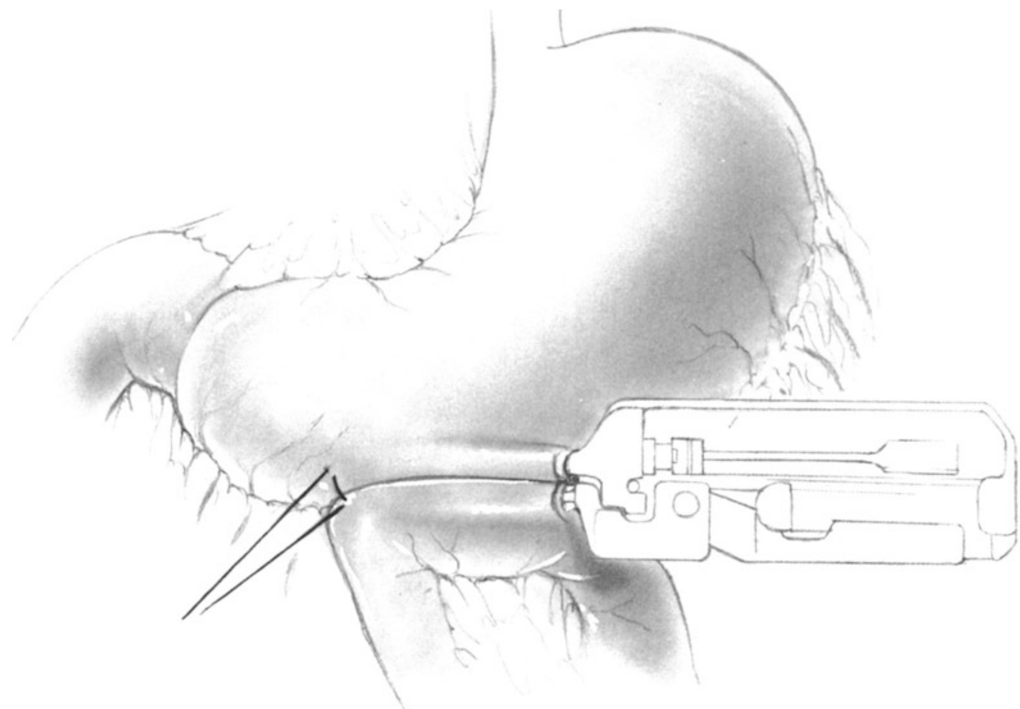


Fig. 23–5

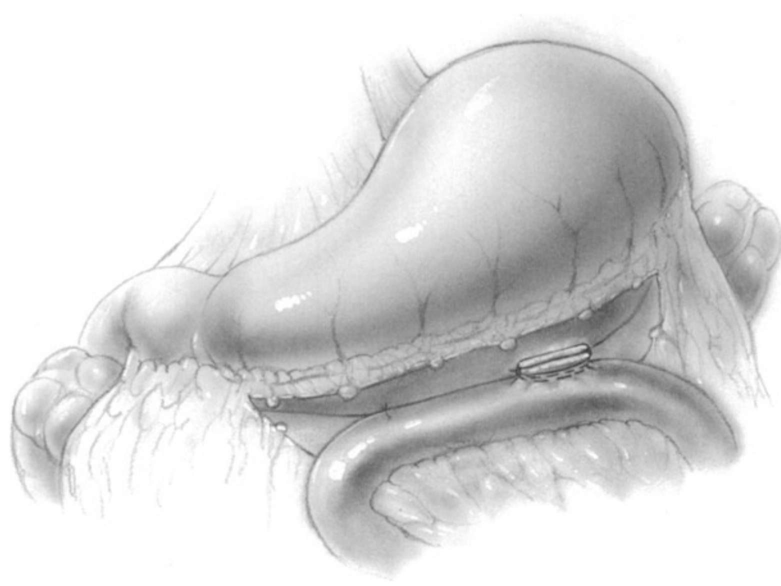


Fig. 23–6

(**Fig. 23–5**). Align the jejunum so that its antimesenteric border is parallel to the fork of the GIA and lock the device. Check the proposed gastrojejunal staple line to insure that the forks of the GIA include no tissue other than stomach and jejunum. Now fire the GIA and remove it.

Apply an Allis clamp to the anterior termination of the GIA staple line. Apply a second Allis clamp to the posterior termination of the GIA staple line. Inspect the GIA staple line carefully for bleeding. Control any bleeding point, either by cautious electrocoagulation or by the insertion of 4–0 PG atraumatic suture-ligatures.

Closure of Stab Wound

Approximate the remaining defect in the anastomosis in an everting fashion by applying several Allis clamps. Apply the TA–55 stapler deep to the Allis clamps. If the gastric wall is of average thickness use 3.5-mm staples: otherwise, the larger size will be necessary. Fire the TA-55 stapler and excise the redundant tissue with a Mayo scissors. Lightly electrocoagulate the everted mucosa and remove the stapling device. The lumen should admit two fingers without difficulty. Place a 4-0 seromuscular Lembert suture to fix the stomach to the jejunum on the right lateral margin of the newly stapled anastomosis (**Fig. 23-6**).

Postoperative Care

Administer nasogastric suction for 1-3 days.

Complications

Gastric bleeding is a rare complication, occurring in 1%-2% of the cases. Anastomotic leakage and obstruction are even less common than gastric bleeding.

24 Gastrectomy for Peptic Ulcer

Indications

(See Chap. 18.)

Preoperative Preparation

(See Chap. 18.)

Pitfalls and Danger Points

Inadequate duodenal stump closure

Trauma to pancreas resulting in postoperative acute pancreatitis

Incomplete removal of distal antrum

Splenic trauma

Laceration of common bile duct or ampulla of Vater during ulcer dissection

Inadequate lumen in gastroduodenal anastomosis (Billroth I) with postoperative obstruction

Inadvertent gastroileostomy (Billroth II)

Excessive length of afferent limb (Billroth II)

Operative Strategy

Duodenal Stump

Most of the serious postoperative complications of gastric surgery involve a failure of the duodenal stump closure. This leads to disruption and duodenal fistula or trauma to the pancreas, which results in acute pancreatitis. Because these complications result from persistent efforts to dissect the duodenum away from the pancreas when there is advanced fibrosis surrounding a penetrating duodenal ulcer, the simplest means of preventing trouble is for the surgeon to become aware early in the operation that the duodenal dissection is fraught with danger. When the difficult duodenum is identified early in the course of operation, either vagotomy with drainage procedure or proximal gastric vagotomy should be performed. If as a result of poor judgment the surgeon gets into difficulty after having broken into a posterior penetrating duodenal ulcer, he or she should be aware of the Nissen technique and the Cooper modification of it, as well as the procedure of catheter duodenostomy. These procedures, described below, can prove to be lifesaving. A successful Nissen maneuver, however, requires that the anterolateral wall of the duodenum be pliable and of fairly normal thickness. If this wall is shrunken and contracted with fibrosis or acutely inflamed, it may not be suitable for inversion into the pancreas by the Nissen-Cooper method.

Catheter Duodenostomy

In any case, a surgeon who doubts the security of the suture line after having closed the duodenal stump should insert a catheter into the duodenum for postoperative decompression. This provides a valuable safety valve and prevents disruption of the duodenal suture line in most instances.

Marginal Ulcer

Among the causes of postoperative marginal ulcer is the erroneous transection of the antrum proximal to the pylorus, thereby leaving antral mucosa in contact with the alkaline bilious secretions. Although an error of this type is not committed in the presence of normal anatomy, this mistake is indeed possible when the area is obscured by inflammation and fibrosis. When the landmarks of the pyloric sphincter are obscured, the surgeon should use frozen section biopsy to confirm the absence of antral mucosa at the cut end of the duodenal stump. If the line of transection is indeed in the duodenum, Brunner's glands will be seen by the pathologist.

Splenic Trauma

Hemorrhage from the spleen is most frequently the result of traction along the greater curvature of the stomach. This results in avulsion of a portion of the splenic capsule adherent to the greater omentum. If downward traction is necessary, it should be applied to the lesser curvature. We have reported that when a portion of splenic capsule has been avulsed, it can generally be managed by direct pressure over a sheet of Surgicel gauze.

Ligating the Bleeding Point in Duodenal Ulcer

The most common source of bleeding in patients who undergo emergency surgery for massive hemor-

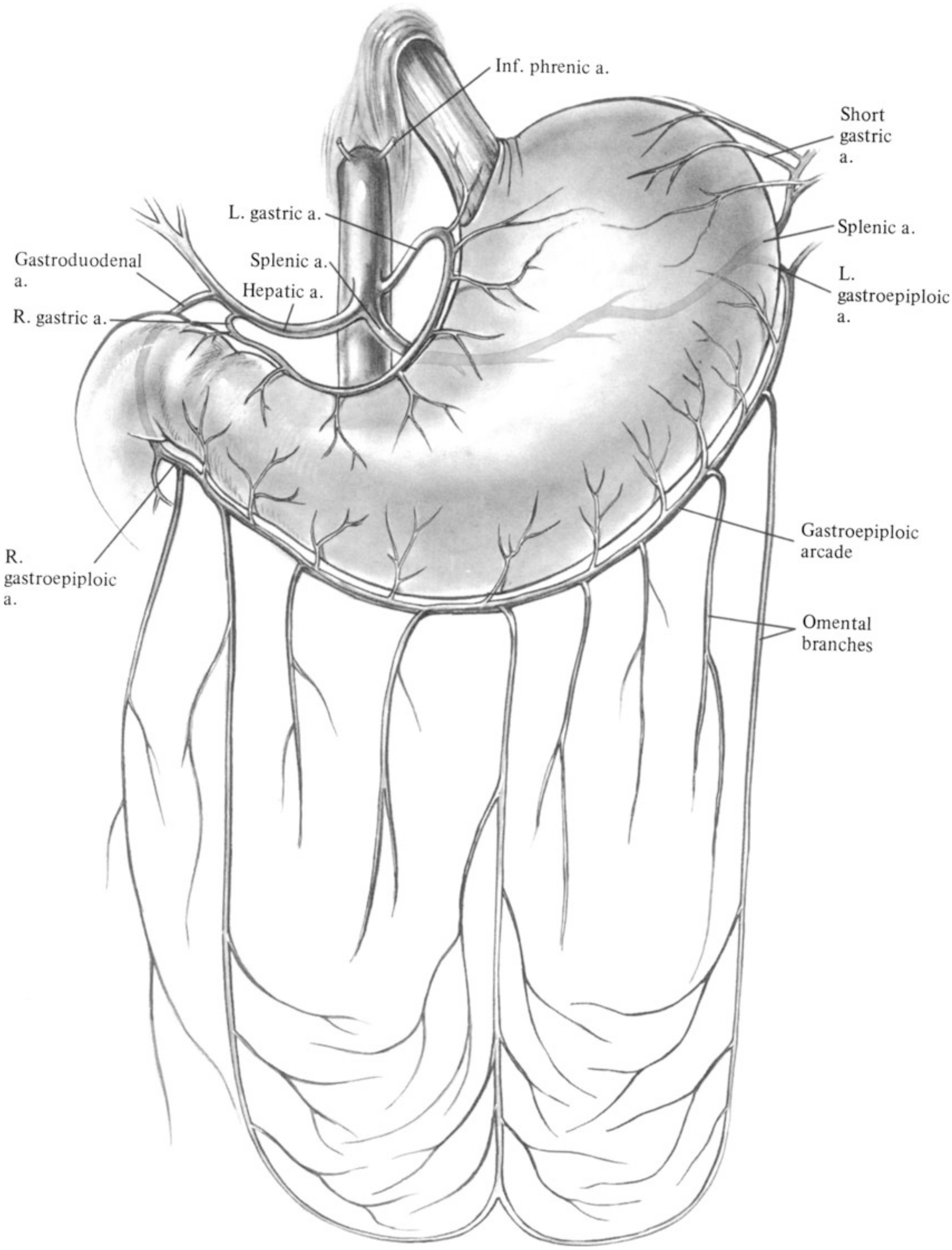


Fig. 24–1

rhage is a posterior duodenal ulcer eroding into the gastroduodenal artery (**Fig. 24–1**). When the defect in this artery is identified, it should be closed by inserting three mattress sutures of 2–0 silk. This should be done so as to interrupt the artery proximal, distal, and deep to the bleeding point. The arterial anatomy of the stomach and the proper ligation of a bleeding point in the gastro-

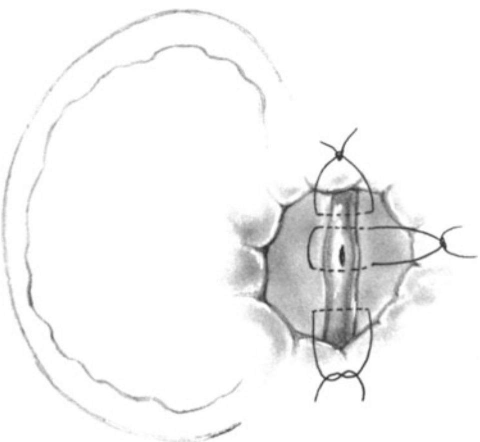


Fig. 24–2

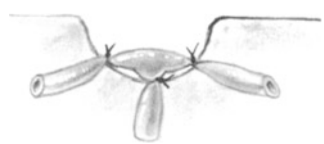


Fig. 24–3

duodenal entery is illustrated in **Figs. 24–2 and 24–3**.

Avoiding Postoperative Wound Infection

Patients who undergo resective procedures for ulcer in the presence of chronic obstruction or massive hemorrhage are more prone to develop postoperative wound infection than are patients who undergo *elective* surgery for duodenal ulcer. The former group should receive perioperative systemic antibiotics and antibiotic irrigation of the abdominal cavity and the wound at the conclusion of the anastomotic procedure.

Operative Techniques: Billroth I and II

Incision

The incision should be midline, from the xiphoid to a point 5 cm below the umbilicus. Use an Upper Hand or Thompson retractor to elevate the lower margin of the sternum and a Harrington to elevate the lower surface of the liver. Perform a vagotomy when indicated (see Chap. 19).

Evaluation of Duodenal Pathology: Control of Bleeding Ulcer

In many cases, characteristic findings from the patient's history and radiographic studies, as well as preoperative endoscopic visualization of the duodenum, make it unnecessary to open the duodenum to confirm the accuracy of the diagnosis of ulcer.

In the presence of active ulcer bleeding, a longitudinal incision across the pylorus and into the proximal 3 cm of the duodenum will generally provide good visualization of a posterior ulcer that is penetrating into the gastroduodenal artery. This artery should be transfixed with sutures of 2–0 cotton proximal and distal to the bleeding point. In addition, a suture should be placed deep to the bleeding point (Fig. 24–3) in order to occlude a hidden posterior branch of the gastroduodenal artery. This branch, generally the transverse pancreatic artery may produce retrograde bleeding following an apparently successful proximal and distal ligation of the gastroduodenal artery. According to Berne and Rosoff, the failure to include all the branches in the operative ligatures will not become apparent unless the surgeon plucks the thrombus out of the lumen of the ulcerated artery to determine whether control of hemorrhage is complete.

It is not easy, when viewing the duodenum from its anterior aspect to evaluate the potential difficulty of dissecting the posterior wall of the duodenum off the pancreas. Just how difficult the procedure may be will not be known until the posterior dissection is initiated. One should pay attention, however, to the quality and flexibility of the anterior wall of the duodenum. If the wall is soft and maneuverable, it will be useful should a Nissen-type stump closure become necessary. A markedly fibrotic, rigid, or edematous anterior wall indicates that closing the stump will be difficult. Marked edema or scarring in the region of the pylorus, pancreas, and hepatoduodenal ligaments is a relative contraindication to gastrectomy.

When the surgeon is uncertain of the nature of the pathology, a short incision may be made in the proximal duodenum in order to visualize the ulcer pathology. This will enable the surgeon to make a more accurate estimate of the technical expertise required to perform the resection. When in doubt, it is better to perform a vagotomy and a drainage procedure or proximal gastric vagotomy rather than a heroic duodenal dissection, for fatal duodenal leakage or acute pancreatitis may follow the dissection.

Dissection of Greater Curvature

Incise the avascular portion of the gastrohepatic ligament to the right of the lesser curvature and pass the left hand behind the lesser curvature and antrum of the stomach, emerging deep to the gastroepiploic arcade along the greater curvature of the stomach (**Fig. 24–4**). This manuever serves to elevate the

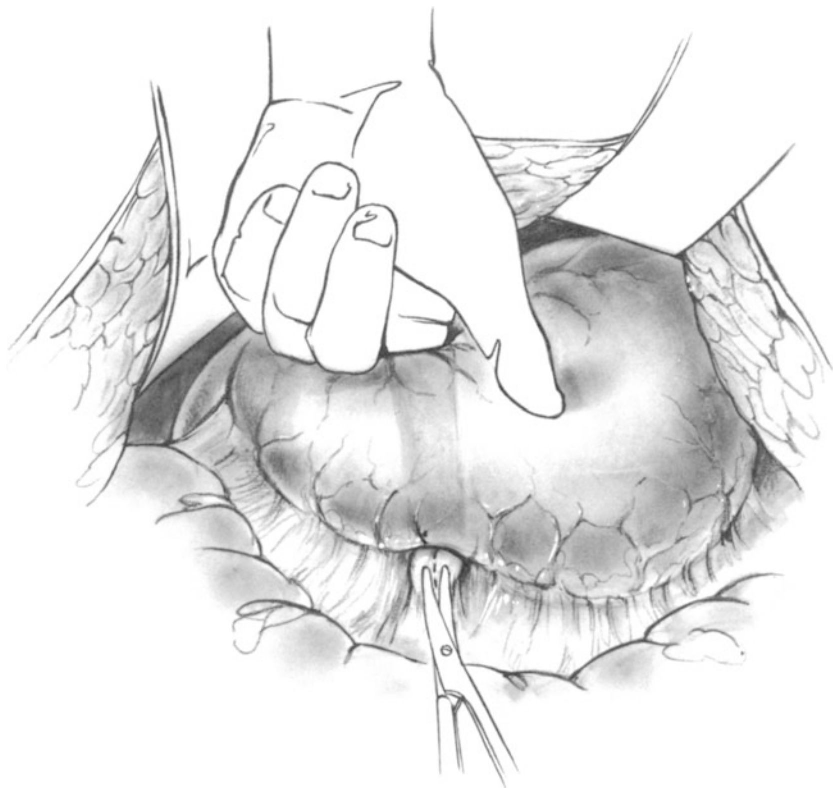


Fig. 24–4

greater omentum from the underlying mesocolon, which contains the middle colic artery. Isolate the branches going from the gastroepiploic arcade to the greater curvature of the stomach, then doubly clamp and divide each. Continue this process up along the greater curve of the stomach until the halfway point between the pylorus and the diaphragm is reached (**Fig. 24–5**).

Next dissect the distal segment of the gastroepiploic arcade from the antrum. The distal 4 cm of this dissection should be done with care, as a number of fragile veins in the vicinity of the origin of the right gastroepiploic vessels may easily be torn. While the dissection of the greater curvature is under way, it is important simultaneously to divide the congenital avascular attachments between the back wall of the antrum and the pancreas. The completion of this dissection frees the entire distal half of the gastric greater curvature.

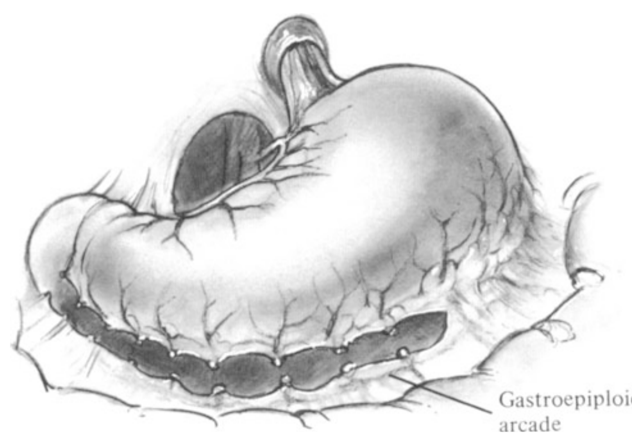


Fig. 24–5

Division of Left Gastric Vessels

Select a point on the lesser curvature about halfway between the esophagogastric junction and the pylorus. This serves as a reasonably good approximation of the upper margin of the antral mucosa. Insert a large hemostat between the lesser curvature and the adjacent vascular bundle, which should be divided between additional hemostats. Place two ligatures, consisting of either 0 silk or a double strand of 2–0 silk, on the proximal side and another

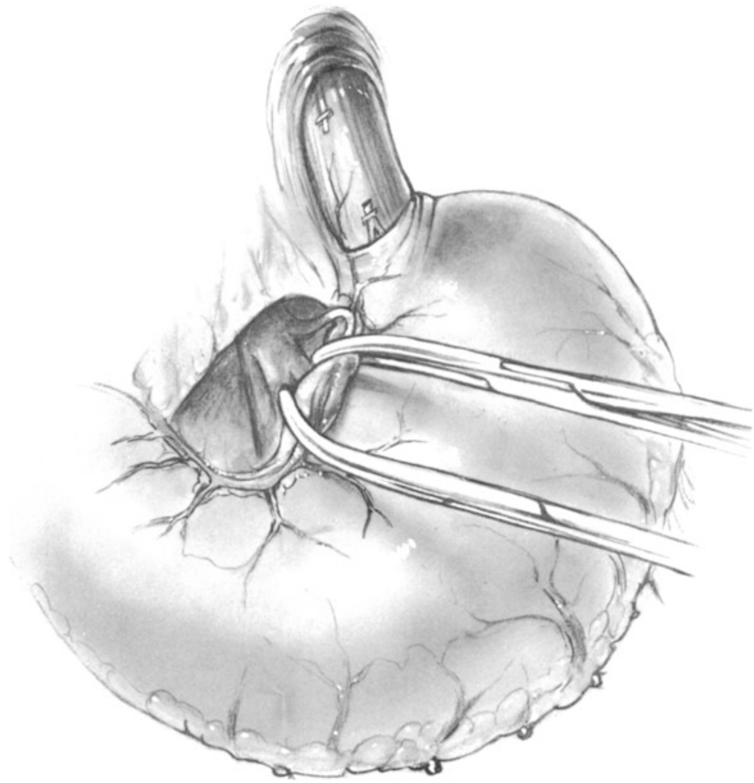


Fig. 24–6a

Fig. 24–6b

one on the specimen side (**Figs. 24–6a and 24–6b**). Preferably there will be at least a 1-cm stump of left gastric artery beyond the cotton ties. This ligated pedicle should be carefully inspected for hemostasis, as occasionally the bulky nature of the ligature permits a trickle of blood to continue through the lumen of the artery. Several additional small venous branches to the lesser curvature may require individual ligatures, as they may get torn during the insertion of the mass ligatures.

Division of Stomach

If vagotomy is adequate, no more than 50% of the stomach need be removed (**Fig. 24–7**). This is accomplished by applying Allen clamps for a distance of 3 or 4 cm, at an angle 90° to the greater curvature of the stomach. The amount of stomach in the Allen clamp should equal the width of the gastrojejunal or gastroduodenal anastomosis that will be performed in a subsequent step.

After the gastric wall has been incised midway between these two clamps, apply a TA–90 Auto Suture stapler at a somewhat cephalad angle to close the lesser curvature portion of the residual gastric pouch (**Fig. 24–8**). Now fire the stapler. Place another Allen clamp opposite the stapler and divide the gastric tissue flush with the stapler. Lightly electrocoagulate the gastric mucosa before removing the stapling device (**Fig. 24–9a**). Invert the stapled portion of gastric pouch, using a layer of interrupted 4–0 silk Lembert sutures (**Fig. 24–9b**). Apply a gauze pad over the exposed mucosa on the specimen side and fix it in place with umbilical-tape ligatures, leaving the Allen clamps in position.

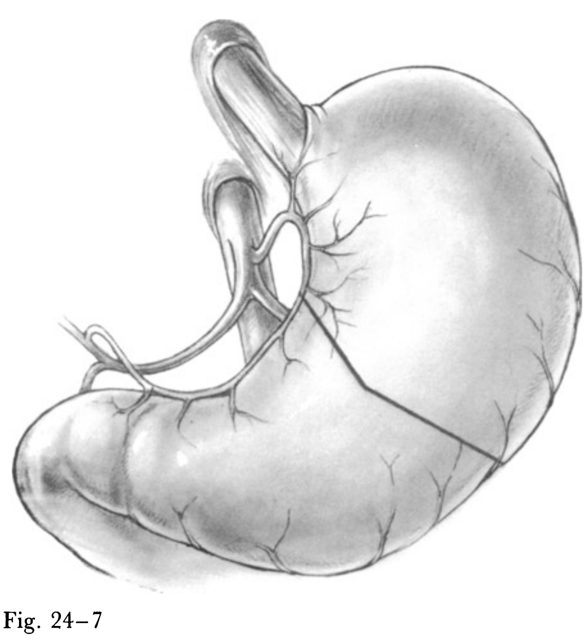


Fig. 24–7

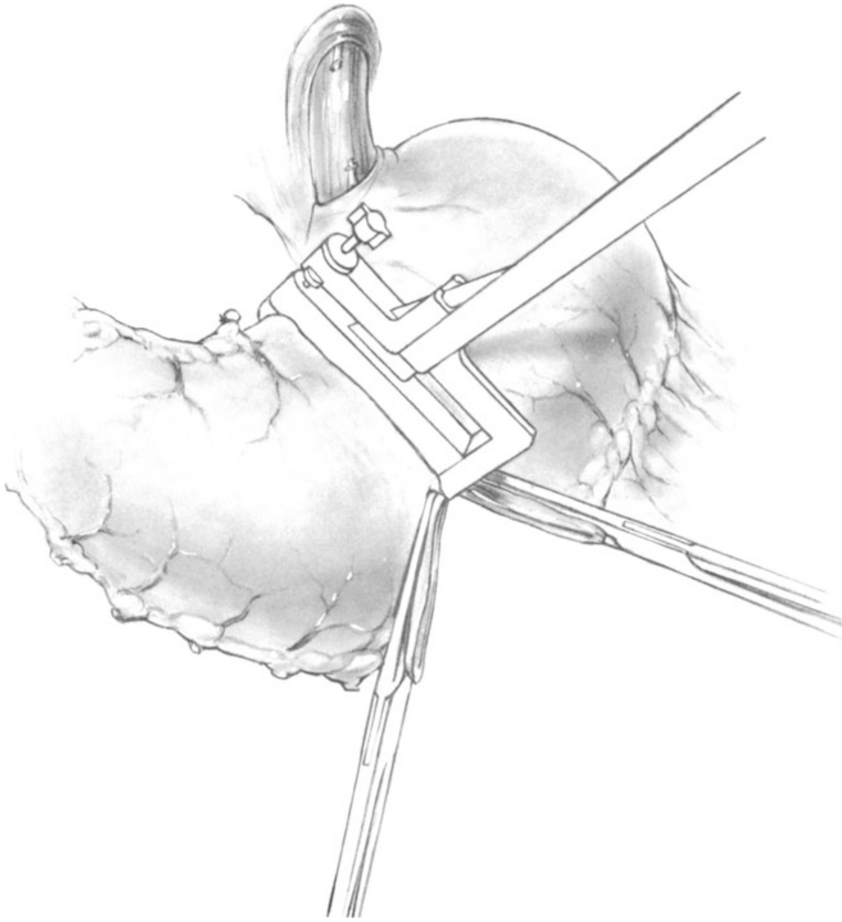


Fig. 24–8

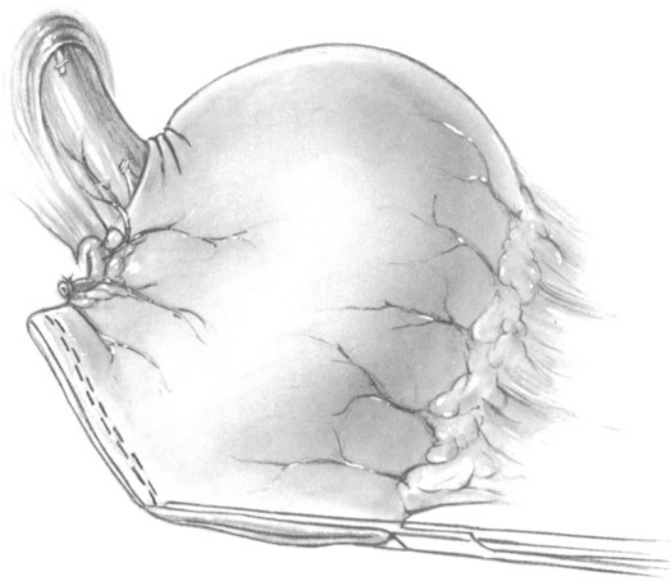


Fig. 24–9a

Fig. 24–9b

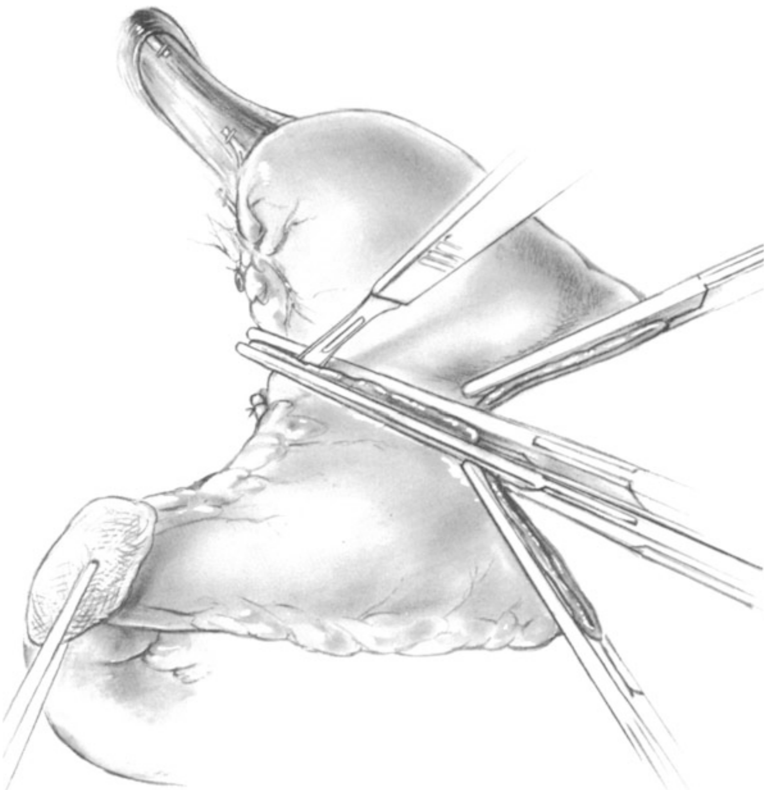


Fig. 24–10

When a stapling device is not used, the lesser curvature should be divided between Allen clamps (**Fig. 24–10**) and then closed in several layers. For the first layer use 3–0 PG on a straight intestinal needle. Initiate this suture on the lesser curvature of the gastric pouch just beneath the Allen clamp. Then pass the straight needle back and forth beneath the Allen clamp to make a basting stitch, terminating it at the base of the Allen clamp (**Fig. 24–11**). After trimming off excess gastric tissue (**Fig. 24–12**) remove the Allen clamp, return the same suture to its point of orgin as a continuous locked suture (**Fig. 24–13**), and tie it to its point of origin. This will complete hemostasis of this suture line. Then invert the mucosa, using one layer of interrupted 4–0 silk Lembert sutures (**Fig. 24–14**).

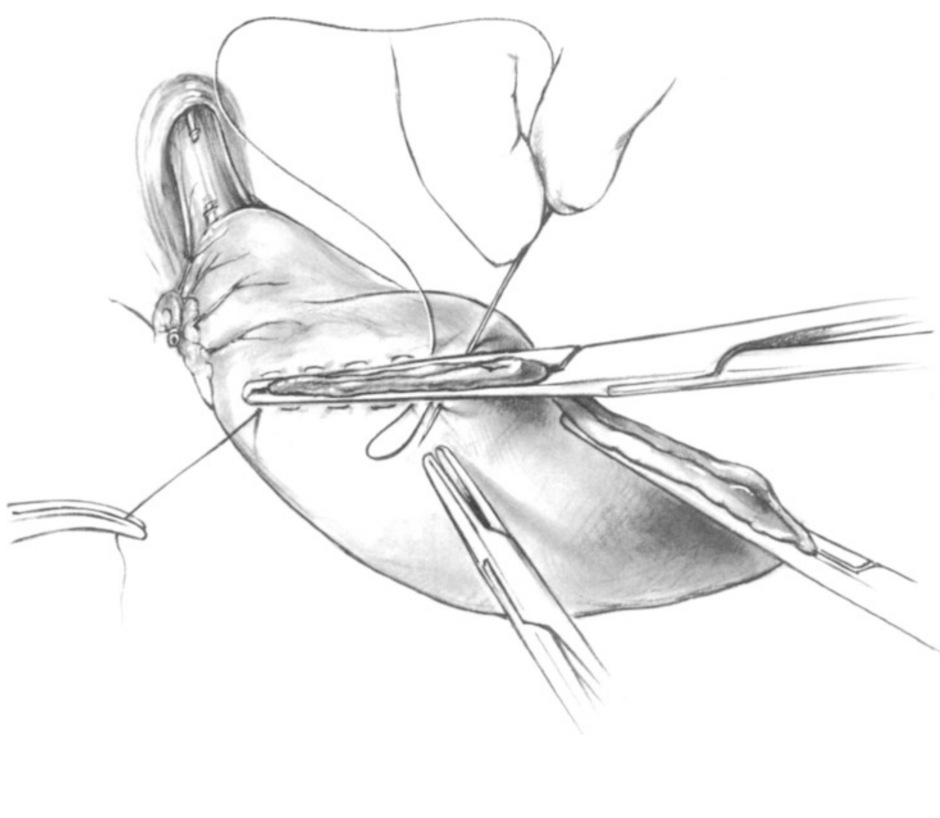


Fig. 24–11

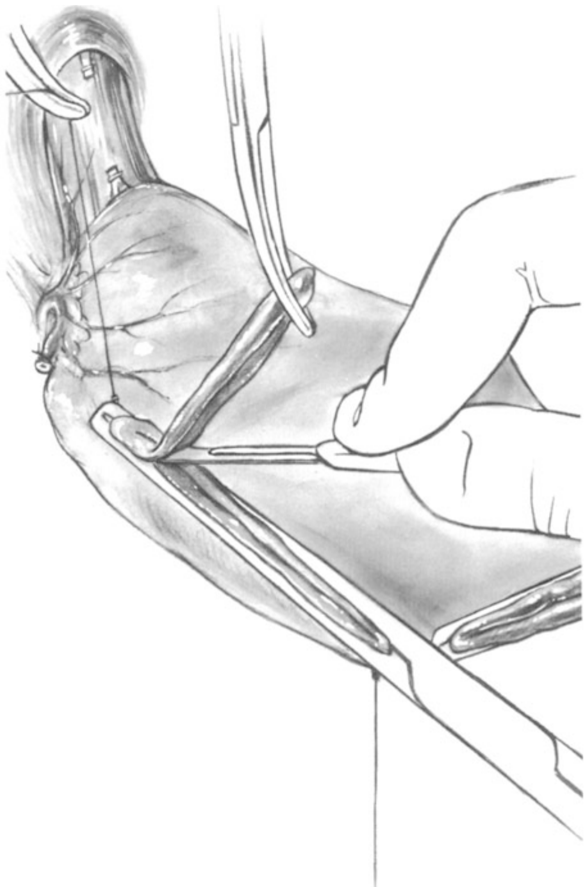


Fig. 24–12

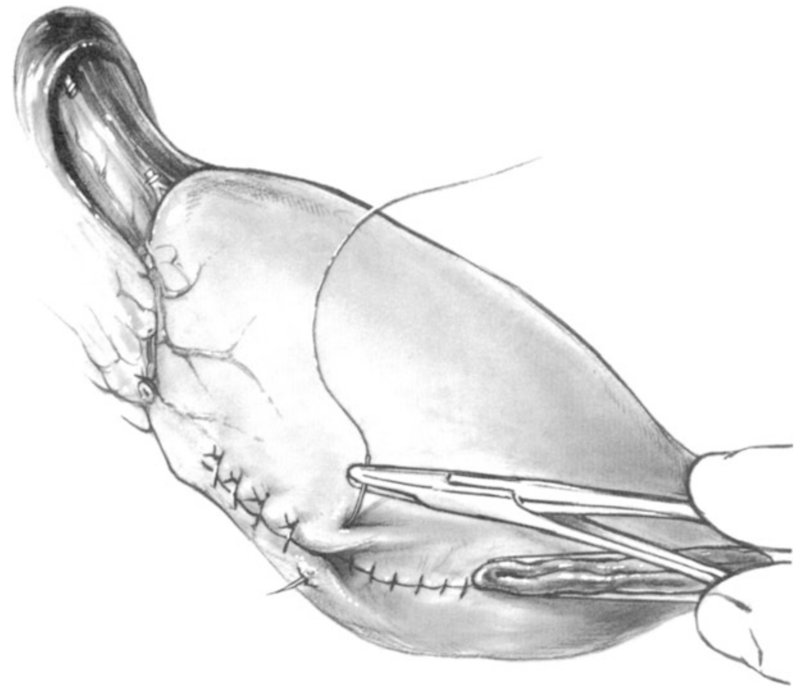


Fig. 24–14

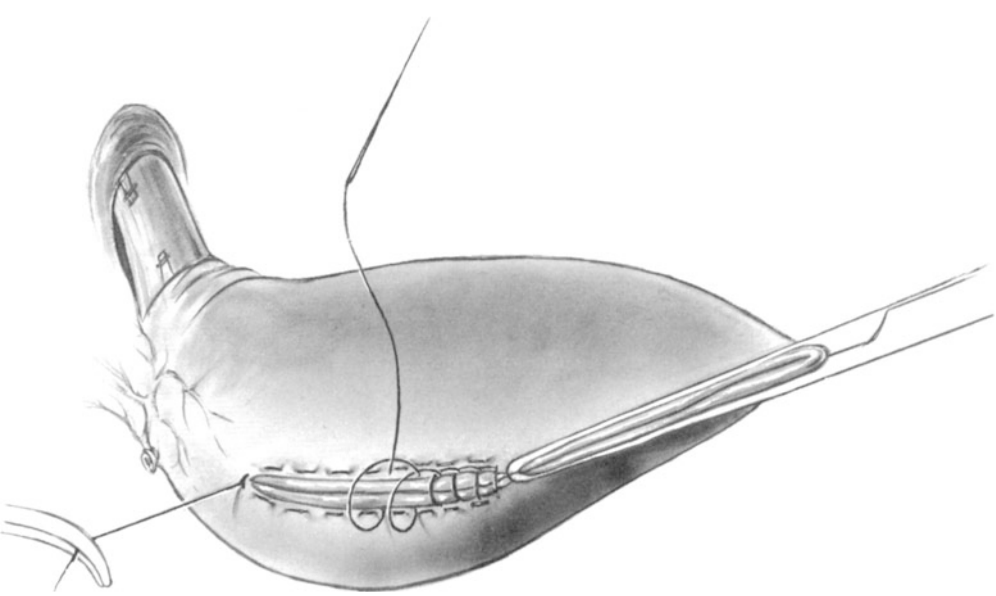


Fig. 24–13

Duodenal Dissection in Absence of Advanced Pathology

Identify, ligate, and divide the right gastric artery (**Fig. 24–15**).

Apply traction to the specimen in an anterior direction to expose the posterior wall of the duodenum and the anterior surface of the pancreas. Five or six blood vessels of small size can usually be identified going from the pancreas to the back wall of the duodenum. Divide each between Crile hemostats and ligate each with 3–0 or 4–0 silk. If there has been some scarring in this area, the stump of a small artery may retract into the substance of the pancreas. In such a case it is prudent to control the bleeding with a mattress suture of 4–0 silk. After 1.5 cm of the posterior duodenal wall has been freed from the underlying pancreas, dissection may be discontinued, as this is adequate either for turning in the duodenal stump or for gastroduodenal end-to-end anastomosis. In any case, the dissection should always be in a plane very close to the posterior wall of the duodenum.

Division of Duodenum

Apply an Allen clamp immediately distal to the pylorus and transect the duodenum flush with the clamp, which should be left on the specimen (**Fig. 24–16**). Before discarding the specimen, remove the clamp and inspect the distal end of the specimen to ascertain that a rim of duodenal mucosa has been removed. This will help assure that there is no remaining antral mucosa left behind in the duodenal stump. If there is still a question, the presence or absence of the antrum should be confirmed by frozen section examination of the distal end of the specimen.

Insert an index finger into the duodenal stump in order to check the location of the ampulla of Vater. The ampulla is situated on the posteromedial aspect of the descending duodenum at a point approximately 7 cm behind the pylorus. Occasionally the

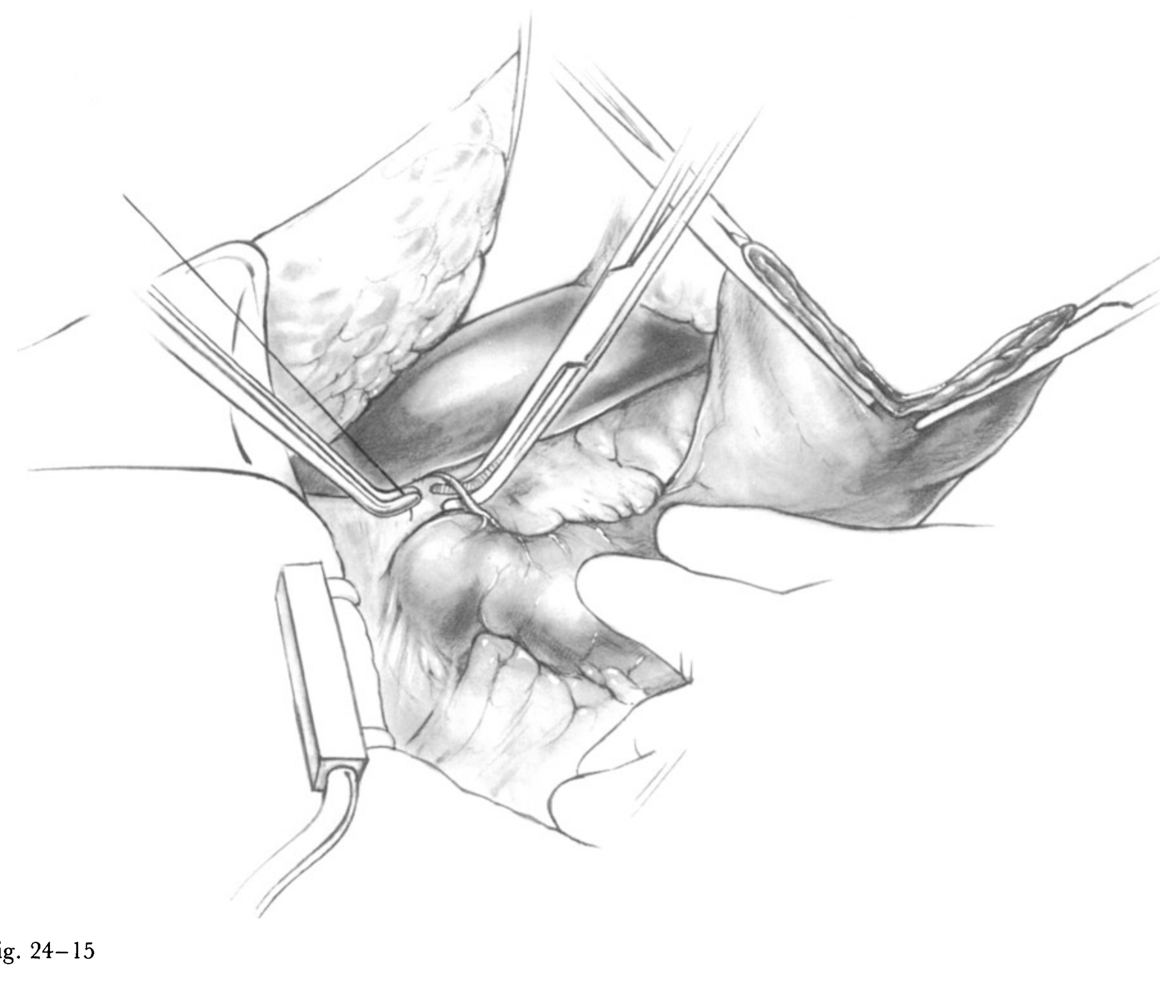


Fig. 24–15

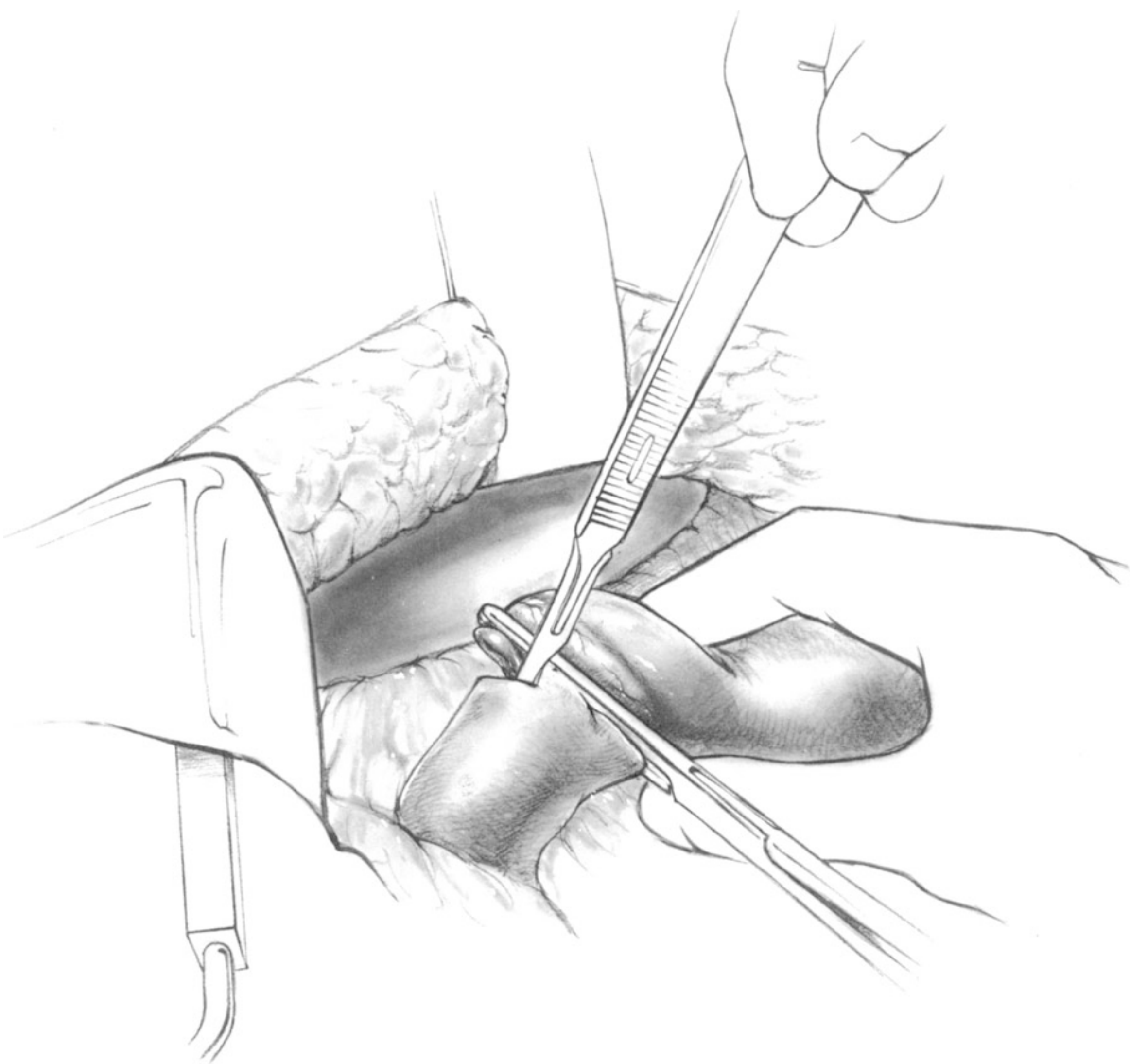


Fig. 24–16

orifice of the duct of Santorini can also be palpated along the back wall of the duodenum. If the duodenal dissection has not continued beyond the gastroduodenal artery, there need be no concern about damage to either the duct of Santorini or the main pancreatic duct. When the dissection continues beyond this point, special attention must be paid to these structures. When the duct of Santorini is divided, the open duct must be closed with a nonabsorbable suture-ligature. If the ampulla has been divided inadvertently and is separated from the duodenum, it should be reimplanted into the duodenal stump or into a Roux-en-Y segment of the jejunum.

Billroth I Gastroduodenal Anastomosis

When at least 1 cm of healthy posterior duodenal wall is available, a routine type of gastroduodenal anastomosis should be constructed. The Allen clamp previously applied to the unsutured portion of the gastric pouch should contain a width of stomach approximately equal to the diameter of the duodenal stump. Insert the corner sutures by the Cushing technique. Complete the remainder of the posterior layer with interrupted 4–0 silk seromuscular Lem-

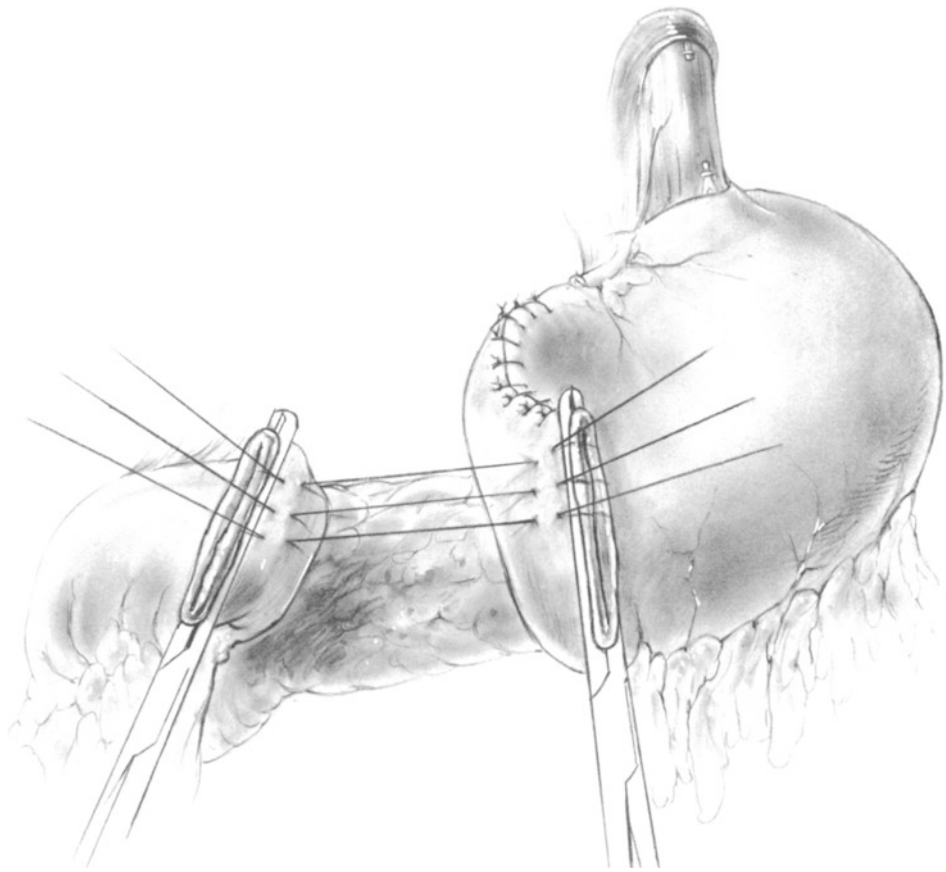


Fig. 24–17

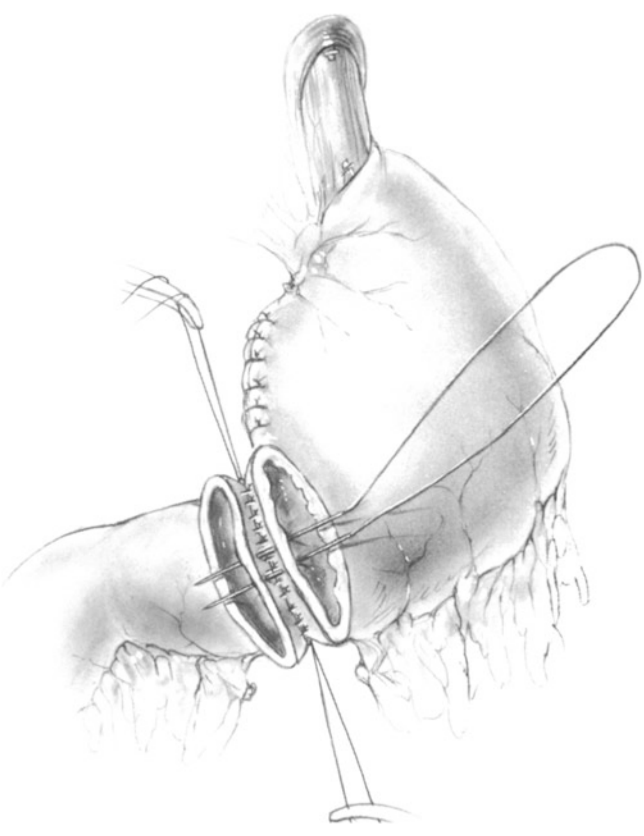


Fig. 24–18

bert sutures (**Fig. 24–17**). To prevent postoperative obstruction, care should be taken that an excessive amount of tissue is not inverted.

Remove the Allen clamp and approximate the mucosal layer by using a double-armed 4–0 PG suture, initiating it at the midpoint of the posterior layer where the knot is tied (**Fig. 24–18**). We prefer to use straight needles for this procedure. Take small bites, as a continuous locked suture is inserted (**Fig. 24–19**). Approximate the anterior mucosal layer with a continuous Connell or Cushing suture, which should be terminated at the middle point of the anterior layer (**Fig. 24–20**). This layer of sutures should be reinforced by a seromuscular layer of interrupted 4–0 silk Lembert sutures (**Fig. 24–21**). At the "angle of sorrow," where the Hoffmeister shelf of the gastric pouch meets the duodenal suture line at its lateral margin, insert a crown stitch by taking seromuscular bites of the anterior wall of the gastric pouch, then of the posterior wall of the gastric pouch, and then returning to catch the wall on the duodenal side (**Fig. 24–22**). If the sutures have been properly inserted, the lumen should admit the tip of the surgeon's thumb. Loosely suture omentum over the anastomosis.

Any bleeding points encountered in the cut edge

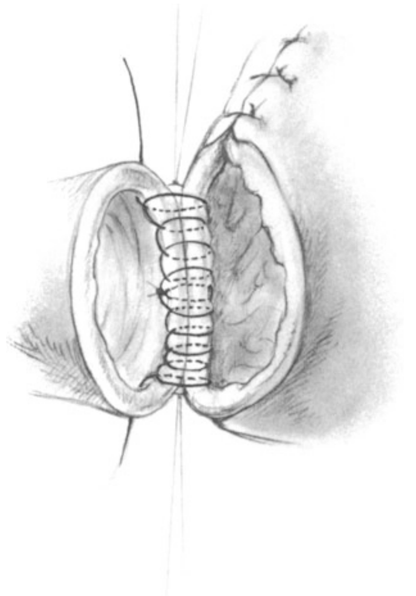


Fig. 24–19

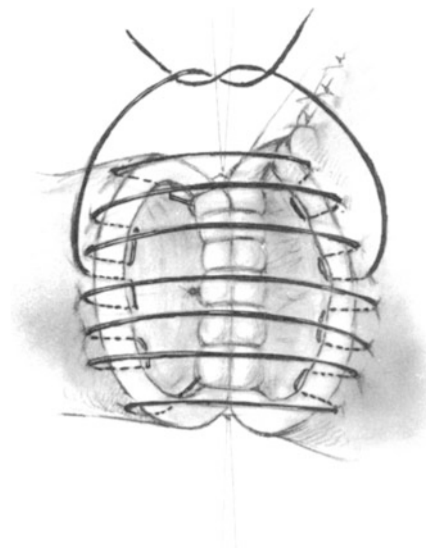


Fig. 24–20

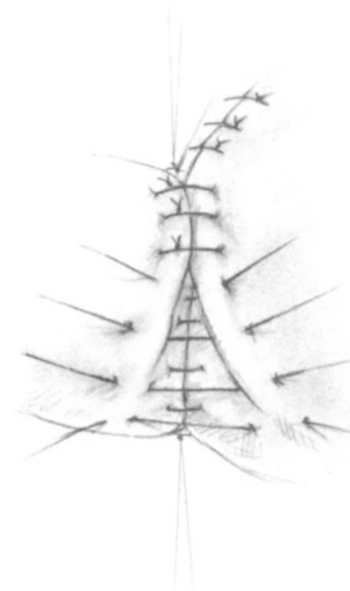


Fig. 24–21

of the stomach or duodenum during the above procedure should be occluded either by catgut suture-ligature or electrocoagulation.

Closure of Duodenal Stump

Closure of the healthy duodenal stump is generally accomplished by a layer of an inverting Connell suture of 4–0 PG supplemented by a layer of interrupted 4–0 silk Lembert sutures. Initiate the Connell suture by placing a half purse-string stitch at the right lateral margin of the duodenum. Continue this strand to the middle of the duodenal stump, and initiate a second strand of 4–0 PG at the left margin of the duodenal stump. Continue this also to the

Fig. 24–22

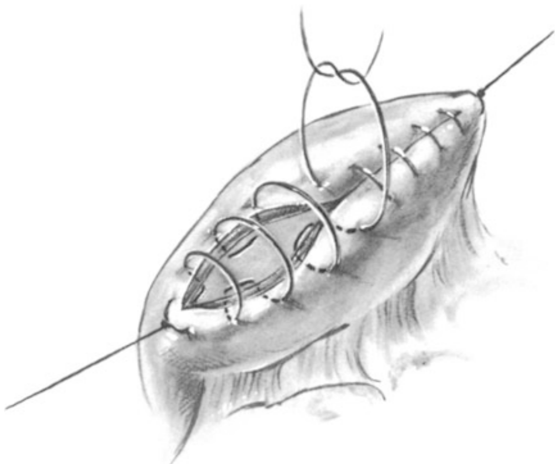


Fig. 24–23

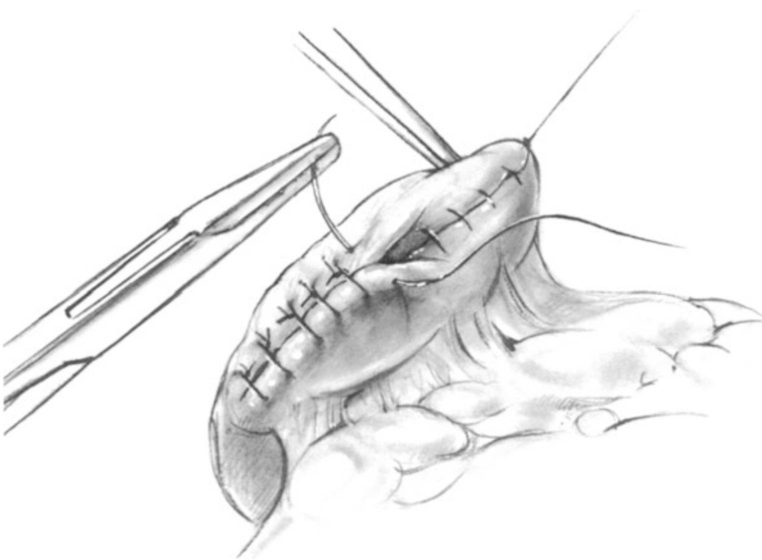


Fig. 24–24

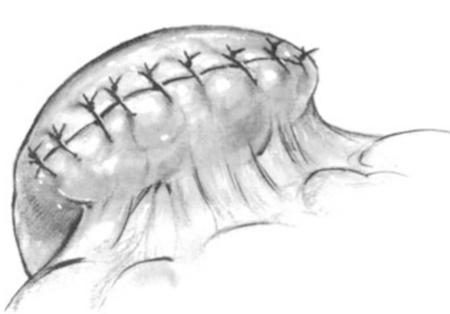


Fig. 24–25

middle of the stump, where it should be terminated by tying it to the first strand (**Fig. 24–23**).

Though it is simple to insert a layer of interrupted Lembert seromuscular sutures as a second layer when the tissues are not thickened (**Figs. 24–24 and 24–25**), suturing the fibrotic duodenum requires judgment and skill. If the stitch is placed deep, through the mucosa, and then tied with strangulating force, a fistula may result. Once a small leak occurs, the powerful duodenal digestive juices may erode the adjacent tissue—with disastrous results.

After the Connell suture has been completed, take a forceps and test the flexibility of the tissue by pushing down tentatively on the suture line. Manipulating the tissue in this manner increases the accuracy of one's judgment about the best place for the Lembert sutures. A common error is to insert the seromuscular Lembert stitch too close to the Connell suture line. If this is done with a pliable duodenum of normal thickness, no harm will result. However, sewing thick, fibrotic tissue into apposition without first sufficiently inverting the Connell suture line creates a lateral shearing force that will cause a small tear when the suture is tied (**Fig. 24–26a**). If the suture also penetrates the mucosa of the duodenum, this mishap, combined with excessive shearing force, may produce a duodenal fistula. The fistula can be prevented if the surgeon inverts the Connell suture line for a distance of 2–3 mm before placing the Lembert suture (**Fig. 24–26b**). If the duodenal serosa has a small tear after the Lembert suture is tied, either the above error (**Fig. 24–26a**) was committed or the suture was tied too tightly.

Dissection of Difficult Duodenum

If the posterior duodenal wall and adjacent pancreas are replaced by fibrosis, scalpel, rather than scissors, dissection should be used (**Fig. 24–27**). It is not necessary to apply hemostats when incising dense scar tissue, but it is important to keep the plane of dissection close to the posterior wall of the duodenum, thus avoiding trauma to the pancreas. When the dissection enters the posterior duodenum at the site of the penetrating ulcer, this "window" in the duodenum should be enlarged by an incision extending proximally from the ulcer toward the pylorus. The incision permits the surgeon's index finger to be inserted into the duodenal lumen. With the finger as a guide, dissection around the borders of the ulcer may be resumed.

It is obviously not necessary to remove the *base* of the ulcer durign this dissection. The base of the ulcer is really the anterior surface of the pancreas, which should not be disturbed. When the duodenum is dissected off the pancreas beyond the dense scar

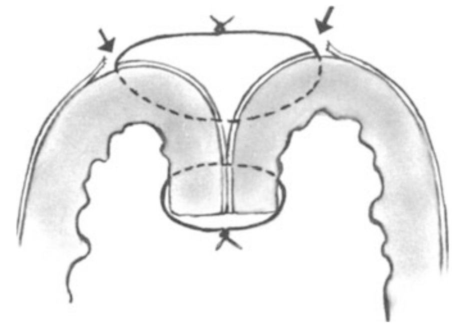


Fig. 24–26a

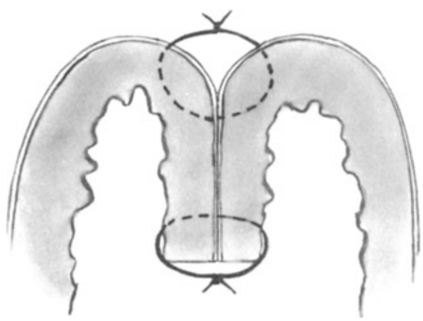


Fig. 24–26b

tissue, small hemostats may again be applied to the vessels on the pancreatic side. The vessels are then divided; any bleeding from the duodenum, which is generally minimal in the presence of fibrosis, can be ignored. If the dissection is successful, the caudal lip of the ulcer will be dissected away from the duodenum and, after a few more millimeters of dissection, the posterior duodenal wall may assume a fairly normal appearance. If at any point it appears that liberating the caudal lip of the ulcer is becoming dangerous, dissection should be discontinued and closure of the stump by the Nissen-Cooper technique (see below) carried out. Otherwise, 1.5 cm of posterior duodenal wall is liberated.

Another contraindication to further dissection of the caudal lip of the ulcer is contiguity of the ampulla of Vater. This should be checked by frequent palpation with the index finger in the duodenal lumen. After an adequate segment of posterior duodenum has been liberated, closure may be performed as described above (Figs. 24–23, 24–24, and 24–25).

When a posterior duodenal or pyloroduodenal penetrating ulcer involves the hepatoduodenal ligament, it may be necessary to identify the course of

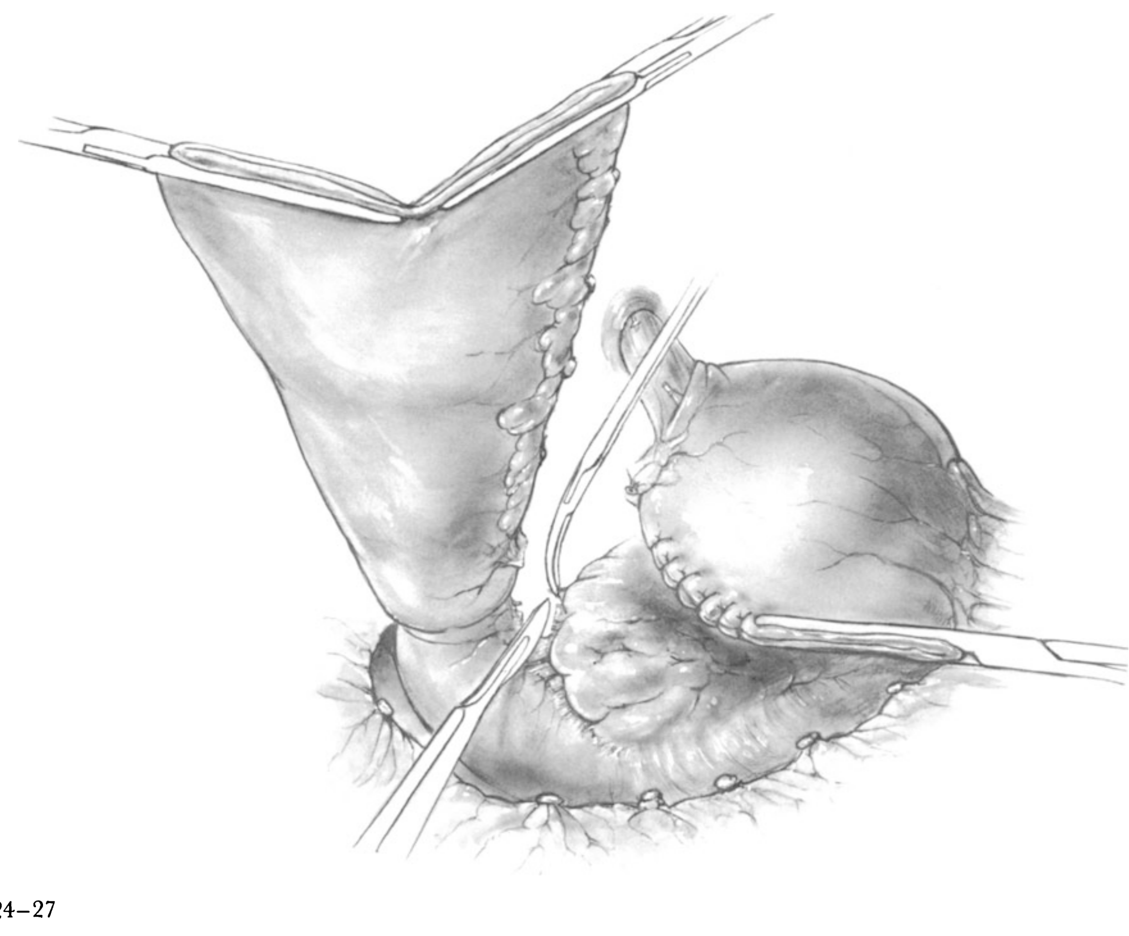


Fig. 24–27

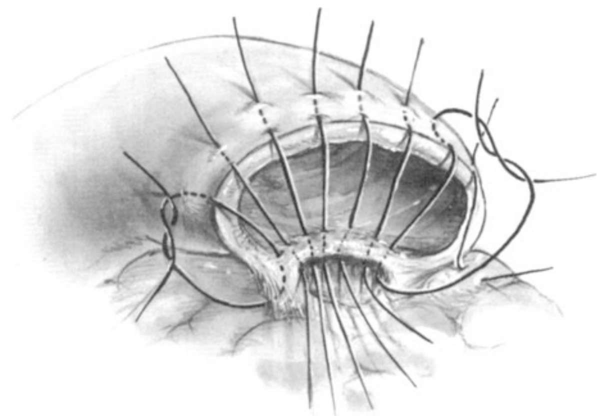


Fig. 24–28

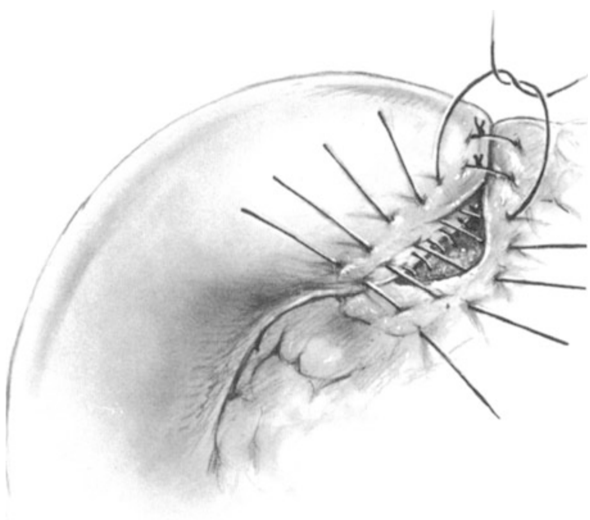


Fig. 24–29

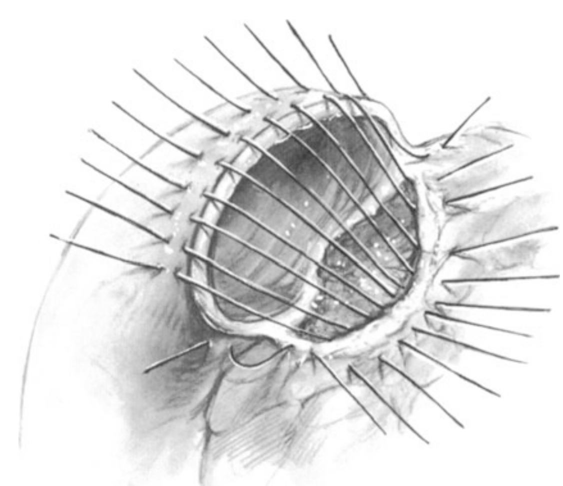


Fig. 24–30

the common bile duct. Make an incision in the proximal common bile duct, for the insertion of a 16F catheter or a No. 4 Bakes dilator, either of which should be passed down to the ulcer. By noting the location of the guide, one can avoid damaging the duct.

Closure of Difficult Stump by Nissen-Cooper Technique

When it is deemed hazardous to free the posterior duodenum beyond a callous ulcer, closure can be accomplished by inserting interrupted 4–0 silk Lembert sutures to attach the free anterior and anterolateral walls of the duodenum to the distal lip of the ulcer (**Fig. 24–28**). Use a second layer of Lembert sutures to invert the first suture line by suturing the pliable anterior wall to the proximal lip of the ulcer and to the adjacent pancreatic capsule (**Fig. 24–29**). Devised by Nissen and by Cooper, this technique was used extensively by Harrower. A variation of it (**Fig. 24–30**) involves inserting the first layer of sutures so as to attach the free anterior wall of the duodenum to the proximal lip of a large ulcer crater. This may be reinforced by a layer of Lembert sutures between the duodenum and adjacent pancreatic capsule. It is *essential* that the anterior wall of the duodenum be soft, pliable, and long enough for use in the Nissen-Cooper maneuver without causing tension on the suture line. A Kocher maneuver must be performed to liberate the duodenum for this type of closure.

Closure of Difficult Duodenal Stump—Duodenal Stenosis

Occasionally, chronic duodenal ulcer disease produces an annular stenosis at some point in the proximal 3–4 cm of the duodenum. If there is no active bleeding, it is safe to close a healthy duodenum proximal to an ulcer. On the other hand, it is unwise to attempt an inversion of the duodenal stump proximal to an area of marked stenosis. There simply is not enough room to invert the normal diameter of proximal duodenum into a stenotic segment. In such cases, the duodenum should be dissected down to the point of stenosis and perhaps 1 cm beyond (**Fig. 24–31**). It is then a simple matter to turn in the stenosed area. Usually only 3–4 interrupted Lembert sutures of 4–0 silk are required for each of the two layers because of their narrow diameter (**Fig. 24–32**).

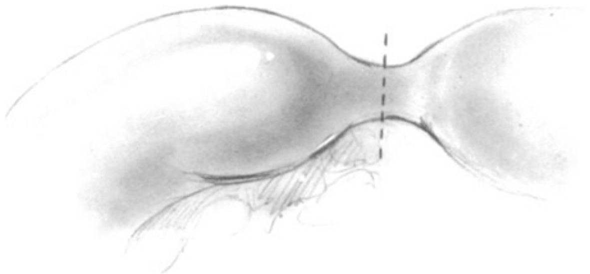


Fig. 24–31

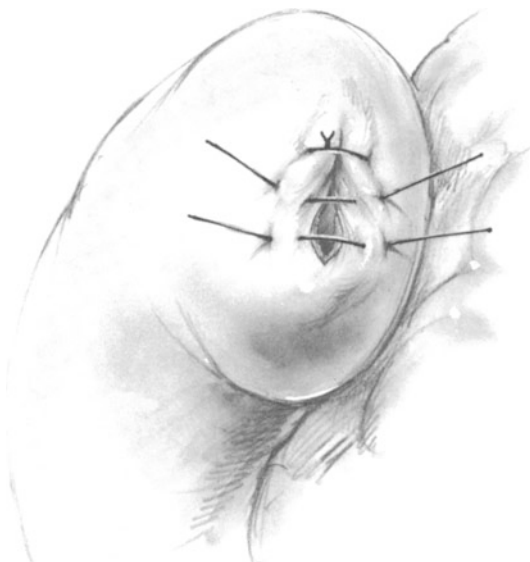


Fig. 24–32

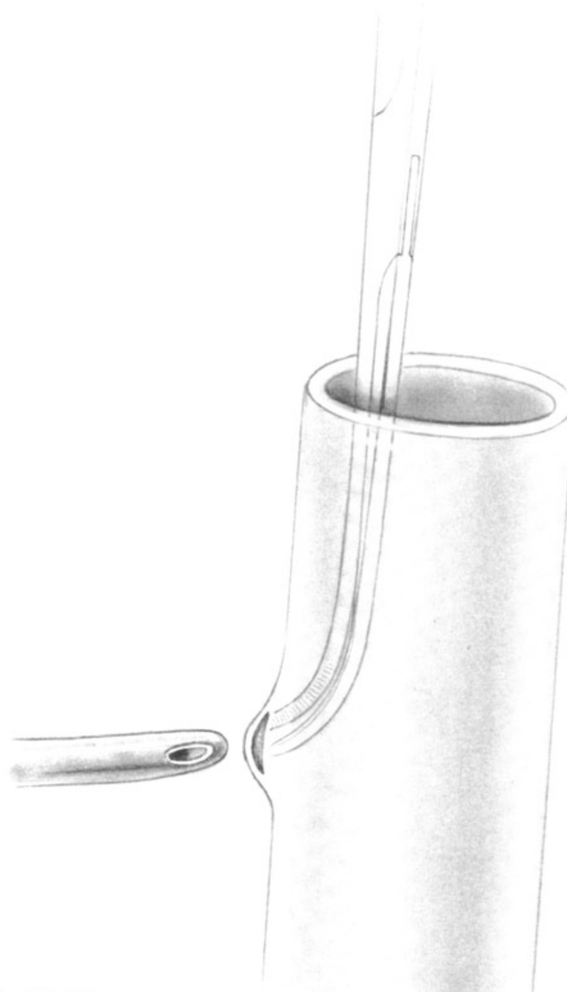


Fig. 24–33

Closure of Difficult Duodenal Stump—Catheter Duodenostomy

Surgeons at the Massachusetts General Hospital (as noted by Austen and Baue) and Parkland Hospital (as observed by Jones et al.) have reported their experience with catheter duodenostomy, which is designed to protect the integrity of a difficult duodenal stump closure. Properly performed, this technique, which prevents the buildup of intraluminal pressure against the newly sutured stump, has been surprisingly safe. If there is doubt about the integrity of the duodenal stump suture line, place a No. 14F whistle-tip or Foley catheter through a tiny incision in the lateral wall of the descending duodenum. This maneuver is easier to perform before the duodenal stump is closed. Pass a right-angled (Mixter) clamp into the open duodenum, press the tip of the clamp laterally against the duodenal wall, and make a 3-mm stab wound to allow the tip of the clamp to pass through the duodenal wall. Use the Mixter clamp to grasp the tip of the catheter and draw it into the duodenal lumen (**Fig. 24–33**). Close the incision around the catheter with a 4–0 silk purse-string suture. Wrap the catheter with omentum and bring it out through a stab wound in the abdominal wall, *leaving some slack* to allow for postoperative abdominal distention. Suture the catheter to the skin with heavy silk. In addition, bring a latex Penrose drain from the area of the duodenotomy out through a separate

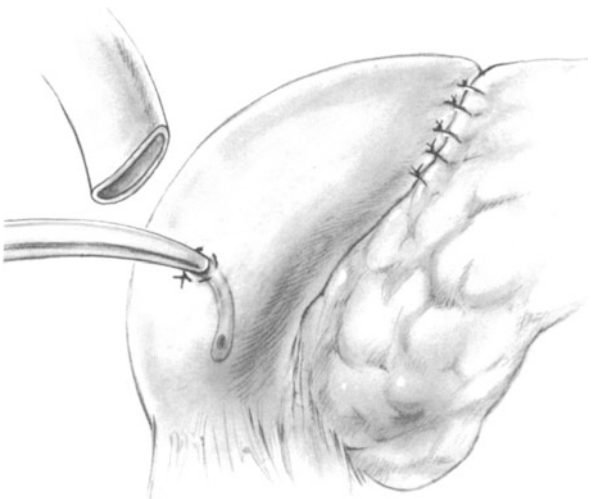


Fig. 24–34

stab wound in the lateral abdominal wall (**Fig. 24–34**).

There may be some occasions when the surgeon may find it impossible to invert the duodenal stump, even with the techniques described earlier. This should happen rarely, but if it does occur, the catheter may be placed directly in the stump of duodenum, which should be closed as well as possible around the catheter. The lateral duodenostomy is much to be preferred, however.

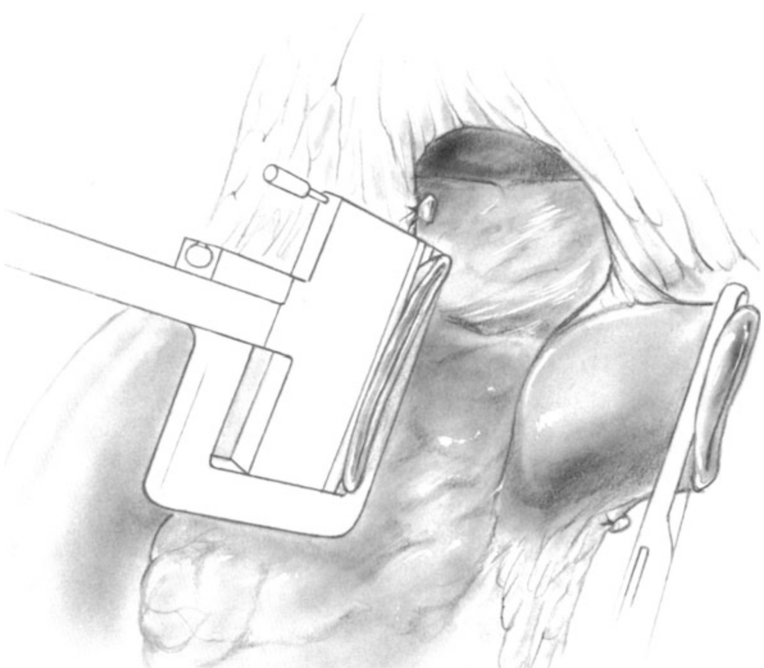


Fig. 24–35

Following the operation, place the catheter on low suction until the patient passes flatus, after which it is attached to a tube leading to a plastic bag for gravity drainage. The catheter should be irrigated twice each day with 5 ml of sterile saline. If the patient does well, the Penrose drain can be removed by the eighth postoperative day. Three days later partly withdraw the catheter so its tip lies just outside the duodenum. Low suction should be applied. If the volume of suction drainage does not exceed 100 ml per day, the catheter can be gradually withdrawn over the next day or two.

Duodenal Closure with Surgical Staples

If the duodenal wall is not thickened markedly with fibrosis or edema, and if an 8–10 mm width of duodenum is available, the stump may safely be closed by the use of the Auto Suture TA–55 stapling device. Apply the stapler to the duodenal stump before dividing the specimen. After the stapler has been fired, apply an Allen clamp on the specimen side and with a scalpel transect the stump flush with the stapling device (**Fig. 24–35**). Lightly electrocoagulate the everted mucosa of the duodenal stump before removing the stapling device. Ravitch et al. (see Chap. 4) see no need to invert this closure with a layer of sutures. Their experimental and clinical evidence shows that despite the eversion of duodenal mucosa in this type of closure, healing is essentially equal to that of the sutured duodenal stump. Generally, we cover the stapled stump with omentum or the pancreatic capsule with a few sutures, but do not invert the mucosa.

When the duodenal wall is at all thickened, the larger size (4.8 mm) staples should be used, as this reduces somewhat the degree of compression applied to the tissues by the stapling device. There should be blood circulation to the narrow rim of tissue that lies distal to the staple line. This is generally manifested by a slight oozing from the tissues despite the staples. It must be emphasized again: If the duodenal wall is so diseased that it probably would not heal if closed by sutures, stapling it will fail too.

Closure of Difficult Duodenal Stump by Billroth I Gastroduodenostomy

In the hands of an expert such as Nyhus, "If one can close the duodenum, one can anastomose to it." While it is not always necessary to liberate the *distal* lip of the ulcer crater, the duodenum should be dissected away from the pancreas at least to this point. The usual technique of gastroduodenal anastomosis,

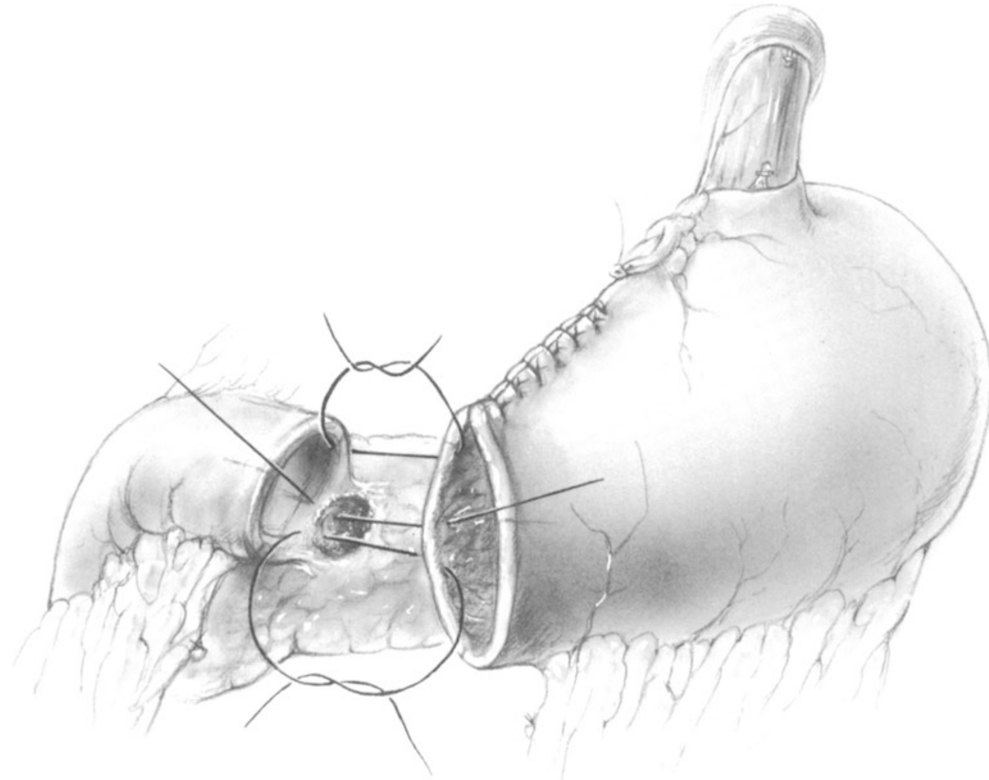


Fig. 24–36

as described in Figs. 24–17 though 24–22, must be modified. In the region of the ulcer crater only one posterior layer of interrupted 4–0 silk sutures should be inserted, taking a bite of stomach, of underlying fibrosed pancreas, and of the distal lip of the ulcer crater and duodenum, with the knot tied inside the lumen (**Fig. 24–36**). If the ulcer crater is so deep that the posterior anastomotic suture line will not be buttressed by the underlying pancreatic bed of the ulcer, the use of this technique may be hazardous. Because surgery for duodenal ulcer has declined in the past decade, fewer surgeons have had the opportunity to develop experience and judgment in managing the difficult duodenum. It is not wise for the inexperienced surgeon to perform a Billroth I anastomosis unless the above precautions are followed.

Billroth II Gastrojejunal Anastomosis

Although there are many variations in the technique of constructing Billroth II anastomoses, we have preferred a short loop antecolonic anastomosis of the Schoemaker-Hoffmeister type. It does not seem to matter whether the afferent segment of the jejunum is attached to the greater curvature of the gastric pouch or to the lesser curvature. The distance from the ligament of Treitz to the gastric pouch should be no greater than 12–15 cm. The major portions of the transverse colon and omentum should be brought to the patient's right for the antecolonic anastomosis.

The antimesenteric aspect of the jejunum should be scored by making a scratch line with a scalpel blade. Place the first posterior suture line posterior to but parallel with the scratch line. This assures that the stoma is accurately placed and may help prevent postoperative obstruction of the gastric outlet. Attach the jejunum to the gastric pouch with interrupted 4–0 silk seromuscular Lembert sutures

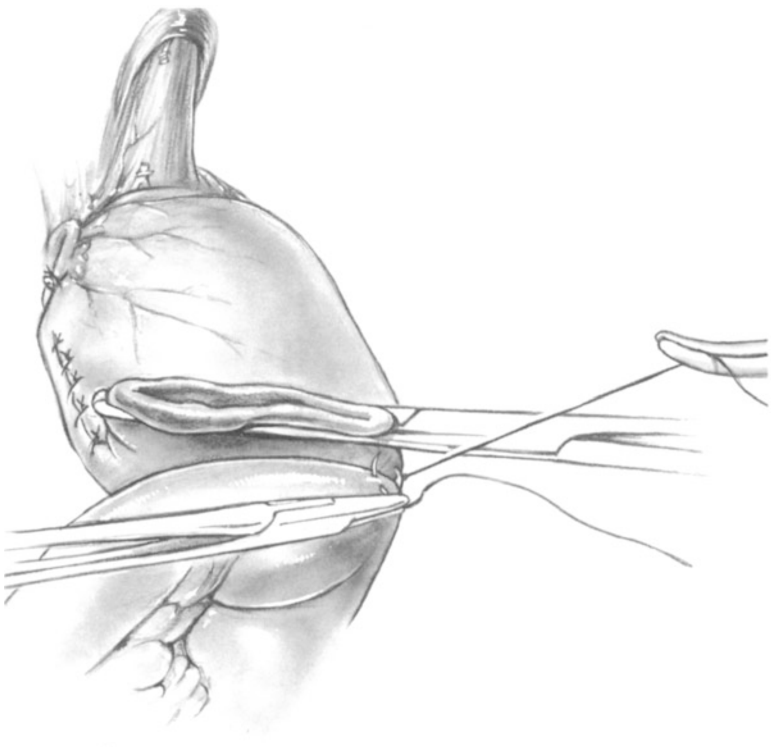


Fig. 24–37

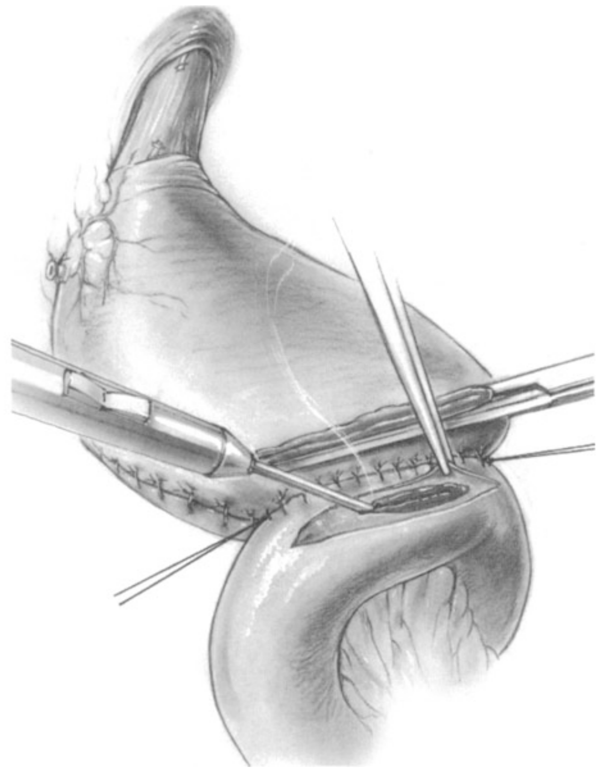


Fig. 24–39

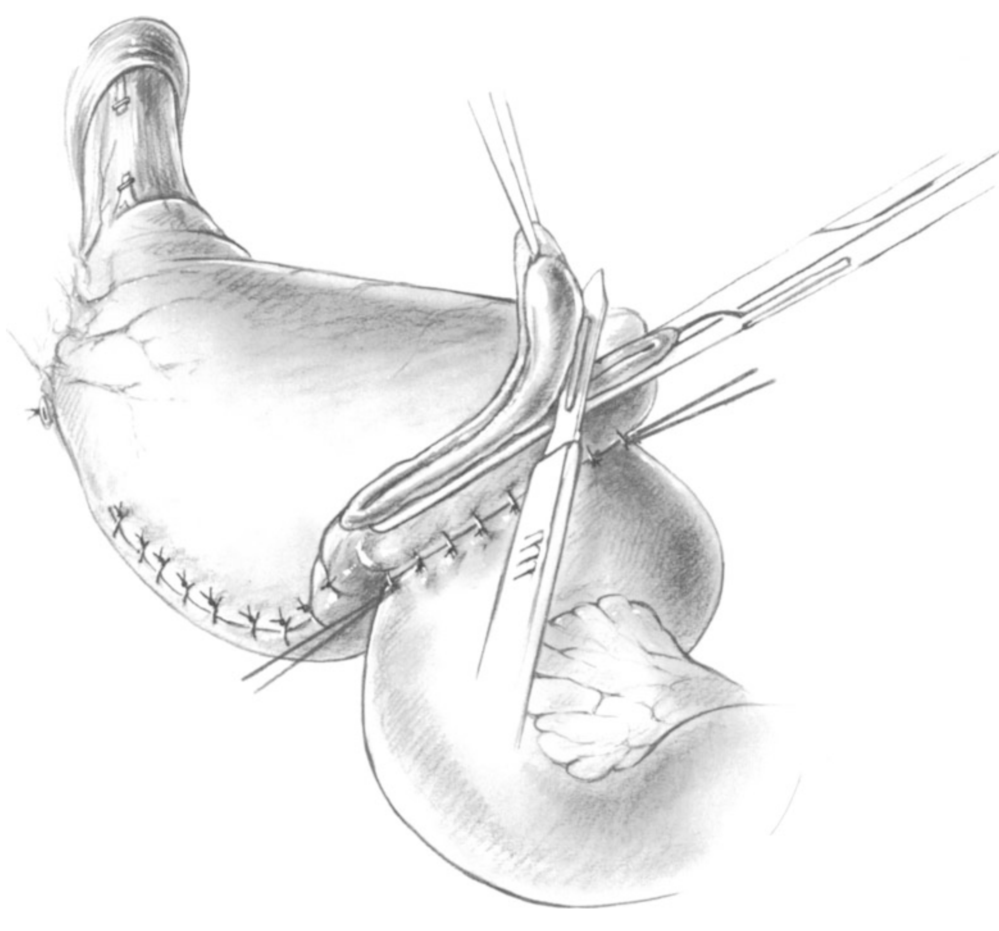


Fig. 24–38

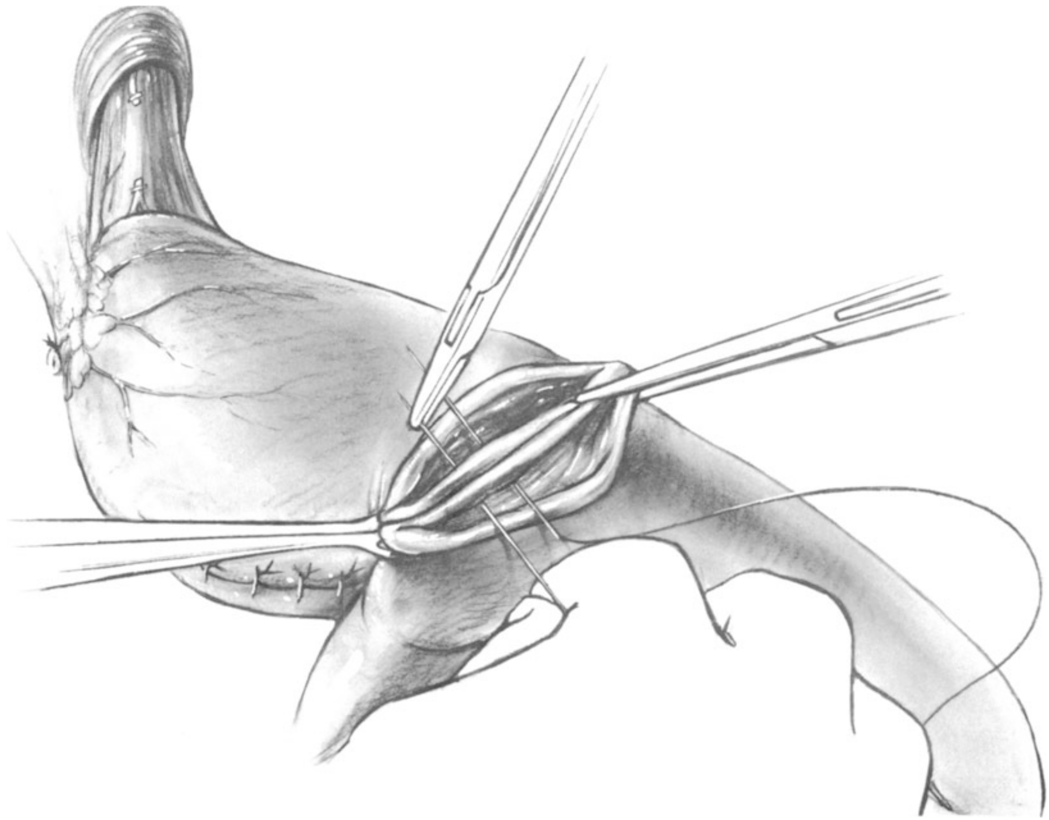


Fig. 24–40a

placed about 5 mm apart (**Fig. 24–37**). Attach hemostats to the first and last stitches which should be left long while all the remaining silk tails are cut.

If any gastric wall protrudes from the Allen clamp, remove the excess with a scalpel incision flush with the clamp (**Fig. 24–38**). Then use the electrocautery to make an incision along the antimesenteric scratch line in the jejunum. Open the mucosa of the jejunum (**Fig. 24–39**). Bleeding points may be controlled by electrocoagulation. The incision in the jejunum should be a few millimeters shorter than the diameter of the opening in the gastric pouch.

The Allen clamp then should be removed and the gastric pouch opened. Bleeding points on the anterior aspect of the gastric pouch must be carefully controlled by means of 4–0 chromic suture-ligatures or electrocoagulation. The posterior wall will be controlled by the mucosal locked suture. Initiate this suture at the middle point of the posterior layer with a double-armed 3–0 chromic catgut or PG suture, which should be inserted through the full thickness of the gastric and jejunal walls and tied (**Figs. 24–40a, 24–40b, and 24–40c**). Straight intestinal needles are preferred for this procedure. Start a continuous locked suture from the middle point and go first to the right and then to the left. Suturing is expedited if the first assistant grasps the straight needle with a straight hemostat, pulls it through the

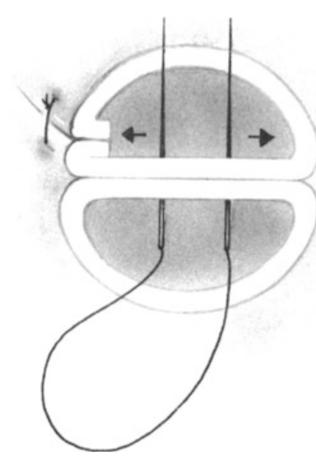


Fig. 24–40b

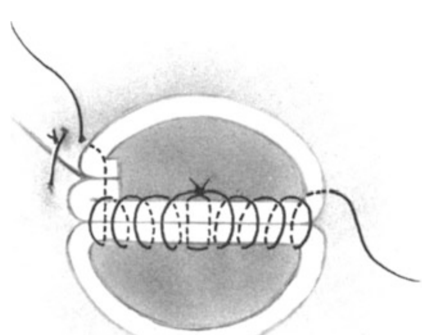


Fig. 24–40c

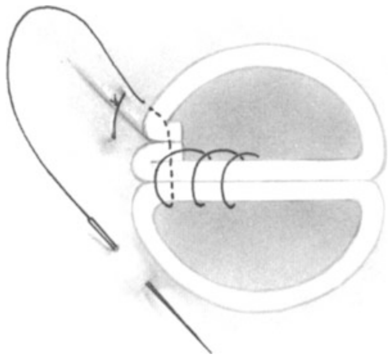


Fig. 24–41a

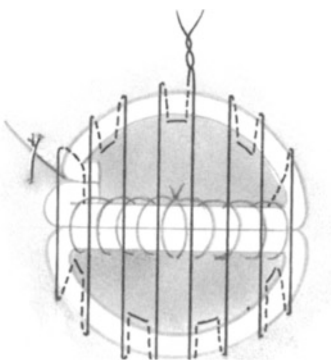


Fig. 24–41c

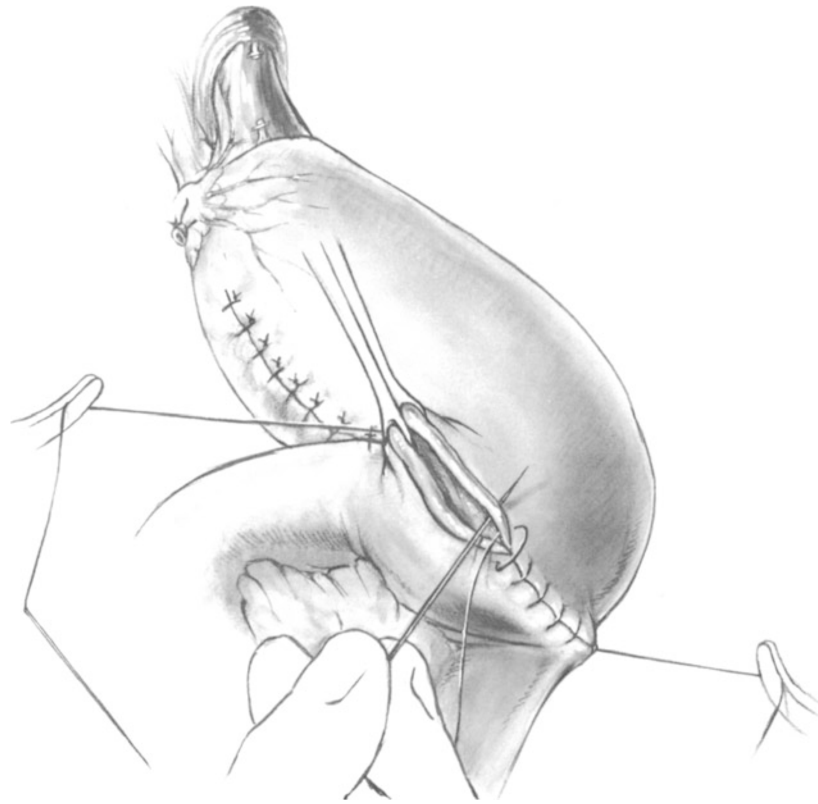


Fig. 24–41b

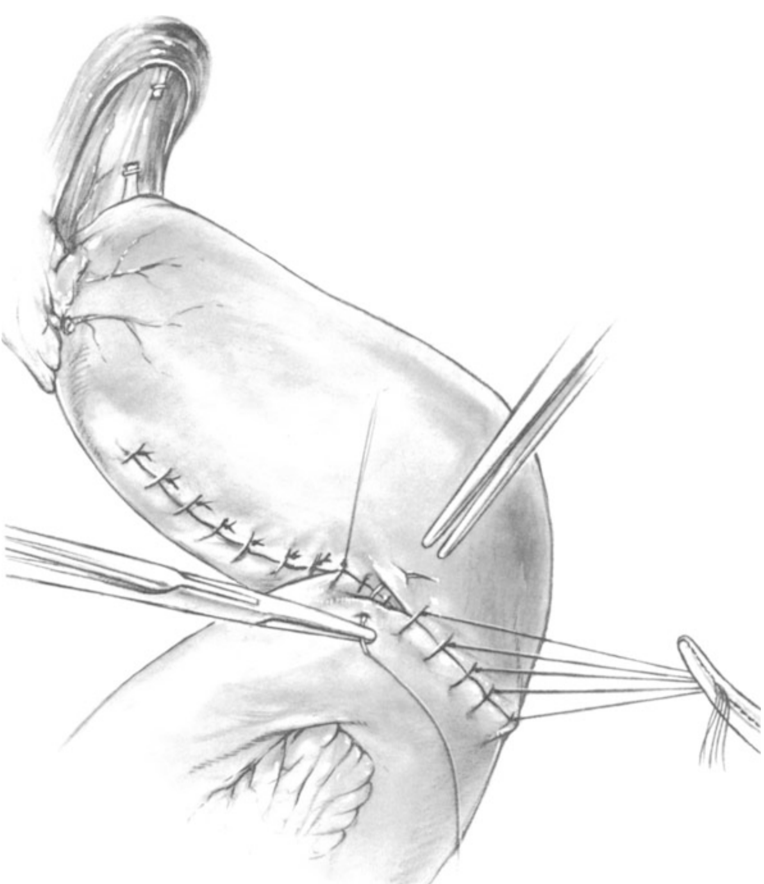


Fig. 24–42

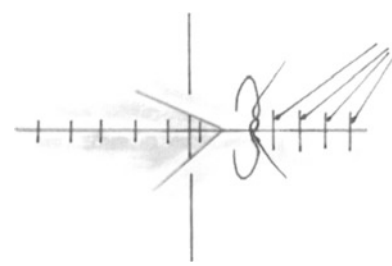


Fig. 24–41d

tissue, and then hands it back to the surgeon. Accomplish the anterior mucosal layer with the same straight needle by means of a continuous Connell or continuous Cushing suture. Initiate the suture line first at the right-hand margin of the anastomosis (**Fig. 24–41a**) and then on the left (**Fig. 24–41b**), working both needles towards the middle point, where the two strands should be tied to each other (**Fig. 24–41c**). Complete the anterior layer with a row of interrupted 4–0 silk seromuscular Lembert sutures (**Figs. 24–41d and 24–42**) on curved needles. At the medial margin of the anastomosis, the "angle of sorrow," insert a crown stitch (**Fig. 24–43**). Occasionally, two crown sutures are inserted for added security.

In the poor-risk patient, to minimize anesthesia time the seromuscular suture layer should be in-

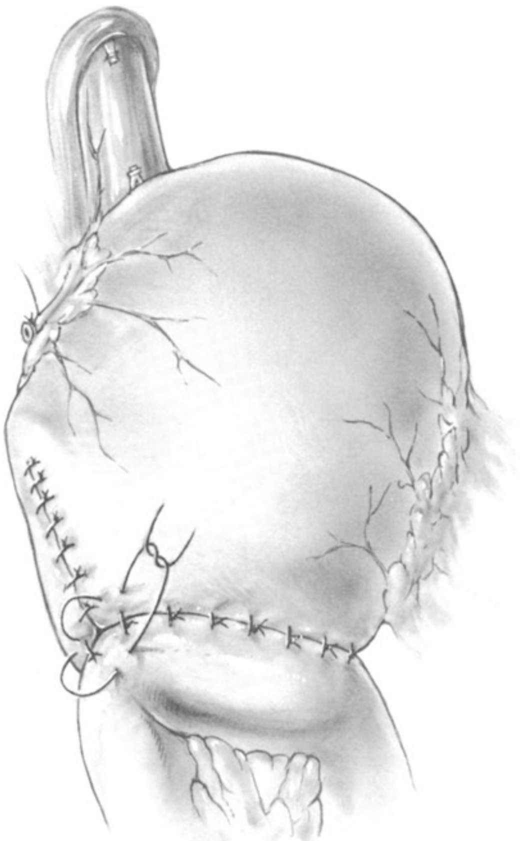


Fig. 24–43

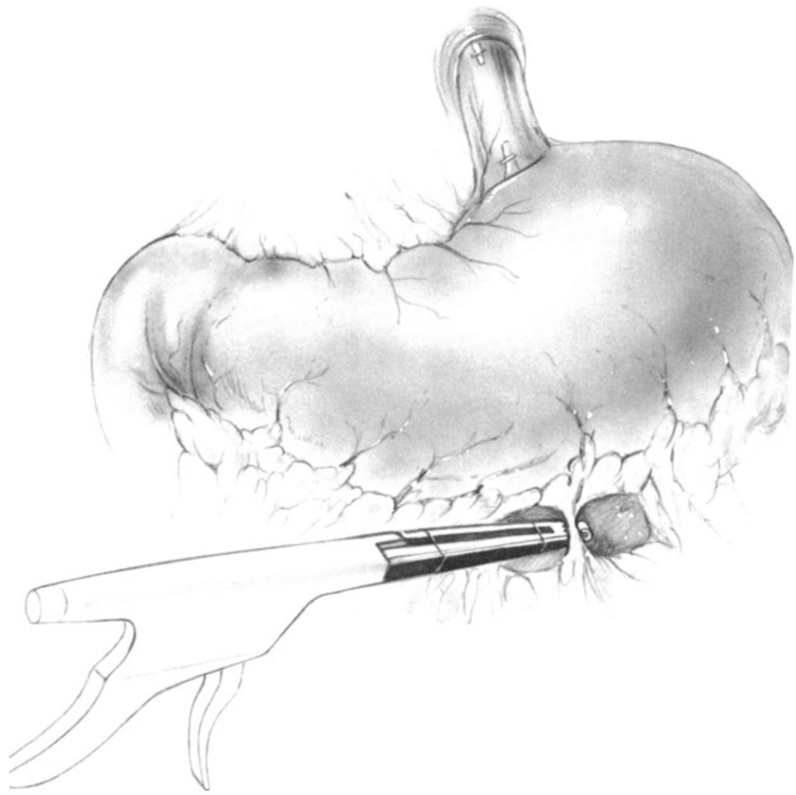


Fig. 24–44

serted in over-and-over continuous Lembert fashion using 3–0 PG instead of interrupted silk. The mucosal layer may be closed by the same technique as described above. When this anastomosis is performed with care, there seems to be no disadvantage to the use of a continuous PG seromuscular suture.

Billroth II Gastrojejunal Anastomosis by Stapling Technique

Isolate the vasa brevia along the greater curvature individually by passing a Kelly hemostat behind the vessels. Then one may use the LDS instrument to divide the vessels and to apply stainless steel clips to both cut ends simultaneously (**Fig. 24–44**). When stapling is used, it is not necessary to close the lesser curvature as a separate step. Instead, apply a TA–90 stapler across the entire stomach, tighten it and fire (**Fig. 24–45**). The 4.8-mm staples are used for this purpose. A large Payr clamp should be applied to the specimen side of the stomach, and the stomach divided flush with the TA–90 by a scalpel. Lightly electrocoagulate the everted mucosa and remove the TA–90 device. Close the duodenal stump by stapling

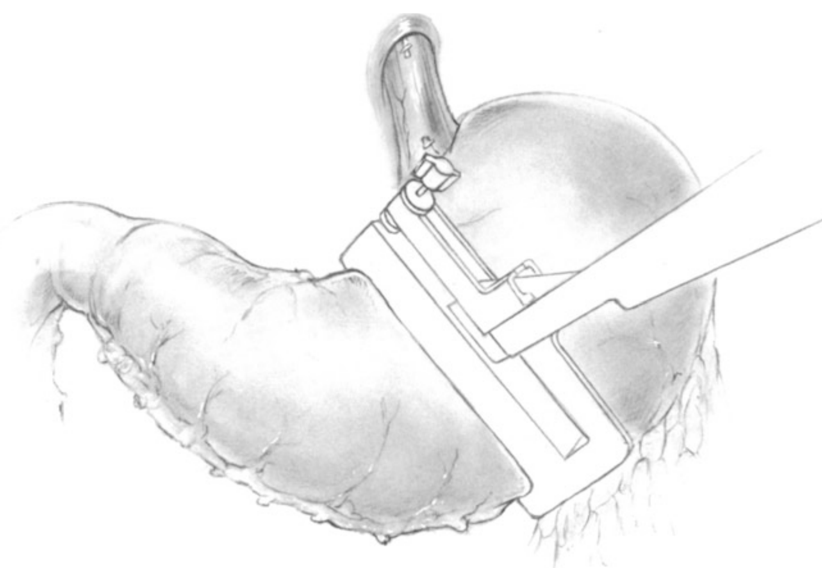


Fig. 24–45

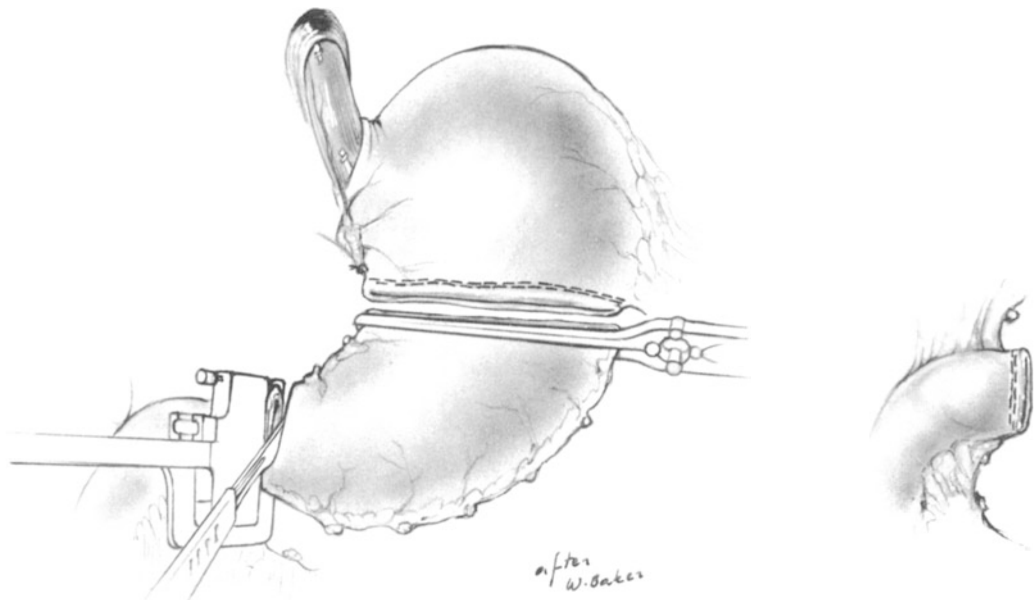


Fig. 24–46

with the TA–55 device, and remove the specimen (**Fig. 24–46**).

It is imperative that the nasogastric tube not be permitted to lie anywhere in the vicinity of the staple line during this step. If the nasogastric tube gets trapped in the gastric staple line, it will not be possible to remove the tube postoperatively without another laparotomy.

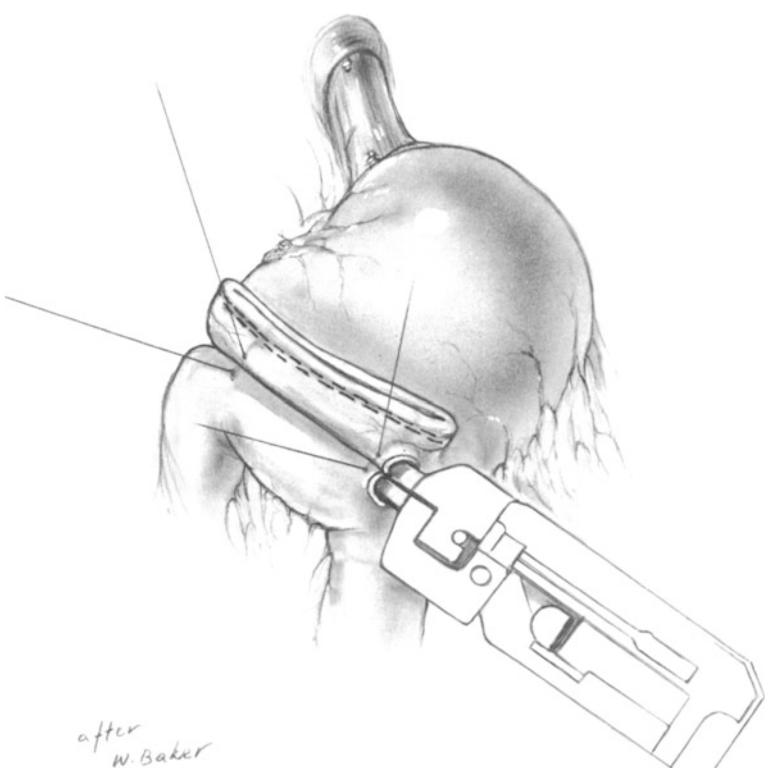


Fig. 24–47

Next identify the ligament of Treitz and bring a segment of proximal jejunum in antecolonic fashion to the greater curvature side of the gastric pouch. Approximate the antimesenteric border of the jejunum with a 4–0 silk suture to a point on the greater curvature of the stomach about 2 cm proximal to the TA–90 staple line. Make small stab wounds in the gastric pouch and the jejunum adjacent to this suture and just deep to it. Then insert the GIA stapling device so that one fork enters the gastric pouch parallel to the TA–90 staple line and the other fork enters the jejunum and is placed exactly along the antimesenteric border (**Fig. 24–47**). Care should be taken that no other organ or tissue is permitted to intrude between the stomach and jejunum being grasped by the GIA device. When the GIA stapler has been inserted to the 4-cm or 5-cm mark, close and lock the device (Fig. 24–47). Then reinspect the area. There should be a width of 2 cm of posterior gastric wall between the TA–90 staple line and the GIA staple line. Also, the gastric and jejunal tissues should be exactly apposed to each other in the hub of the GIA device. At this point fire and remove the GIA.

Apply an Allis clamp to the anterior termination of the GIA staple line and another to the posterior termination of the same staple line. Carefully inspect the mucosal surface of the GIA anastomosis for bleeding, as arterial spurting from the gastric wall may occur occasionally. If this should happen, transfix the vessel with a fine chromic or PG suture-ligature.

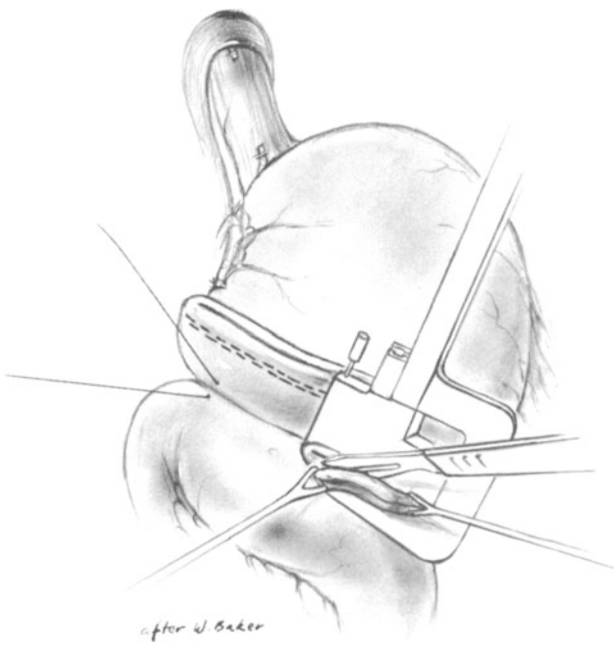


Fig. 24–48

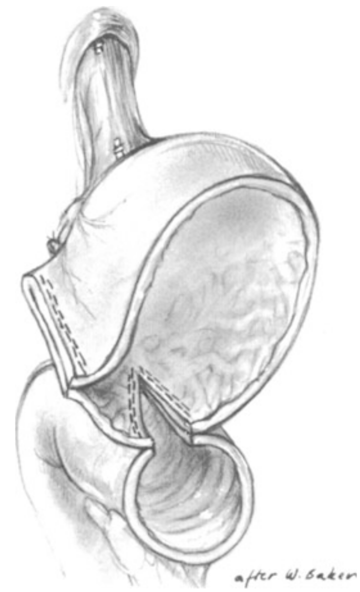


Fig. 24–50

Lesser bleeding may be controlled by cautious electrocoagulation. On rare occasions there may be multiple bleeding points: The entire mucosal suture line should then be oversewn with a locked continuous suture of 4–0 PG. The needle must be inserted deep to the staples in performing this maneuver. This should be necessary in no more than 1% or 2% of all cases.

After hemostasis is assured, approximate the gastric and jejunal layers of the open stab wounds in an everting fashion with several Allis or Babcock clamps. Close the defect with one application of a TA–55 stapler deep to the line of Allis clamps (**Fig. 24–48**). *This staple line must include the anterior and posterior terminations of the GIA staple line*, guaranteeing that there will be no defect between the two lines of staples. Excise the redundant tissue, lightly electrocoagulate the everted mucosa, and remove the TA–55 device. Alternatively, the stab-wound defect may be closed in an inverting fashion by various suturing techniques. Then place a single 4–0 silk seromuscular suture at the right termination of the gastrojejunal GIA anastomosis (**Fig. 24–49**). Palpation of the gastrojejunal stoma should admit two fingers. A three-dimensional diagram of the anastomosis is shown in **Fig. 24–50**.

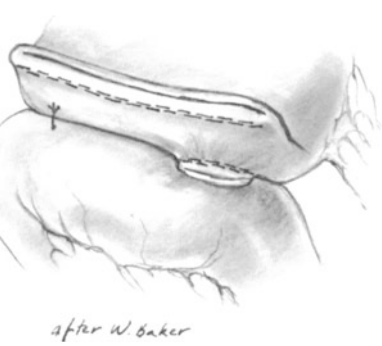


Fig. 24–49

Drainage, Irrigation, and Closure

To reduce the incidence of postoperative wound infection, especially when gastrectomy has been undertaken in the presence of active hemorrhage or to correct a long-standing gastric outlet obstruction, the abdominal cavity as well as the subcutaneous tissues should be irrigated thoroughly with an antibiotic solution.

In Billroth II operations, whenever the surgeon thinks that a duodenal closure is less than perfect, a closed-suction drain should be brought out from the vicinity of the duodenal stump through a stab wound in the right upper quadrant. The drain should be separated from the actual duodenal suture line by a layer of omentum. Accomplished this way, drainage does no harm to the patient. Close the abdominal wall in the usual fashion, after taking pains to assure that the efferent limb of the jejunum descends freely and without any kinks.

Postoperative Care

Nasogastric suction should be continued for several days.

Oral intake can be resumed when there is evidence of bowel function. For the first 4–6 weeks following gastric resection the composition of the diet should be low in carbohydrates and fluids and high in protein and fat, so as to reduce the osmolarity of the meals. Liquids should largely be eliminated from meals and be consumed beginning one hour after meals. Very sweet drinks should be avoided. If this course is followed, the transitory dumping symptoms, which many patients have in the early postgastrectomy period, will be eliminated. Generally, after 4–6 weeks most patients can take an unlimited diet.

Complications

Duodenal Fistula

In the presence of an adequate drain, the appearance of duodenal content in the drainage fluid without any other symptoms may not require vigorous therapy. On the other hand, if there are signs of spreading peritoneal irritation, prompt relaparotomy is indicated. If no drain was placed during the initial operation, immediate relaparotomy should be undertaken whenever there is reason to suspect duodenal leakage. On *rare* occasions, relaparotomy can be performed before the intense inflammatory reaction of the duodenal tissues occurs, and the defect may be closed by suture. This is very seldom possible, however. If suturing of the virgin duodenum at the first operation was not successful, an attempt at secondary suturing will fail unless considerable additional duodenum can be freed from the pancreas for a more adequate closure. In most cases the operation is done to provide excellent drainage. A small sump-suction drain should be inserted into the fistula and additional latex and sumps placed in the area. If a controlled duodenocutaneous fistula can be achieved, this will generally close after a few weeks of total parenteral nutrition. Prescribing somatostatin to reduce duodenal and pancreatic secretion is also helpful.

Leaks from Billroth I gastroduodenal anastomoses, while rare, are even more serious than from duodenal stump (Billroth II) procedures. Generally they should be treated by the Graham technique of closing a perforated duodenal ulcer with a segment of viable omentum (see Figs. 24–2 and 24–3). Multiple sump drains should also be inserted.

Acute Pancreatitis

This serious complication can best be avoided by preventing trauma to the pancreas during the initial operation. Therapy here is identical with that for acute pancreatitis in the patient who has not undergone an operation.

Gastric Outlet Obstruction

In the gastroduodenal anastomosis, obstruction is generally due to the inversion of too much tissue, which produces a mechanical block. If this condition does not respond after a period of conservative treatment, reoperation to convert to a Billroth II anastomosis will probably be necessary.

Be aware that Billroth II gastrojejunal anastomosis occasionally develops an outlet obstruction which appears to be due to a malfunction of the efferent loop of the jejunum. This diagnosis can be confirmed by inserting a gastroscope well into the efferent and afferent limbs of jejunum, which demonstrates the absence of any mechanical stomal obstruction. Relaparotomy in these cases is of no value. Generally, a period of several weeks of conservative treatment with total parenteral nutrition will be successful. We managed one patient by inserting a 3-mm plastic nasogastric feeding tube. We passed this tube into the efferent jejunal loop for a distance of 10–12 cm. Continuous infusion of a blenderized diet was well tolerated by the patient for a period of 8 weeks, at the end of which time she had achieved complete recovery of function.

Bilious Vomiting Syndrome

Toye and Williams have described an unusual syndrome following Billroth II gastrectomy: Patients are able to eat a satisfactory diet but are afflicted by episodes in which they vomit clear bile not accompanied by ingested food. Sometimes these episodes do not occur until several years after the operation. The patients tend to remain well nourished. They do not experience pain after meals, as seen in alkaline gastritis. The syndrome appears to result from the gastric pouch's intolerance of the bile that enters from the afferent loop. This bile is promptly ejected by the stomach while ingested food remains undisturbed. There is no obstruction or malfunction of the afferent loop in these cases. This condition can be corrected surgically by using the technique illustrated in **Figs. 24–51 and 24–52**.

Transect the afferent limb of jejunum just at its point of entry into the gastric pouch. Use a TA-55 stapler to close the gastric side of the jejunum. Then anastomose the open end of the afferent segment to the side of the efferent segment of the jejunum. This

Fig. 24–51

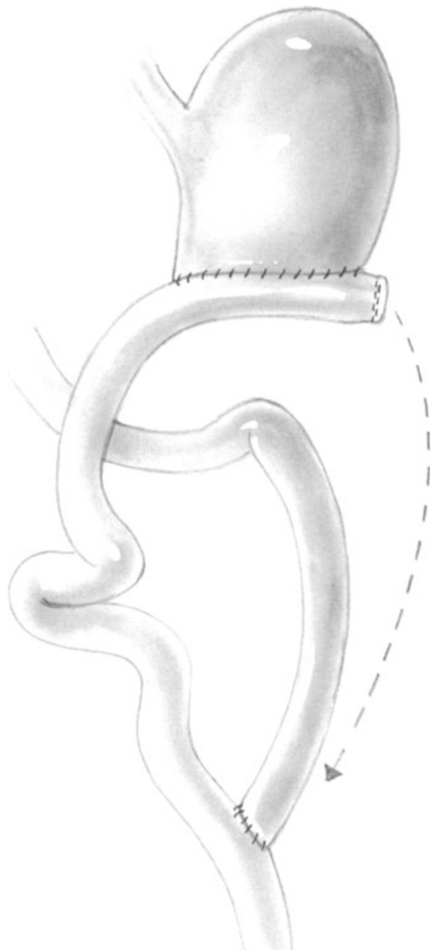


Fig. 24–52

anastomosis should take place at a point 60 cm distal to the gastrojejunostomy. It converts the efferent limb of the jejunum into a Roux-en-Y configuration. Vagotomy is necessary to prevent marginal ulceration following this type of Roux-en-Y anastomosis.

It is essential that the gastric pouch drain efficiently into the jejunum by gravity. Otherwise, serious gastric stasis may result, according to Gowen, who has written a careful review on this subject.

Alkaline Gastritis

The entrance of bile and other duodenal secretions into the gastric pouch sometimes results in severe gastritis accompanied by superficial ulcerations, metaplasia of the gastric mucosa, weight loss, and severe pain that is accentuated by eating. Alkaline gastritis may occur after the pylorus has been bypassed, removed, or rendered ineffective by pyloroplasty. Occasionally it is seen in a patient who has not been operated on but has a patulous pyloric sphincter.

After the diagnosis has been confirmed by endoscopy and biopsy, surgical relief can be obtained by total diversion of the bile and duodenal contents from the gastric pouch, as described above in the discussion of bilious vomiting. Unfortunately, only about 50% of such patients achieve complete relief. Also see Chap. 14.

Silen asserts that he has never encountered a case of reflux gastritis, bilious vomiting, or bacterial overgrowth in the afferent loop after Billroth II gastrectomy in which the afferent jejunum was attached to the lesser curvature side of the gastric remnant.

Afferent Loop Syndrome

For many years the symptoms discussed under bilious vomiting and alkaline gastritis were attributed to intermittent afferent loop obstruction. It was hypothesized that a partial obstruction at the entrance of the afferent jejunum into the gastric pouch resulted in the accumulation of bile and duodenal contents under pressure in the afferent jejunum. Suddenly, it was alleged, the jejunum expelled its contents forcefully into the gastric pouch, which resulted in vomiting. This mechanism must be extremely rare, however. Patients who experience bilious vomiting syndrome and alkaline gastritis do not exhibit a dilated afferent loop: nor is there evidence of an obstructed afferent stoma in these cases.

On the other hand, complete mechanical blockage of the afferent stoma often accompanied by jejunogastric intussusception does result in an acute closed-loop obstruction, manifested by excruciating upper abdominal pain and retching. Gastrointestinal X rays at this moment will show a complete block at the afferent stoma, which can be confirmed by endoscopy. This situation is a surgical emergency, for if the distended afferent loop bursts lethal peritonitis will result. Obviously, emergency surgery for the correction of the obstruction is essential. When X rays reveal no dilatation of the afferent loop, and no other evidence of organic stomal obstruction can be discovered, afferent loop malfunction is probably not the cause of the patient's symptoms.

One cause of acute afferent stomal obstruction is jejunogastric intussusception, another condition that may require emergency surgical correction. This diagnosis can be confirmed by endoscopy.

Most afferent loop symptomatology can be prevented by assuring that the distance between the ligament of Treitz and the gastric pouch is never more than 12–15 cm. Enthusiasts of the Billroth I gastrectomy are quick to point out that gastroduodenostomy averts this group of complications.

Internal Hernia

Herniation of the small bowel into the antecolonic jejunal loop has been reported following antecolonic Billroth II gastrojejunal anastomoses. This complication is quite rare and has never been observed by us, but it does make another argument in favor of gastroduodenostomy.

Dumping Syndrome

Much has been written about the "dumping syndrome," which may occur in any patient whose pylorus has been rendered nonfunctional. It is more common in the patient who has an asthenic habitus and who has never achieved normal body weight, even before surgery. These patients should probably be subjected to a proximal gastric vagotomy rather than gastrectomy, even if the recurrence rate of duodenal ulcer is higher after this operation than after vagotomy–antrectomy. When dumping does occur, the best therapy is a low-carbohydrate, high-protein, high-fat diet, in which fluid is not permitted during mealtime. As Sawyers and Herrington have pointed out, *rarely* is a patient so disabled by dumping as to require the interposition of an antiperistaltic jejunal segment between the gastric pouch and the remainder of the alimentary canal.

Postvagotomy Diarrhea

Postvagotomy diarrhea appears to be rare in this region of the world, even after a truncal vagotomy. When diarrhea occurs, a complete investigative study to rule out other causes of this condition, such as nontropical sprue, should be carried out. Sawyers has reported some success in the control of intractable diarrhea by placing a reversed segment of the jejunum about 100 cm down from the ligament of Treitz.

Recurrent Ulcer

Recurrent peptic ulcer following a gastrectomy is often the result of the surgeon's having overlooked the right vagus trunk during a vagotomy or having failed to perform a vagotomy in a case of duodenal ulcer. Another cause of recurrent ulcer is the surgeon's having left behind gastrin-secreting antral mucosa on the duodenal stump following a Billroth II gastrectomy. An ulcer will rarely recur because some residual antral mucosa was left behind in the gastric pouch. Here the secretion of gastric acid, even though subnormal following a vagotomy, is sufficient to suppress the secretion of gastrin. Yet another important cause of recurrent ulcer is the Zollinger-Ellison syndrome, which the surgeon may have overlooked during the diagnostic study of the peptic ulcer before the operation.

Malabsorption

Smith and Jeffries have made the following observations about malabsorption:

Anemia may be caused by inadequate iron absorption. Folic acid and vitamin B_{12} deficiencies also may develop on rare occasions following gastrectomy.

Another late complication is osteomalacia or osteoporosis caused by poor calcium or vitamin D absorption.

Steatorrhea and diarrhea develop in some cases and may contribute to malnutrition. These cases should be studied for the presence of gluten enteropathy, which may be unmasked by the gastrectomy.

Although almost all the early complications are manageable, the occurrence of malabsorption and malnutrition many years after a gastrectomy is quite difficult to treat. Following a 40%–50% gastrectomy, these complications seem to be very rare, however. It is not certain that vagotomy and pyloroplasty are devoid of these late complications.

References

Austen WG, Baue AE. Catheter duodenostomy for the difficult duodenum. Ann Surg 1964;160:781.

Berne CJ, Rosoff L. Peptic ulcer perforation of the gastroduodenal artery complex. Ann Surg 1969;169:141.

Chassin JL. Pros and cons. Surg Gynecol Obstet 1978; 146:619.

Gowen GF. Delayed gastric emptying after Roux-en-Y due to four types of partial obstruction. Ann Surg 1992;215:363–367.

Harrower HW. Closure of the duodenal stump after gastrectomy for posterior ulcer. Am J Surg 1966;111:488.

Jones RC et al. Difficult closures of the duodenal stump. Arch Surg 1967;94:696.

Nyhus LM, Wastell C. Surgery of the stomach and duodenum. Boston: Little, Brown; 1977:368.

Sawyers JL, Herrington JL Jr. Superiority of antiperistaltic jejunal segments in management of severe dumping symptoms. Ann Surg 1972;178:311.

Silen W. Surgical treatment for a surgically induced disease. Surgery Alert 1989;6:9–10.

Smith FW, Jeffries GH. In: Sleisinger MH. Fordtran JS. Gastrointestinal disease. Philadelphia: Saunders; 1973:826.

Toye DKM, Williams JA. Post-gastrectomy bile vomiting. Lancet 1965;2:524.

25 Perforated Peptic Ulcer

Concept

Perforated Gastric Ulcer

Not all free perforations of gastric ulcers are susceptible to simple plication techniques. Often the ulcer is quite large and surrounded by edema. When the perforation occurs on the posterior surface of the antrum, adequate repair by plication techniques is generally not possible. Also, gastric ulcers have a high rate of recurrence. For these reasons, in a good-risk patient, in whom the diagnosis of perforation has been made reasonably early, gastric resection is *preferred* to simple plication. If for technical reasons a sound plication cannot be constructed, then gastric resection is *mandatory*, regardless of the risk, as a recurrent gastric leak into the peritoneal cavity is almost always fatal.

Perforated Duodenal Ulcer

If a perforated duodenal ulcer is treated with a simple closure, about one-third of the patients will remain nonsymptomatic. Perhaps two-thirds will develop recurrent ulcer symptoms, and one-half of these will require definitive surgery at a later date.

In the good-risk patient who comes to the operating room within 8 hours of the first sign of perforation, vagotomy and antrectomy or pyloroplasty has proved to be a safe operation, according to Jordan and associates (1966). Consequently, in middle-aged patients, especially males, who have a history of chronic *duodenal ulcer symptoms*, a definitive operation including vagotomy and antrectomy or pyloroplasty or proximal gastric vagotomy is indicated unless the peritoneal insult is severe or shock has occurred.

One category of patients in whom vagotomy and antrectomy should be done if possible are those whose perforation is accompanied by acute bleeding. These patients have a posterior penetrating ulcer as well as the anterior perforation. They experience a high mortality rate unless a definitive operation is accomplished early.

Whether to do a plication or a definitive operation on good-risk patients whose duodenal ulcer perforations are fresh and who have had *no prior ulcer symptoms* is a controversial matter, because 50% of these patients may never need further definitive surgery if simple plication is done. The long-term ill effects of pyloroplasty or antrectomy are avoided if plication is combined with a proximal gastric vagotomy. Plication with proximal gastric vagotomy may well be the ideal treatment for these patients. Jordan (1989) performed proximal gastric vagotomy and applied omental patches in 91 patients suffering from perforation of duodenal (86) and pyloric or prepyloric (5) ulcers. No patient was selected for vagotomy if he suffered from shock, systemic sepsis, or any major medical risk factor. Jordan's postoperative mortality rate was 1.1%.

Simple plication of the ulcer is indicated for patients in poor general health, the aged, and patients who have waited many hours between the onset of perforation and surgical therapy, or who have suffered shock or sepsis.

Preoperative Preparation

Fluid and electrolyte resuscitation, primarily with a balanced salt solution

Nasogastric suction

Systemic antibiotics

Monitoring of hourly urine output, central venous pressure, or pulmonary artery wedge pressure, as indicated

Pitfalls and Danger Points

Inadequate fluid and electrolyte resuscitation

Inadequate closure of perforation

Operative Strategy

The most important initial step in the operative strategy is to determine, on the basis of the principles discussed above, whether the patient should be treated by plication or by a definitive ulcer operation. On technical grounds alone, very large defects in the stomach or duodenum are better handled by resection than by attempted plication. Also, if it appears that plication will produce duodenal obstruction, a definitive procedure is indicated.

In most perforated duodenal ulcers, an attempt to close the defect by sutures alone will often result in the stitch tearing through the edematous tissue. It is preferable simply to place a plug of viable omentum over the defect and use through-and-through sutures to hold the omentum in contact with the wall of the duodenum. This avoids tension on the sutures.

It is important to irrigate the abdominal cavity thoroughly with large quantities of saline and then with a dilute antibiotic solution to remove the contamination from the peritoneal cavity.

Operative Technique of Plication

Incision

A midline incision from the xiphoid to the umbilicus provides good exposure and can be made rapidly.

Identification of Perforation

By following the lesser curvature aspect of the stomach down to the pylorus, the perforation along the anterior wall of the duodenum generally becomes quickly evident (**Fig. 25–1**). In some cases it is sealed off either by omentum or by the undersurface of the liver. If this area is not the site of the perforation, then the entire stomach must be carefully searched, up to the esophagus and including the entire posterior surface of the stomach in the lesser sac. On rare occasions an unusual type of perforation may be found somewhere in the small intestine or colon, as, for instance, that secondary to a sharp fish bone.

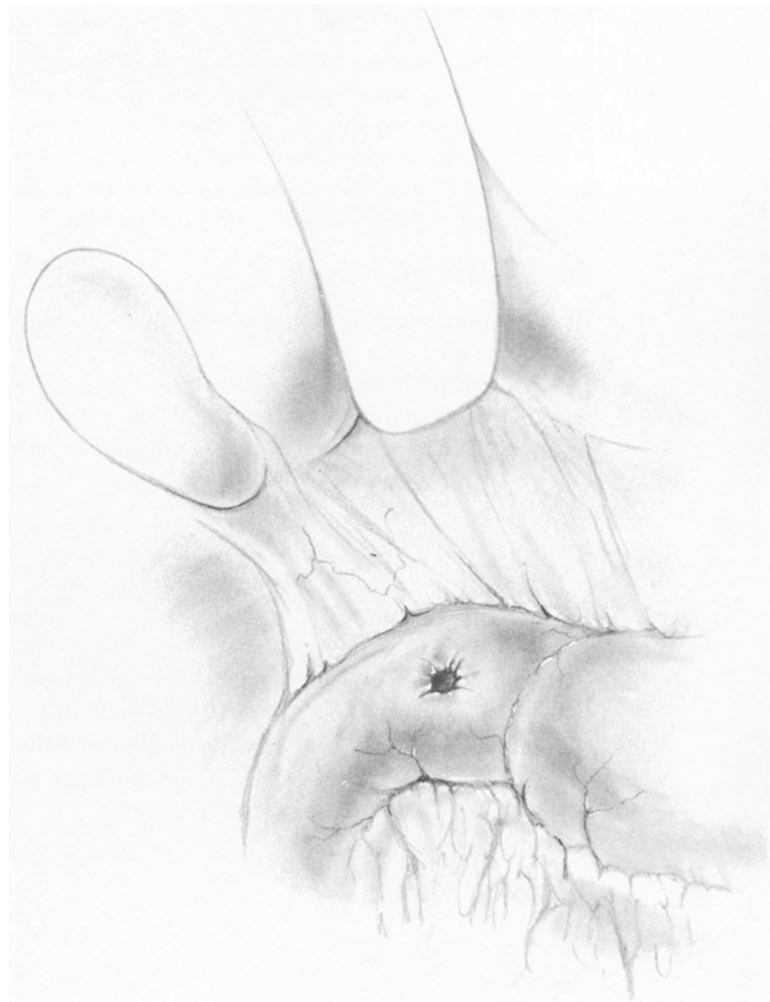


Fig. 25–1

Plication of Perforation

Generally, insert 3–0 silk (or PG) on an atraumatic intestinal needle beginning at a point about 5 mm above the perforation. Bring the stitch out at a point 5 mm distal to the perforation and leave it untied. Two additional sutures of the same type are needed for the average perforation. Next, isolate a viable segment of omentum and place it over the perforation. Tie the three sutures over the plug of omentum in order to fasten it in place (**Figs. 25–2 and 25–3**). It is *not* necessary to approximate the margins of the hole in the duodenum, but only to cap it with viable omental tissue.

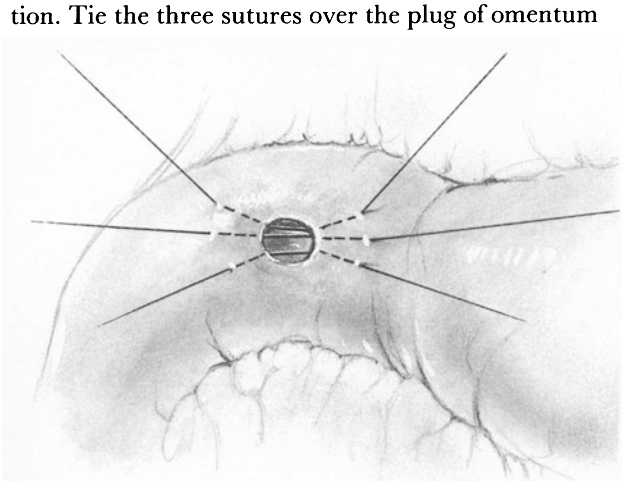


Fig. 25–2

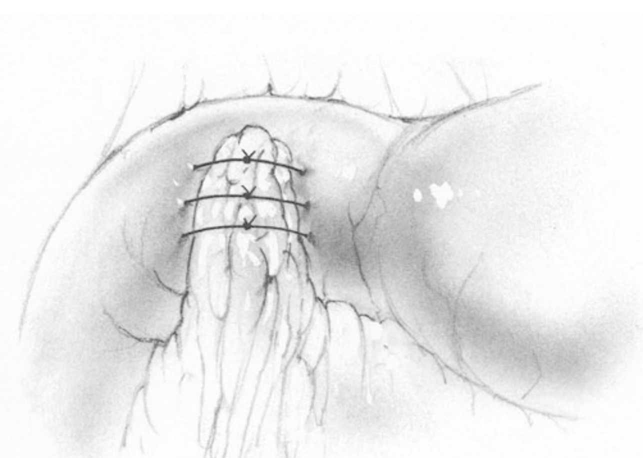


Fig. 25–3

Peritoneal Lavage

Using large volumes of warm saline, thoroughly lavage the peritoneal cavity with multiple aliquots until the gastric contents and fibrin are removed from the surfaces of the bowel and peritoneum. The final liter of lavage fluid should be a dilute antibiotic solution, all of which should then be aspirated.

Abdominal Closure

Insert a needle catheter jejunostomy if the patient is malnourished.

Close the midline incision without drainage by the modified Smead-Jones technique as described in Chap. 5. Unless the patient has advanced peritonitis, the skin may be closed in routine fashion.

Postoperative Care

Nasogastric suction

Intravenous fluids

Systemic antibiotics, the selection of which is governed by the results of bacteriological cultures, aerobic and anaerobic, obtained during the operation

Enteral feeding by needle catheter jejunostomy for malnourished patients

Complications

Subphrenic and subhepatic abscesses occur mainly in patients whose operations have been delayed for more than 8–12 hours after the perforation.

Duodenal obstruction, caused by the plication, should be suspected if gastric emptying has not returned to normal by the eighth or ninth postoperative day. This may be confirmed by a gastrointestinal X-ray series.

Reperforation of the same duodenal ulcer may occur in rare cases, and the surgeon must be alert to detect this complication. When it does occur, gastric resection is mandatory if there is to be any hope of stopping the duodenal leak.

References

Jordan GL Jr et al. Acute gastroduodenal perforation: comparative study of treatment with simple closure, subtotal gastrectomy and hemigastrectomy and vagotomy. Arch Surg 1966;92:449.

Jordan PH Jr. Indications for parietal cell vagotomy without drainage in gastrointestinal surgery. Ann Surg 1989;210:29–41.

26 Gastrostomy

Indications

When gastric suction is to be achieved without traversing the esophagogastric junction or the nasopharynx

For gastric tube feeding

Concept

Patients who have a history of reflux esophagitis often tolerate nasogastric tubes poorly. Occasionally a patient who has unrecognized reflux esophagitis develops a virulent esophagitis after a period of 2 weeks with an indwelling nasogastric tube. This may progress rapidly to an extensive stricture. Although this complication is uncommon, when it does occur, management is extremely difficult.

Some surgeons believe that nasogastric intubation increases the incidence of bronchopneumonia in patients who have pulmonary problems or an inadequate gag reflex. Improved nursing care and good nasotracheal suction can successfully prevent postoperative pulmonary complications. Consequently, the need for gastrostomy is no longer as great as it was a decade ago.

For those patients who require long-term gastric tube feeding, the Janeway gastrostomy is more convenient than the usual Stamm gastrostomy, as the Janeway does not require an indwelling tube. Another method of administering gastric tube feedings is the percutaneous endoscopic gastrostomy (not described in this work). This procedure also requires that the patient always have an indwelling gastrocutaneous tube.

Pitfalls and Danger Points

Gastric leak into the peritoneal cavity

Operative Strategy

When constructing a tube gastrostomy, the gastrostomy opening must be carefully sutured to the anterior abdominal wall around the stab wound made for the exit of the tube. Otherwise, gastric contents may leak out around the tube and escape into the abdominal cavity.

Operative Technique

Stamm Gastrostomy

Tube gastrostomy is generally done as part of some other operation on the gastrointestinal tract, so the abdominal incision will already have been made. If necessary, it can be extended upward into the epigastrium to expose the stomach. Using 2–0 atraumatic PG, insert a circular purse-string suture with a 1.5-cm diameter. Do this in the midportion of the stomach, closer to the greater than to the lesser curvature (**Fig. 26–1**).

Fig. 26–1

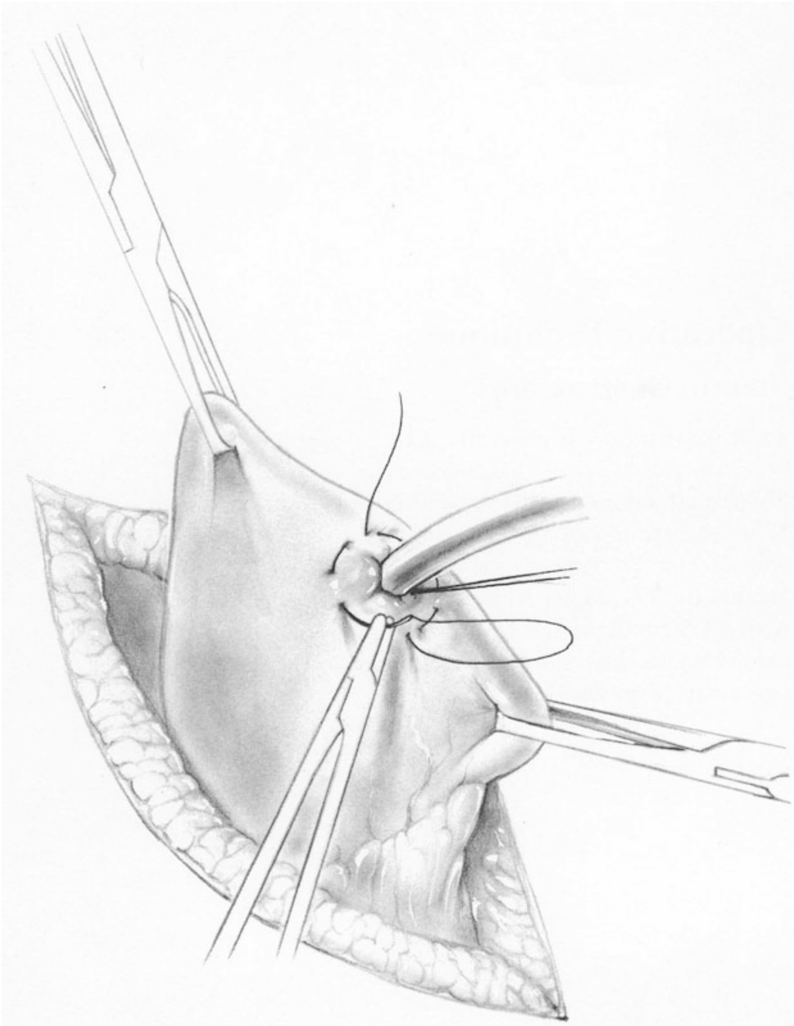


Fig. 26–2

Grasp the left side of the incised linea alba with a Kocher clamp and elevate it. Then make a stab wound through the middle third of the left rectus muscle at the level of the purse-string suture. Pass a Kelly hemostat through the stab wound from the peritoneum outward. The Kelly should grasp the tip of an 18F Foley catheter, which has a 5-ml bag. Draw the catheter into the abdominal cavity with the hemostat. With the electrocoagulator make a stab wound into the anterior gastric wall in the middle of the previously placed purse-string suture (Fig. 26–1). Insert the Foley catheter into the stomach, tighten the purse-string suture, and tie it so as to invert the gastric serosa (**Fig. 26–2**). Invert this purse-string suture in turn with a second concentric 2–0 PG purse-string suture (**Fig. 26–3**). Inflate the Foley catheter balloon and draw the stomach toward the anterior abdominal wall. Insert Lembert sutures of PG in four quadrants around the Foley catheter to sew the stomach to the anterior abdominal wall around the stab wound (**Fig. 26–4**). When these four Lembert sutures are tied, the anterior gastric wall will be firmly anchored to the abdominal wall (**Fig. 26–5**).

Janeway Gastrostomy, Stapled

Make a midline incision in the mid-epigastrium for a distance of 10–12 cm. This may be performed under local anesthesia in the poor-risk patient. Apply Babcock clamps to the anterior gastric wall near the lesser curvature. Then apply the GIA stapling device (**Fig. 26–6**). Fire the device, laying down four rows of staples, and incising for a distance of

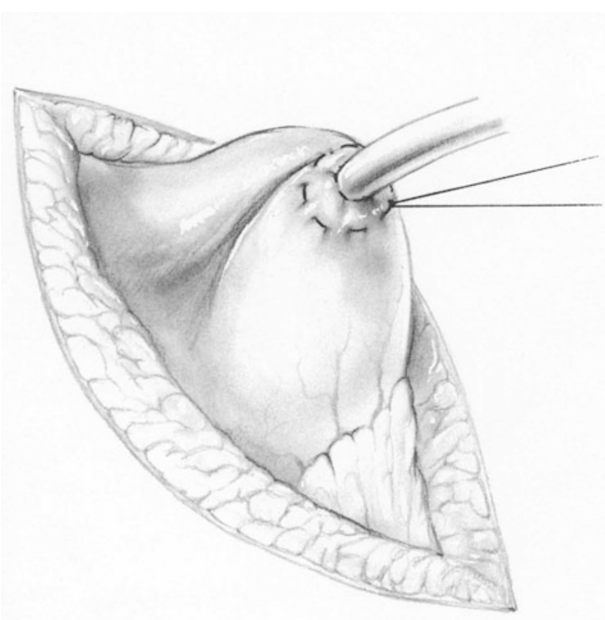


Fig. 26–3

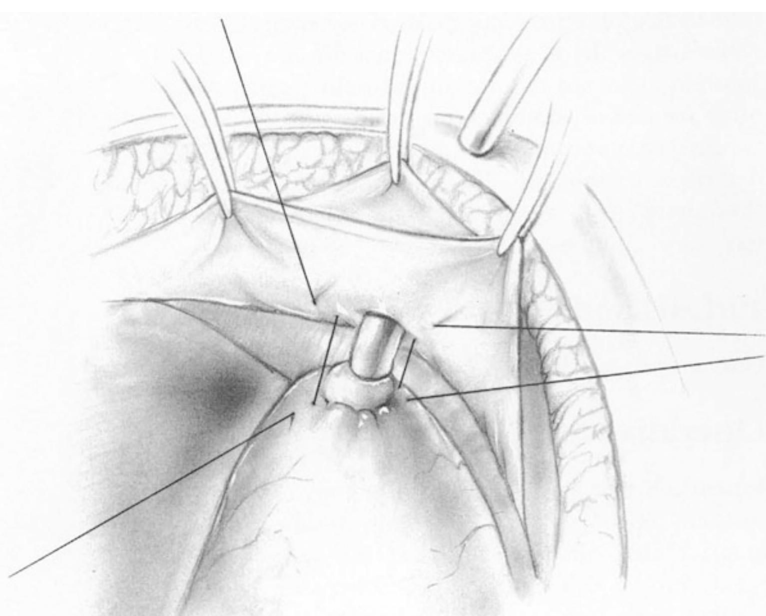


Fig. 26–4

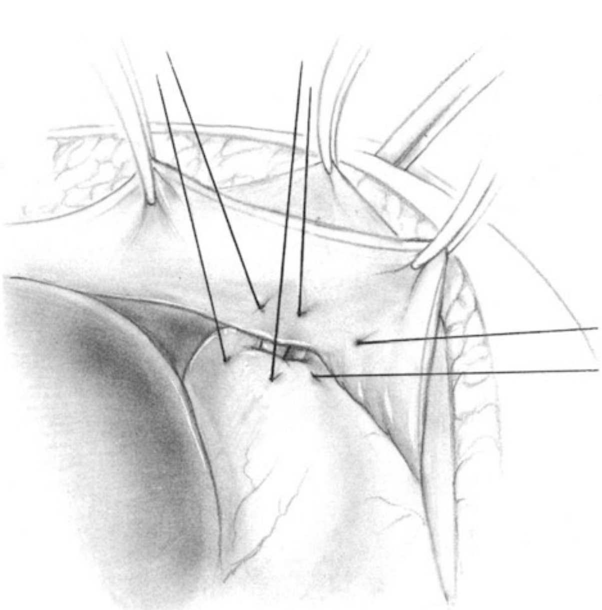


Fig. 26–5

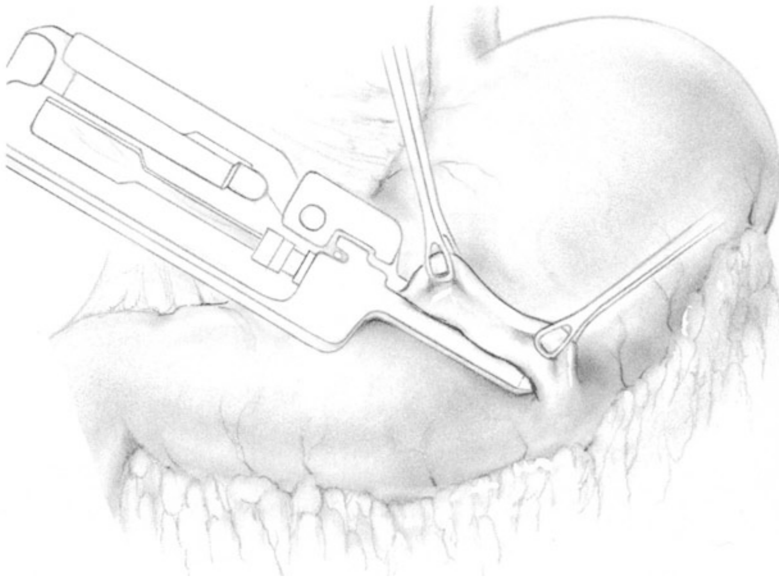


Fig. 26–6

about 4 cm between the staples (**Fig. 26–7**). This provides a tunnel of gastric mucosa about 4 cm in length, which is sufficient to pass through the abdominal wall. Reinforce the line of staples with a layer of continuous or interrupted 3–0 atraumatic PG seromuscular Lembert sutures, so as to invert the staples (**Fig. 26–8**).

Make a vertical incision, about 1.5 cm in length, in the skin overlying the middle third of the left rectus muscle. Deepen the incision through the rectus muscle with the aid of the electrocautery, then dilate it by inserting the index finger.

Grasp the gastric nipple and draw it to the outside by passing a Babcock clamp into the incision in the rectus muscle. This brings the gastric wall into contact with the anterior abdominal wall, to which it should be fixed with two Lembert sutures of 3–0 PG. Then transect the tip of the gastric nipple with a Mayo scissors, leaving enough gastric tissue to reach the skin level. Insert an 18F catheter into the stomach to test the channel.

Accomplish immediate maturation of the gastrostomy by interrupted mucocutaneous sutures of 3–0 PG, which should pass through the entire thickness of the gastric nipple and catch the subcuticular layer of the skin.

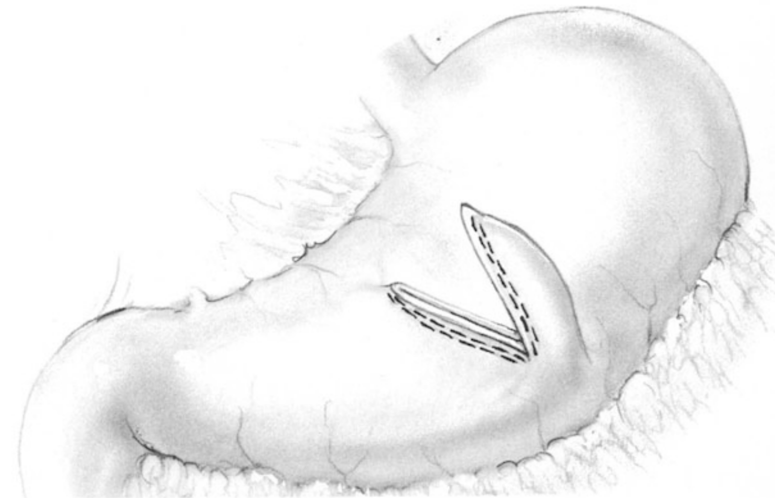


Fig. 26–7

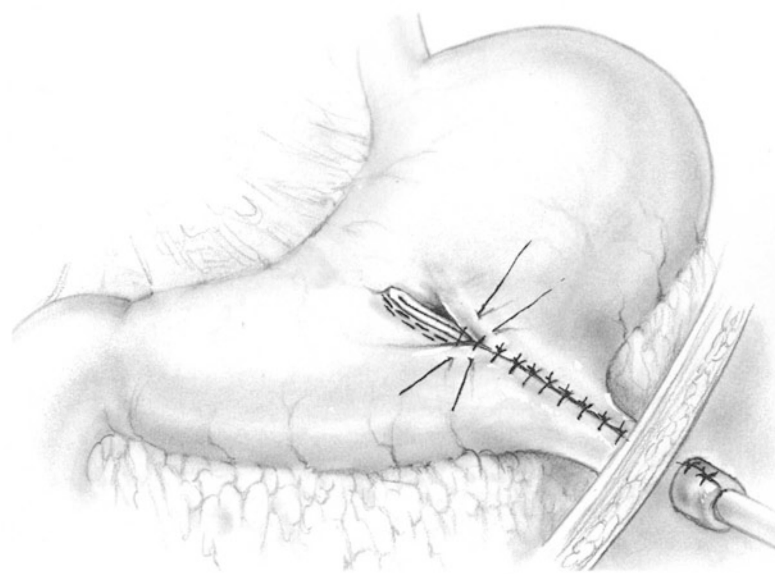


Fig. 26–8

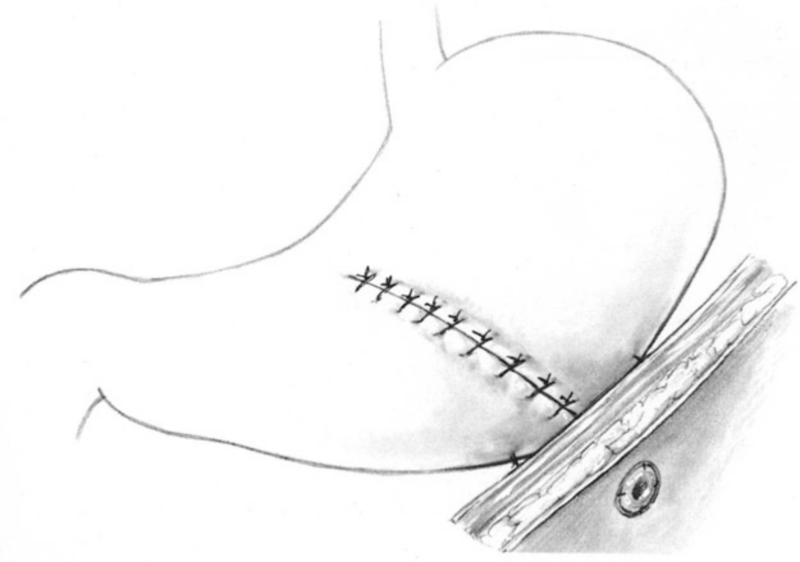


Fig. 26–9

Close the abdominal incision in the usual fashion and apply a sterile dressing (**Fig. 26–9**). Leave the catheter in place until the wound heals.

After healing has taken place, gastric feeding can be given by inserting a catheter into the stomach while the feeding is being administered. The catheter should be removed between meals.

27 Gastrectomy for Cancer

Concept: How Radical an Operation for Gastric Cancer?

Points of Controversy

For the past 30 years there has been great confusion over the choice of operations for gastric malignancies. The pendulum has swung from partial gastrectomy to total gastrectomy and back again. Lacking adequate data that correlate survival statistics with various lesions, surgeons have based their choice of operations on anatomical study of the distribution of lymphatic metastases. The *routine* use of total gastrectomy for all gastric malignancies has been shown not to improve survival of patients.

According to Hoerr and to Nyhus, antral malignancy requires only a distal two-thirds gastrectomy, including adjacent lymph nodes, duodenum, and omentectomy. On the other hand, Menguy recommends an 80%–90% gastrectomy, with division of the left gastric artery at its origin, omentectomy, and splenectomy, followed by gastroduodenostomy or gastrojejunostomy.

Smith, Shiu, Kelsey, and Brennan advocate the routine dissection of both R1 and R2 lymph nodes in surgery for carcinoma of the stomach. Their definition of the terms R1 and R2 corresponds to those widely used in Japan (Maruyama et al.) for the classification of gastric lymph nodes. The Japanese results with gastric carcinoma appear to be better than those obtained in the United States. Whether this is due to the fact that the type of gastric carcinoma common in Japan constitutes a different variety from that which is seen in this country has remained a point of great controversy. Smith et al. demonstrated that the radical lymphadenectomy in conjunction with surgery for gastric carcinoma could be performed with a low mortality (1.6%) and with a morbidity which was not significantly different from that of the more conservative operation. Randomized prospective studies comparing the conservative versus radical lymphadenectomy operations are currently in progress in Europe and may in future years provide a definitive answer to the question: How radical an operation for gastric cancer?

Anatomical Zones of Spread

Direct Extension

Spread by direct invasion of gastric malignancy can involve a number of organs. Posteriorly, the tumor can invade the body or tail of the pancreas, the middle colic artery, or the transverse colon, all of which can be included in the specimen. Invasion of the aorta contraindicates resection. Extension into the left lobe of the liver is amenable to resection, as is extension into the crura of the diaphragm.

Lymphatic Metastasis

A malignancy of the cardia or fundus drains into the paracardial, left gastric, and pancreaticolienal lymph nodes. A tumor of the body or antrum drains into the celiac, left gastric, and accompanying lymph nodes on the lesser curvature of the stomach, and into the greater curvature nodes. Cancer involving the prepyloric area drains into the hepatic artery and subpyloric node groups. In general, the more advanced tumors tend to metastasize to nodes at greater distances from the primary site than listed above.

Operation for Lesions of Cardia and Fundus

As described in Chaps. 6 and 8, small to medium-sized lesions of the proximal stomach and esophagogastric junction are best handled by resecting the lower esophagus and proximal stomach, including transection of the left gastric artery at the celiac axis to include these nodes in the specimen. The paracardial lymph nodes around the diaphragmatic crura should also be included. The spleen and lymph nodes around the tail and superior border of the pancreas should be removed. If the tail of the pancreas has been invaded by tumor, this too should be included in the specimen.

After the dissection has been completed, the surgeon can decide whether to perform an esophagogastric resection with end-to-side esophagogastric anastomosis or a total gastrectomy with Roux-en-Y esophagojejunostomy. The esophagogastric end-to-side reconstruction offers most patients the possibility of a normal diet and normal nutrition because the end-to-side technique generally prevents reflux esophagitis. If more than half the stomach has to be resected to provide an adequate margin beyond a proximal gastric carcinoma, and if the left gastric vessels and celiac lymph nodes are removed, what remains after the resection is a small tubular segment of gastric antrum. *In this case an end-to-end esophagogastric anastomosis is doomed to failure because there is no way of preventing the reflux of bile and gastric juice.* Also, as Chassin has reported, the rate of anastomotic leakage following the end-to-end anastomosis is much higher than after the end-to-side. Soga et al. advocated not only total gastrectomy but also hemipancreatectomy, splenectomy, and extensive lymphadenectomy for advanced lesions of the proximal one-third of the stomach.

On the other hand, a number of proximal lesions are localized in the area of the esophagogastric junction. These can be resected with an adequate margin, while sufficient stomach is preserved for the construction of an end-to-side anastomosis at a point 6–7 cm beyond the proximal cut edge of the remaining gastric segment. Sometimes the proximal portion of the residual gastric pouch can be shaped into a partial fundoplication. Even when this has not been done, we have rarely encountered a serious degree of gastroesophageal reflux in our end-to-side reconstructions.

In summary, if enough stomach can be spared for an end-to-side anastomosis, esophagogastrectomy is the procedure of choice. Otherwise, total gastrectomy followed by some type of esophagojejunal reconstruction on the Roux-en-Y principle is indicated. Whether the addition of a jejunal substitute pouch is of value in these cases has yet to be determined, although most experienced surgeons do not believe that the Hunt-Lawrence pouch is helpful.

Operation for Lesions of Body

A malignancy in the body of the stomach involving most of the lesser curvature requires total gastrectomy. Circumscribed lesions of the body may be treated by subtotal gastrectomy, as described below for lesions of the antrum.

Operation for Lesions of Antrum

Studies by Paulino and Roselli of the lymphatic distribution of metastases have demonstrated that when a lesion is confined to the antrum and is not so large as to extend into the body of the stomach, involvement of the splenic and pancreatic lymph nodes is rare. Consequently, it appears unnecessary to perform a routine splenectomy for lesions of the distal stomach. A major drawback of including the spleen in a resection, which also involves the ligation of the left gastric artery *at its origin*, is that ischemia or gangrene of the residual gastric pouch may develop. After a left gastric ligation and the division of the left gastroepiploic artery, the blood supply of the residual gastric pouch is limited. There is often a posterior gastric branch that arises from the splenic artery proximal to the origin of the left gastroepiploic. It is possible to preserve this artery if care is taken during the operation, but it is a small vessel and is easily traumatized. In addition, there are collateral branches from the inferior phrenic vessels and intramural circulation from the esophagus. Gangrene of the residual stomach following the combined gastrectomy and splenectomy has been reported by Spencer and by Thompson. If a rim of only a few centimeters of gastric tissue is left attached to the esophagus, intramural circulation will suffice. However, anastomosis of this tissue to the side of the jejunum or to the duodenum results in a high incidence of reflux alkaline esophagitis. The reconstruction here should be to a Roux-en-Y segment of the jejunum as in total gastrectomy. As to postoperative nutrition, this operation seems to offer no advantage over total gastrectomy.

Since there are insufficient data to demonstrate that this radical subtotal resection improves a patient's chances of survival, most surgeons agree with the conservative philosophy of Hoerr, who is supported by Nyhus and Wastell; Cady et al.; Diehl et al.; and Paulino and Roselli. The more conservative approach to treating malignancy of the distal stomach is to do a small operation for the small tumor and a large operation for the large tumor. If the tumor is localized to the antrum and is small, a two-thirds gastric resection that includes the accompanying omentum and adjacent lymph nodes plus 3–5 cm of the duodenum constitutes an adequate operation.

For larger carcinomas of the distal stomach, the left gastric artery may be ligated at its origin and included in the specimen, together with the nodes along the lesser curvature of the stomach and the lesser omentum. A hepatic artery node dissection down to the pylorus should be included, together with any visible subpyloric and right gastric nodes, the lymph glands around the origin of the right gastroepiploic artery and the upper border of the pancreas. The spleen should not be removed. The spleen provides a good blood supply to the gastric pouch through the short gastric vessels, which is important if the left gastric artery is divided at its origin. Adjacent organs should be included when there is evidence of direct invasion. Total gastrectomy should be done if most of the lesser curve of the stomach is invaded.

Unless a large margin (8–10 cm) of normal appearing gastric wall has been included in the specimen, frozen section histological examination of both ends of the specimen should be carried out as significant submucosal spread of cancer may occur.

Preoperative Preparation

The patient should receive nutritional rehabilitation by tube feeding when feasible or by total parenteral nutrition when indicated.

Antibiotic preparation of the stomach is necessary because necrotic tumor often harbors virulent bacteria similar to those in the colon. The same intestinal antibiotics are used here as are employed for colon preparation.

Perioperative systemic antibiotics also should be administered.

Operative Strategy

Blood Supply to Residual Gastric Pouch

As memtioned above, whenever the left gastric artery is divided at its origin and splenectomy is performed, the blood supply to the gastric pouch may be inadequate. Thus one should avoid a splenectomy in these cases unless so little gastric pouch is left behind that it may receive adequate nourishment through the intramural channels from the esophagus if the posterior gastric and inferior phrenic collaterals prove inadequate. If there is any doubt about the adequacy of the blood supply, perform a total gastrectomy.

Duct of Santorini

When carcinoma approaches the pyloric region, microscopic spread into the proximal 4–5 cm of the duodenum is possible. When as much as 5 cm of the duodenum is mobilized, the dissection will have progressed beyond the gastroduodenal artery. In this area there is a risk that the duct of Santorini will be transected. Since the duodenal wall is free of inflammation in cases of this type, this structure may well be identifiable in which case it should be divided and ligated. If the duct of Santorini communicates with the duct of Wirsung, the pancreatic juice will then drain freely into the larger duct, and there should be no postoperative difficulty. In some cases, the duct of Santorini does not communicate with the main duct. In this event, despite the ligature, a pancreatic fistula may well develop. This will probably require a secondary operation to anastomose a Roux-en-Y segment of the jejunum to the transected duct for internal drainage. Fortunately, in most cases the two ducts do communicate.

Operative Technique

The technique for removing lesions of the cardia and fundus is described in Chap. 8. Distal gastrectomy in the usual case of antral carcinoma is performed by the same technique described for peptic ulcer (Chap. 24), except that additional duoduenum may have to be resected. Frozen section examination should be performed on the distal margin of the duodenum in such cases. Omentectomy should be carried out, and the left gastric artery may be divided at its origin, as described in Chap. 28. Remove the lymph nodes along the left gastric, the gastroduodenal, the right gastric, and the right gastroepiploic arteries together with the gastrohepatic omentum along the lesser curve.

Lavage of the operative site with a dilute antibiotic solution helps to counteract bacterial contamination.

Postoperative Care

Postoperative care is identical to that following gastrectomy for peptic ulcer (Chap. 24), with the addition of needle-catheter jejunostomy or total parenteral nutrition when indicated.

Complications

Complications are similar to those following gastrectomy for peptic ulcer (Chap. 24), but subphrenic and subhepatic sepsis is more common because of the increased bacterial contamination in carcinoma cases.

References

Cady B, Rossi R et al. Gastric adenocarcinoma: a disease in transition. Arch Surg 1989;124:303–308.

Chassin JL. Esophagogastrectomy: data favoring end-to-side anastomosis. Ann Surg 1978;188:22.

Diehl JT, Hermann RE, Cooperman AM et al. Gastric carcinoma. Ann Surg 1983;198:9–12.

Hoerr S. Prognosis for carcinoma of the stomach. Surg Gynecol Obstet 1973;137:205.

Maruyama K, Okabayashik, Kinoshita T. Progress in gastric cancer surgery in Japan and its limits of radicality. World J Surg 1987;11:418–425.

Menguy R. Surgical treatment of gastric adenocarcinoma. JAMA 1974:228:1286.

Nyhus LM. Wastell C. Surgery of the stomach and duodenum Boston: Little, Brown 1977:672.

Paulino F, Roselli A. Carcinoma of the stomach. Curr Probl Surg 1973;Nov.:3–72.

Smith JW, Shiu MH, Kelsey L, Brennan MF. Morbidity of radical lymphadenectomy in the curative resection of gastric carcinoma. Arch Surg 1991;126:1469–1472.

Soga J et al. The role of lymphadenectomy in curvative surgery for gastric cancer. World J Surg 1979;3:701.

Spencer FC. Ischemic necrosis of the remaining stomach following subtotal gastrectomy. Arch Surg 1956;73:844.

Thompson NW. Ischemic necrosis of proximal gastric remnant following subtotal gastrectomy. Surgery 1963; 54:434.

28 Total Gastrectomy

Indications

Zollinger-Ellison syndrome.

Malignant tumors arising from midportion of stomach and occupying more than two-thirds of the lesser curvature.

Malignant tumors arising in proximal stomach, if more than 50% of stomach must be resected.

Palliation in patients who have obstructing or bleeding tumor, provided that degree of metastasis is not massive and that primary tumor is not technically difficult to resect.

On rare occasions, life-threatening hemorrhage from extensive erosive gastritis.

Preoperative Preparation

Preoperative gastroscopic biopsy or lavage cytology should be positive for malignancy before a total gastrectomy is elected. Otherwise, the diagnosis may be confirmed by frozen section at surgery.

For malnourished patients, administer preoperative total parenteral alimentation.

Administer perioperative systemic antibiotics.

Carry out mechanical and antibiotic preparation of the colon if there is a possibility that the tumor has invaded the middle colic artery or the transverse colon.

Insert a nasogastric tube.

Pitfalls and Danger Points

1) Improper reconstruction of alimentary tract, which can lead to postoperative reflux alkaline esophagitis.
2) Erroneous diagnosis of malignancy: Patients have undergone total gastrectomy when surgeons have misdiagnosed a large posterior penetrating ulcer as a malignant tumor. Because benign gastric ulcer can be cured by relatively simple surgery, this error may have serious consequences for the patient. If preoperative gastroscopic biopsy has been negative, perform a gastrotomy and with a scalpel or a biopsy punch obtain a direct biopsy of the edge of ulcer in four quadrants.
3) Inadequate anastomotic technique, resulting in leak or stricture.
4) Sepsis, either in wound or subhepatic and subphrenic spaces, due to contamination by gastric contents.
5) Failure to identify submucosal infiltration of carcinoma in esophagus or duodenum beyond the line of resection.

Operative Strategy

Exposure

If the primary lesion is a malignancy of the body of the stomach that does not invade the lower esophagus, a midline incision from the xiphocostal junction to a point 6–8 cm below the umbilicus may prove adequate for total gastrectomy if the Upper Hand or Thompson retractor is used to elevate the lower sternum. If the tumor is approaching the esophagogastric junction, it may be necessary to include 6–10 cm of lower esophagus in the specimen to circumvent submucosal infiltration by the tumor. In this case a left thoracoabdominal incision is indicated, as described in Chap. 8. No esophageal anastomosis should ever be performed unless there is excellent exposure.

Esophageal Anastomosis

We prefer an end-to-side esophagojejunal anastomosis because it permits invagination of the esophagus into the jejunum. This results in a lower incidence of leakage. With end-to-end esophagojejunostomy, invagination would result in constriction of the lumen.

The lumen of the anastomosis can be increased also if the anterior wall of the esophagus is left 1 cm longer than the posterior wall. This converts the anastomosis from a circular shape to an elliptical one, adding to its circumference.

The anastomotic technique requires close attention, for, according to Schrock and Way, two-thirds of the fatalities that followed total gastrectomies they did were caused by leakage, and one-fifth of all resections for cancer resulted in anastomotic disruption.

A properly performed end-to-side EEA stapled anastomosis also has a high rate of success.

Prevention of Reflux Alkaline Esophagitis

An anastomosis between the end of the esophagus and the side of the jejunum combined with a side-to-side jejunojejunostomy (**Fig. 28–1**), results in a high incidence of *disabling* postoperative alkaline esophagitis, according to Scott et al. (1965), Schrock and Way, and Paulino and Roselli. *This must be prevented by utilizing the Roux-en-Y principle in all cases.* The distance between the esophagojejunal anastomosis and the jejunojejunal anastomosis must be 60 cm or more to prevent reflux of the duodenal contents into the esophagus. This is a far more important consideration than is the construction of a jejunal pouch for a reservoir. Although we have used the Hunt-Lawrence [as described by Scott et al. (1965)] and the Paulino pouches in some patients, metabolic studies done by Scott et al. (1968) have not produced sufficient data to demonstrate their superiority over a single-limb esophagojejunostomy done by the Roux-en-Y principle. We no longer construct pouches in these cases.

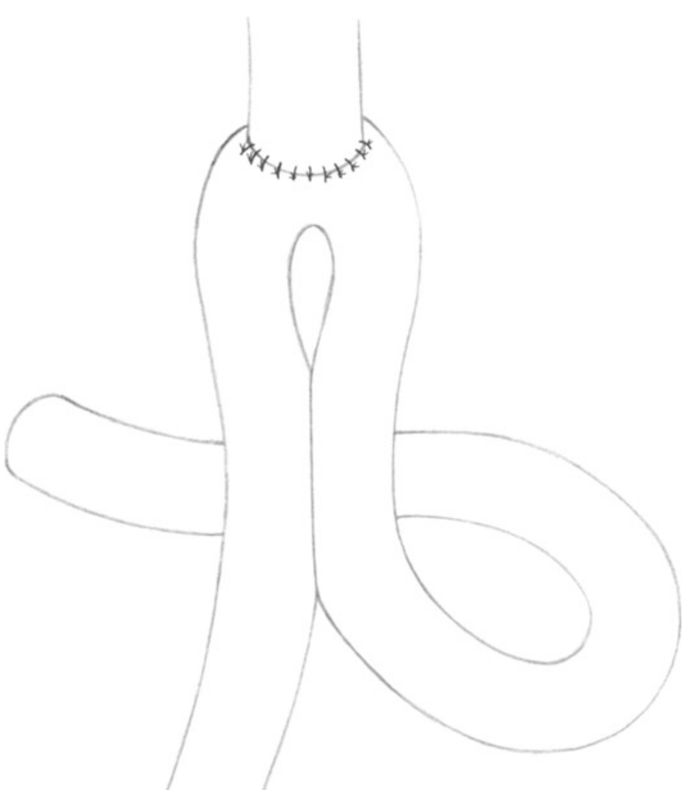


Fig. 28–1

Extent of the Operation

When performing a total gastrectomy for adenocarcinoma of the stomach, the surgeon must be aware that microscopic submucosal infiltration may occur in the esophagus as far as 10 cm proximal to a grossly visible tumor and occasionally well down into the duodenum. Frozen section microscopic examination of both the esophageal and duodenal ends of the specimen should be obtained in order to avoid leaving behind residual submucosal carcinoma. In Schrock's series, microscopic tumor was found at the esophageal or duodenal margin or both in 33% of patients.

The lymph nodes along the celiac axis should be swept up with the specimen when the left gastric artery is divided at its origin. The lymphatics along the hepatic artery also should be removed, along with those at the origin of the right gastroepiploic artery. Whether it is beneficial to skeletonize the hepatic artery and portal vein all the way to the hilus of the liver is not clear.

Routine resection of the body and tail of the pancreas may increase the mortality rate from this operation because pancreatic complications can occur; at the same time it has not been proved that this additional step improves a patient's long-term survival. However, if the tail of the pancreas shows evidence of tumor invasion, then this portion of the pancreas should certainly be included in resection.

The anatomy of the structures involved in this operation can be seen in **Fig. 28–2**.

Ulcerated and necrotic gastric tumors may harbor virulent bacteria, so patients with these maladies should be prepared by being given preoperative intestinal antisepsis as well as prophylactic systemic antibiotics. This appears to be especially applicable to malignant lymphoma. The abdominal cavity should be irrigated with an antibiotic solution at intervals during the operation in order to minimize the effect of local contamination.

Operative Technique

Incision and Exposure

In many cases adequate exposure is obtained by a midline incision from the xiphocostal junction to a point 6 cm below the umbilicus, along with the use of an Upper Hand or Thompson retractor. When the carcinoma involves the lower esophagus, a left thoracoabdominal approach should be used.

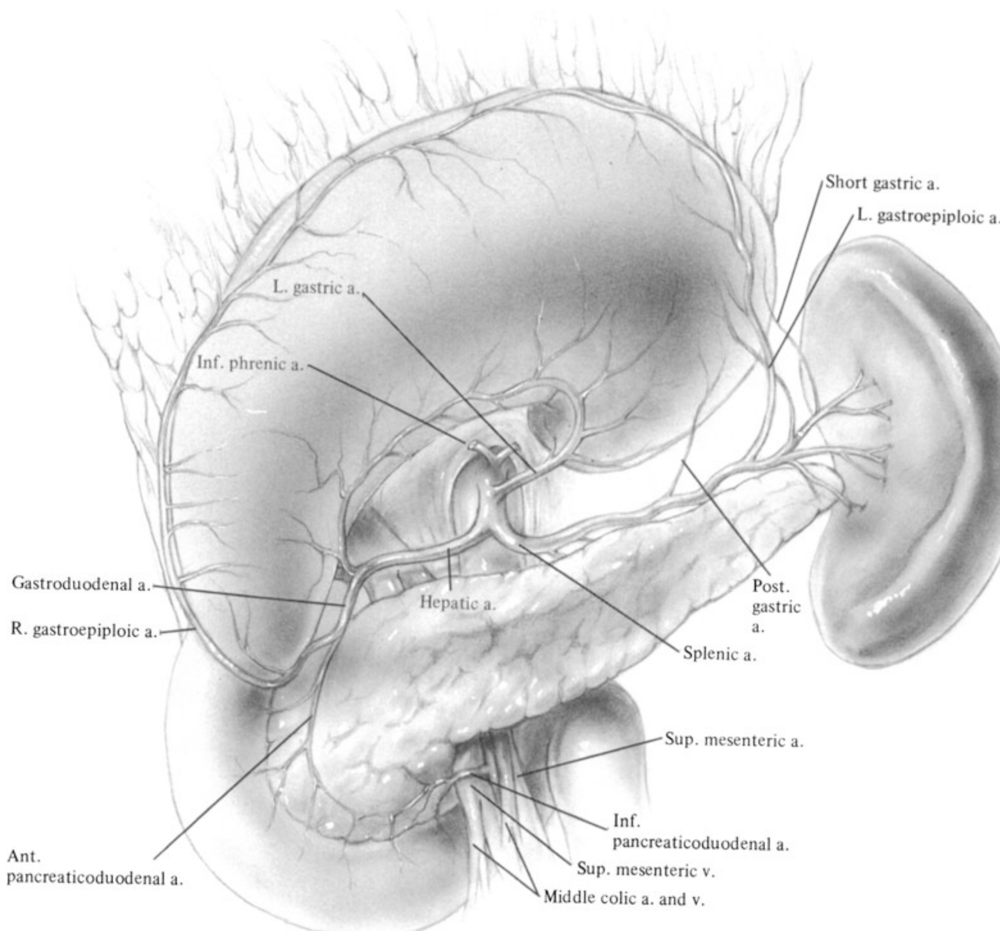


Fig. 28–2

Exploration and Determination of Operability

Tumors are considered nonresectable when there is posterior invasion of the aorta, the vena cava, or the celiac axis. Invasion of the body or tail of the pancreas is not a contraindication to operation; nor is invasion of the left lobe of the liver, as these structures can be included in the specimen if necessary.

When there is only a moderate degree of distant metastasis in the presence of an extensive tumor, a palliative resection is indicated *if it can be done safely*, according to the findings of Monson et al. of the Mayo Clinic.

Invasion of the root of the mesocolon, including the middle colic artery, does not contraindicate resection if leaving these structures attached to the specimen removes the tumor. This often requires the concomitant resection of a segment of the transverse colon. It is surprising that, in some patients, removing a short segment of the main middle colic artery does not impair the viability of the transverse colon, as long as there is good collateral circulation.

Splenectomy

With a scalpel or Metzenbaum scissors incise the avascular lienophrenic ligament that attaches the lateral aspect of the spleen to the undersurface of

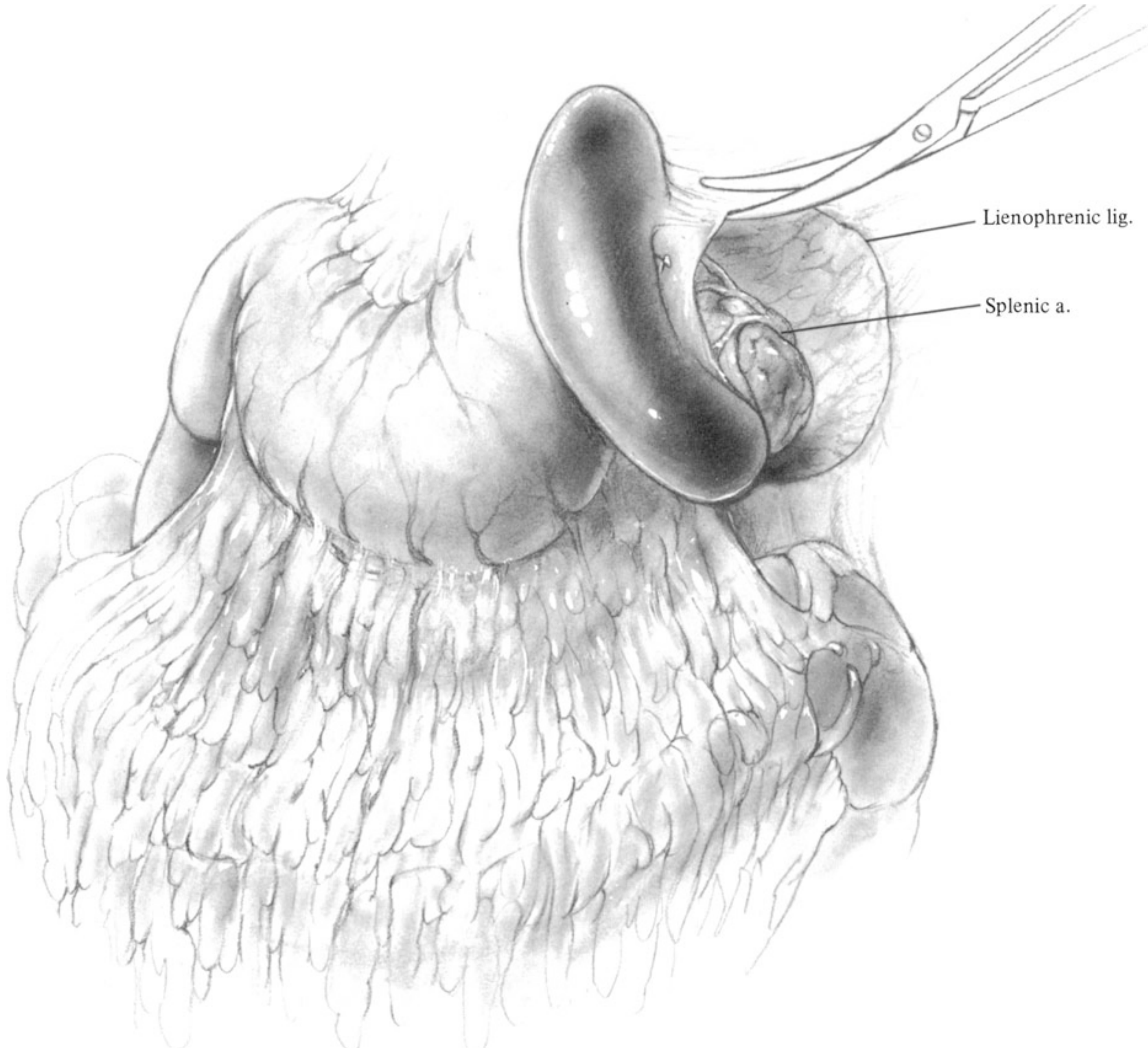


Fig. 28–3

the diaphragm (**Fig. 28–3**). As this incision reaches the inferior pole of the spleen, divide the lienocolic ligament; the posterior surface of the pancreatic tail then can be seen. This can be elevated gently from the retroperitoneal space. Palpate the splenic artery near the distal end of the pancreas, encircle it with 2–0 silk, and ligate it and the splenic vein. Divide these vessels between ligatures, releasing the tip of the pancreas from the hilus of the spleen. Incise a fold of posterior parietal peritoneum along the upper border of the body of the pancreas to separate the pancreas from the specimen. The spleen may be left attached to the greater curvature of the stomach, or it may be more convenient to divide and ligate the short gastric vessels and remove the spleen as a separate specimen. In the retroperitoneal dissection, expose the fascia of Gerota and the left adrenal gland. If there is evidence of tumor invasion, include these structures in the specimen.

Omentectomy

Separate the entire gastrocolic omentum from the transverse colon by scalpel and scissors dissection through the avascular embryonic fusion plane, as seen in the coronal section of the abdomen in **Fig. 28–4**. Be alert to the difference in texture and color of the fat in the epiploic appendices of the colon and that of the omentum. Considerable bleeding will be avoided by keeping the plane of dissection between the appendices and omentum (**Fig. 28–5**). Next

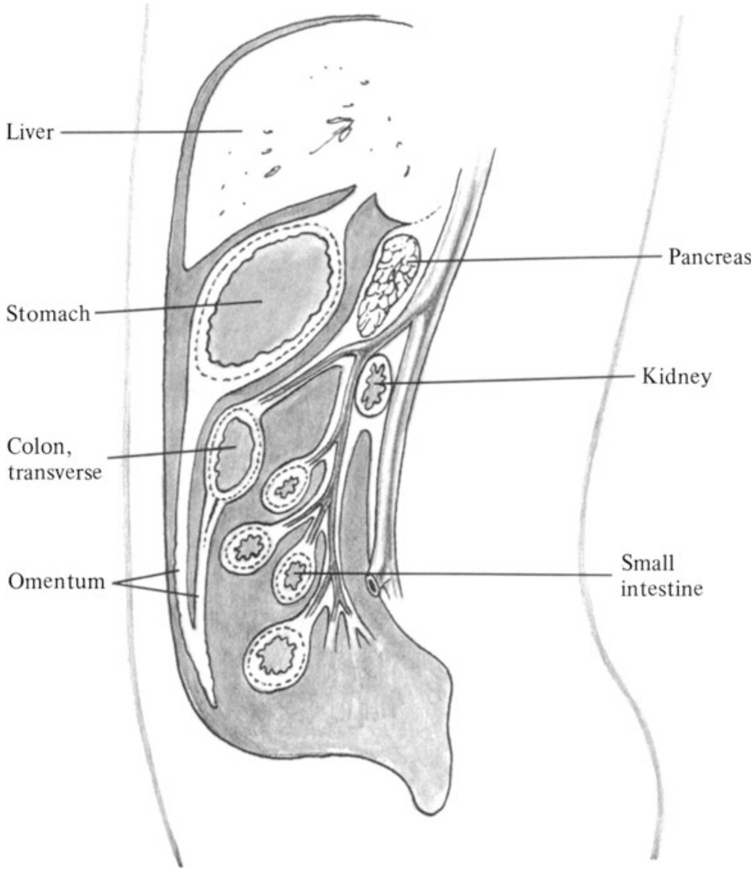


Fig. 28–4

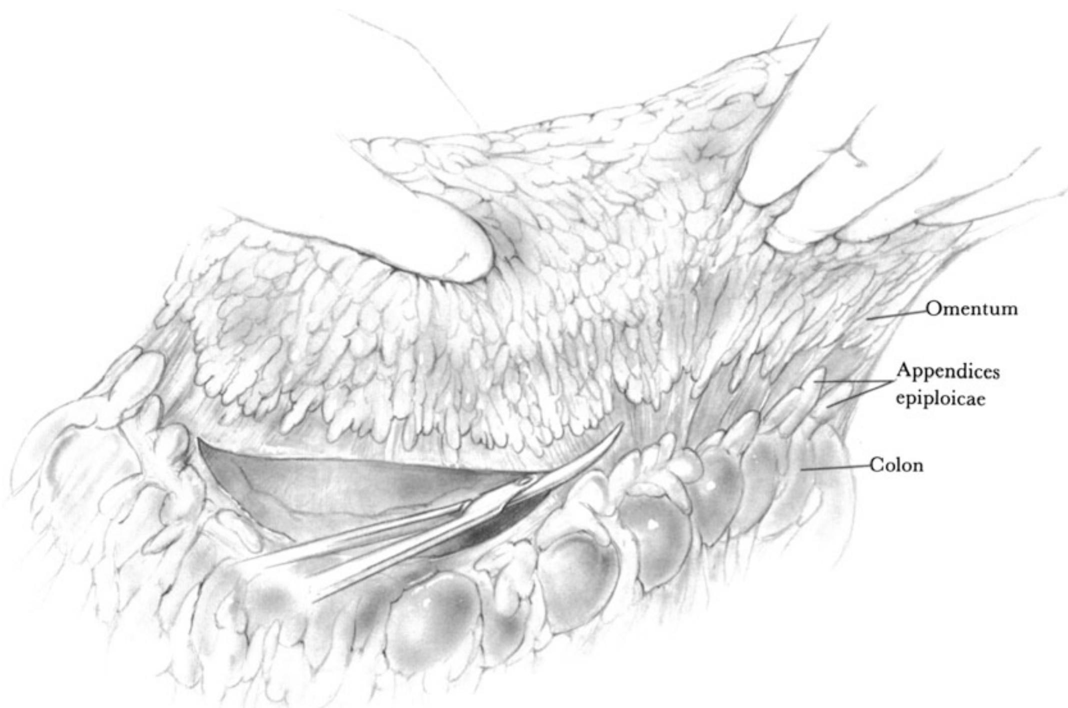


Fig. 28–5

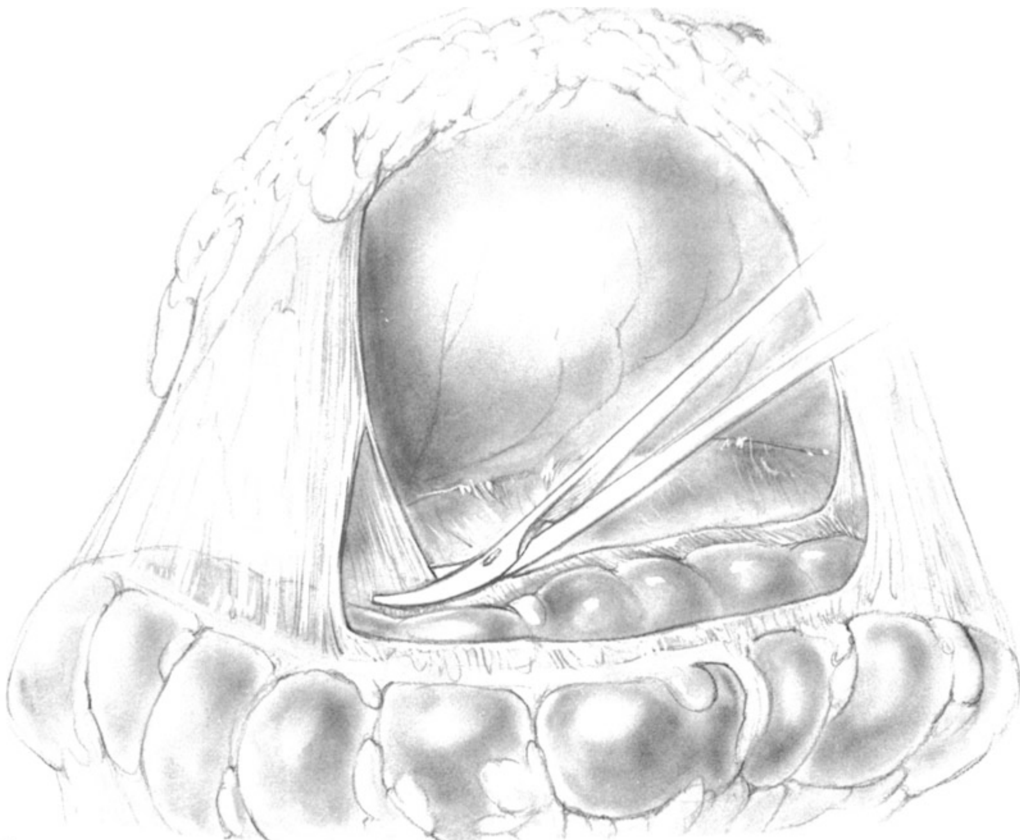


Fig. 28–6

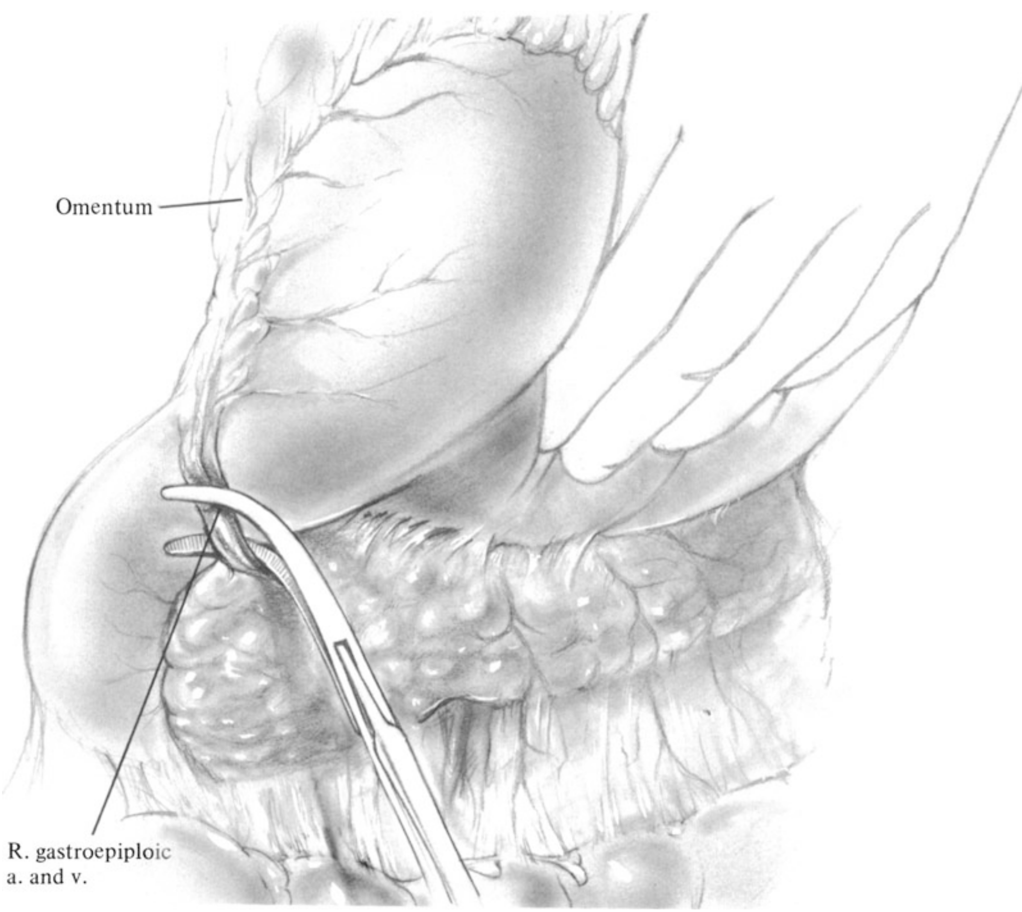


Fig. 28–7

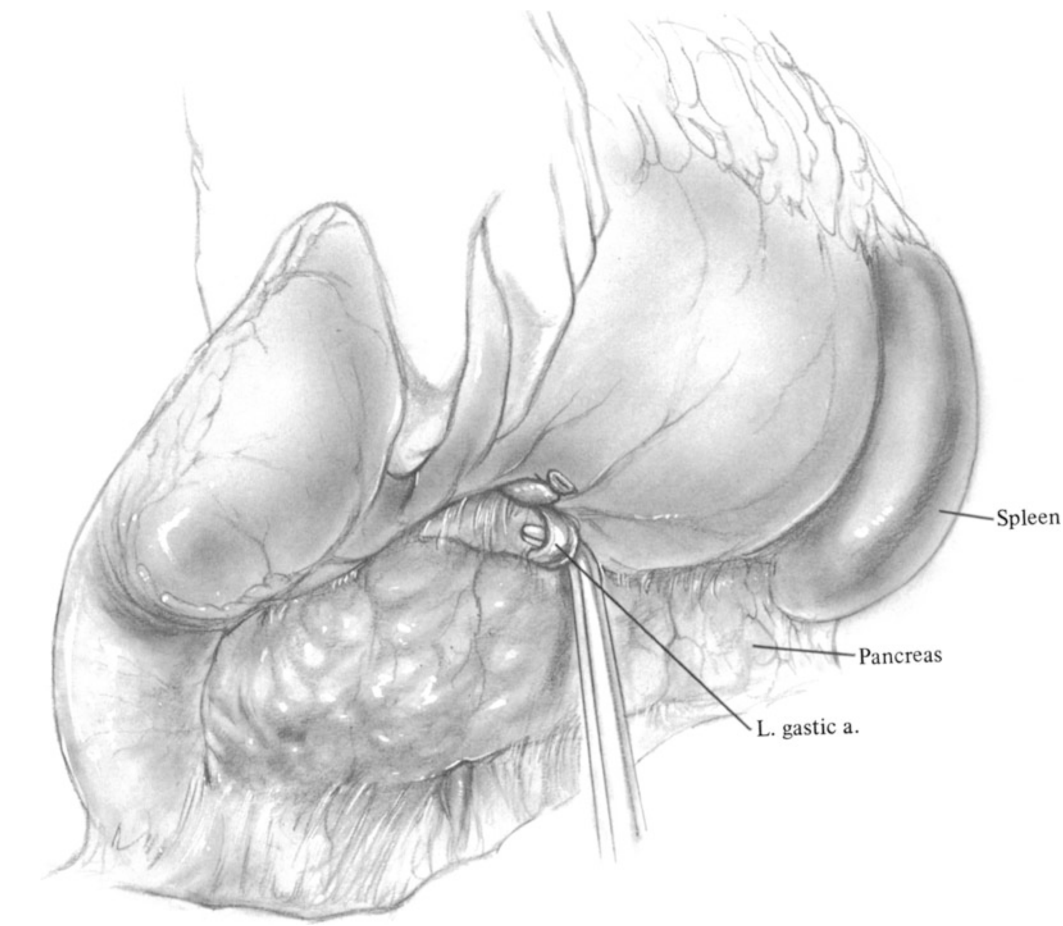
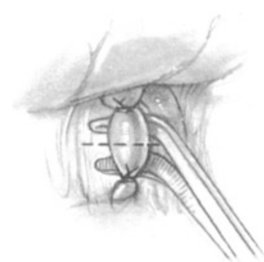


Fig. 28–8

elevate the omentum from the transverse mesocolon (**Fig. 28–6**). Expose the anterior surfaces of the pancreas and duodenum, along with the origin of the right gastroepiploic vessels. Ligate the latter at their origin with 2–0 silk and divide them, sweeping all adjacent lymph nodes toward the specimen (**Fig. 28–7**).

Pancreatic Resection

If the body and tail of the pancreas are to be resected, incise the peritoneum along the lower border of the pancreas. Ligate the splenic artery near its origin from the celiac axis and divide it. Trace the splenic vein to its junction with the portal vein, and ligate and divide it there. The inferior mesenteric vein enters the splenic near its termination. Divide and ligate this vessel also. If the pancreas is of average thickness, apply a TA–55 stapler with 3.5-mm staples across the neck of pancreas and fire it, in the manner of Pachter et al. Incise the pancreas along the stapler and leave the tail of the pancreas attached to the specimen. If the body of pancreas is too thick to undergo stapling, even with 4.8-mm staples, divide the organ with a scalpel and close the cut end by overlapping interrupted mattress sutures



of 3–0 Prolene. Occlude the pancreatic duct by an individual suture-ligature.

The pancreas should be resected only when invaded by tumor.

Celiac Axis Dissection and Division of Left Gastric Vessels

With the greater curvature of the stomach elevated and retracted toward the patient's right, it is a simple matter to palpate the left gastric artery as it travels from the region of the aorta, anteriorly, to meet the lesser curvature of the stomach. When there is tumor in this area, either the splenic or hepatic artery may be followed in a proximal direction. This will lead to the celiac axis and to the origin of the left gastric. By dissecting the areolar and lymphatic tissue away, the artery may be skeletonized (**Fig. 28–8**). A blunt-tipped Mixter right-angle clamp is very helpful in delineating the circumference of the artery. Use the clamp to pass 2–0 silk ligatures around the vessel. After it has been doubly ligated, divide it. The coronary vein, which is situated just caudal to the artery, often is identified first in the course of the dissection. This, too, should be divided and ligated, and the lymphatic tissue swept toward the specimen. At the conclusion of this step, the superior border of the adjacent pancreas and the anterior surface of the celiac axis and the aorta should be free of lymphatic tissue.

Hepatic Artery Node Dissection

Make an incision in the peritoneum overlying the common hepatic artery as it leaves the celiac axis. Carry this incision down to the origin of the gastroduodenal artery. There are lymph nodes overlying the hepatic artery; dissect them toward the lesser curve of the gastric specimen, leaving the artery skeletonized (**Fig. 28–9**). If desirable, the lymph node dissection may be pursued to the hilus of the liver by skeletonizing the hepatic artery, portal vein, and common bile duct. Adequate data are not yet available to indicate how extensive a lymph node dissection should be done.

Suspicious nodes in the subpyloric region and the superior margin of pancreas should be excised and the splenic artery should be skeletonized up to the distal end of the pancreas.

Division of Duodenum

Divide and ligate the right gastric artery. Perform a Kocher maneuver, and if the malignancy involves the distal stomach dissect the duodenum from the anterior surface of the pancreas for a distance of 5 cm. Extensive duodenal dissection is not necessary when the distal antrum is free of tumor.

If a stapled closure of the duodenum is elected, apply the TA–55 Auto Suture stapler to the duodenal stump. Generally, 4.8-mm staples are used. Fire the stapler and apply an Allen clamp to the specimen side of the duodenum. Divide the duo-

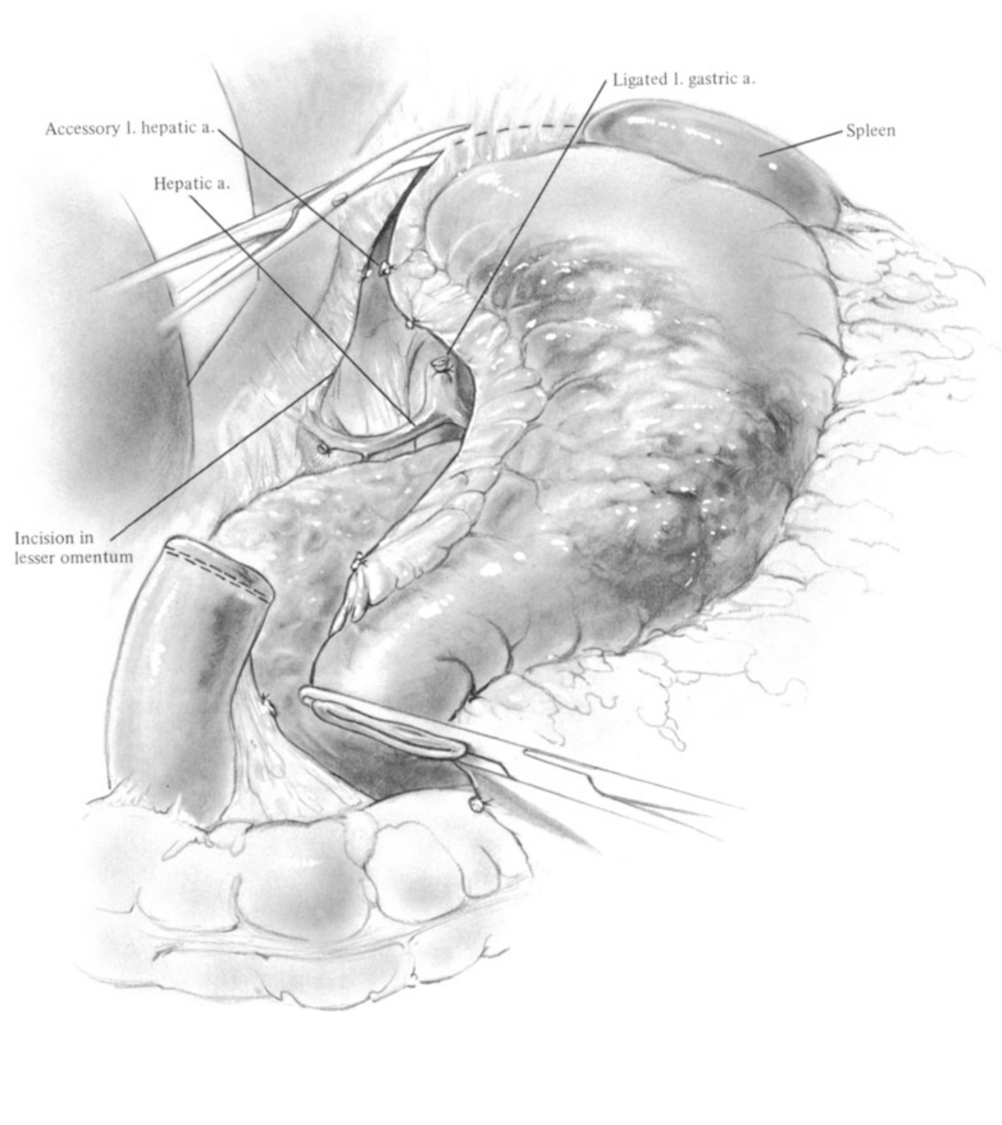


Fig. 28–9

denum flush with the stapling device, as in Fig. 24–46. Ligate the distal end of the specimen with umbilical tape behind the Allen clamp and remove the clamp. Cover the distal end of the specimen with a sterile rubber glove, which should be fixed in place with an additional umbilical tape ligature.

When it is elected to suture the duodenal stump, the technique illustrated in Figs. 24–23, 24–24, and 24–25 should be followed.

Dissection of the Esophagocardiac Junction: Vagotomy

After the triangular ligament has been divided, retract the left lobe of the liver to the patient's right and incise the peritoneum overlying the abdominal esophagus. Using a peanut dissector, dissect away the esophagus from the right and left branches of the diaphragmatic crux. Then encircle the esophagus with the index finger and perform a bilateral truncal vagotomy, as described in Chap. 19. Incise the peritoneum overlying the right crux (Fig. 28–9). Identify the cephalad edge of the gastrohepatic ligament, which contains an accessory left hepatic branch of the left gastric artery. Divide this structure between clamps at a point close to the liver, thus completing the division of the gastrohepatic ligament.

Pass the left hand behind the esophagocardiac junction, a maneuver that will delineate the avascular gastrophrenic and any remaining esophagophrenic ligaments, all of which should be divided (**Fig. 28–10**). This frees the posterior wall of the stomach. In order to minimize further spill of neoplastic cells into the esophageal lumen, occlude the esophagogastric junction with umbilical tape or an application of staples with the TA-55.

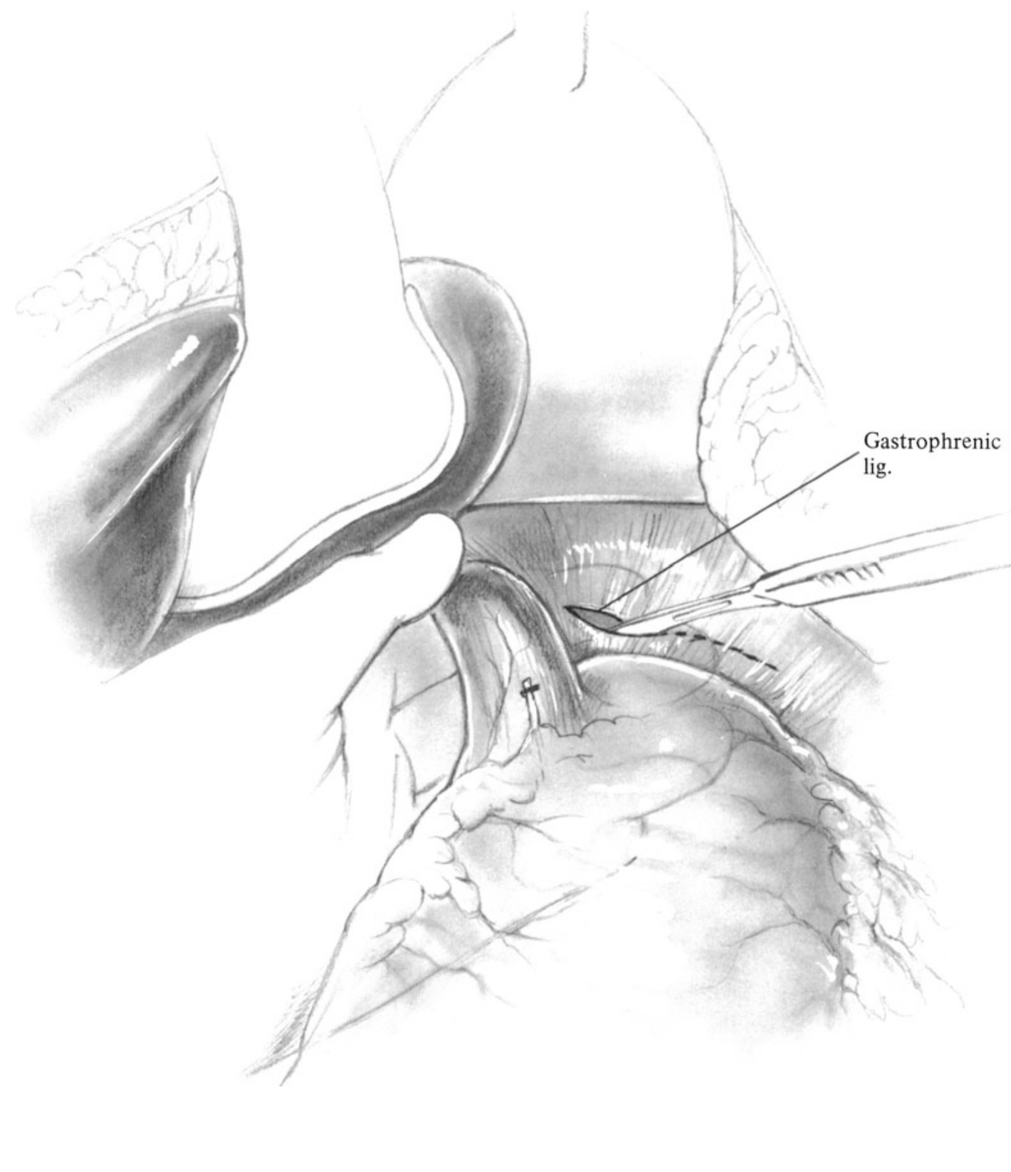


Fig. 28–10

Preparation of Roux-en-Y Jejunal Segment

After identifying the ligament of Treitz, elevate the proximal jejunum from the abdominal cavity and inspect the mesentery to determine how it will reach the apex of thc abdominal cavity for the esophagojejunal anastomosis. In some patients who have lost considerable weight before the operation, the jejunum will reach the esophagus without the need to divide anything but the marginal artery. In patients whose jejunal mesentery is short, it may be necessary to divide several arcade vessels. Transillumination is a valuable aid in dissecting the mesentery without undue trauma.

Generally, the point of division of the jejunum is about 15 cm distal to the ligament of Treitz, between the second and third arcade vessels. Make an incision in the mesentery across the marginal vessels, and divide and ligate them with 3–0 silk. Divide and ligate one to three additional arcade vessels to provide an adequate length of the jejunum to reach the esophagus without tension (**Fig. 28–11**).

Apply a TA-55 stapler to the point on the jejunum previously selected for division. Fire the stapler. Apply an Allen clamp just *proximal* to the stapler and divide the jejunum flush with the stapler. Lightly electrocoagulate the everted edge and remove the stapler.

Next make a 3–4 cm incision in the avascular portion of the transverse mesocolon to the left of the middle colic artery. Deliver the stapled end of the jejunum through the incision in the mesocolon to the region of the esophagus. After the jejunal segment is properly positioned, suture the defect in the mesocolon to the wall of the jejunum in order to prevent herniation later.

End-to-Side Sutured Esophagojejunostomy

For reasons discussed in Chap. 8, we prefer an anastomosis of the end-to-side type. The anticipated

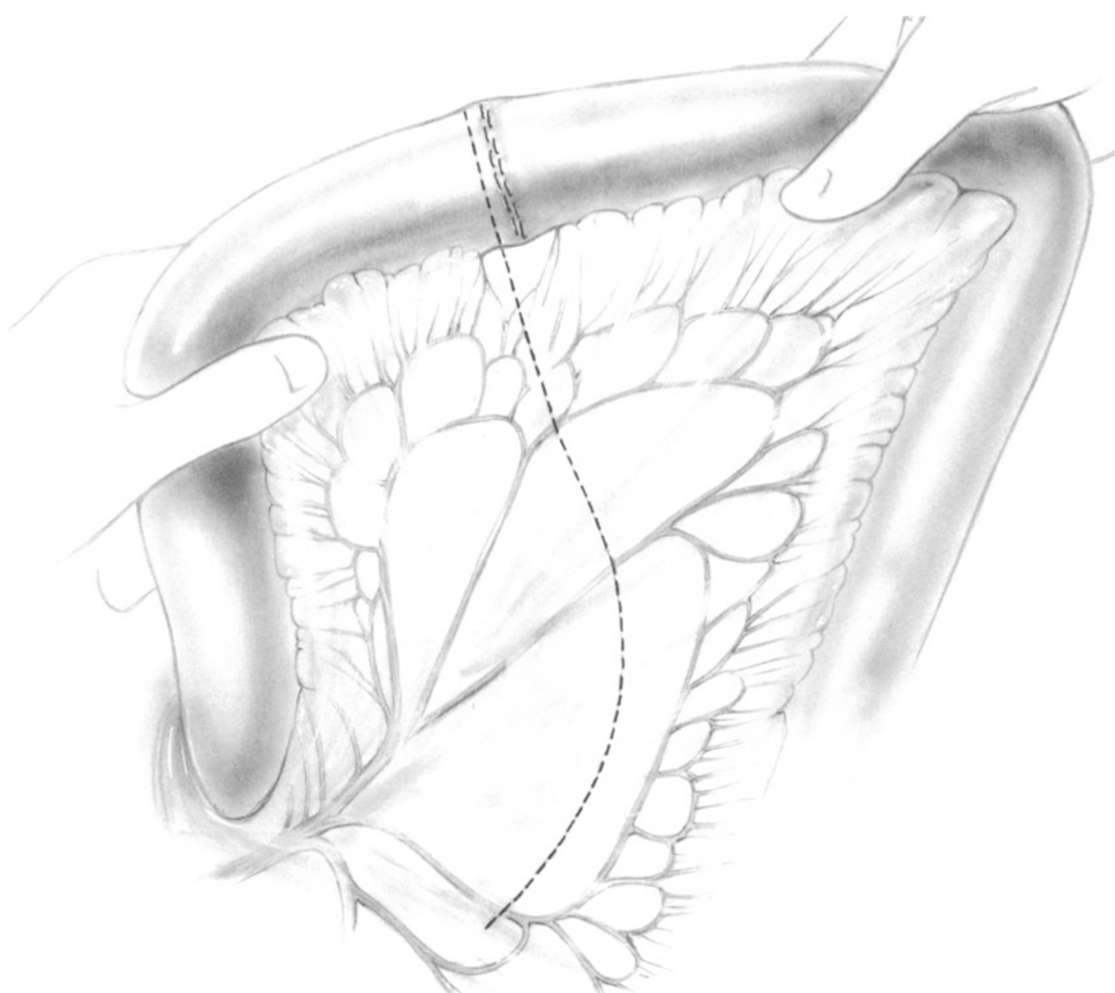


Fig. 28–11

site of the esophageal transection should be 6–10 cm above the proximal margin of the visible tumor. If the diaphragmatic hiatus is excessively large, narrow it with one or two 2–0 silk sutures (**Fig. 28–12**). Then insert several interrupted 3–0 silk sutures between the undersurface of the diaphragm and the posterior wall of the jejunum to prevent tension on the anastomosis caused by gravity. The sutures

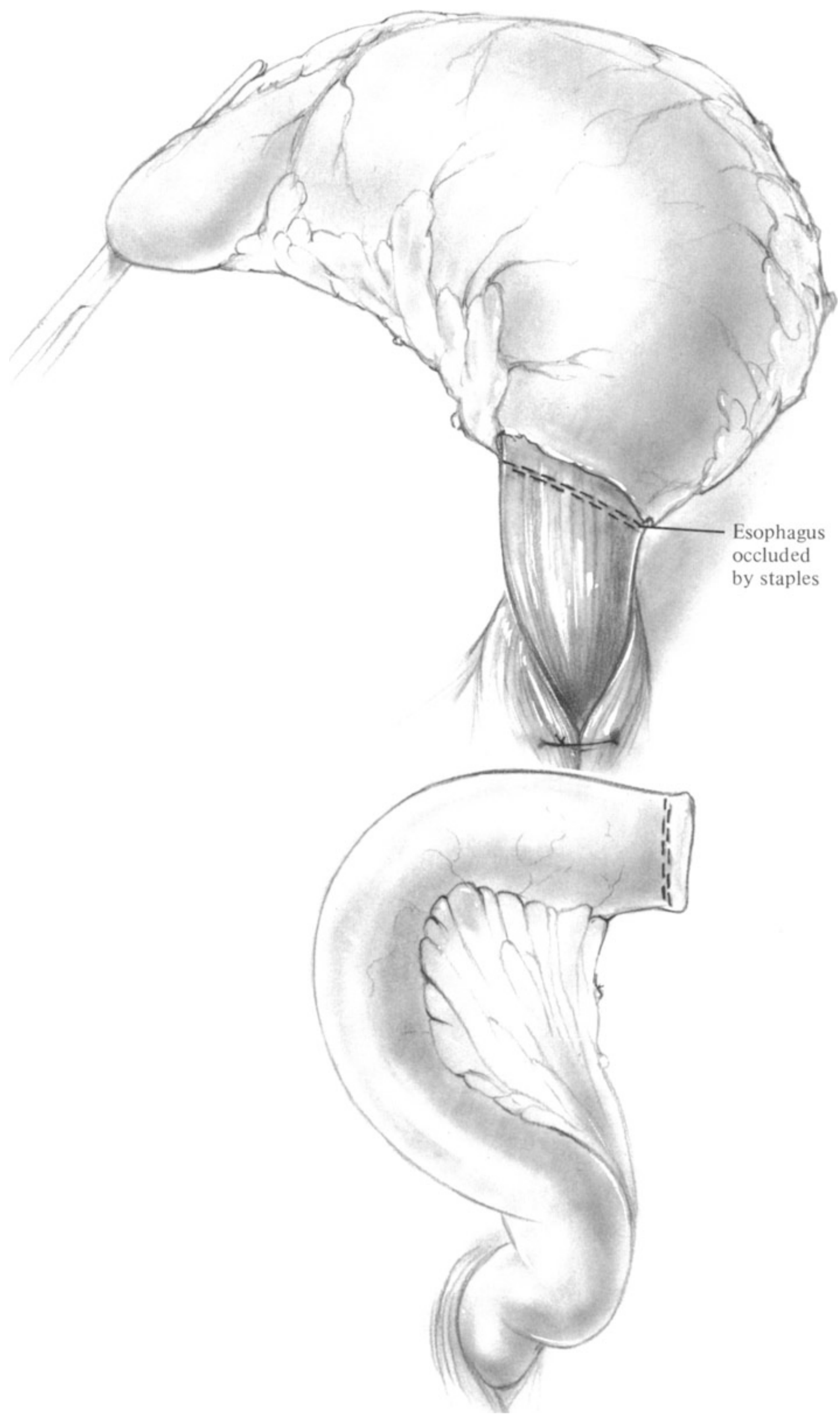


Fig. 28–12

should be placed in the jejunum sufficiently posterior so as to preserve the antimesenteric border for anastomosis.

Before beginning to construct the anastomosis, mark the exact site of the anticipated jejunal incision by making a scratch with a scalpel along the antimesenteric border of the jejunum. This will serve as a guide for the insertion of the first layer of esophagojejunal sutures. Then place the specimen on the patient's chest. This will expose the posterior wall of the esophagus for the first layer of anastomotic sutures. Place a 4–0 atraumatic silk Cushing suture beginning at the right lateral portion of the esophagus. With the same needle take a bite at the right lateral margin of the jejunal scratch mark. Place a similar suture at the left lateral margins of the esophagus and jejunum. Apply hemostats to each suture, as none will be tied until the suture line has been completed (**Fig. 28–13**). Note that the anticipated incision in the jejunum will be slightly longer than the diameter of the esophagus.

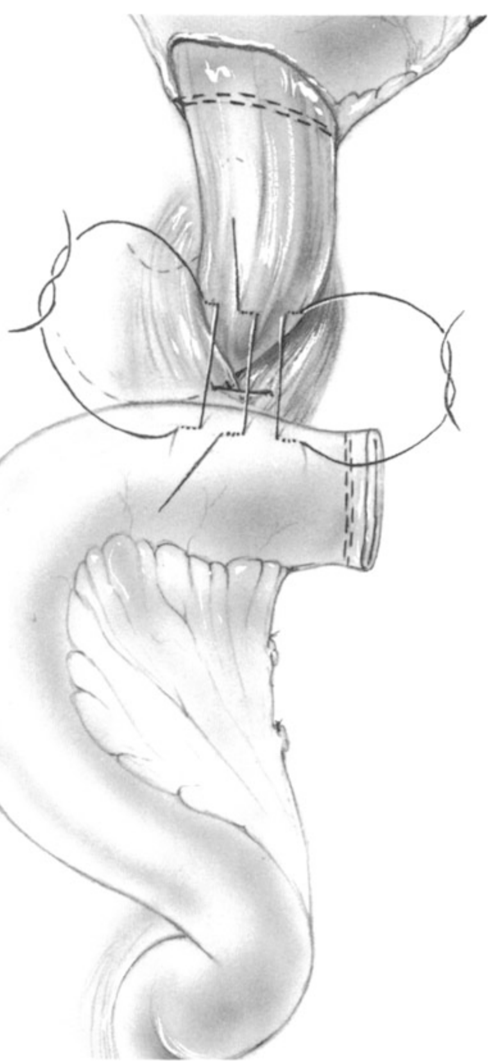


Fig. 28–13

With three or four additional Cushing sutures of 4–0 silk, complete the posterior seromuscular layer of the anastomosis by successive bisection (see Figs. B–22 and B–23). After inserting the sutures, but before tying them, it is helpful to divide the posterior wall of the esophagus. Do this in a transverse manner, using a scalpel, until the mucosa has been transected. Complete the incision with a Metzenbaum scissors, leaving the anterior wall of esophagus intact. Now tie and cut the sutures, but leave the right and left lateralmost sutures long, with the identifying hemostats attached.

Make an incision in the antimesenteric border of the jejunum, as previously marked. If there appears to be considerable redundant mucosa, this may be excised. Control excessive bleeding with 4–0 PG suture-ligatures or careful electrocoagulation. Now approximate the posterior mucosal layers by interrupted sutures of atraumatic 5–0 Vicryl, with the knots tied inside the lumen (**Fig. 28–14**). Instruct the anesthesiologist to pass the nasogastric tube farther down the esophagus. When the tube appears in the esophageal orifice, guide it down the jejunum.

Divide the remaining esophagus so that the anterior wall is 1 cm longer than the already anastomosed posterior wall (**Figs. 28–15, 28–16, 28–17, 28–18**). Remove the specimen and ask the pathologist to

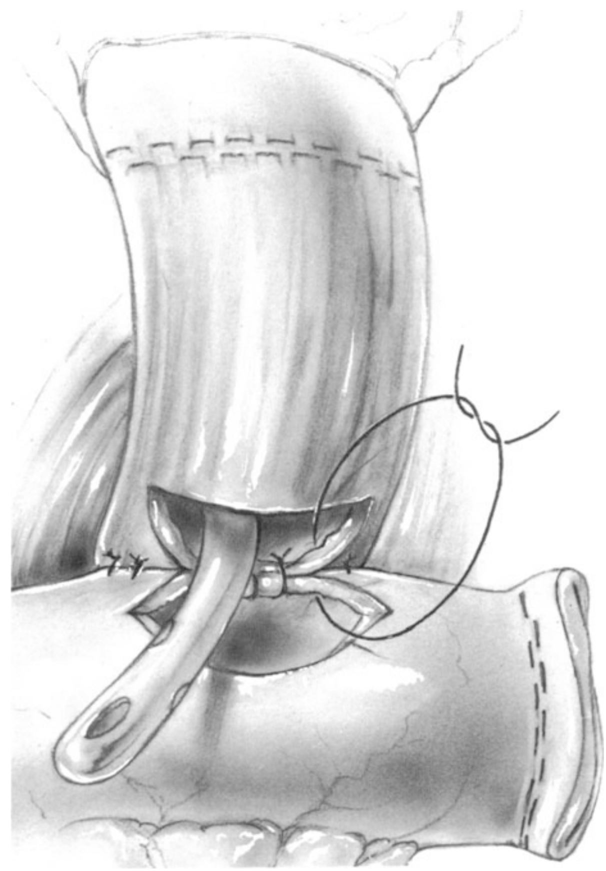


Fig. 28–14

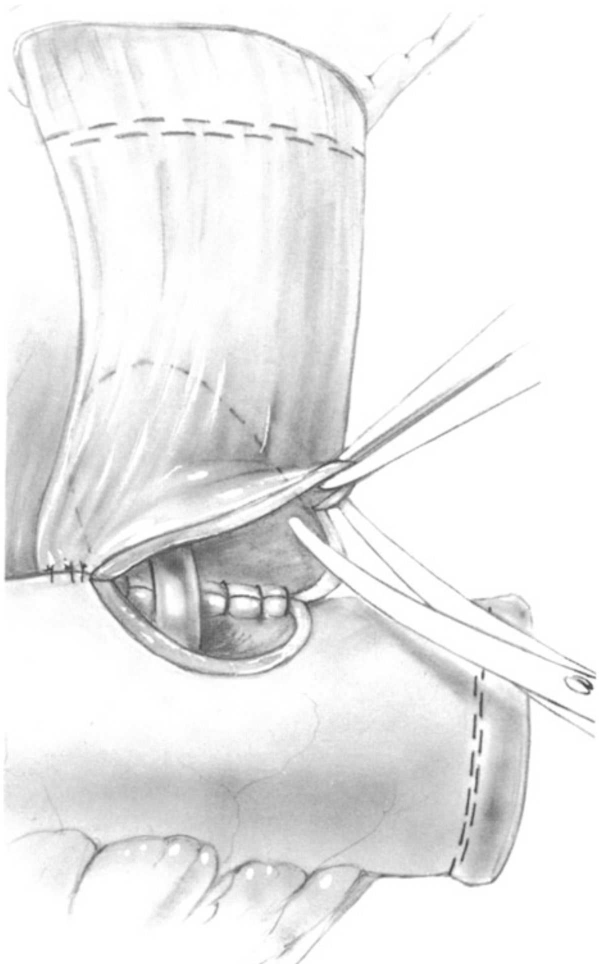


Fig. 28–15

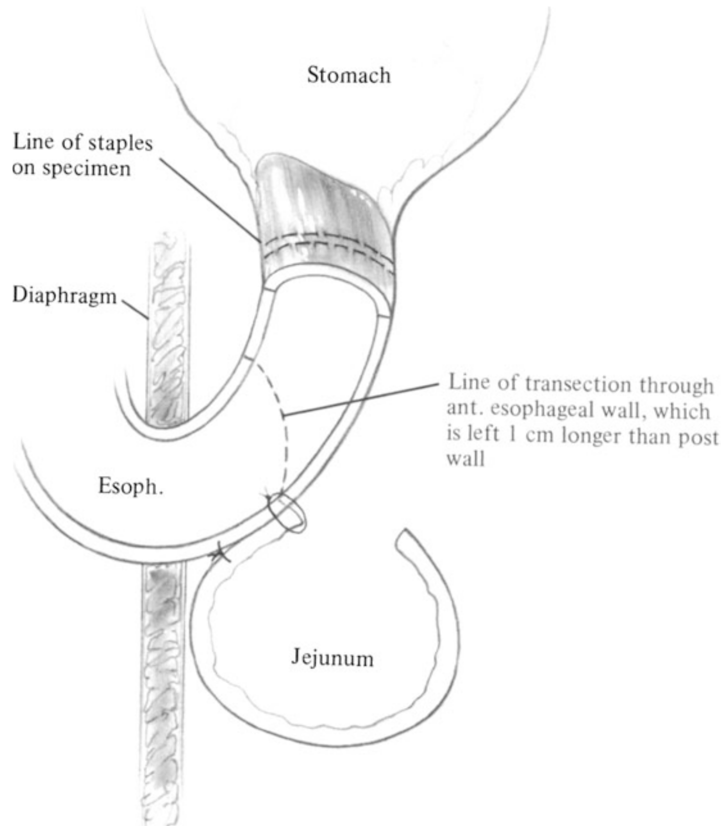


Fig. 28–16

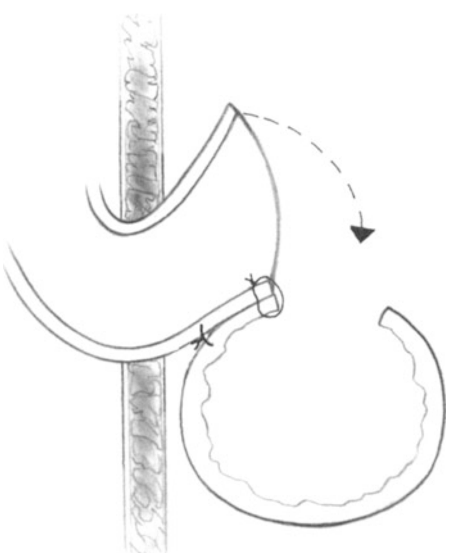


Fig. 28–17

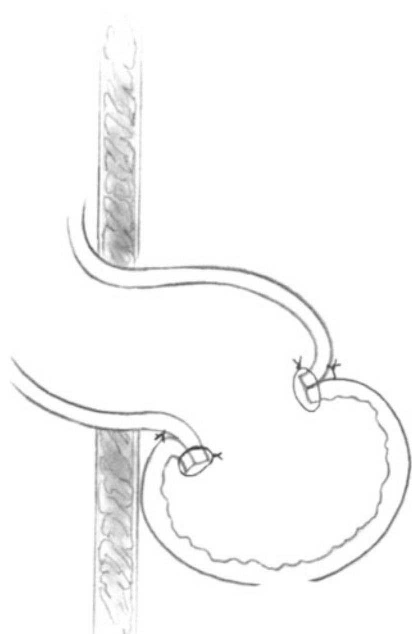


Fig. 28–18

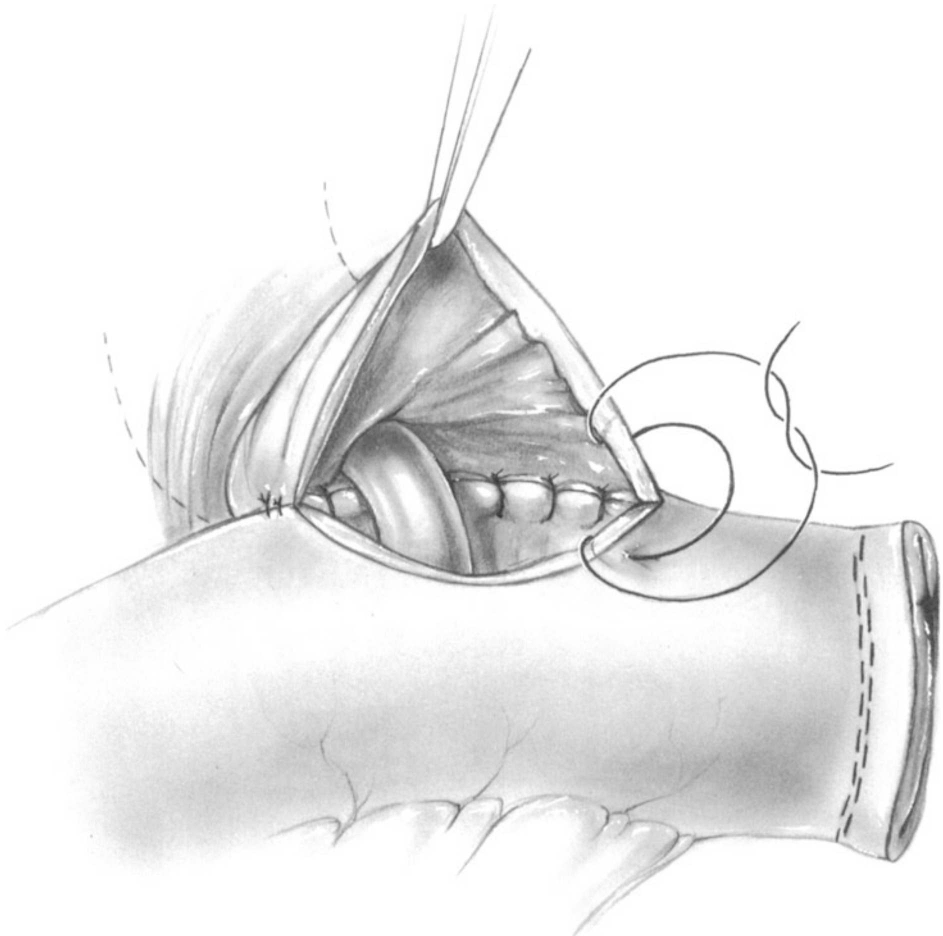


Fig. 28–19

Fig. 28–20

perform a frozen section examination of both the proximal and distal margins. If the frozen section examination is positive for malignancy, further excision is indicated.

Approximate and invert the anterior mucosal layer by 5–0 Vicryl sutures, interrupted, with the knots tied inside the lumen (**Fig. 28–19**). If it is difficult to invert the mucosa by this technique, the procedure may be accomplished with interrupted "sero-mucosal" sutures of 5–0 Vicryl, 4–5 mm wide, inserted so as to include the cut end of the esophageal muscularis and mucosa (Fig. B–16).

Complete the final anastomotic layer by inserting interrupted 4–0 silk Cushing sutures to approximate the outer layers of the esophagus and jejunum (**Fig. 28–20**). Each suture should encompass a bite of about 5 mm of esophagus and of jejunum. The peritoneum overlying the diaphragmatic hiatus can now be brought down over the anastomosis. Attach it to the anterior wall of the jejunum by several interrupted 4–0 silk stitches (**Fig. 28–21**). A sagittal section of the completed anastomosis can be seen in **Fig. 28–22**.

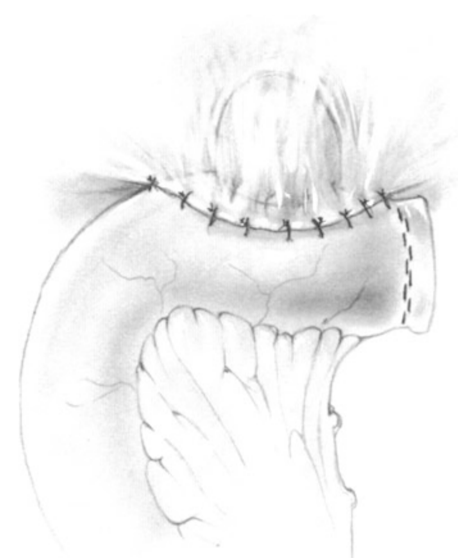


Fig. 28–21

On occasion the esophagus will appear to be unusually narrow, secondary either to spasm or atrophy. In this case *gentle* digital dilatation by the surgeon before constructing the anastomosis may serve to accomplish a somewhat larger anastomotic lumen than would otherwise be the case. If desired, it is possible to perform the anastomosis over a 40F Hurst or Maloney esophageal bougie instead of the nasogastric tube.

The area should be irrigated intermittently with an antibiotic solution.

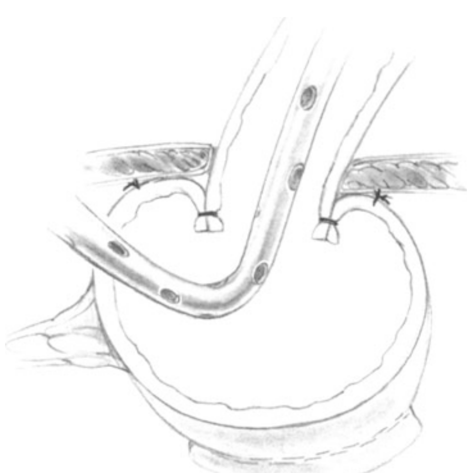


Fig. 28–22

End-to-Side Stapled Esophagojejunostomy

Performance of an end-to-end esophagojejunostomy with the use of the EEA stapler requires easy access to 4–5 cm of relaxed esophagus with good exposure to enable the surgeon to inspect the anastomosis carefully at its conclusion.

After the esophagus has been transected and the specimen removed, insert a guy suture of 3–0 silk in each of the four quadrants of the esophagus, going through all of the layers. Attach a hemostat to each suture. Then insert a purse-string suture of 2–0 Prolene no more than 3–4 mm proximal to the cut edge of the esophagus. Attach a hemostat to the completed purse-string. Now check the diameter of the esophagus by first gently dilating it with the middle finger or thumb. Then gently insert a lubricated EEA–25 sizer. Vigorous attempts at dilating the esophagus will result in a tear along the mucosa. This may require the resection of a considerably greater amount of esophagus than is convenient. It is not wise to try to repair a tear of this type and use the damaged tissue for an anastomosis. For this reason, be gentle in the dilatation. If the EEA–25 sizer does not enter the esophagus readily, convert to a sutured anastomosis as described above. We prefer to use the EEA–28 or EEA–31 size cartridge whenever possible. In a patient who has suffered from chronic esophagogastric obstruction, the esophagus may well admit the EEA–31 cartridge.

One has the option to use the regular EEA device or the CEEA method. The latter has a detachable anvil which is easier to insert into a small esophagus than the anvil which is attached to the EEA device itself. The methodology of using the CEEA device is described in Chap. 39 for low anterior resection.

Now bring the previously prepared Roux-en-Y segment of jejunum and pass it through an incision in the avascular part of the transverse mesocolon. The jejunum should easily reach the esophagus with 6–7 cm to spare. Gently dilate the lumen of the jejunum and insert the lubricated cartridge of the EEA device into the open end of the jejunum as

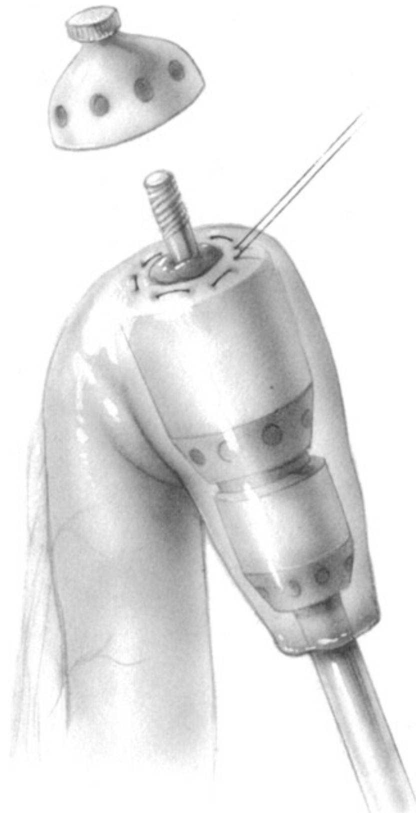


Fig. 28–23

Fig. 28–24

illustrated in **Fig. 28–23**. Remove the anvil from the cartridge before inserting it into the jejunum. Make a small incision over the rod of the EEA device through the elbow of the jejunum so that the rod can penetrate the antimesenteric border of the jejunum. Then insert a 2–0 Prolene purse-string suture around this rod and tie the suture. Reattach the anvil to the EEA device and be certain that the screw is tight. Now turn the wing-nut at the base of the EEA device so that the anvil separates from the cartridge as much as possible. Then have the assistants grasp the four guy sutures and gently stretch the opening of the esophagus by applying mild traction. This will loosen the purse-string suture. Gently insert the well-lubricated anvil into the lumen of the esophagus and tie the purse-string suture as illustrated in **Fig. 28–24**. Now turn the screw at the base of the EEA so that the anvil is approximated to the cartridge. When this has been completed, fire the device by pulling the trigger. Then turn the wing-nut seven half-turns in a counterclockwise direction and rotate the device and manipulate the anvil in such fashion as to withdraw the EEA device from the anastomosis. At this point, it is important to insert the index finger into the open end of the jejunum (**Fig. 28–25**). The index finger should go easily

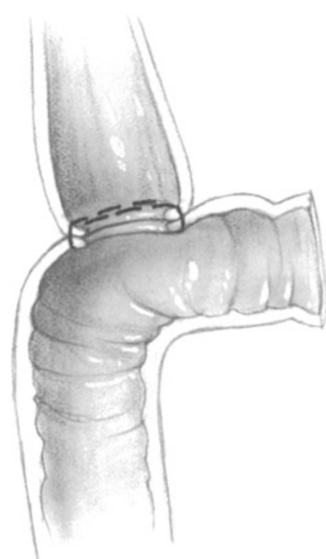


Fig. 28–25

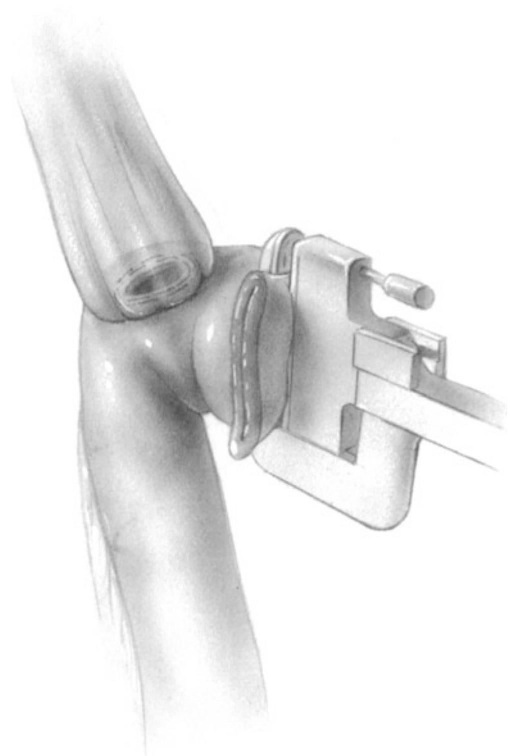


Fig. 28–26

both through the anastomosis into the esophagus and in a caudal direction into the distal jejunum. If this finger exploration is satisfactory, apply a TA–55 stapler with 3.5-mm staples to the jejunum as seen in **Fig. 28–26**. Apply the stapler at a point about 1–2 cm away from the anastomosis. Close the jaws of the TA–55 and fire the staples. Then amputate the redundant jejunum and lightly electrocoagulate the exposed mucosa. It is important to amputate the jejunum close to the anastomosis so that no blind loop will develop.

If the finger exploration was not satisfactory, and the index finger goes from the open end of the jejunum directly into the esophagus but cannot enter the distal jejunum, as shown in **Fig. 28–27**, the surgeon has committed the error of permitting the shoulder of the cartridge to carry the left wall of the jejunum (**Fig. 28–28**) along with it so that it is enclosed within the anastomosis, thus totally occluding the entrance into the efferent limb of the jejunum. This serious error can be prevented if the surgeon will closely observe the passage of the cartridge as shown in Fig. 28–23, to be certain that it slides past the side wall of the jejunum to completely abut the antimesenteric border. If this error has been made, the anastomosis will have to be repeated.

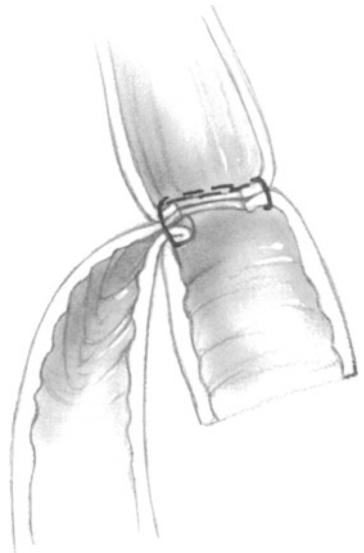


Fig. 28–27

Fig. 28–28

Roux-en-Y Jejunojejunostomy, Sutured

Attention should now be directed to restoring the continuity of the small intestine by doing an end-to-side anastomosis between the cut end of the proximal jejunum and the side of the Roux-en-Y limb. This anastomosis should be made 60 cm from the esophagojejunal anastomosis in order to prevent bile reflux. After the proper site on the antimesenteric border of jejunum has been selected, make a longitudinal scratch mark with a scalpel. Use interrupted 4–0 silk Lembert sutures for the posterior seromuscular layer of the end-to-side anastomosis (**Fig. 28–29**). When all these sutures have been placed,

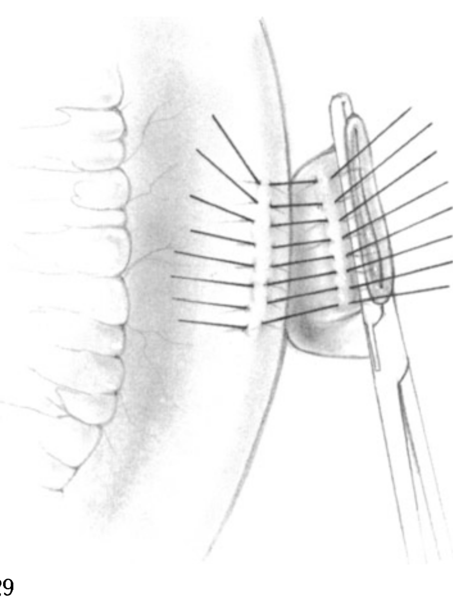


Fig. 28–29

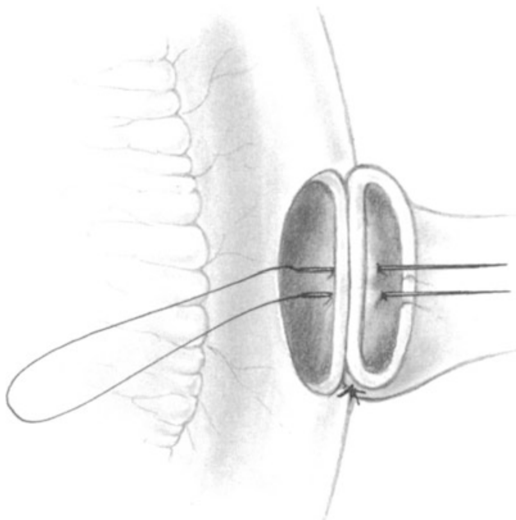


Fig. 28–30

make an incision along the previously marked area of the jejunum and remove the Allen clamp from the proximal segment of the jejunum. Approximate the mucosal layers, using 4–0 chromic catgut or PG doubly armed with straight needles (**Fig. 28–30**). Take the first stitch in the middle of the posterior layer and tie it. Close the remainder of the posterior mucosal layer with a continuous locked suture (**Fig. 28–31**). Approximate the anterior mucosal layer

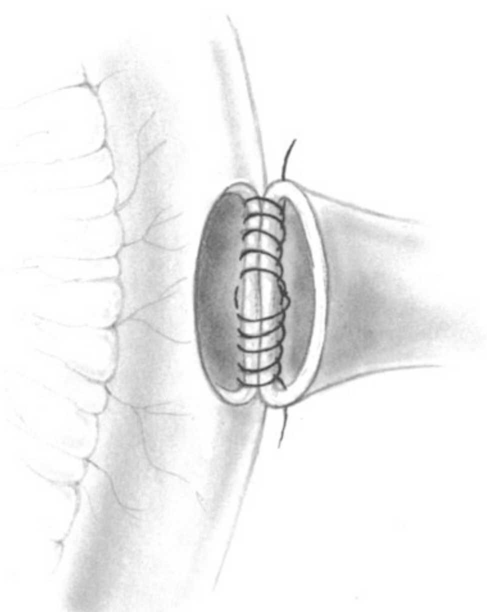


Fig. 28–31

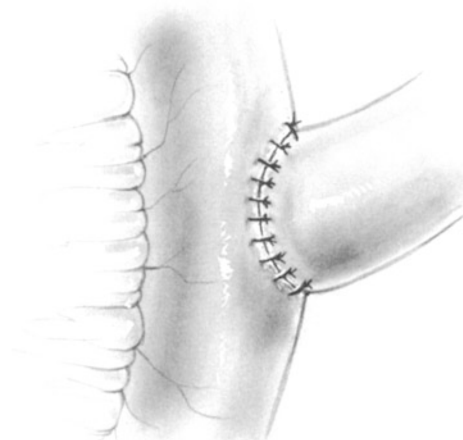


Fig. 28–32

with a continuous suture of either the Connell or Cushing type. Then close the final anterior seromuscular layer with interrupted 4–0 silk Lembert sutures (**Fig. 28–32**). Test the lumen by invaginating the jejunum with the index finger.

Stapled Roux-en-Y Jejunojejunostomy

In most cases, we prefer to perform the Roux-en-Y jejunojejunostomy with a stapling technique. To accomplish this, the proximal segment of the jejunum is approximated to the Roux-en-Y limb. With the electrocautery make a 1.5-cm longitudinal incision on the antimesenteric border. Insert a GIA stapling device, one fork into the descending segment of the jejunum and the other fork into the open end of the proximal segment of the jejunum (**Fig. 28–33**). Be certain that the *open end of the proximal segment of jejunum is placed so that the opening faces in a cephalad direction.* If the limbs of the jejunum are not joined in this manner, there is increased risk of narrowing the lumen of the jejunum. When the GIA device is in place, lock and fire; it will be seen that the first layer of the anastomosis has been completed in a side-to-side fashion between the antimesenteric borders of both segments of the jejunum (**Fig. 28–34**).

To close the remaining defect in the anastomosis, apply an Allis clamp to the right-hand termination of the staple line and another Allis to the left-hand termination of the staple line. Insert a guy suture into the midpoint of the remaining defect on the proximal segment of the jejunum and pass it through the midpoint of the defect on the distal segment of the jejunum (**Fig. 28–35**). When the guy suture approximates these two points, apply Allis clamps to the right side of the defect to approximate the two

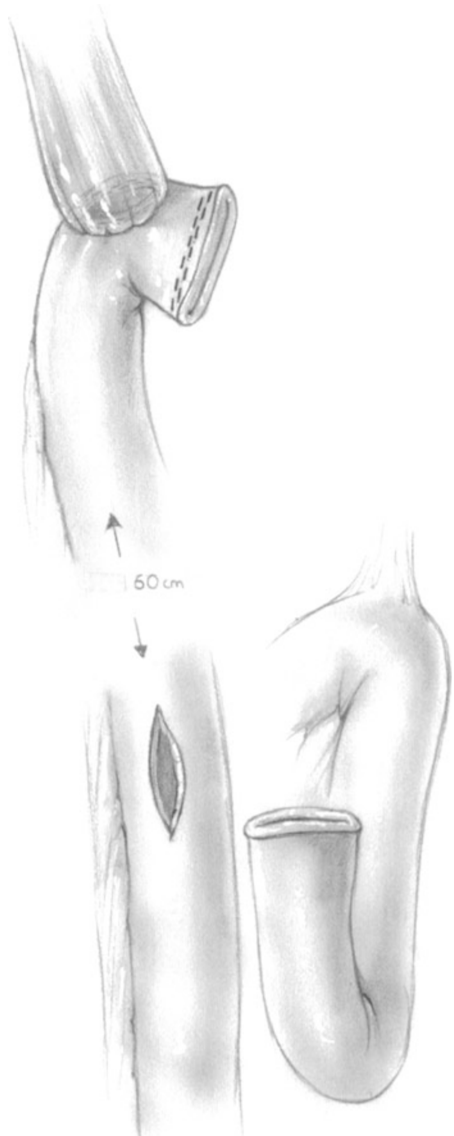


Fig. 28–33

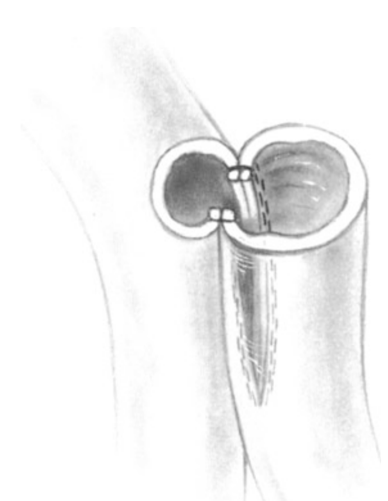


Fig. 28–34

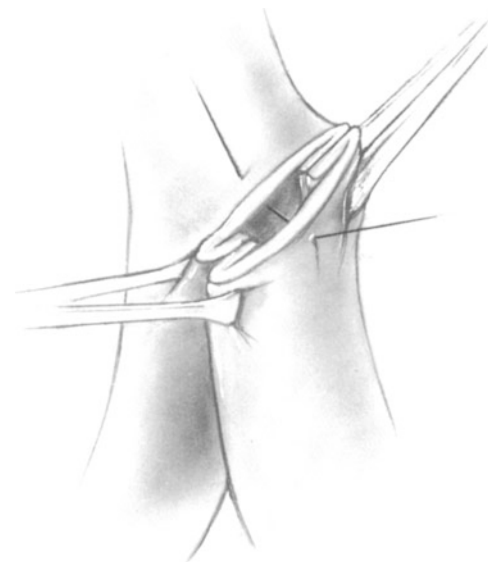


Fig. 28–35

segments of the jejunum in an everting fashion. Complete this part of the anastomosis by applying and firing the TA-55 stapling device deep to the Allis clamps and the guy suture (**Fig. 28–36**). Excise the redundant mucosa flush with the stapling device, but preserve the guy suture. Lightly electrocoagulate the everted mucosa.

Use Allis clamps again to close the remaining defect and apply the TA-55 stapler once more deep

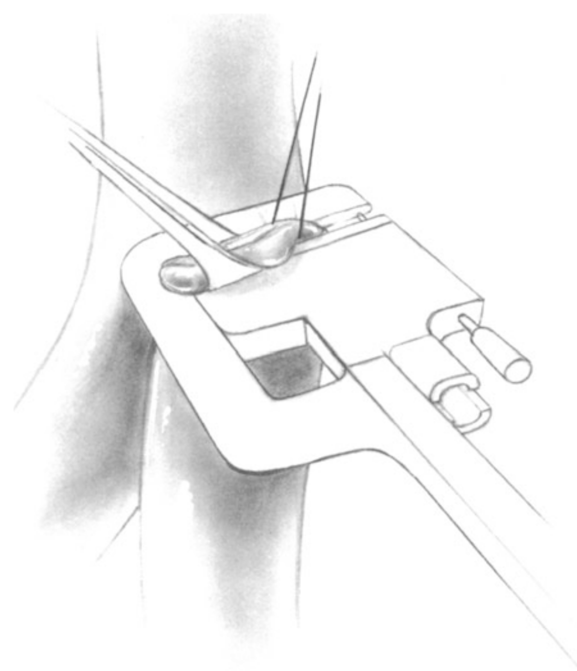


Fig. 28–36

Fig. 28–37

to the Allis clamps and the guy suture. When the stapler is fired and the redundant mucosa excised, the anastomosis is complete. It can be seen that the lumen is quite large (**Fig. 28–37**).

Close the remaining potential defects between the mesentery of the proximal and distal jejunum with interrupted sutures of 4–0 silk to prevent herniation.

Modifications of Operative Technique for Patients with Zollinger-Ellison Syndrome or Benign Disease

When total gastrectomy is being performed for the Zollinger-Ellison syndrome or for benign disease, several modifications are indicated. First, it is not necessary to excise considerable lengths of the esophagus or duodenum. Both these structures are divided close to the margins of the stomach. Second, it is not necessary to remove the spleen or omentum, and the greater curvature dissection can be carried out by dividing each of the vasa brevia between the greater curvature of the stomach and the greater omentum, leaving the omentum behind. Third, dissection of the lymph nodes in the region of the celiac axis, hepatic artery, and pancreas is not indicated. But for the foregoing modifications, the technique is essentially the same as for cancer operations; however, the incidence of postoperative complications is far lower in patients with the Zollinger-Ellison syndrome.

Needle-Catheter Jejunostomy

Since most patients requiring a total gastrectomy are malnourished, we perform a needle-catheter jejunostomy at this point in the operation.

Wound Closure

Irrigate the abdominal cavity again with saline and antibiotic solution. If hemostasis is excellent and the anastomoses have been performed with accuracy, we do *not* insert drains into the abdominal cavity. Otherwise, a 6-mm Silastic Jackson-Pratt catheter may be brought out from the vicinity of the anastomosis through a puncture wound in the abdominal wall and attached to closed-suction drainage.

Postoperative Care

Administer nasogastric suction for 3–4 days.

Administer perioperative antibiotics.

Administer enteral feedings by way of the needle catheter jejunostomy after the patient recovers from anesthesia.

As in other esophageal anastomoses, nothing should be permitted by mouth until the seventh postoperative day, at which time an esophagram should be performed in the X-ray department. If no leakage is identified, a liquid diet should be initiated. This may be increased rapidly according to the patient's tolerance.

Long-term postoperative management requires all patients to be on a dietary regimen that counteracts dumping. The diet should be high in protein and fat while low in carbohydrate and liquids. Frequent small feedings are indicated. Liquids should not be consumed during and 1 or 2 hours after meals in order to prevent hyperosmolarity in the lumen of the proximal jejunum. Some patients may require several months of repeated encouragement to establish adequate caloric intake following total gastrectomy. Others seem to do well with no dietary restrictions.

Dietary supplements of vitamins, iron, and calcium as well as continued parenteral injections of vitamin B_{12} are necessary in the long-term management of patients following total gastrectomy.

Complications

Sepsis of the abdominal wound or the subphrenic space is one complication that follows surgery for an ulcerated gastric malignancy. Early diagnosis and management are necessary.

Leakage from the esophagojejunal anastomosis is the most serious postoperative complication, but should occur *rarely* if proper technique has been used. A minor degree of leakage may be managed by prompt institution of adequate drainage in the region, supplemented every 8 hours by injection through the drainage catheter of 15 ml of saline with suitable antibiotics. A nasogastric tube of the sump type should be passed to a point just proximal to the esophagojejunal anastomosis for continuous suction. Nutritional support is essential, as are systemic antibiotics. In more serious cases, a diverting cervical esophagostomy may be required. Fortunately, a properly performed Roux-en-Y anastomosis will divert duodenal and pancreatic enzymes from the leak. If the Roux-en-Y technique has not been used, exteriorization of the jejunal segment, temporary occlusion of the distal esophagus, and cervical esophagostomy become necessary to control the septic process.

References

Monson JRT, Donohue JH, McIlrath DC et al. Total gastrectomy for advanced cancer; a worthwhile palliative procedure. Cancer 1991;68:1863–1868.

Pachter HL, Pennington R, Chassin JL et al. Simplified distal pancreatectomy with the Auto Suture stapler: preliminary clinical observations. Surgery 1979:85:166–170.

Paulino F, Roselli A. Carcinoma of the stomach. Curr Probl Surg 1973;Nov:3–72.

Schrock TR, Way LW. Total gastrectomy. Am J Surg 1978;135:348.

Scott HW Jr et al. Clinical experience with a jejunal pouch (Hunt-Lawrence) as a substitute stomach after total gastrectomy. Surg Gynecol Obstet 1965;121:1231.

Scott HW Jr et al. Clinical and metabolic studies after total gastrectomy with a Hunt-Lawrence food pouch. Am J Surg 1968;115:148.

29 Exposure of the Third and Fourth Portions of the Duodenum

Indications

Tumor
Bleeding

Concept

Because the third portion of the duodenum is located behind the superior mesenteric vessels and transverse mesocolon, a direct approach to it would be hazardous. Liberating the right colon and small bowel mesentery from their attachments to the posterior abdominal wall permits the surgeon to elevate the right colon and entire small bowel to a position over the patient's thorax. This changes the course of the superior mesenteric and middle colic vessels so that they travel directly cephalad, leaving the transverse portion of the duodenum completely exposed.

Preoperative Care

Nasogastric tube
Some lesions in the third and fourth portions of the duodenum may be biopsied by the endoscopist, which permits more accurate planning of the operation

Pitfalls and Danger Points

Trauma to superior mesenteric artery or vein
Trauma to pancreas

Operative Strategy

After liberating the right colon by incising the peritoneum of the right paracolic gutter, divide the renocolic attachments. Continuing in this plane, the surgeon will be able to free the entire mesentery of the small intestine in an entirely avascular dissection. It is important to devote special attention to the superior mesenteric vein as it emerges from the pancreas; rough traction in the area may avulse one of its branches, producing troublesome bleeding.

In planning a resection of the third and fourth portions of the duodenum, it should be noted that to the right of the superior mesenteric vessels the blood supply of the third portion of the duodenum arises from many small branches of the inferior pancreaticoduodenal arcade. These must be dissected, divided, and ligated delicately, one by one, to avoid pancreatic trauma and postoperative acute pancreatitis. The distal duodenum is not attached to the body of the pancreas to the left of the superior mesenteric vessels: its blood supply arises from branches of the superior mesenteric artery, as does that of the proximal jejunum. These are easy to identify and control.

If the pancreas has not been invaded it is possible to resect the third and fourth portions of the duodenum for tumor and then to construct an anastomosis between the descending duodenum and the jejunum, so long as the ampulla is not involved. When working in this area, it is essential that the ampulla of Vater be identified early in the dissection.

Operative Technique

Incision

A long midline incision from the midepigastrium to the pubis gives excellent exposure for this operation.

Liberation of Right Colon

Make a Metzenbaum incision in the peritoneum of the right paracolic gutter. Insert the index finger to separate the peritoneum from underlying fat and areolar tissue; this will provide an avascular plane. When the hepatic flexure is encountered, the electrocoagulator can help control bleeding as the peritoneum is cut. It is not generally necessary to dissect the greater omentum off the transverse colon in this operation. It is important, however, to continue the division of the paracolic peritoneum around the inferior portion of the cecum and to move on medially to liberate the terminal ileum, all in the same plane (**Fig. 29–1**). Identify the renocolic ligament at the medial margin of Gerota's fascia. Division of this thin, ligamentous structure will completely free the right mesocolon.

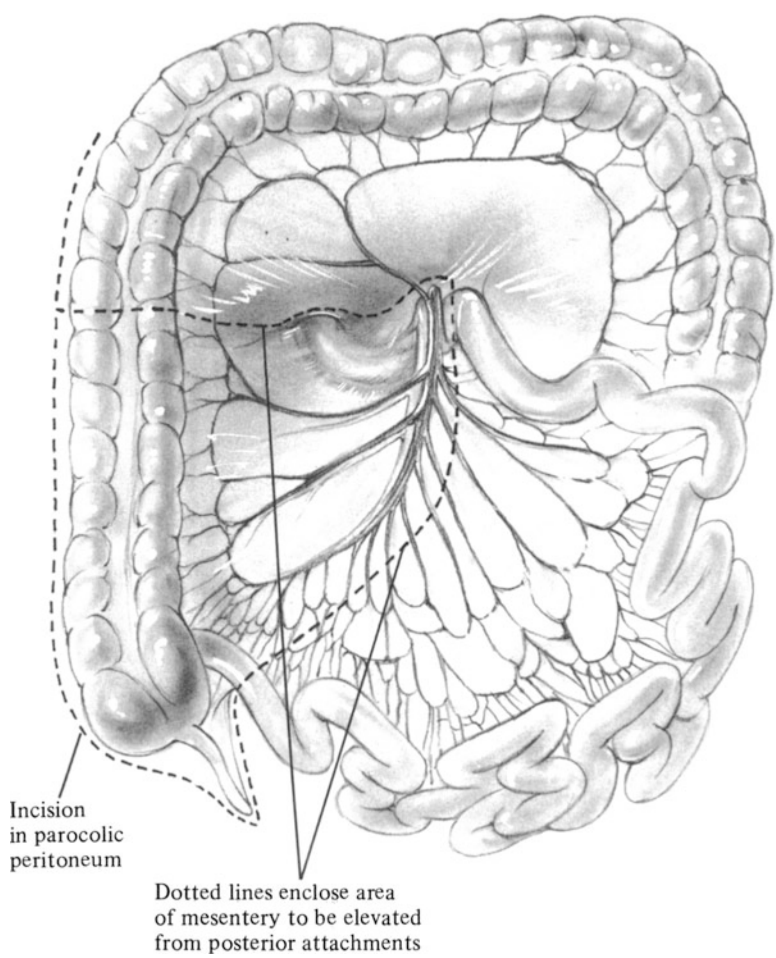


Fig. 29–1

Liberation of Small Bowel Mesentery

Insert the left index finger beneath the remaining avascular attachments between the mesentery of the small bowel and the posterior wall of the abdomen; incise these attachments until the entire small intestine up to the ligament of Treitz is free and can be positioned over the patient's thorax. This configuration resembles the anatomy of patients who have a congenital failure of rotation or malrotation of the bowel (**Fig. 29–2**).

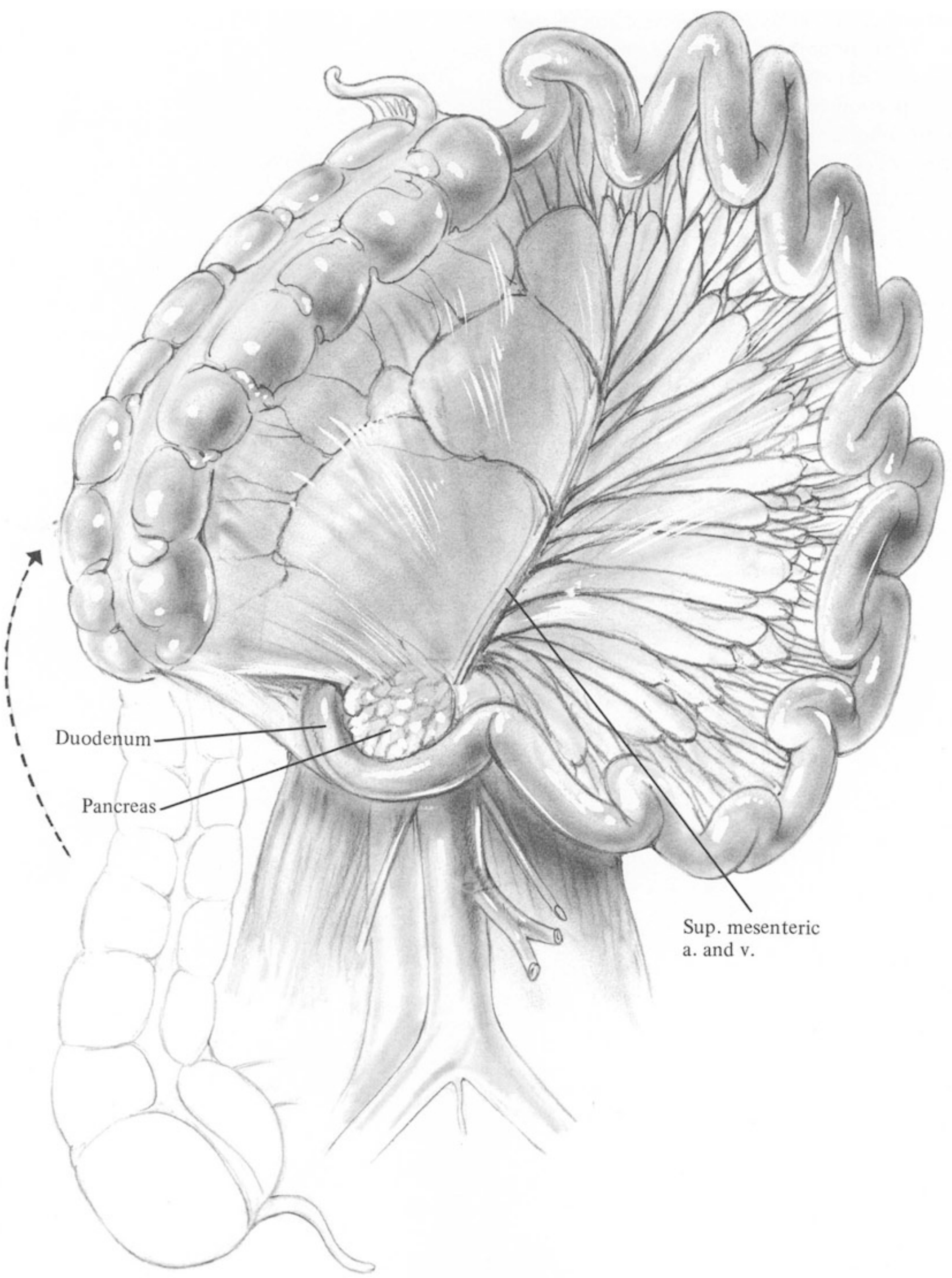


Fig. 29–2

Resection of Duodenum

There is no structure lying over the third and fourth portions of the duodenum or proximal jejunum at this time. If a tumor of the duodenum is to be resected, it is important to determine now if it is safe to do so. If some portion of the pancreas has been invaded, a decision will have to be made whether a partial or total pancreatectomy is indicated for the patient's pathology. If the duodenum is free, dissection is best begun by identifying the blood supply of the distal duodenum, dividing each vessel between clamps, and ligating. As the pancreatic head is approached, the dissection should be done with delicacy. It is possible to identify and divide each of the small vessels arising from the pancreas. This frees the duodenum and permits resection and anastomosis.

About 1 cm of the duodenum should be freed from the pancreas proximal to the point of transection. This permits an end-to-end anastomosis between the proximal duodenum and a segment of the jejunum that is brought over for this purpose. Mere closure of the distal duodenum plus a gastrojejunostomy is not a satisfactory operation, as the proximal duodenum will eventually dilate to huge proportions and form a blind loop. If for some reason the end of the duodenum is suitable for closure but not for anastomosis, a side-to-side anastomosis between the second portion of the duodenum and proximal jejunum is a good alternative.

Closure

After the anastomosis has been performed, return the right colon and small bowel to the abdomen. Make no attempt to reestablish the posterior attachments of the mesentery. Close the abdomen in routine fashion.

Postoperative Care

Aside from the administration of nasogastric suction until bowel function has resumed with the passage of flatus, postoperative care is routine. Be aware that acute pancreatitis is a possible complication of any dissection in the region of the pancreas. If the serum amylase remains elevated and the patient shows any signs of acute pancreatitis, nasogastric suction should be continued until no danger exists.

Postoperative Complications

Pancreatitis

Anastomotic leaks

Small Intestine and Appendix

30 Small Bowel Resection and Anastomosis

Indications

Tumor
Trauma
Strangulation
Crohn's enteritis with complications
Ischemic enteritis

Preoperative Preparation

Nasogastric intubation
Perioperative antibiotics

Pitfalls and Danger Points

The small bowel anastomosis is generally quite safe unless there is also some impairment of the blood supply or advanced peritoneal sepsis. When the small bowel anastomosis fails because of mechanical errors, the leak almost invariably occurs at the mesenteric border, where in the serosa has not been adequately cleared of blood vessels and fat.

Operative Strategy

Requirements for Successful Bowel Anastomosis

1) A *good blood supply* is required for optimal healing. Determine this by noting the pulsatile flow after dividing a terminal arterial branch in the region where the bowel is to be transected. There should be no hematoma near the anastomosis, as this may impair circulation.
2) *Accurate apposition of the seromuscular coats* is essential. There should be no fat or other tissue between the two bowel walls being sutured. The seromuscular suture must catch the submucosa, where most of the tensile strength of the intestine is situated. Optimal healing of an anastomosis requires serosa-to-serosa approximation. Special attention must be devoted to the mesenteric border of any anastomosis. This is the point at which several terminal blood vessels and accompanying fat are dissected off the bowel wall to provide the surgeon with sufficient visibility to permit accurate insertion of the seromuscular suture. If fat and blood vessels are cleared away from a 1-cm width of serosa around the circumference of an anastomosis, there need be no worry about impairing the blood supply of the bowel. The increased accuracy with which the sutures are inserted will minimize anastomotic complications.
3) A *sufficient length of bowel must be freed* proximal and distal to each anastomosis to insure there will be no tension whatever on the healing suture line. Allowance should be made for some degree of foreshortening of the length of the intestine in case postoperative distention occurs.
4) *Do not apply excessive force* in tying the anastomotic sutures as this will result in strangulation of tissue. If the suture should inadvertently have been placed through the full thickness of the bowel and into the lumen, strangulating the suture will cause the intestinal contents to leak. The suture should be tied with no more tension than is needed to approximate both intestinal walls.
5) *Do not apply excessive force to the forceps* when manipulating the ends of the bowel to be anastomosed. If the imprint of forceps teeth is visible on the serosa after the forceps has been removed, the surgeon obviously has compressed the tissue with too much force. When a curved needle is used, the needle must be passed through the tissue with a rotatory motion to minimize trauma. As discussed in detail in Appendix B, it does not matter whether an intestinal anastomosis is constructed with one or two layers or whether a stapling method is used, as long as proper technique is employed.
6) *Before constructing stapled intestinal anastomoses, learn the pitfalls*, both technical and conceptual, of the method. Study the strategy of avoiding the complications of surgical stapling (see Chap. 4). We have published a report demonstrating that when done by those who have learned the technique, stapled anastomoses are no more prone to complications than are sewn anastomoses. This is surprising, considering that many stapled anastomoses are, in part, of the *everting* type,

which most surgeons believe is not conducive to optimal healing in the sutured anastomosis.

7) Some errors often are made by residents who are learning the art of anastomotic suturing. One is inserting the outer layer of seromuscular sutures with the collapsed bowel resting on a flat surface. An even worse error consists in putting the left index finger underneath the back of the anastomosis while inserting the anterior seromuscular sutures. Both errors make it possible to pass the seromuscular suture through the bowel lumen and then to catch a portion of the posterior wall. When the sutures are tied, an obstruction is created. While some of these sutures may later tear out of the back wall in response to peristalsis, others may remain permanently in place and produce a stenosis. In order to prevent this complication, simply have the assistant *grasp the tails of those anastomotic sutures that have already been tied.* Skyward traction on these sutures keeps the lumen of the anastomosis wide open while the surgeon inserts additional sutures.
8) Another error consists in inserting anastomotic sutures while the bowel is under linear tension. This stretches the bowel wall so that it becomes relatively thin, making it difficult to enclose a substantial bite of tissue in the suture. A *sufficient length of the intestine, proximal and distal, should be loosely placed in the operative field.* After the first seromuscular bite has been taken, the needle is then ready to be reinserted into the wall of the opposite segment of intestine. At this time it is often helpful to use forceps to elevate the distal bowel at a point 3–4 cm distal to the anastomosis. Elevation relaxes this segment of the bowel and permits the suture to catch a substantial bite of tissue, including the submucosa. Each bite should encompass about 4–5 mm of tissue. These stitches should be placed about 4–5 mm from each other.

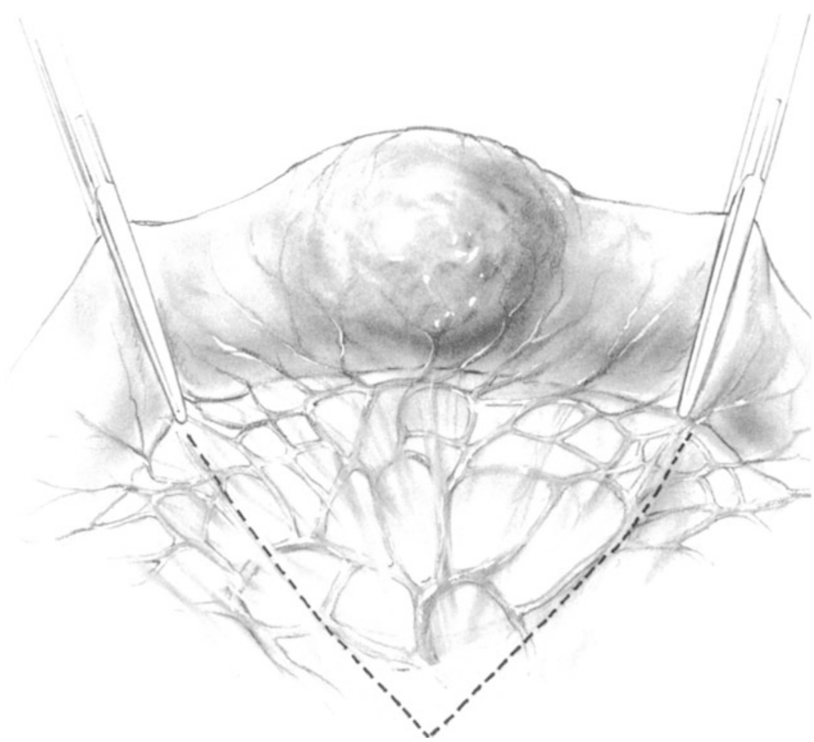


Fig. 30–1

Results

Carty and associates studied 500 intestinal anastomoses constructed with one layer of extramucosal sutures. Clinical anastomotic leaks occurred in 2.3% of elective operations. The mortality rate was 2.5% of elective cases, but leaks were not considered to be the cause of death in any case.

Contraindications to Anastomosis

Because of the excellent blood supply and substantial submucosal strength of the small bowel, anastomoses are often successful even in the presence of such adverse circumstances as intestinal obstruction and gross contamination of the abdominal cavity. Consequently, the only major contraindications to a primary small bowel anastomosis are peritoneal sepsis, questionable blood supply, or a patient whose condition on the operating table is precarious. In these cases both ends of the divided small bowel may be brought to the skin as temporary enterostomies.

Operative Technique: Small Bowel Anastomosis by Suturing

Incision

For the best exposure of the small bowel, use a midline vertical incision.

Division of Mesentery

Expose the segment of intestine to be resected by laying it flat on a moist gauze pad on the abdominal wall. With a scalpel make a V-type incision in the mesentery to be removed, carrying it through the superficial peritoneal layer only, in order to expose the underlying blood vessels (**Fig. 30–1**). Apply medium-size hemostats in pairs to the intervening tissue. Divide the tissue between hemostats and ligate each with 2–0 PG. After the wedge of mesentery has been completely freed, apply Allen clamps

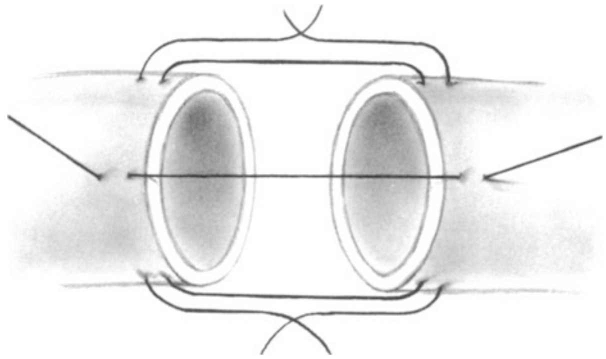


Fig. 30–2

to the bowel on the specimen sides. Apply linen-shod Doyen noncrushing intestinal clamps proximal and distal to prevent spillage of intestinal contents. Remove the diseased segment of intestine by scalpel division.

Open Two-Layer Anastomosis

Considerable manipulative trauma to the bowel wall can be eliminated if the anterior seromuscular layer of sutures is the first layer to be inserted. This should be done by the technique of successive bisection (see Appendix B). First, insert a Lembert 4–0 silk atraumatic seromuscular suture on the antimesenteric border. Then insert the second suture on the mesenteric border (**Fig. 30–2**). Tie both sutures. Next, bisect the distance between these two sutures and insert and tie the third Lembert suture at this point. Follow this sequence until the anterior seromuscular layer has been completed (**Fig. 30–3a**). Retain the two end sutures as guys, but cut the tails of all the remaining sutures. *The bowel should then be rotated by passing guy suture A behind the anastomosis* (**Fig. 30–3b**) so that the posterior layer is on top (**Fig. 30–3c**).

Accomplish closure of the mucosal layer with 5–0 Vicryl preferably double-armed with straight needles. Insert the two needles at the midpoint of the

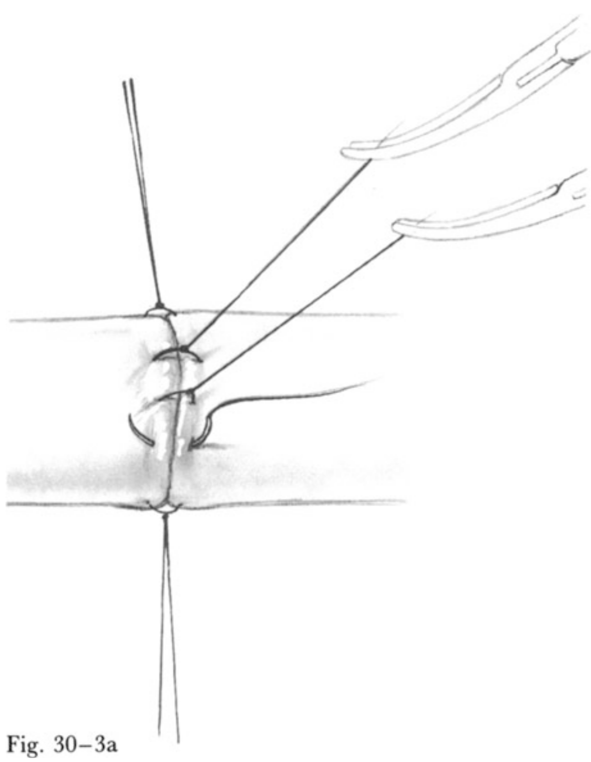


Fig. 30–3a

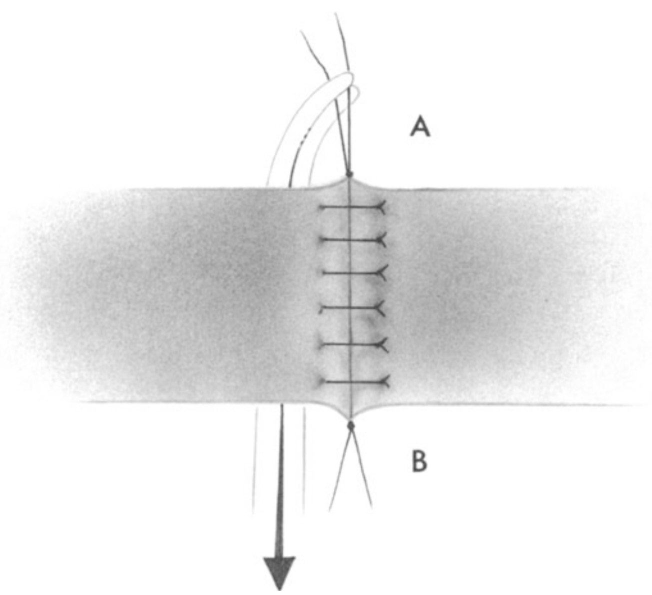


Fig. 30–3b

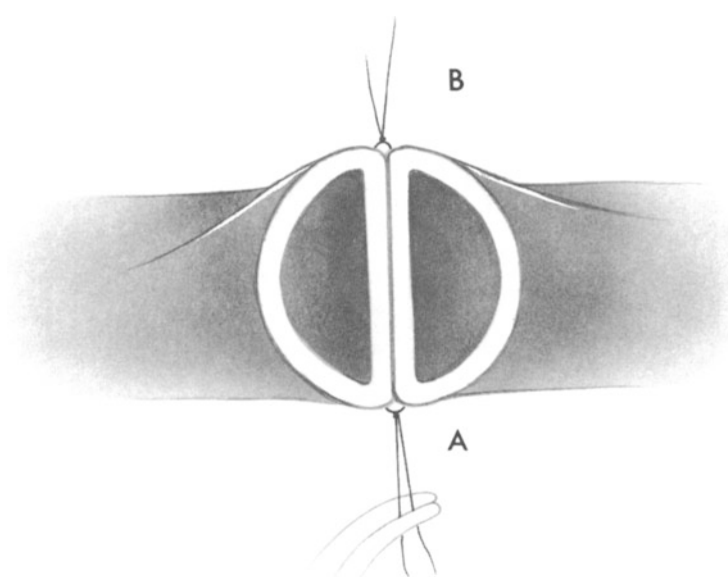


Fig. 30–3c

deep layer (**Fig. 30–4**). Tie the suture and close the posterior layer, which should include both mucosa and a bit of seromuscular tissue, with a continuous locked suture (**Figs. 30–5, 30–6, and 30–7**). Turning in the corners with this technique is simple. Bring the needle from inside out through the outer wall of the intestine (**Fig. 30–8**). Then complete the final mucosal layer, using either the Connell technique or a continuous Cushing suture (**Fig. 30–9**). After this mucosal layer has been completed, insert the final seromuscular layer of interrupted 4–0 silk Lemberts (**Fig. 30–10**). The technique of successive

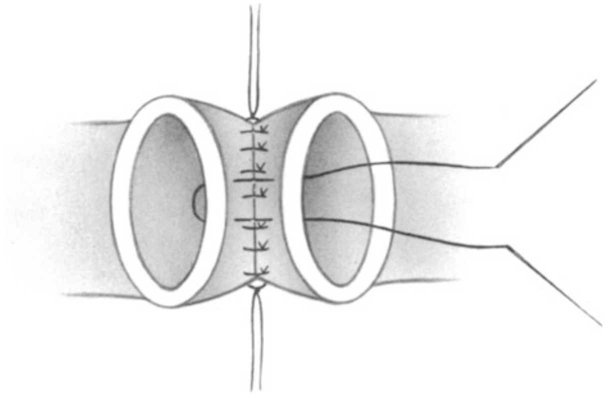


Fig. 30–4

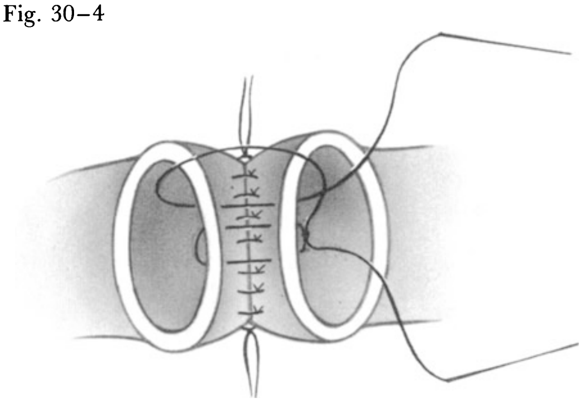


Fig. 30–5

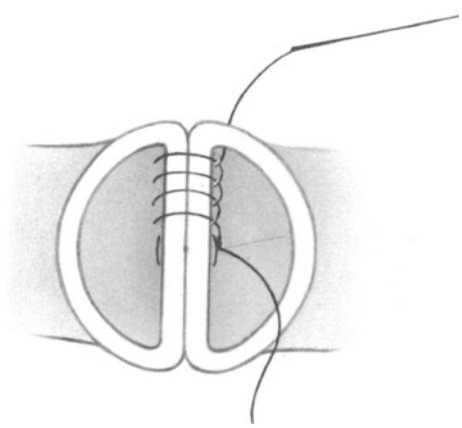


Fig. 30–6

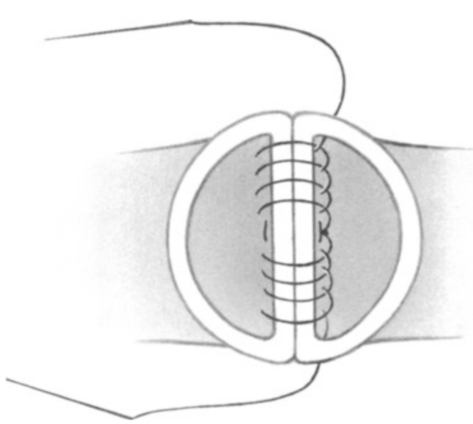


Fig. 30–7

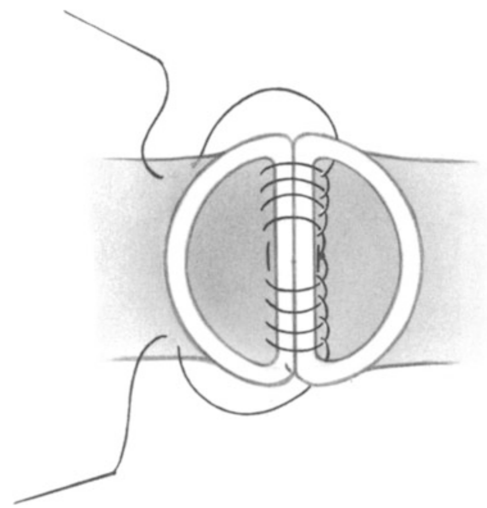


Fig. 30–8

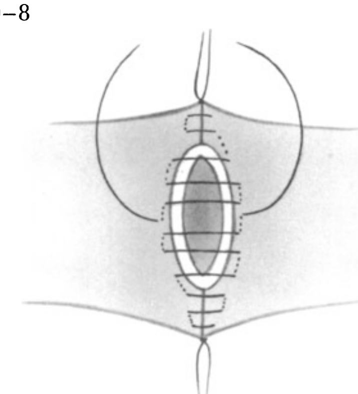


Fig. 30–9

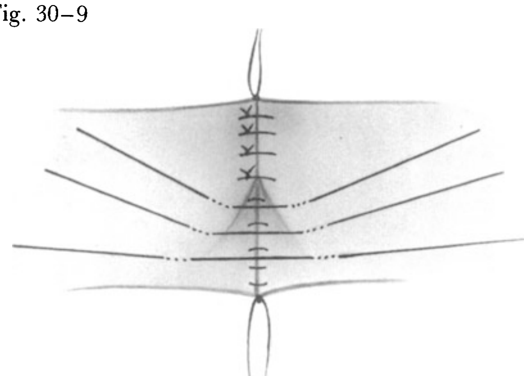


Fig. 30–10

bisection is not necessary in the final layer because the two segments of bowel are already in accurate apposition.

After all the suture tails have been cut, inspect carefully for imperfections in the suture line, especially at the mesenteric margin. Test the patency of the lumen by invaginating one wall of the intestine through the anastomosis with the tip of the index finger.

Open One-Layer Anastomosis

The first step in constructing an end-to-end anastomosis in one layer is identical with Figs. 30–2 and 30–3a. Insert interrupted Lemberts on the anterior seromuscular layer. Cut the tails of all the sutures except the two at the end, and rotate the bowel to expose the opposite, unsutured bowel (see Figs. 30–3b and 30–3c). Approximate this too with interrupted 4–0 silk *seromuscular* Lembert sutures, paying special attention to the mesenteric border, where fat and blood vessels may hide the seromuscular tissue from view if the dissection has not been thorough.

After the anastomosis is completed, check it closely for defects. Test the size of the lumen by invaginating the wall with a fingertip.

Alternatively, instead of Lemberts, "seromucosal" stitches may be inserted (**Fig. 30–11**). This suture enters the seromuscular layer and like the Lembert penetrates the submucosa, but instead of emerging from the serosa the needle emerges just beyond the junction of the cut edge of the serosa and underlying mucosa. This stitch has the advantage of inverting a smaller cuff of tissue than does the Lembert or Cushing technique and may therefore be useful when the small bowel lumen is small. When inserted properly the seromucosal suture does invert the mucosa, but not to the extent that the Lembert stitch does.

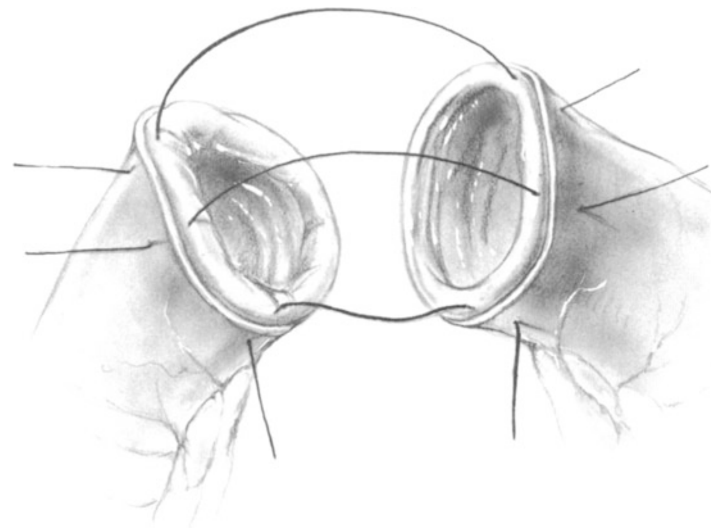


Fig. 30–11

Closure of Mesentery

Close the defect in the mesentery by a continuous suture of 2–0 PG on a large, intestinal-type needle. Take care not to pierce the blood vessels.

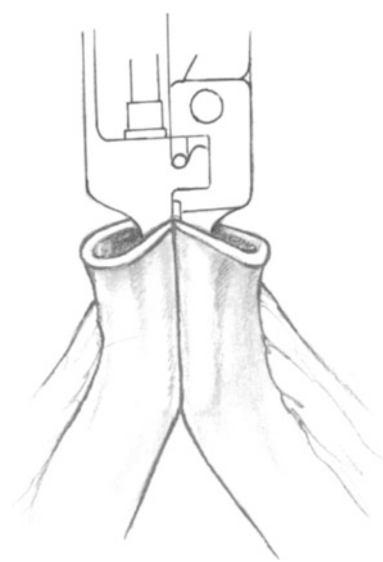


Fig. 30–12

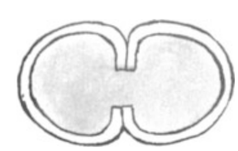


Fig. 30–13

Operative Technique: Small Bowel Anastomosis Using Stapling Technique

In our experience, the most efficient method of stapling the small bowel is a two-step functional end-to-end technique which we have developed. This requires the two open-ended segments of the small bowel to be positioned so that their antimesenteric borders are in apposition. Insert a GIA stapling device, one fork into the proximal and the other fork into the distal segment of the intestine (**Fig. 30–12**). Fire the GIA instrument, which will form one layer of the anastomosis in an inverting fashion (**Fig. 30–13**). Apply one Allis clamp to the anterior termination of the staple line and the other

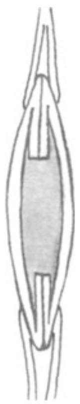


Fig. 30–14

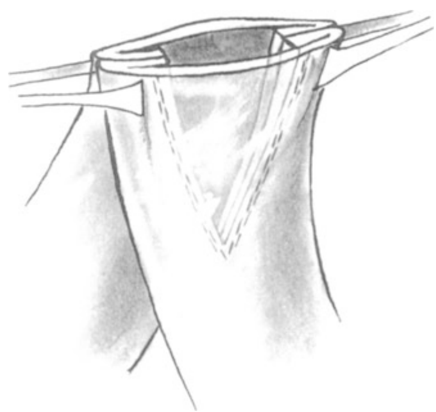


Fig. 30–15

Allis clamp to the anterior termination. Then draw the two Allises apart (**Figs. 30–14 and 30–15**). Close the remaining defect in the anastomosis in an everting fashion after applying 4–5 Allises to maintain apposition of the walls of the proximal and distal segments of bowel (**Fig. 30–16**).

After all the Allis clamps have been aligned, staple the bowel in eversion by applying a TA–90 device just deep to the Allis clamps, and fire the device (Fig. 30–16). To be sure there are no gaps in the closure it is essential that the line of staples cross both the anterior and posterior terminations of the GIA staple line. Generally, staples of 3.5-mm size should be used unless the bowel wall is thick, in which case 4.8-mm staples are preferable. Excise the redundant bowel flush with the stapling device, using Mayo scissors. Lightly electrocoagulate the everted mucosa.

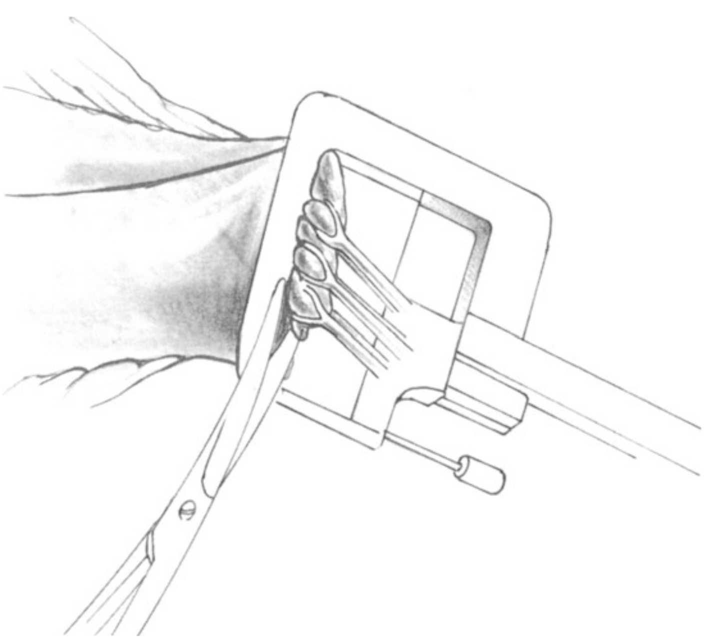


Fig. 30–16

Carefully inspect the staple line to be sure each staple has formed a proper B. Bleeding may be controlled by conservative electrocoagulation or by using 4–0 atraumatic PG sutures.

Close the defect in the mesentery with a continuous 2–0 atraumatic PG suture. If feasible, cover the everted mucosa by the mesenteric suture line to minimize the possibility of it becoming a nidus of adhesion formation.

Whether the anastomosis is sutured or stapled, it is advisable to cover it with a layer of omentum, whenever possible, to prevent adhesions.

Postoperative Care

Administer nasogastric suction until bowel function resumes.

Complications

Although it is quite uncommon for the patient to develop complications following a small bowel anastomosis, postoperative obstruction does occasionally occur. Anastomotic leaks accompanied by intraperitoneal sepsis or enterocutaneous fistula are rare except after resection in the face of sepsis or when mesenteric circulation is impaired.

References

Carty NJ, Keating J, Campbell J et al. Prospective audit of an extramucosal technique for intestinal anastomosis. Br J Surg 1991;78:1439–1441.

Chassin JL et al. The stapled gastrointestinal tract anastomosis: incidence of postoperative complications compared with the sutured anastomosis. Ann Surg 1978;188:689.

31 Enterolysis for Intestinal Obstruction

Indications

Enterolysis is indicated in acute cases of complete small bowel obstruction.

Concept: When to Operate?

Despite long years of experience, in cases of acute small bowel obstruction a surgeon *often* cannot determine preoperatively whether strangulation has taken place. Numerous retrospective studies confirm this fact. There is more risk in overlooking strangulation of the intestine than there is in possibly performing an unnecessary operation on a patient who might have been salvaged by successful long-tube suction. Consequently, most surgeons feel that a patient suffering a recent onset of acute *complete* intestinal obstruction, confirmed by flat X rays of the abdomen, should be operated upon as soon as rehydration has taken place. When strangulation is suspected, rapid resuscitation may be accomplished within 1 hour and continued in the operating room with appropriate monitoring.

Some patients present to the surgeon with evidence that the obstruction is incomplete, as suggested by the presence of a significant amount of air in the colon or the passage of flatus intermittently. A trial of conservative management in the group of patients *with incomplete obstruction* is warranted if there is *no* fever, leukocytosis, tachycardia, evidence of toxicity, nor a tender mass in the abdomen. Unremitting pain and radiation of pain to the back are both suggestions that the patient has a closed-loop obstruction that requires surgery. Most patients with incomplete obstruction will indeed respond to several days of nasogastric suction.

Patients suffering from acute small-bowel obstruction who have never had previous surgery should have a barium colon enema or colonoscopy to rule out a carcinoma of the cecum obstructing the ileum, whether the obstruction appears to be complete or incomplete.

Many surgeons are willing to attempt conservative treatment for a longer period of time in the postoperative patient in the belief that the adhesions are fibrinous and may be disrupted by the passage of a long intestinal tube. Another common explanation of postoperative obstructions is to call them paralytic ileus. In most operations, after the seventh postoperative day the persistence of ileus, as manifested by intestinal distention and failure of the patient to pass stool or flatus, is probably the result of anastomotic obstruction or some intraperitoneal pathology such as hematoma or sepsis. An internal hernia of the small intestine through a pelvic suture line following abdominoperineal resection or abdominal hysterectomy is another common cause of this clinical complex. For these reasons, even in the postoperative patient conservative treatment should be limited to a fixed number of days. If no response is forthcoming, relaparotomy is safer than continued persistence in conservative management.

Preoperative Preparation

Nasogastric suction should be instituted promptly.
Initiate fluid and electrolyte resuscitation.
Order perioperative antibiotics.

Pitfalls and Danger Points

Inadvertent laceration and spillage of the contents of the intestine is a hazard of this procedure.

Operative Strategy

Approach to Densely Adherent Abdomen

While the contents of the normal small intestine may be sterile, in intestinal obstruction the stagnation of bowel content often results in an accumulation of virulent bacteria and toxic products. When these are spilled in the peritoneal cavity, the likelihood of postoperative mortality and infection increases. To avoid this mishap, dissection should be done carefully and patiently.

The basic dissection strategy consists of entering the abdominal cavity through a scar-free area. Even though an old midline scar is frequently used to reenter an abdomen to relieve an obstruction, it is advantageous to make some part of the incision through an area of the abdomen above or below the old scar. Access to the peritoneal cavity through an unscarred area often gives the surgeon an opportunity to assess the location of adhesions in the vicinity of the anticipated incision. After the free abdominal cavity is entered and any adherent segments of intestine freed, the remainder of the incision should be carefully opened.

The next aspect of the strategy employed to free a densely adherent abdomen is to attach Allis clamps to the peritoneum and linea alba on one side of the incision. After the clamps are elevated, a Metzenbaum scissors can generally be insinuated behind the various layers of avascular adhesions to incise them (see Fig. 31–1). If the left index finger can be passed beneath a loop of bowel adherent to the abdominal wall, this will help guide the dissection. The aim is to free all the intestine from the anterior and lateral abdominal wall, first on one side of the incision and then on the opposite, so the anterior and lateral layers of parietal peritoneum are completely free of intestinal attachments (see Fig. 31–2).

Once the intestine has been freed, trace a normal-looking segment to the nearest adhesion. If possible, insert an index finger into the leaves of mesentery separating the two adherent limbs of the intestine. By gently bringing the index finger up between the leaves of mesentery, often the adherent layer can be stretched into a fine, filmy membrane, which is easily divided with a scissors (see Fig. 31–3). In general, the strategy is to insinuate either the left index finger or the closed blunt-tipped curved Metzenbaum scissors beneath an adhesion to delineate the plane, then to withdraw the closed scissors and to cut the fibrous layer. A guiding principle should be to *perform the easy dissection first*. If this principle always is followed, the difficult portion of a dissection will become easy. Avoid tackling a dense adherent mass head on; if the loops of intestine going to and coming from the adherent mass are dissected on their way in and on their way out of the mass of adhesions, a sometimes confusing collection of intestine can be easily untangled.

In the case of an acute small bowel obstruction, frequently there are only one or two adhesions and a markedly distended proximal bowel. When this occurs, be careful not to permit the distended bowel to leap out of a small portion of the incision, as it may be torn inadvertently in the process. If possible, first deliver the collapsed bowel (distal to the point of obstruction) and then trace it retrograde up to the point of obstruction. The adhesion can then be divided under direct vision and the entire bowel freed.

Relaparotomy for Early Postoperative Obstruction

To reexplore the postoperative abdomen we most often reenter the same incision, usually in the midline. Since most relaparotomy operations are done after the eighth to tenth postoperative day, some sharp dissection may be necessary to enter the abdomen.

To divide adhesions in these cases, many of the loops of bowel can be separated by inserting the index finger between the leaves of adjoining mesentery. By elevating the finger, the adhesion can be stretched between the bowel segments. Often the adhesion may be disrupted by pinching it *gently* between the thumb and index finger without damaging the serosa of the bowel.

Operative Intestinal Decompression

If the diameter of the small bowel appears to be so distended that closing the incision would be difficult, operative decompression of the bowel will make the abdominal closure simpler and may improve the patient's postoperative course. Decompression may also lessen the risk of inadvertent laceration of the tensely distended intestine.

For this procedure we prefer to use the Baker or a Nyhus-Nelson intestinal tube. This is a 270 cm long tube with a 5-ml balloon at its tip. It may be passed through the patient's nose by the anesthesiologist or introduced by the surgeon through a Stamm gastrostomy. It is then passed through the pylorus with the balloon deflated. The balloon is partially inflated and the tube milked around the duodenum to the ligament of Treitz and then down the small intestine. Meanwhile, intermittent suction should be applied for the aspiration of gas and intestinal content. Caution should be exercised in milking the tube through the intestine, as the distended bowel has impaired tensile strength and can easily be torn. In patients who have relatively few adhesions, the Baker tube may be removed at the conclusion of the decompression and a nasogastric tube substituted for postoperative suction. In patients who have extensive serosal damage due to universal adhesions, it may be desirable to perform a stitchless plication by leaving the Baker tube in place for 2–3 weeks (see Chap. 32).

Management of Serosal Damage

Small areas of intestine from which the serosa has been avulsed by dissection require no sutures for repair if the submucosa has remained intact. This is evident in areas where some remnants of muscle fibers remain. Otherwise, when only thin mucosa

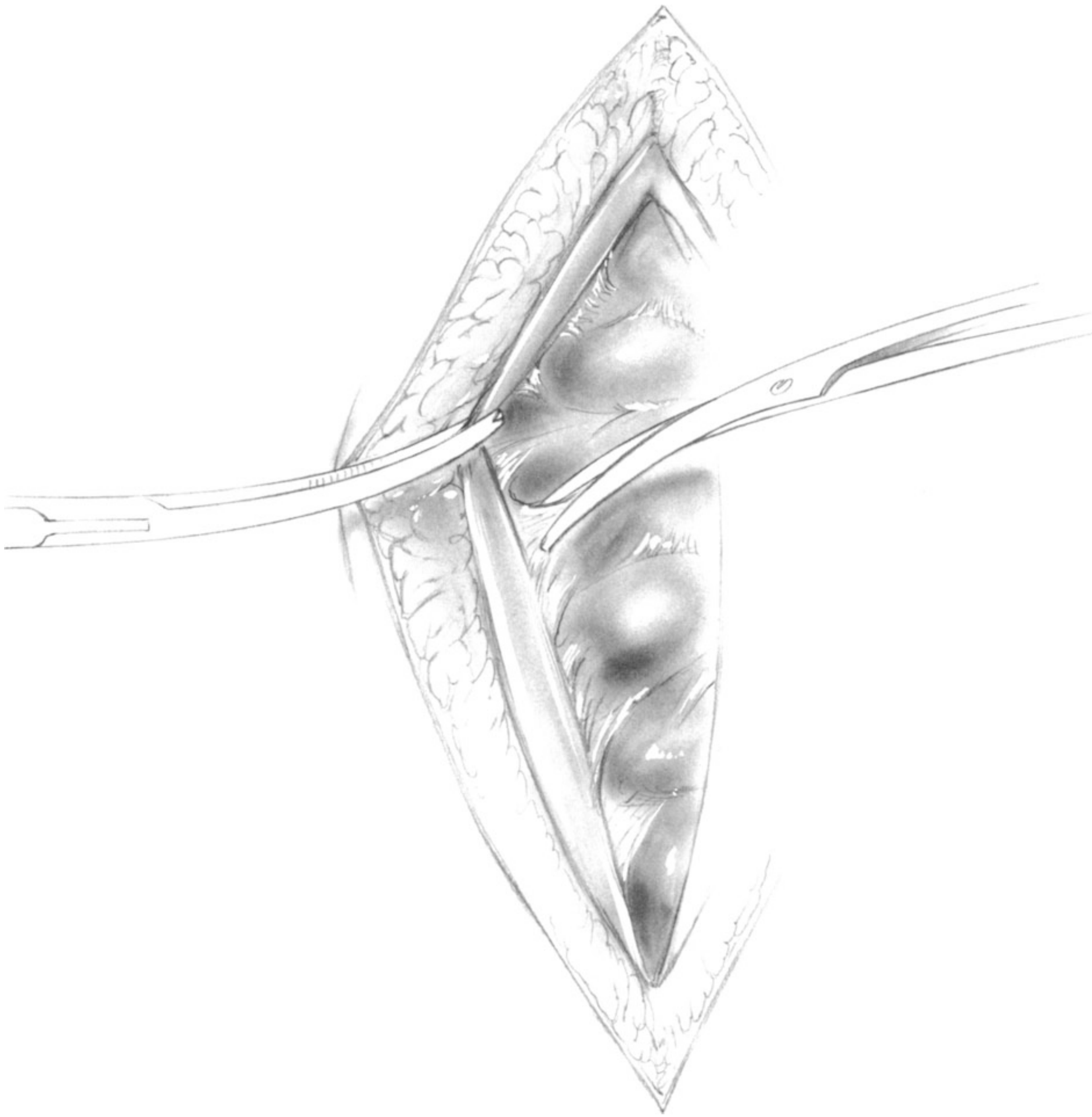


Fig. 31–1

bulges out and the mucosa is so transparent that bubbles of fluid can be seen through it, the damage is extensive enough to require inversion of the area with a continuous 5–0 Vicryl Lembert seromuscular suture.

Operative Technique

Incision and Bowel Mobilization

A long midline incision is preferable. If the site has an earlier incision, start the new incision 3–5 cm cephalad to the upper margin of the old incision so that the abdomen can be entered through virgin territory. Carry the skin incision through the middle of the old scar and down to the linea alba. After opening the upper portion of the incision, identify the peritoneal cavity, then carefully incise the remainder of the scar. At the same time dissect away any adherent segments of underlying intestine (**Fig. 31–1**).

Divide adhesions by the method described above in "Operative Strategy," until the entire anterior and lateral portion of the abdominal wall and parietal

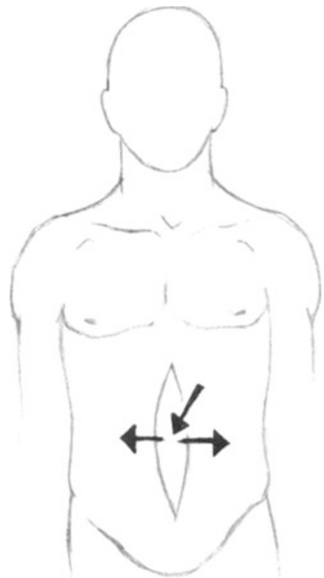


Fig. 31–2

peritoneum are free of underlying adhesions (see **Fig. 31–2**). Thereupon, free the remainder of the bowel of adhesions, from the ligament of Treitz to the ileocecal valve. Accomplish this by delicate Metzenbaum scissors dissection, alternately sliding the scissors underneath a layer of fibrous tissue to visualize its extent and then cutting the adhesion. This can be done more efficiently if the left index finger can be insinuated in such a way as to circumscribe the adherent area, or if the index finger can be brought between the leaves of mesentery separating the adherent bowel, thereby placing the adhesion on stretch and making it visible (**Fig. 31–3**). In some cases there are adhesions of a cartilaginous nature, especially in patients whose obstruction is due to multiple malignant implants. Bold scalpel incisions should be made to divide adhesions of this type. Again, by doing the easy dissection first, the difficult parts will become easier.

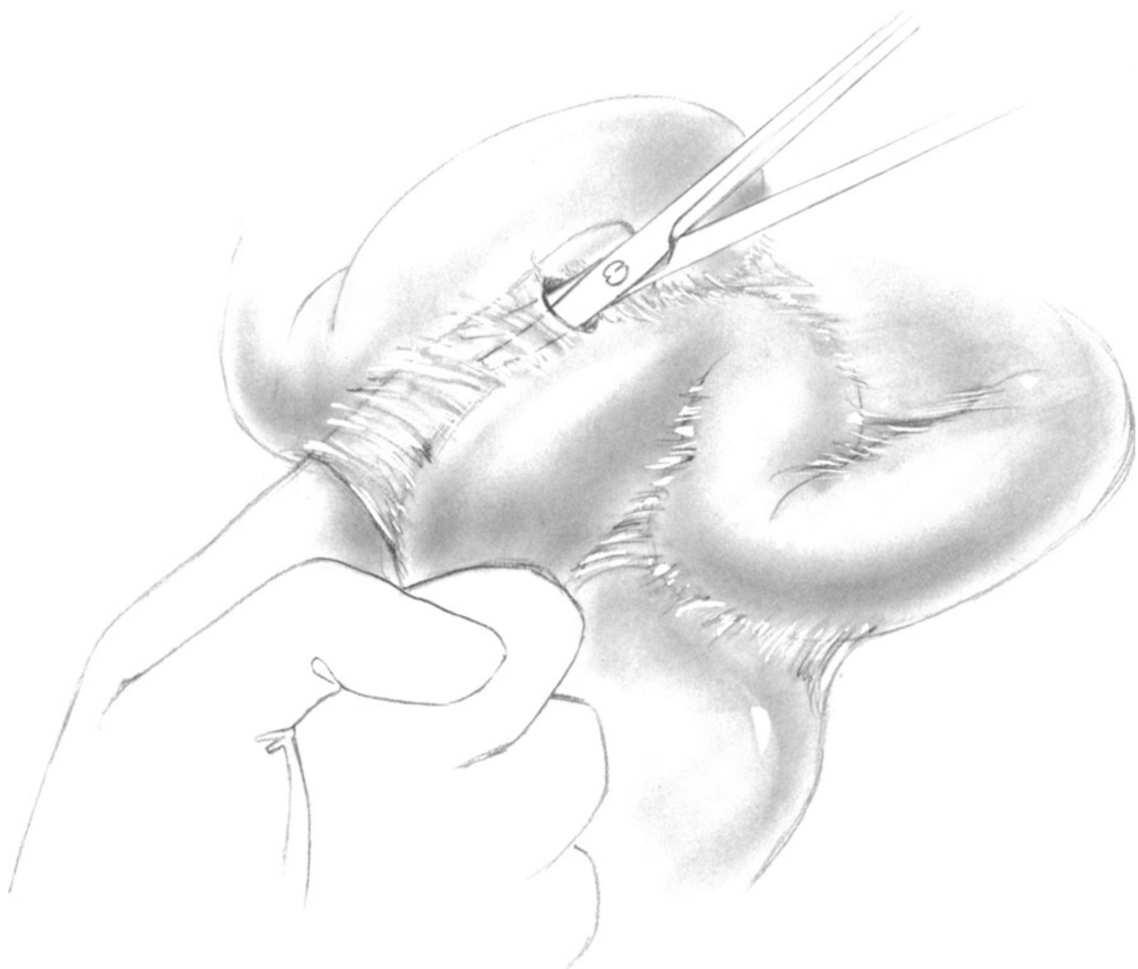


Fig. 31–3

Repair of Damage to Bowel Wall

Small areas of damage to the bowel wall, as evidenced by the protrusion of a thin transparent layer of mucosa, should be repaired by continuous 5–0 Vicryl seromuscular Lembert sutures. If there are larger areas of damage, such as a longitudinal rent, they may be repaired by one or two layers of Lembert sutures in a transverse manner. Extensive damage requires a bowel resection with anastomosis either by sutures or stapling.

Closure

After decompressing the bowel, replace it in the abdominal cavity. If there has been any spillage, thoroughly irrigate the abdominal cavity with large volumes of warm saline solution followed by lavage with a dilute antibiotic solution. Close the abdominal wall in the usual fashion with a modified Smead-Jones technique (see Chap. 5).

Postoperative Care

Nasogastric and/or long intestinal tube suction will be required postoperatively until evidence of bowel function returns, as manifested by the passage of flatus or stool per rectum, or active bowel sounds.

When a patient requires that a Baker tube remain in place postoperatively due to extensive serosal damage or some other indication for a "stitchless plication"(see Chap. 32), it will generally be necessary to insert a nasogastric tube in the other nostril to decompress the upper gastrointestinal tract. Our policy is to avoid filling both nostrils with intestinal tubes. It is far preferable in these cases to insert the long Baker tube through a newly constructed Stamm gastrostomy, thereby leaving one nostril free.

Perioperative antibiotics

Complications

Recurrent intestinal obstruction

Intestinal fistula or peritonitis

32 Baker Tube Stitchless Plication

Indications

Operations for intestinal obstruction due to extensive adhesions, when patient has already undergone numerous similar operations

Patients who suffer extensive serosal damage following division of many adhesions

Concept

After extensive adhesions involving most of the small intestine have been dissected, or the patient has undergone numerous similar operations, it can be anticipated that adhesions will reform after enterolysis. With the aim of causing these adhesions to form in an orderly fashion, Noble, and Childs and Phillips, performed a suture plication of the entire small intestine so that the bowel could not twist around localized adhesions.

Baker has developed a technique for accomplishing the same end by passing a 270-cm tube through a jejunostomy opening down to the cecum. This decompresses the small bowel after enterolysis. In addition, by leaving the tube in place for 10 days and by arranging the bowel in an orderly fashion (**Fig. 32–1**), any adhesions that develop presumably will form in a similar orderly fashion. In a series of 52 cases reported by Baker, 46 results were excellent and only one developed a postoperative obstruction, which responded to suction through a long intestinal tube. Since Baker's is a simpler procedure, it has largely replaced the intestinal suture-plications of the Noble or Childs type for patients who have recurrent obstructions due to adhesions.

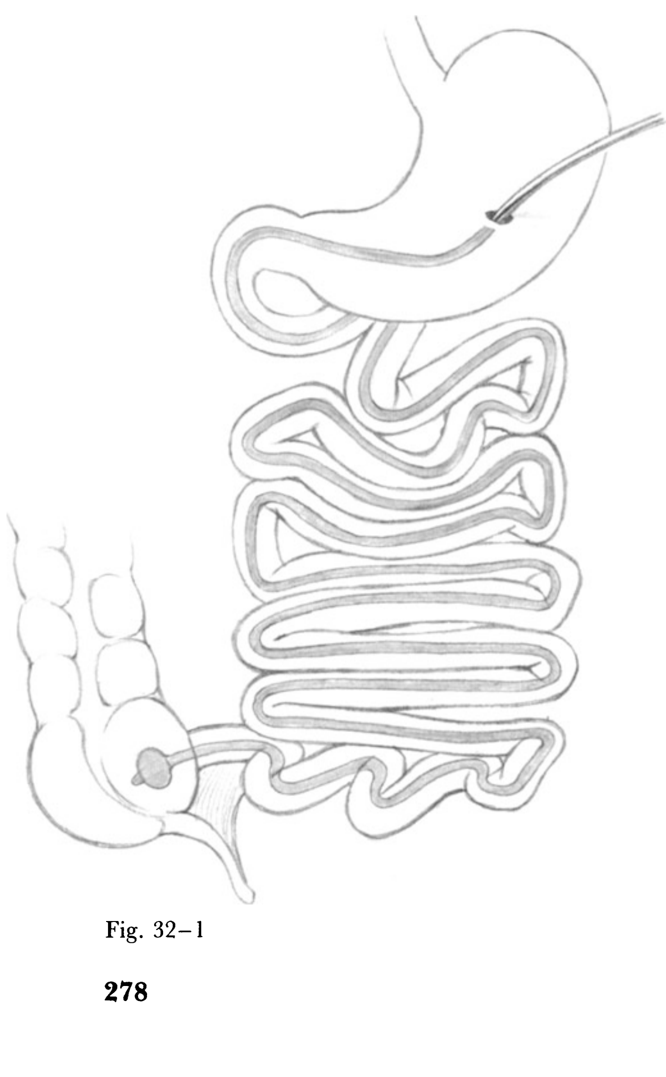


Fig. 32–1

Preoperative Preparation

Nasogastric suction should be initiated before the operation.

Pitfalls and Danger Points

Trauma to the bowel while passing the Baker tube is a hazard of this procedure.

Operative Strategy

The 18 F Baker tube, 270 cm long with a 5-ml bag at its tip, should be passed either through a jejunostomy or a gastrostomy. Of the two routes, the gastrostomy has far fewer postoperative complications than the jejunostomy and is the much preferred method. A gastrostomy of the Stamm type should be used (see Figs. 26–1 through 26–5). It is not advisable to pass the tube by the nasogastric route, as the tube must remain in place for at least 10 days. Also, a second nasogastric tube may be required to decompress the stomach postoperatively.

If the stomach or the duodenum has been the site of a previous operation that would impede construction of a gastrostomy, then pass the Baker tube retrograde through a cecostomy up to the jejunum.

This route too is safer than is the jejunostomy as the jejunostomy sometimes leaks or causes intestinal obstruction after the Baker tube is removed.

Operative Technique

Enterolysis of the entire small bowel should be performed as the first step of this operation. Create a Stamm gastrostomy (see Chap. 26). Pass the sterile Baker tube into the gastrostomy. Then pass it through the pylorus and partially inflate the balloon. By milking the balloon along the intestinal tract the tube may be drawn through the entire length of the intestine. Supply intermittent suction to the tube to evacuate gas and intestinal content. Pass the balloon through the ileocecal valve, where it should be inflated to 5 ml.

Distribute the length of the intestine evenly over the length of the tube. Then arrange the intestine in the shape of multiple S's. Irrigate the peritoneal cavity with a dilute antibiotic solution and close the abdomen in the usual fashion. If there has been any spillage of bowel content during the dissection, if gangrenous bowel has been resected, or if an enterotomy has been performed for intestinal decompression, the skin incision should not be closed primarily. Stewardson et al. have pointed out that over 50% of the patients they treated who had these conditions developed wound infections.

When local factors contraindicate a gastrostomy, pass the Baker tube through a stab wound near McBurney's point. Then construct a cecostomy by the Stamm technique. Insert a purse-string suture using 3–0 PG in a portion of the cecum that is near the stab wound. Make a puncture wound in the center of the purse-string, insert the Baker tube, and hold the purse-string taut. To pass the Baker tube through the ileocecal valve, make a 3–4 mm puncture wound in the distal ileum. Then insert a Kelly hemostat into the wound and pass the hemostat into the cecum. Grasp the Baker tube with the hemostat and draw the tube into the ileum. Close the puncture wound with sutures.

Inflate the balloon of the Baker tube and milk the balloon in a cephalad direction until the tip of the Baker tube has reached a location proximal to the point of obstruction and to any area of bowel that has suffered serosal damage. Suction all the bowel contents through the Baker tube and deflate the balloon.

Insert a second 3–0 PG purse-string suture inverting the first purse-string. Then suture the cecostomy to the abdominal wall with one 3–0 PG suture in each quadrant surrounding the abdominal stab wound.

Postoperative Care

Deflate the balloon at the end of the Baker tube on the second postoperative day. However, leave the tube in place for 14–21 days if a stitchless plication is to be achieved. An additional nasogastric tube for suction may be required for several days. The patient should be permitted to eat when evidence of bowel function returns, at which time the Baker tube suction can be discontinued.

Antibiotics should be given postoperatively to patients who have had intraoperative spill of intestinal contents.

Postoperative Complications

Wound infection

References

Baker JW. Stitchless plication for recurring obstruction of the small bowel. Am J Surg 1968;116:316.

Childs WA, Phillips RB. Experience with intestinal plication and a proposed modification. Ann Surg 1960; 152:258.

Noble TB. Plication of small intestine as prophylaxis against adhesions. Am J Surg 1937;35:41.

Stewardson RH et al. Critical operative management of small bowel obstruction. Ann Surg 1978;187:189.

33 Appendectomy

Indications

Acute appendicitis

Interval appendectomy following conservative treatment of appendiceal abscess

Mucocoele of appendix

Adenocarcinoma and carcinoid of appendix may require right colon resection in addition to appendectomy, especially if there is suspicion of metastases in lymph nodes

Concept

Probably 85% of the time acute appendicitis is the result of a closed-loop obstruction generally secondary to an appendiceal fecalith. The base of the appendix, which is proximal to the obstructing fecalith, usually is fairly healthy even in the presence of advanced inflammation or even if the remainder of the organ is gangrenous. This makes ligature or inversion of the appendiceal stump a safe procedure.

There has been a decline in the incidence of acute appendicitis in the United States during the past two decades, while the accuracy of the diagnosis has increased. In good hospitals perhaps less than 10% of all appendectomies done are cases in which histological finding is of a normal appendix. Accuracy of diagnosis can be increased if in all doubtful cases the surgeon rechecks the physical findings every 4–8 hours. Frequently, by the end of 24 hours the presence or absence of acute appendicitis is clarified, at minimal risk to the patient. The most difficult diagnosis is of young women, in whom disease of the pelvic organs can be a source of confusion.

Whether an immediate operation is indicated in a patient who first presents with an *appendiceal abscess* in the right lower quadrant remains a matter of controversy. If the signs are well localized and the patient shows improvement with antibiotic therapy, conservative management will probably prove successful. In this case an interval appendectomy should be done in 6 weeks. If there is any progression in the abdominal findings or in the patient's toxicity, prompt laparotomy should be done to drain the abscess.

In cases of spreading peritonitis secondary to a feeding focus at the appendix, it may be necessary to perform an emergency ileocecal resection in some cases.

Preoperative Preparation

In young women a pelvic sonogram may be helpful in the differential diagnosis of acute appendicitis.

Intravenous fluids

Perioperative antibiotics

Nasogastric tube if ileus is present

Pitfalls and Danger Points

Inadvertent laceration of inflamed cecum during blunt dissection

Inadequate control of blood vessels in edematous mesoappendix

Operative Strategy

Incision

When classic signs of acute appendicitis present themselves, the McBurney incision is an appropriate one. Because this procedure splits the muscles along the lines of their fibers, each in a somewhat different direction, the healed scar is usually quite strong and the cosmetic result good. For most cases the incision proves to be centered over the base of the appendix. If the exposure is inadequate, the incision may be carried in a medial direction by dividing the rectus sheath. If necessary the right rectus muscle itself may be transected for the exposure of the pelvic organs.

If it is obvious that even with an extension the exposure will be inadequate, a new vertical incision should be made, suitable to the pathology, and the McBurney incision closed.

The McBurney incision is contraindicated for young women in whom the diagnosis is not clear-cut. Either a midline or paramedian incision should be made.

Management of Appendiceal Stump

After the appendix has been removed, the stump may be managed either by simple ligation or by inversion with a purse-string suture around its base. There does not appear to be any proof of the superiority of either method, although one would suspect that a purse-string inversion might produce fewer adhesions than a simple ligation, which permits eversion of a bit of the mucosa. Inversion is preferable in simple cases, but if the area is quite edematous, making inversion difficult, simple ligation is preferable.

Indication for Drainage

The presence of inflammation or even of free pus due to a perforated appendix is not an indication for external drainage. The abdominal wall should be closed without drainage after thorough irrigation of the abdominal cavity and pelvis. In cases of perforated appendix, to avoid wound sepsis the surgeon should leave the skin wound open for secondary closure at a later date. If an abscess with rigid walls is encountered, then it may be indicated to insert a drain through a stab wound in the abdominal wall.

Operative Technique

Incision

Draw an imaginary line from the right anterior superior iliac spine to the umbilicus. At a point 3–4 cm medial to the anterior spine, draw a perpendicular to this line (**Fig. 33–1**). This is the general direction of the McBurney skin incision. About one-third of the incision should be above the imaginary line between the iliac spine and umbilicus and two-thirds below this line. The average length of this incision is 6 cm.

Make an incision identical to that in the skin in the external oblique aponeurosis, along the line of its fibers (**Fig. 33–2**). After this incision has been initiated with a scalpel and extended with a Metzenbaum scissors, elevate the medial and lateral leaves of the external oblique from the underlying

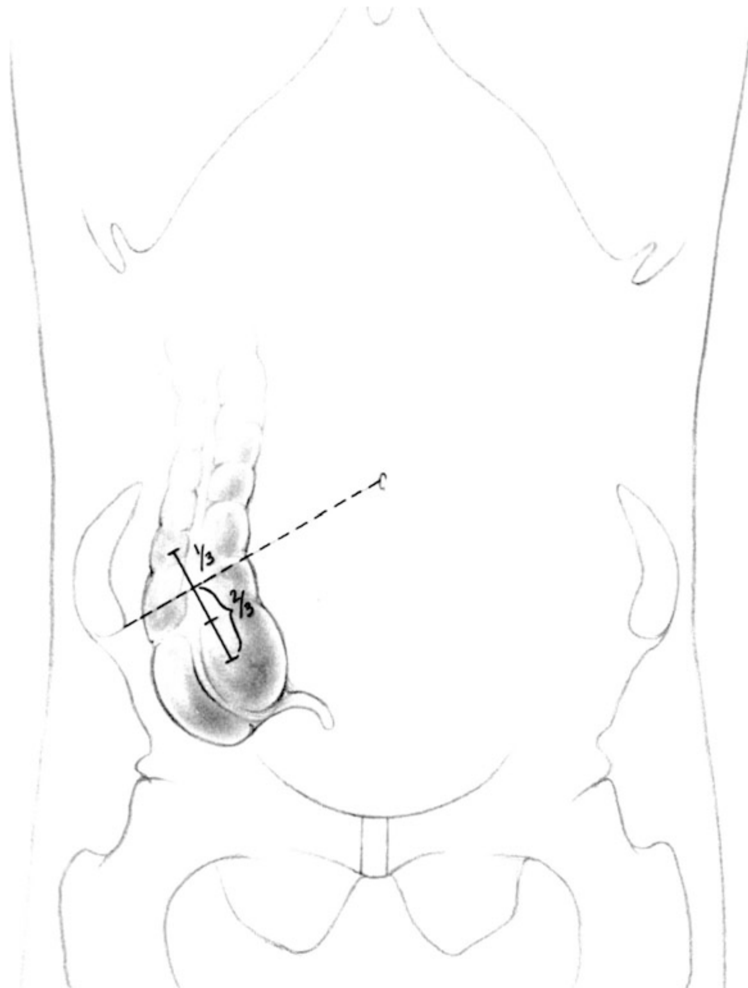


Fig. 33-1

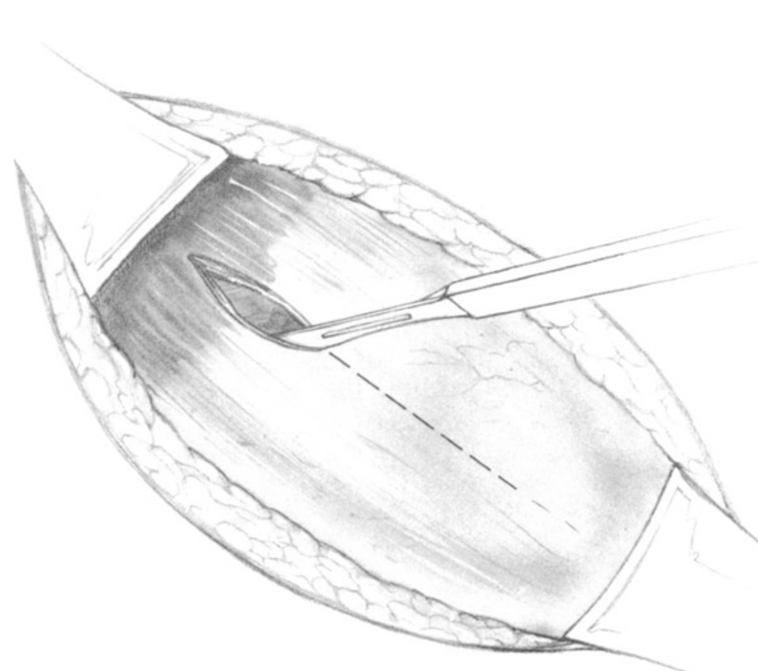


Fig. 33-2

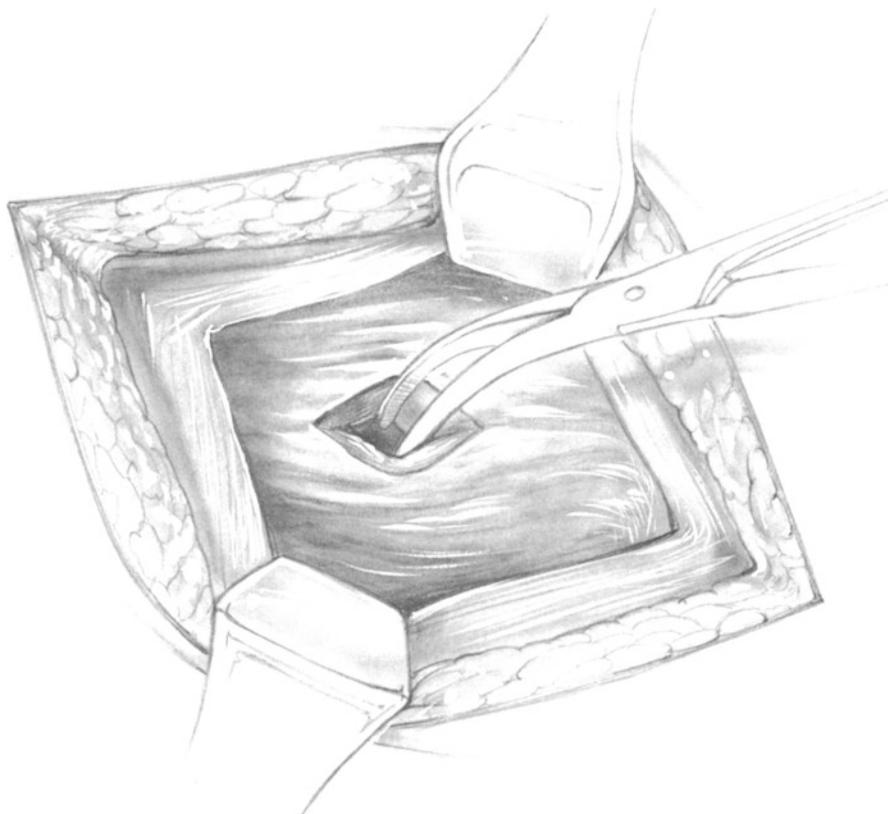


Fig. 33-3

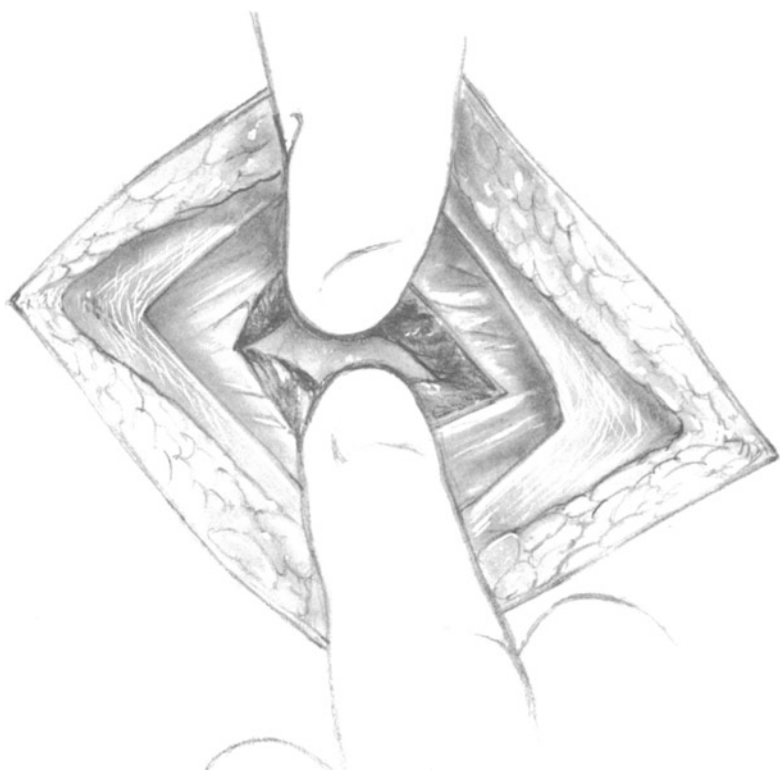


Fig. 33-4

muscle, and separate them between retractors (**Fig. 33–3**).

Note now that the internal oblique muscle, which is fairly thick, and the transversus muscle, which is deep to the internal oblique, run in a transverse direction. Make an incision just below the level of the anterior superior iliac spine into the thin fascia of the internal oblique muscle. Then insert a Kelly hemostat to separate the muscle fibers of the internal oblique and underlying transversus muscle (Fig. 33–3). Using either two Kelly hemostats or both index fingers, enlarge this incision sufficiently to insert small Richardson retractors (**Fig. 33–4**).

By electrocoagulation, obtain adequate hemostasis of one or two vessels in the internal oblique. Then note the layer of fat that adjoins the peritoneum. By teasing the fat off the peritoneum lateral to the rectus muscle, a clear area of peritoneum can be identified. Elevate this between two hemostats and make an incision into the peritoneal cavity (**Fig. 33–5**). Enlarge this sufficiently to insert Richardson retractors. Then explore the region.

For additional exposure in a medial direction when, for example, it is necessary to identify a woman's pelvic organs, a medial extension of about

2 cm can be made across the anterior rectus sheath. Following this, a similar division of the posterior sheath can be carried out and the rectus muscle retracted medially.

When the lateral extremity of the McBurney incision must be extended, the surgeon has two choices: 1) Close the McBurney incision and make a separate vertical incision of adequate length for exposure. 2) If only a few centimeters of additional exposure are needed, the oblique and transverse muscles may be deliberately divided with the electrocautery in a cephalad direction along the lateral portion of the abdominal wall. Be aware that if this vertical extension along the lateral abdominal wall is continued for *more* than 4–5 cm, two or more intercostal nerves are likely to be divided, resulting in muscular weakness of the lower abdomen. If a 4–5 cm extension of the incision is closed carefully, generally no serious problems of weakness or herniation will develop.

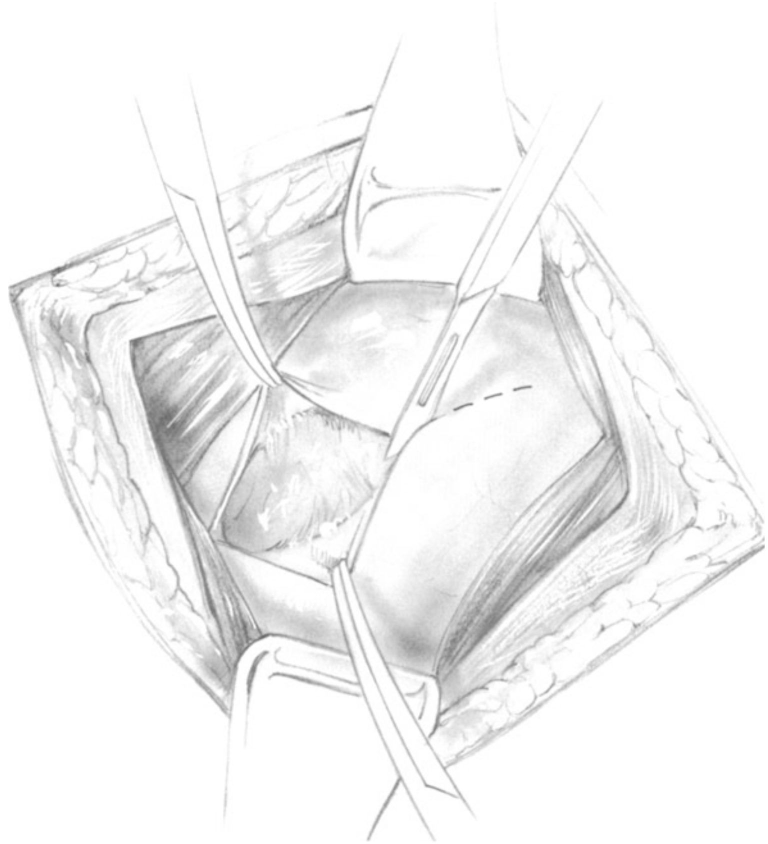


Fig. 33-5

Delivery of Appendix

Insert small Richardson retractors into the peritoneal cavity and grasp the anterior wall of the cecum with a moist gauze pad (**Fig. 33–6**). With the cecum partially exteriorized, identify the appendix. If the appendix cannot be seen, exploration with the index finger may reveal an inflammatory mass consisting of inflamed appendix and mesoappendix. By gentle digital manipulation around the borders of this mass, it can usually be delivered into the incision.

If this palpatory maneuver is not successful in locating the appendix, follow the taenia on the anterior wall of the cecum in a caudal direction. This leads to the base of the appendix, which can then be grasped in a Babcock clamp. Apply a second Babcock clamp to the tip of the appendix and deliver it into the incision.

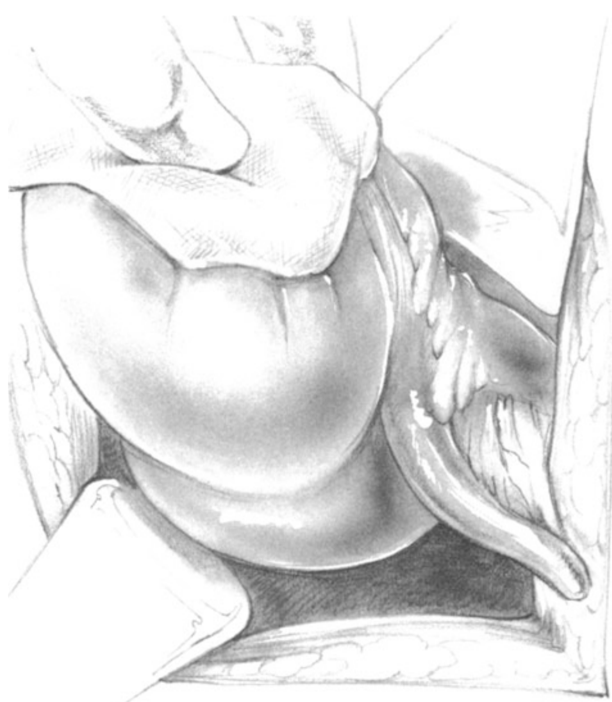


Fig. 33-6

Division of Mesoappendix

If the base of the mesoappendix is not thick it may be encompassed by a single ligature of 2–0 PG. Otherwise, divide the mesoappendix between serially applied hemostats, and ligate each with 2–0 or 3–0

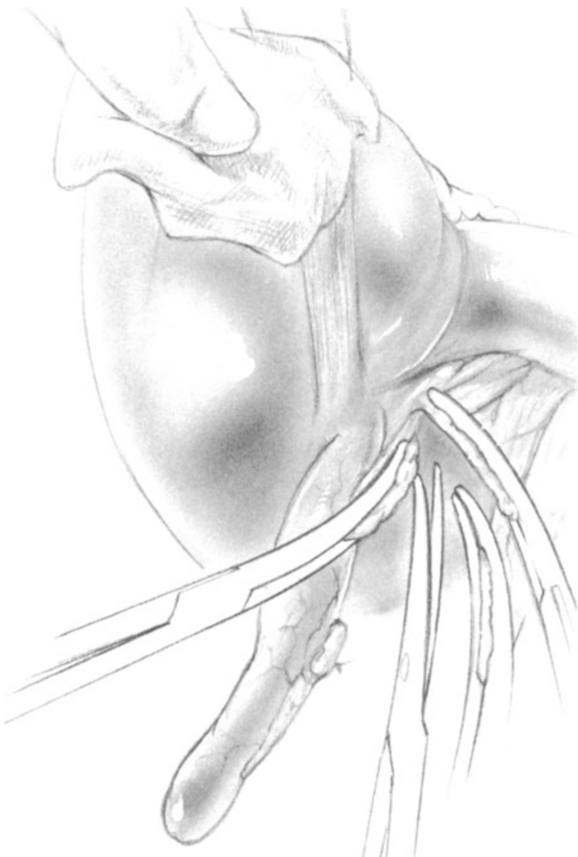


Fig. 33-7

PG until the base of the appendix has been dissected free (**Fig. 33–7**).

Ligation of Appendiceal Stump

Hold the tip of the appendix in a Babcock clamp and doubly ligate the base with 2–0 PG or chromic catgut at a point 4–6 mm from the cecum. Apply a straight hemostat to the appendix 1 cm distal to the ligature. Then transect the appendix with a scalpel 5–6 mm distal to the ligature (**Fig. 33–8**) and remove the specimen. The appendiceal stump may be cleansed with phenol and alcohol, if desired, or the mucosa of the stump may be electrocoagulated. Or nothing at all need be done to the stump except to return it to the abdominal cavity (**Fig. 33–9**).

Inversion of Appendiceal Stump

To invert the stump, insert a purse-string suture around the base of the appendix, using 3–0 PG or silk on an atraumatic needle. The radius of this purse-string should exceed the anticipated length of the appendiceal stump (**Fig. 33–10**). Apply a small straight hemostat to the base of the appendix at a point 5–6 mm from the cecum. Apply a second hemostat 1 cm distal to the first. Using a scalpel, transect the appendix just distal to the first hemostat (**Fig. 33–11**), which should now be used to invert the sump into the previously placed purse-string suture (**Fig. 33–12**). As the first knot is being tied, gradually withdraw the hemostat, thus completing the purse-string tie. The single suture should be sufficient; if there is some doubt of its adequacy, it may be reinforced with a figure-of-eight suture of the same material.

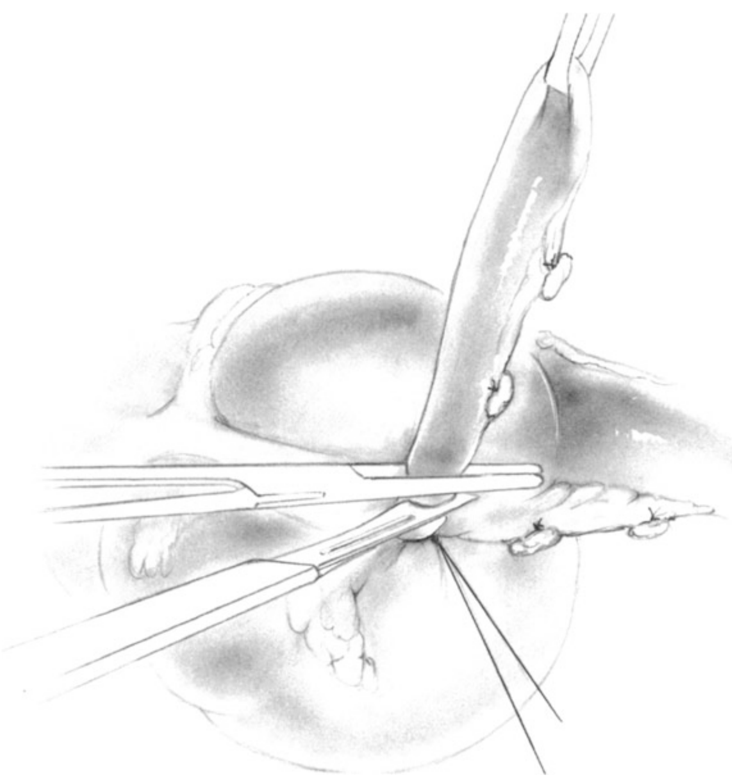


Fig. 33-8

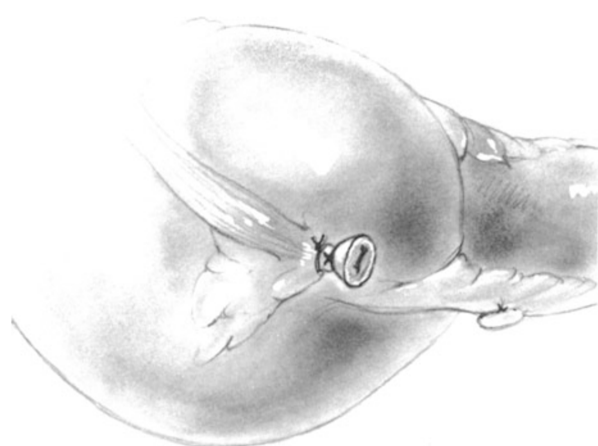


Fig. 33-9

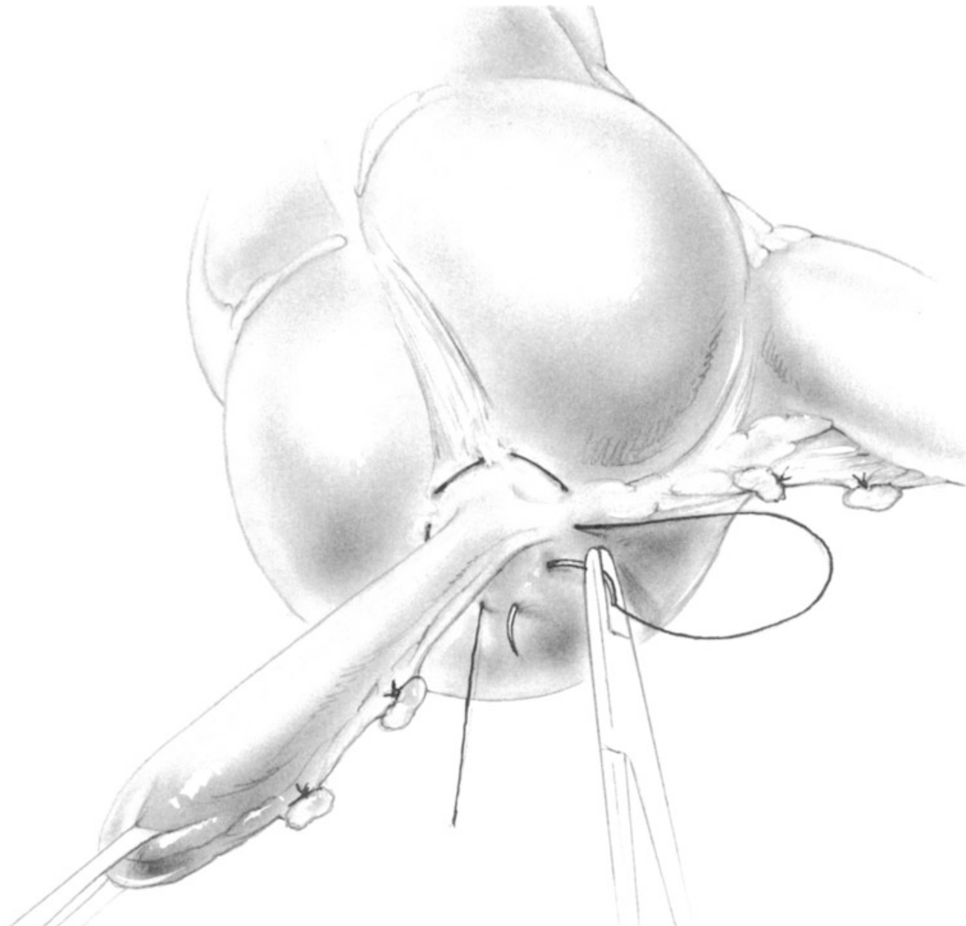


Fig. 33-10

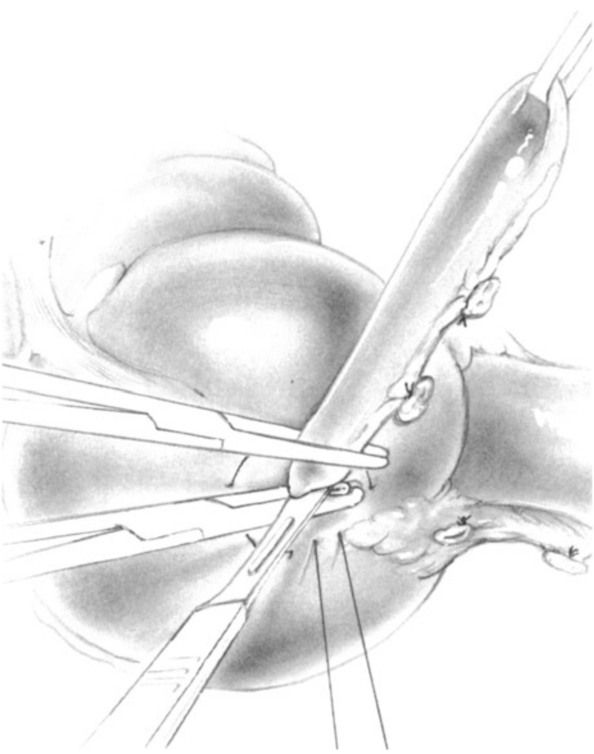


Fig. 33-11

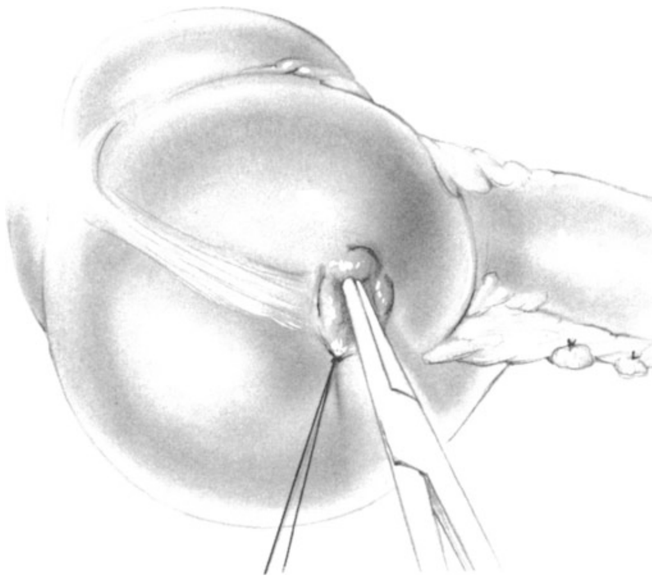


Fig. 33-12

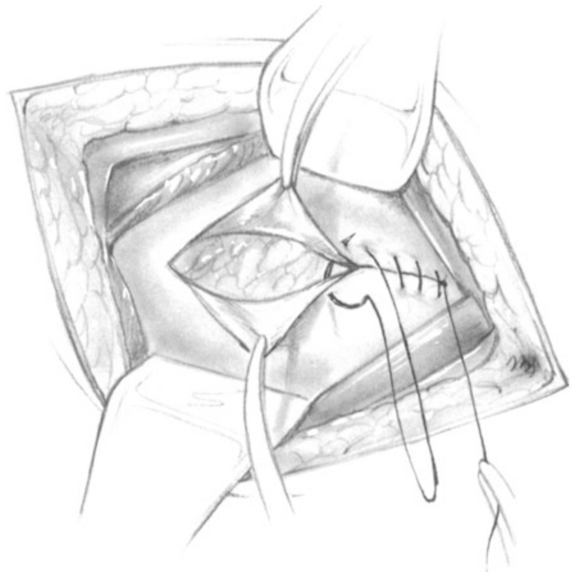


Fig. 33-13

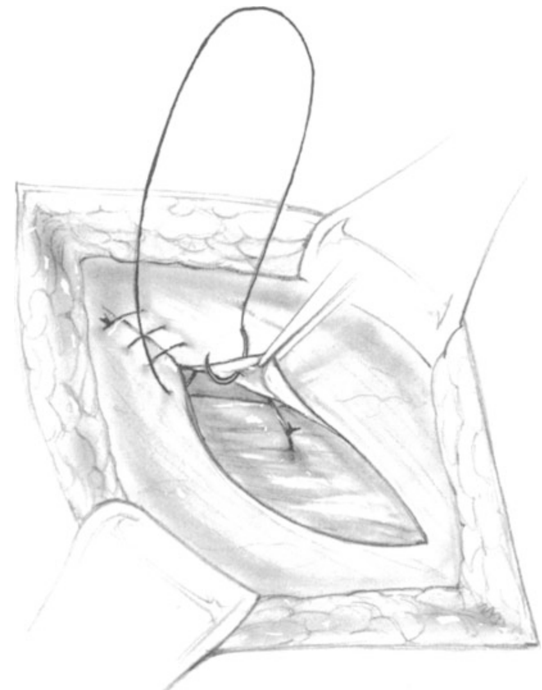


Fig. 33-15

Closure of Incision

Irrigate the right lower quadrant and pelvis with a dilute antibiotic solution. Then apply four hemostats to the cut ends of the peritoneum. Close the peritoneum with continuous 3–0 atraumatic PG suture (**Fig. 33–13**). Close the internal oblique and transversus muscles as a single layer with interrupted sutures of 2–0 PG tied loosely (**Fig. 33–14**). Close the external oblique aponeurosis with either continuous or interrupted sutures of 2–0 PG (**Fig. 33–15**).

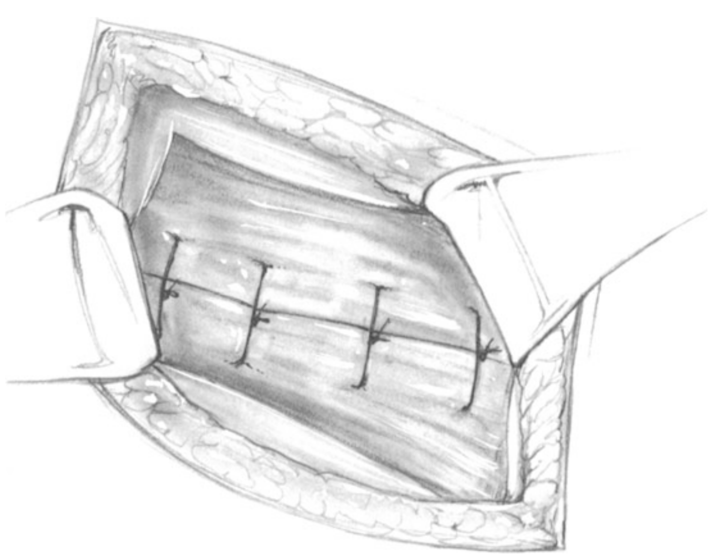


Fig. 33-14

If intraperitoneal pus or a gangrenous appendix is present, no attempt should be made at primary closure of the skin incision. Rather, a few vertical mattress sutures of 4–0 nylon may be inserted but not tied. Insert just enough gauze into the incision to keep the skin edges separated.

Postoperative Care

In the absence of pus or perforation, postoperative antibiotics need not be administered beyond the operative period. Otherwise, appropriate systemic antibiotics are indicated.

Most patients recover rapidly following an appendectomy. They usually do not require intravenous fluid for more than 1 day.

If the skin wound has been packed open, the packing should be changed daily. If the area is clean, the previously placed skin sutures may be tied on the fourth postoperative day.

Complications

Postoperative sepsis, either in the form of peritonitis or a pelvic abscess, is the most serious postoperative complication of an appendectomy. If the patient's temperature is elevated after the fourth or fifth postoperative day, a rectal or pelvic examination should be performed daily to try to detect a pelvic abscess. Often this can be discovered when the tip of the examining finger feels a fluctuant and tender mass pressing on the anterior wall of the rectum. If the abscess has progressed on antibiotic therapy, incision and drainage may be performed with general anesthesia. To do so, dilate the anus; then pass a needle into the palpable mass. Aspiration should reveal pus just deep to the rectal wall. If pus is found, insert a hemostat along the needle tract to make a 1–2 cm drainage opening.

Use of the CT scan or sonography serves to identify abdominal and pelvic abscesses. The interventional radiologist can often drain those abscesses percutaneously with CT guidance.

Wound infection following an appendectomy for a perforated appendicitis is another cause of fever. This may be prevented by delaying closure of the skin. Otherwise, when a wound abscess is detected, the overlying skin must be opened for drainage.

Intestinal obstruction due to adhesions occasionally occurs in the postoperative period, especially when there is some degree of peritonitis. Early relaparotomy is indicated for a complete obstruction.

Colon and Rectum

34 Colon Resection

Resection of the colon is performed in such conditions as carcinoma, diverticulitis, inflammatory bowel disease, ischemic colitis, volvulus, polyposis, arteriovenous malformation, and trauma. The nature of the dissection and the extent of the colectomy will vary with the pathology. The principles of performing an anastomosis of the colon remain constant.

Concept: Principles of Successful Colon Anastomosis

According to Schrock et al., if during an elective operation two segments of well-prepared, healthy colon are properly anastomosed, and infection and other adverse factors are not present, 98% of all cases can be expected to heal without clinical leakage. A number of technical requirements must be met, however, before this level of excellence can be reached.

Blood Supply

The end of each segment of colon should have demonstrable pulsatile arterial blood flow in the mesentery at the cut edge of the bowel. It is a valuable routine to make an incision in one of the small end-arteries near the point at which the colon is transected to determine if this is indeed so. An intramural hematoma at the anastomosis or a hematoma in the adjacent mesentery may impair blood flow. Generally, this impairment requires reresection of the involved bowel or mesentery.

Suturing

Although it probably does not matter whether the anastomosis is constructed with one or two layers of sutures, it is essential that seromuscular apposition be accurate. There should be no blood clot or interposition of globs of fat between these two layers. This requires that a 1-cm cuff of serosa be completely cleared of fat, mesentery, and epoploic appendices. *Most leaks in anastomoses occur on the mesenteric side of the bowel*, where there is greater difficulty in clearing off fat and blood vessels. Special attention should be devoted to accomplishing an accurate inversion of the bowel at this place. Submucosa must be included in each suture. Seromuscular sutures should not be tied with excessive force, as this may bring on strangulation necrosis.

Tension

Enough colon should be liberated from the surrounding ligaments and omentum to guarantee that there will be no linear tension on the anastomosis during the healing process. Remember: In the postoperative period the colon will distend and thus become shorter. Consequently, any tension on the anastomosis at the time of the operation will be increased during the next 5–7 days and may produce disruption.

Perianastomotic Hematoma

The accumulation of blood or serum in the vicinity of an anastomosis, especially in the pelvis, is an invitation to localized sepsis, for absolute sterility of the colon's lumen is not possible. Many leaks from anastomoses in the pelvis occur when an abscess from an infected hematoma erodes into the lumen of the rectum. Prevention requires good hemostasis as well as postoperative suction-drainage of the presacral space.

Dead Space

If the surgeon closes the pelvic peritoneum proximal to a colorectal anastomosis in the pelvis, considerable dead space may be left in the vicinity of the colorectal anastomosis. This dead space is conducive to anastomotic leakage. Anastomoses are more certain to heal when they are surrounded by adjacent viable tissue, such as *small bowel* or omentum. Consequently, it is wise to leave the pelvic peritoneum unsutured after performing colorectal anastomosis. This allows the small bowel to help eliminate the dead space. Another way to eliminate dead space is to liberate omentum and bring it into the pelvis. In addition, *enough proximal colon should be liberated to permit the hollow of the sacrum to be occupied by redundant descending colon*, thereby helping to eliminate dead space.

Drainage

There appears to be no advantage in draining an anastomosis in the intraperitoneal space. On the other hand, it is very important to use closed-suction drains in the presacral space to evacuate serum and blood from the pelvic cavity. Leakage from low colorectal anastomoses is often caused by an infected presacral hematoma. Suction catheters can be kept open for an indefinite period if 50 ml of an antibiotic solution are instilled every 6 hours.

Omental Wrap

Some authorities believe that wrapping an anastomosis with omentum is important to prevent leakage. While we use this technique when the omentum is easily available, we do not perform elaborate omentum-lengthening maneuvers to accomplish an omental wrap. A properly constructed anastomosis does not require the contiguity of the omentum to heal without leaking.

Stapled versus Sutured Colon Anastomoses

In 1978 we (see Chap. 4) reported a retrospective study of 812 patients, comparing the anastomotic complications that occurred following stapled and sutured gastrointestinal anastomoses. No difference was detected. Since that time, numerous other reports, some randomized and prospective, have appeared demonstrating the equal safety of suturing and stapling. In fact, the West of Scotland and Highland Anastomosis Study Group (1991) in a randomized study found that sutured colorectal anastomoses had a higher incidence of radiological anastomotic leaks than did the stapled cases.

Akyol and associates noted in a prospective study of 294 patients undergoing colorectal resection for cancer, that the use of stapling techniques of anastomosis seemed to be associated with a significant reduction in the 24-month recurrence and mortality rates.

Another advantage of stapling is the capacity to perform a colorectal anastomosis with the CEEA U.S. Surgical device after resecting a cancer as low as 6 cm above the anal verge.

Conditions Conducive to Anastomotic Leakage

(The figures given in this section are taken from the extensive statistical study by Schrock et al. of clinical leakage following anastomoses of the colon.)

Sepsis

The presence of infection in the vicinity of colon anastomoses had long been believed to increase the incidence of leakage. Schrock et al. found that "Peritonitis, abscess, or fistula strongly favored leakage regardless of the segment anastomosed." The *clinical* leak rate in 909 intraperitoneal ileocolonic or colocolonic anastomoses, performed in the absence of intraabdominal infection, was 2.4%–3.1%. When infection was present, 6.9% of 87 ileocolonic anastomoses leaked and 12.1% of 58 colocolonic anastomoses disrupted. The figures are equally striking for extraperitoneal coloproctostomy: In the absence of infection 7.9% of 329 anastomoses leaked, and 20.5% of 39 anastomoses disrupted if infection was encountered during the operation. In summary, *when infection was encountered during the operation, there was an increase of 150%–500% in the incidence of postoperative leakage of anastomoses.*

Although this result is less marked in ileocolonic anastomoses, even here the surgeon should be cautious about electing to perform a primary ileocolostomy in the presence of serious abdominal sepsis.

Shock, Major Hemorrhage

Diminution of systolic blood pressure by more than 50 mm Hg below the base line for 15 minutes or longer during the operation resulted in a 150% increase in the rate of leakage. If four or more units of blood replacement were required during the 24-hour period following the induction of anesthesia, there was a 400% increase in the rate.

Carcinoma at the Anastomotic Margin

Carcinoma at the margin of anastomoses was associated with a 20% leakage rate compared with 4.2% for cancer operations in which the margins were free of tumor.

Preoperative Radiation Therapy

Anastomoses failed three times as frequently in a group of 35 irradiated patients as in the remaining cases.

Segment Anastomosed

Ileocolonic and colocolonic anastomoses showed no significant difference in the incidence of leakage as long as extraperitoneal colorectal anastomoses were excluded from the comparison. Intraperitoneal anastomoses of all types leaked 3.4% of the time: extraperitoneal anastomoses disrupted in 10.4% of the cases.

Emergency Operations

When primary anastomoses were performed in emergency operations on the left colon, the rate of leakage increased from 3.0% to 10.8%. For coloproctostomies the rate went from 8.4% to 21.7%. On the other hand, in the ileocolonic anastomoses the increase from 3.3% to 5.4% was not statistically significant. It is not clear exactly what it is about an emergency operation that produces these adverse results. It might logically be assumed that lack of opportunity for preoperative cleansing of the colon plays an important role.

In summary, it is obvious that abdominal sepsis, massive hemorrhage, emergency operation, and preoperative radiation therapy all militate against primary healing. In many cases, colon resection should be followed by exteriorization of the proximal segment as an end colostomy or ileostomy and conversion of the distal segment into a mucous fistula. This is especially valid for the left colon. Ileocolonic anastomoses seem to tolerate some of these adverse factors better than do the colocolonic anastomoses. Performing a complementary colostomy proximal to an anastomosis did not reduce the incidence of leakage in the anastomoses Schrock et al. studied. However, proximal colostomy did indeed sharply reduce the rate of fatalities from leakage. Details of technique, such as open or closed, one or two layers, or end-to-end, did not make a significant difference in the rate of leakage in anastomoses. Tube cecostomy did *not* significantly reduce the mortality rate from leakage in anastomoses following coloproctostomy.

If a good-risk patient is found to have sepsis from a *localized* cecal perforation, it is permissible to perform an ileocolonic anastomosis following a right colectomy, provided the two intestinal segments to be anastomosed are free of inflammation. Also, the anastomosis should be placed in the upper abdomen, away from the abscess. The same principle can be applied to a resection of the sigmoid colon if there is an intramural diverticular abscess—but only if the pelvis, where the anastomosis will be constructed, is clean, and if the colon is not packed with feces. Where contamination and inflammation are not well localized, primary anastomoses are hazardous.

Preoperative Preparation

Barium colon enema or sigmoidoscopy or colonoscopy for diagnosis

Intravenous pyelogram, if indicated by location and size of tumor

Blood transfusions to correct anemia

Nasogastric tube

Insert a Foley catheter in the bladder

Perioperative systemic antibiotics

Bowel Preparation

Preoperative Day No. 1

Clear liquid diet

Cleanse the colon by having the patient drink 4 liters of Golytely between 9:00 A.M. and 11:00 A.M.

Neomycin and erythromycin base, 1 g each at 1:00 P.M., 2:00 P.M., and 11:00 P.M.

Initiate intravenous fluids morning of surgery.

Operative Strategy: The Colon Anastomosis

Type of Anastomosis

No one technique of colon anastomosis has been demonstrated to have any inherent superiority over the others. What is most important is the skill with which the surgeon constructs the union between the two bowel segments. The most commonly employed method is the two-layer end-to-end anastomosis with interrupted Lembert seromuscular sutures and a continuous mucosal suture. If one segment of bowel has a diameter which is considerably less than that of the other segment, this may be corrected by making a so-called Cheatle slit, which is a longitudinal incision along the antimesenteric border of the smaller limb. This enlarges the circumference and thereby equalizes the diameter of the two segments. One pitfall in constructing the two-layer anastomosis is that too much bowel may be turned in, thereby producing stenosis. The diameter of the colon should be large enough to prevent this problem.

A second method of anastomosis is the closed technique using one layer of sutures. This is often done by applying narrow-blade straight Dennis clamps to each of the two cut ends of colon, or by using the Furniss technique. One advantage of the closed technique is that it reduces fecal contamination. It is also more rapid to execute than the two-layer method and minimizes narrowing of the lumen. The closed technique requires greater skill and experience of the surgeon, as each stitch must be placed with perfection when a second reinforcing layer of sutures is omitted. The closed technique also introduces the danger that the opposite wall may be included in one or more of the sutures, producing an obstructed anastomosis. The closed technique does not allow visualization of the lumen when the sutures are inserted. For these reasons, the technique is not suitable for those surgeons who have not been trained in its use. The closed one-layer technique is not used for anastomosis in the pelvis because there is inadequate space to permit the placement of straight clamps or the Furniss clamp.

A third technique is the open method of doing the one-layer anastomosis with interrupted seromuscular sutures.

A fourth method of anastomosis is based on the use of *surgical staples*. In a study we completed, patients who underwent stapled anastomoses did not develop a greater number of complications than did patients on whom sutures were used. There are, however, just as many pitfalls in the use of stapling techniques as in suturing. In order to achieve equal results, the surgeon must learn the details of stapling techniques, just as the surgeon learned how to sew. Stapling is by far the most rapid method of completing an anastomosis. Stenosis is easily prevented by using stapling techniques. The bowel should not be stapled when there is gross infection, the blood supply is poor, or there is tension on the anastomosis. Any segment of bowel that is not fit to be sewn should not be stapled. Stapling is especially valuable in operating upon the poor-risk or critically ill patient, when reducing operating time may be important.

Lembert, Cushing, or Halstead Suture Technique

There are no solid data demonstrating an intrinsic superiority of any of these suture techniques over the others, so the choice depends upon personal preference, familiarity, and the efficiency with which the suture may be inserted. For instance, in colorectal and esophagogastric anastomoses, the exposure is sometimes such that a Cushing type stitch can be inserted more efficiently than the Lembert or Halstead types.

Of more importance than the suture technique is the judgment exercised as to the exact point at which the needle should penetrate the bowel wall, as well as the exact point of exit. In general, the needle containing the seromuscular suture should *emerge* from the serosa at a point 1–2 mm behind the cut edge of the muscular coat. A width of approximately 4–5 mm should be included in each bite, and the sutures should be about 4–5 mm apart. The muscularis and submucosa must be included in each stitch, for the latter layer has been demonstrated to have the greatest holding power. The sutures should not be tied with such force that the enclosed bowel will be strangulated. When a suture incorrectly is passed deep through the mucosa and tied with excessive force, strangulation may lead to leakage of the anastomosis. When the sutures are tied, apply only the force needed to accomplish apposition.

Closing the Mucosal Layer: The Connell Suture

When Connell in 1892 first reported the technique that bears his name, he was describing a one-layer bowel anastomosis. In a two-layer anastomosis, it is the seromuscular suture layer that constitutes the major source of strength. Far too much time and effort has been expended on the undeviating perpetuation of the Connell technique for approximating the mucosal layer. It does not matter whether this layer is accomplished by the method of Connell or by continuous or interrupted sutures of the Cushing, Lembert, or seromucosal (see Fig. B–16) type.

If a continuous suture is used, care must be taken not to apply excessive force when drawing up the suture after each bite, as this exerts a purse-string constricting effect and narrows the lumen. A loose suture should be employed. If the lumen of the bowel being approximated is already narrow, then *interrupted* sutures should be used exclusively. Another aid in avoiding the purse-string effect is the use of absorbable 5–0 Vicryl for the mucosal layer, as these sutures may be absorbed by the twelfth postoperative day. This permits enlargement of the lumen as stool begins to pass through.

Selection of Suture Material

While absorbable suture material has been the invariable choice for mucosal approximation, most surgeons prefer nonabsorbable material for the seromuscular sutures. The size of the suture material should not exceed 4–0, as this is adequate in strength to maintain approximation accompanied by minimum foreign-body reaction. We prefer silk, but polyester and Tevdek have their proponents, as do the monofilament sutures like Prolene and 5–0 wire. Although the latter two have the advantage of inciting the least amount of inflammatory reaction and granuloma formation, it is more difficult to tie knots with these monofilament materials.

The polyglycolic synthetics (Dexon or Vicryl) are unique in that they maintain adequate tensile strength for 12–14 days before being absorbed. Another favorable aspect of the polyglycolic sutures is that they are *not* digested by proteolytic enzymes. Consequently, local sepsis does not accelerate the rate of absorption as it does with catgut. These two features seem to indicate that the polyglycolics are suitable for seromuscular suturing as well as for approximating the mucosa, especially in those cases in which *large* anastomoses (e.g., gastrojejunostomy) lend themselves to continuous sutures in the seromuscular as well as mucosal layers.

Side-to-End Coloproctostomy (Baker)

Several difficulties present themselves after a low anterior resection with anastomosis to the extraperitoneal rectum. The diameter of the rectal ampulla is frequently much larger than that of the proximal segment of colon to which it is being anastomosed. Correction of this disproportion with a Cheatle slit followed by end-to-end anastomosis requires a surgeon to be highly skilled in suture technique. On the other hand, the lumen of a side-to-end anastomosis can easily be made quite large, while the end of the rectum can be invaginated into the side of the colon for additional protection against leakage, without the risk of creating stenosis. There need be no fear that a blind-loop syndrome will result from the closed end of the colon, because the anastomosis will extend to within 1 cm of this closed end. In agreement with Zollinger and Sheppard, and Baker, we are convinced that this suture technique is a more efficient method of reconstruction following low anterior resection than is end-to-end anastomosis. It has been followed by a lower incidence of leakage and of stenosis of the anastomosis in this location than has been the experience with end-to-end anastomoses.

The side-to-end principle may also be applied to the ileocolonic anastomosis in order to correct a large disparity between the diameter of the ileum and transverse colon. However, in this location the use of the Cheatle slit in the ileum, followed by end-to-end anastomosis, is generally not difficult and is faster than side-to-end.

Strategy of Postoperative Care

How Long Nasogastric Suction?

Surgeons vary widely in their prescriptions for the duration of nasogastric suction following colon resection. In the absence of food, gas will not be produced in the gastrointestinal tract, and nasogastric suction should eliminate air that has been swallowed. Nasogastric intubation has the disadvantages of encouraging gastroesophageal refux with consequent esophagitis as well as an increase in nasopharyngeal secretions. Numerous randomized studies have demonstrated no significant increase in complications if nasogastric suction is terminated on the first or second postoperative day. If gastric or intestinal distention develops, suction can be reinstituted.

When to Feed the Patient

Studies of wound healing in animals show that before the seventh postoperative day intrinsic tensile strength is inadequate to withstand the application of a disruptive force. From the third to the seventh days there is a rapid increase in the tensile strength of the healing wound. Thereafter, the rate of increase levels off sharply.

In humans it makes sense to rest an anastomosis of the colon for 5–7 days following the operation. If the bowel has been properly prepared, the intestinal tract should be empty of anything save intestinal secretions. If the patient does not receive any oral feeding at all for this period, it is likely that any minor imperfections the surgeon has produced in the anastomosis will have an opportunity to heal spontaneously without resulting in leakage. *In malnourished patients, for whom 5–7 days of caloric starvation would constitute an added insult, intraoperative institution of needle-catheter feeding jejunostomy is indicated,* rather than the early institution of oral feeding. Because there is a 3% incidence of clinical leakage following colon anastomoses, and since modern means of enteral nutrition can safeguard the patient against caloric deficiency, it seems the caution of adding a jejunostomy to the operation in undernourished patients can enhance the surgeon's efforts to reduce the 1%–2% surgical mortality rate that follows elective colectomy. This is especially applicable to low colorectal anastomoses below the peritoneal reflection, which have the highest rate of postoperative leakage and sepsis.

References

Akyol AM, McGregor JR, Galloway DJ et al. Recurrence of colorectal cancer after sutured and stapled large bowel anastomoses. Br J Surg 1991;78:1297–1300.

Baker JW. Low end to side anastomosis. Arch Surg 1950; 61:143.

Chassin JL et al. The stapled gastrointestinal tract anastomosis: incidence of postoperative complications compared with the sutured anastomosis. Ann Surg 1978; 188:689.

Clarke JS et al. Preoperative oral antibiotics reduce septic complications of colon operations. Ann Surg 1977; 186:251.

Connell ME. An experimental contribution looking to an improved technique in enterorrhapy whereby the number of knots is reduced to two or even one. Med Record 1892;42:335.

Schrock TR et al. Factors contributing to leakage of colonic anastomoses. Ann Surg 1973;177:513.

West of Scotland and Highland Anastomosis Study Group. Suturing or stapling in gastrointestinal surgery: a prospective randomized study. Br J Surg 1991;78: 337–341.

Zollinger RM, Sheppard MH. Carcinoma of the rectum and the rectosigmoid. Arch Surg 1971;102:335.

35 Colon Resection for Cancer

Concept: Extent of Colon Resection

Considerable data have been reported by Turnbull et al. and by Stearns and Schottenfeld suggesting that wide resection of colon neoplasms results in a higher percentage of 5-year survivals than does conservative excision. This is especially true of Duke's stage C lesions, those that have histologically positive lymph nodes. It is not that the length of colon removed results in increased survival, but that wide resection permits higher dissection of the mesentery and its lymphovascular complex. Because the lymphatic network tends to follow the course of the veins, a more extensive dissection of the lymph nodes requires a concomitant extensive resection of the blood vessels. Thus an additional length of colon must be removed.

Tumors of the cecum drain along the ileocolic vein. Here the apex of the lymph-node dissection is at the junction of the ileocolic and the superior mesenteric veins. The middle colic lymph nodes are not likely to harbor metastases unless the ileocolic lymph nodes are saturated with tumor. This is uncommon in any case in which there is some hope of cure. **Fig. 35–1** illustrates the extent of the resection in cases of cecal cancer.

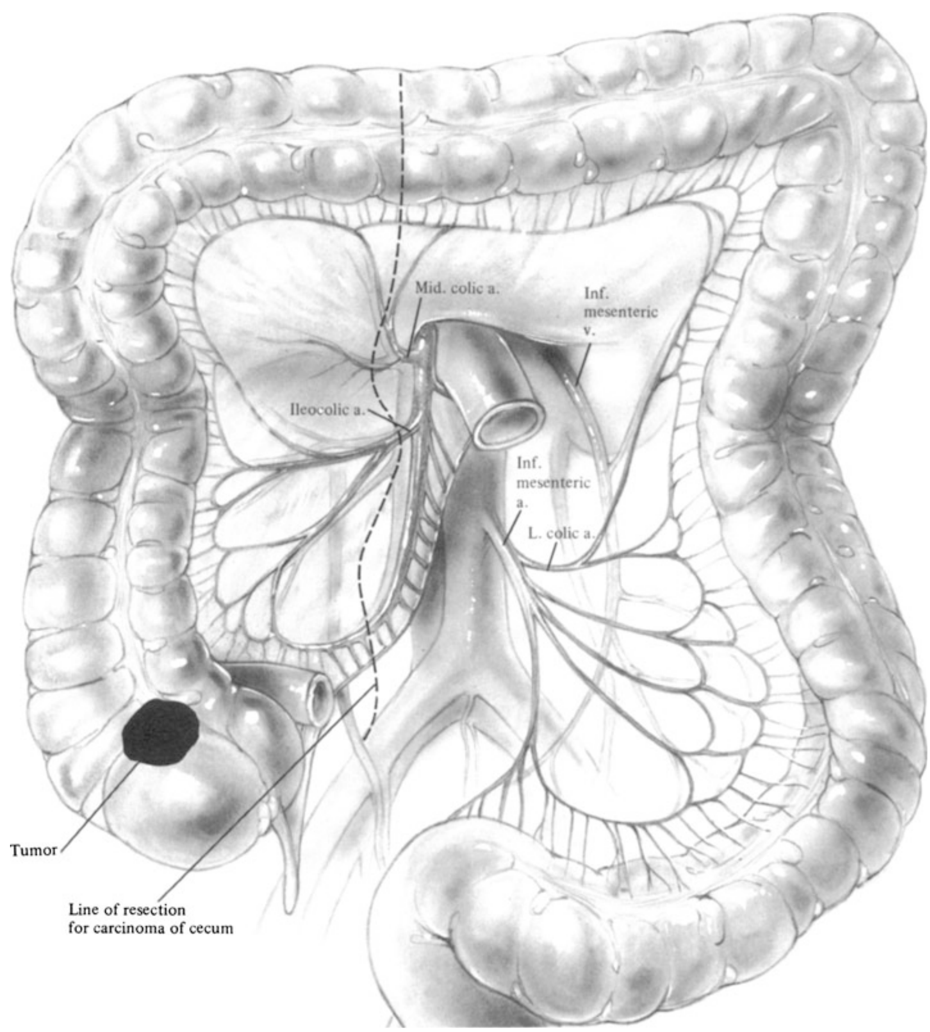


Fig. 35–1

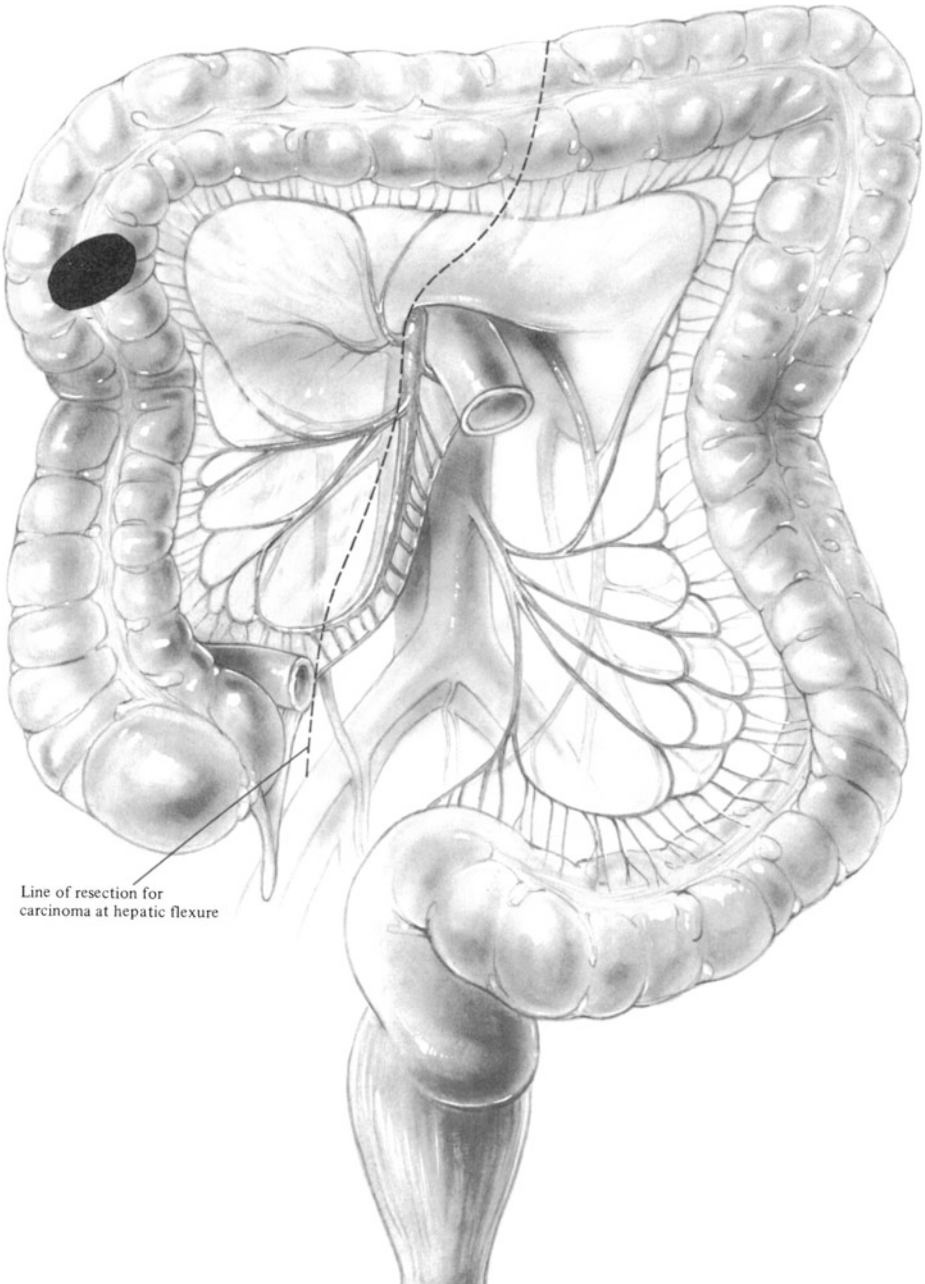


Fig. 35–2

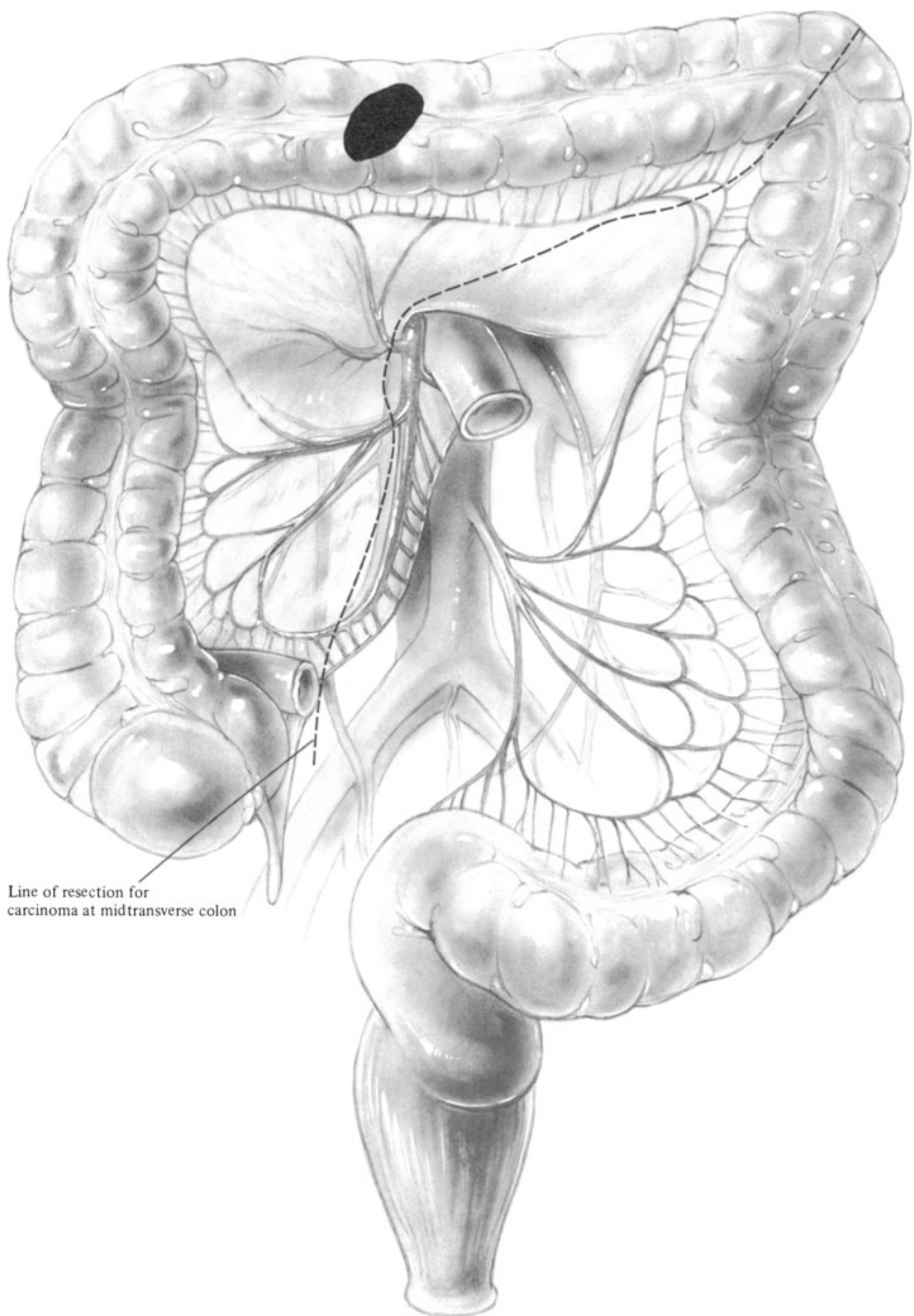


Fig. 35–3

When the tumor is situated near the hepatic flexure, lymphatic drainage both to the ileocolic and middle colic lymph nodes may be anticipated. Consequently, the apex of the dissection in this instance should be situated at the upper reaches of both the ileocolic and the middle colic veins (**Fig. 35–2**). For lesions of the midtransverse colon, the apex of the lymph-node dissection should be located at the origin of the middle colic vessels (**Fig. 35–3**).

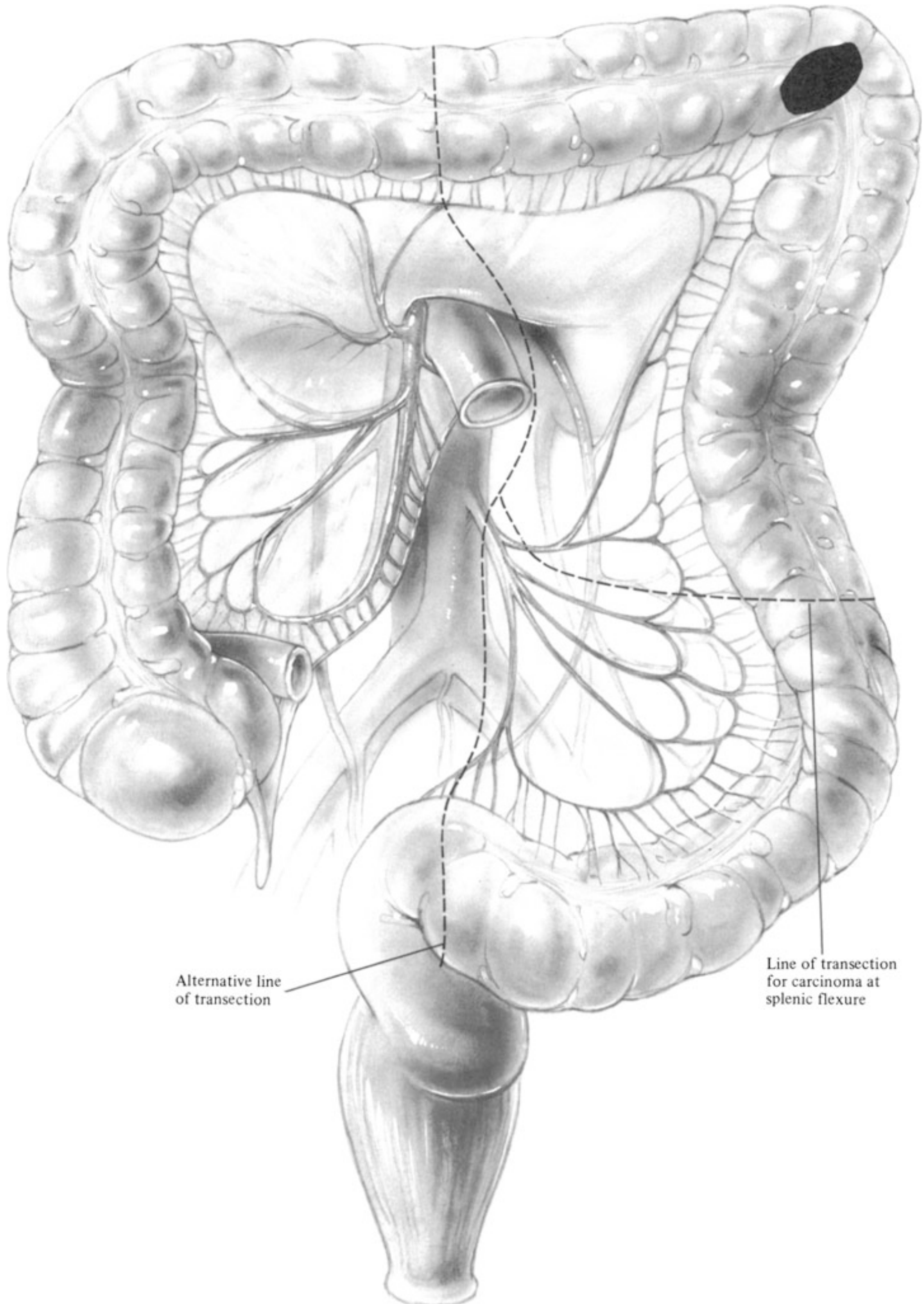


Fig. 35–4

Tumors of the splenic flexure require that the left colic vessels be resected (**Fig. 35–4**).

Neoplasms situated in the descending and sigmoid colon drain into lymphatics along the left colic and the inferior mesenteric vessels. The inferior mesenteric artery should be divided at the aorta and the inferior mesenteric vein removed if one wishes to extend the lymphovascular dissection to the farthest practical limit (**Fig. 35–5**).

Although in advanced stages of splenic flexure carcinoma metastatic lymph nodes may sometimes be observed in the area between the pancreatic tail and the splenic hilum, there are no data to show that

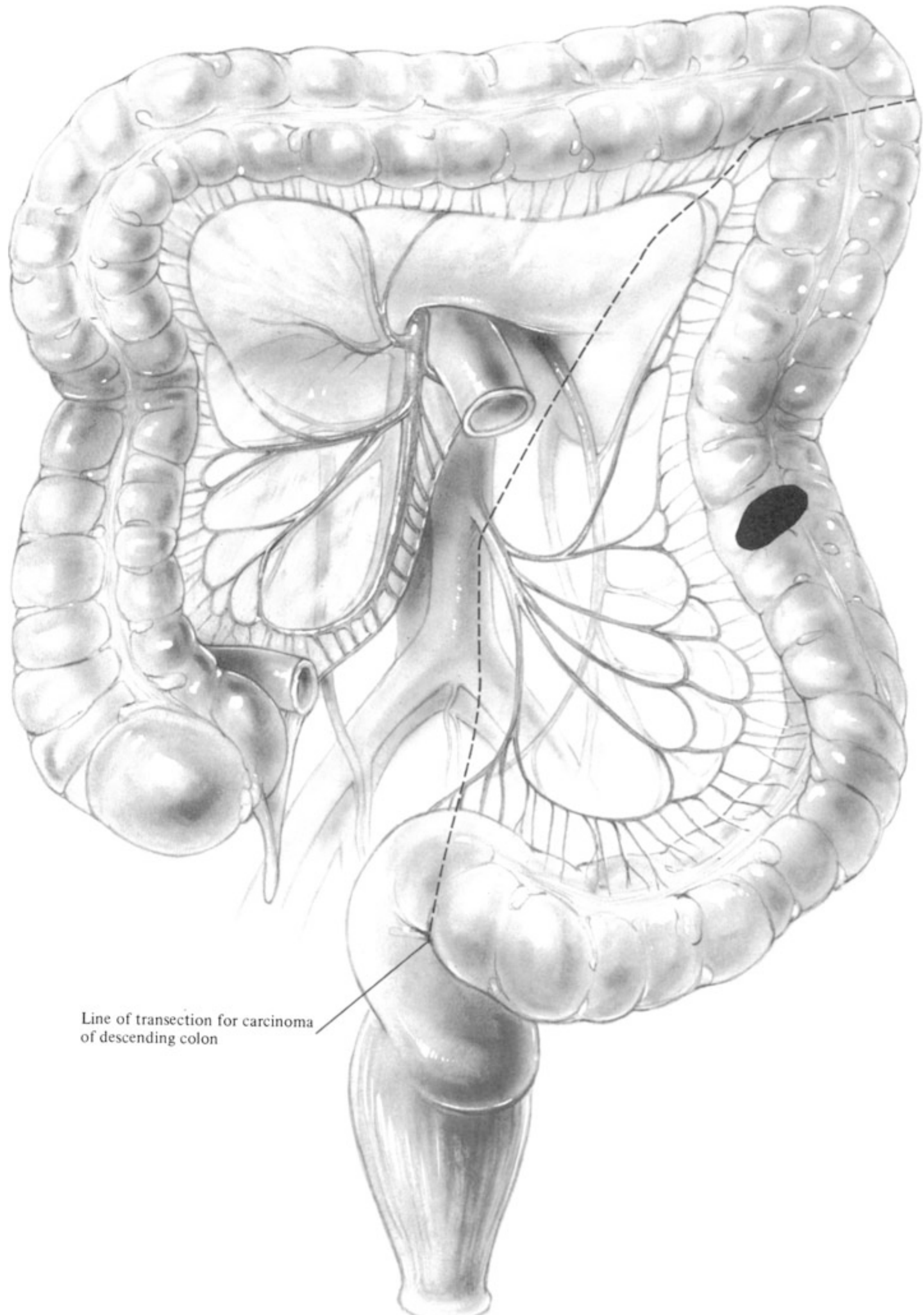


Fig. 35–5

routine splenectomy improves the survival of patients who have lesions in this location.

There is some controversy, in treating carcinoma of the rectum, over the optimal point for dividing the lymphovascular bundle: Is it the origin of the inferior mesenteric artery at the aorta, or is it a point on the inferior mesenteric artery just distal to the take-off of the left colic artery? Unless there is clear evidence to indicate otherwise, we generally select

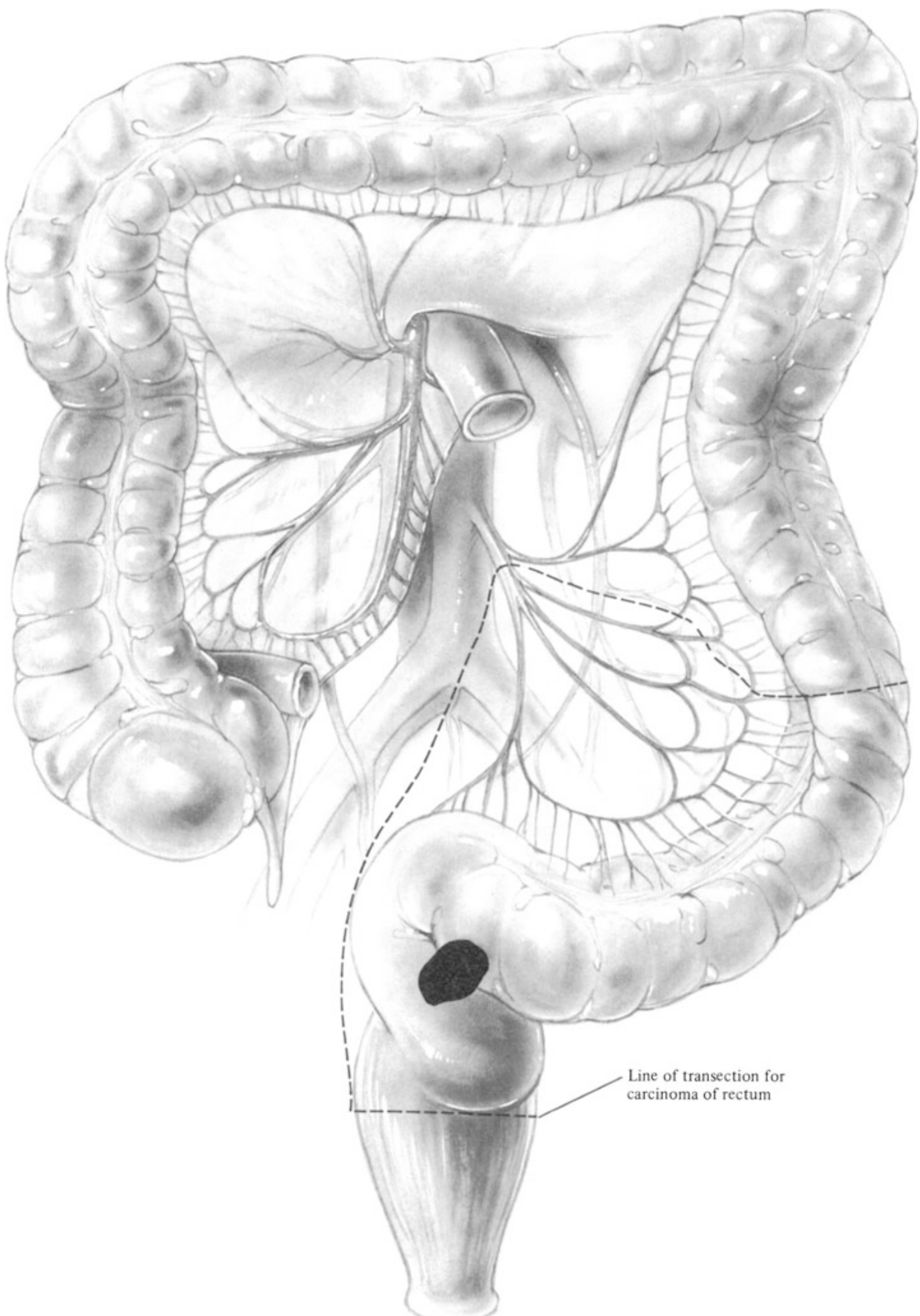


Fig. 35–6

the latter point (**Fig. 35–6**) as the apex of the dissection for carcinoma of the rectum and rectosigmoid junction. Goligher, and Stearns and Schottenfeld, prefer to transect the inferior mesenteric artery at the aorta (**Fig. 35–7**) and to rely upon the middle colic artery to supply adequate circulation to the descending colon.

Concept: The No-Touch Technique

A "no-touch" technique of right colon resection for carcinoma was first described in 1952 by Barnes. Serious attention was paid to this concept only 15 years later, when Turnbull et al. of the Cleveland

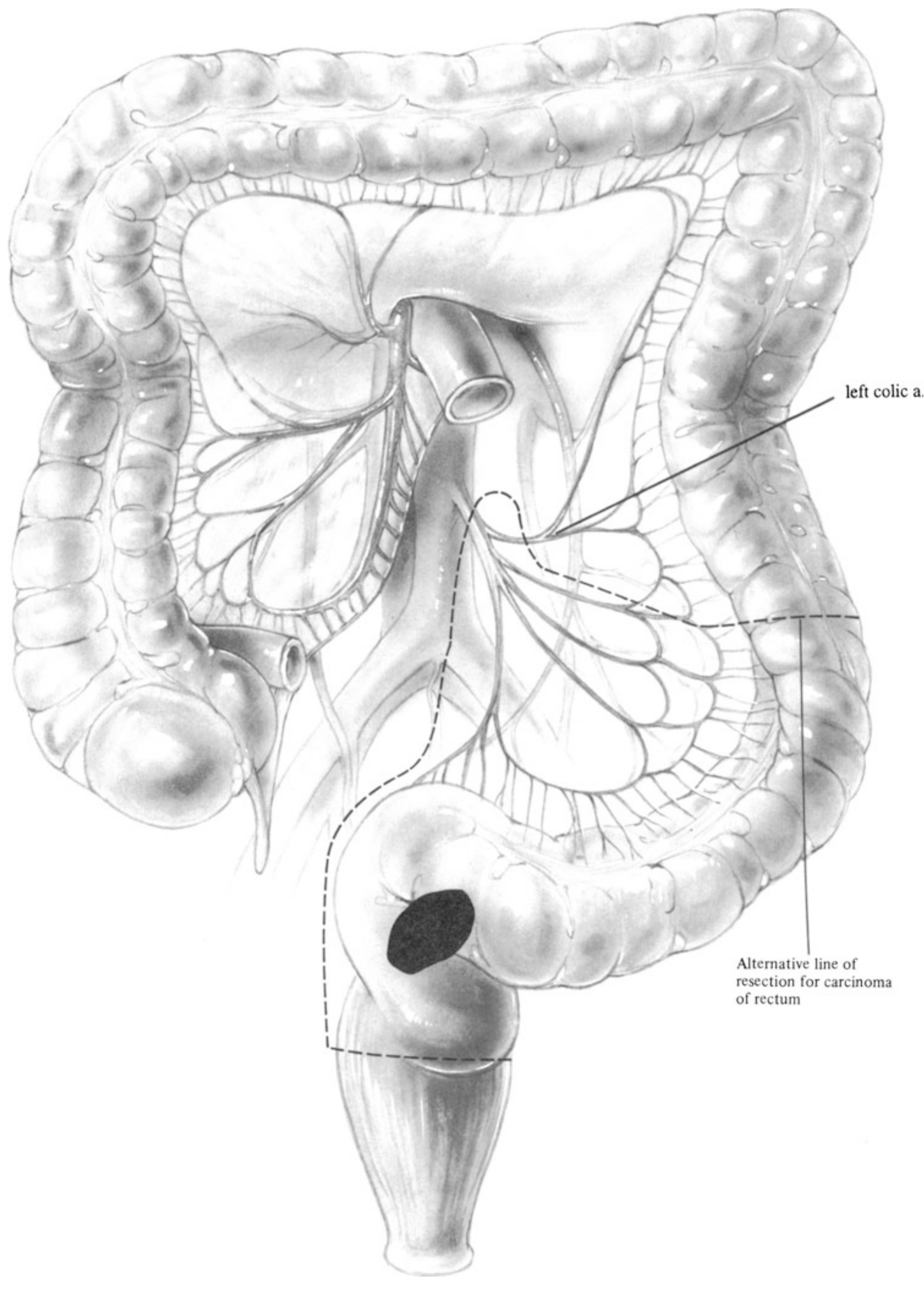


Fig. 35–7

Clinic demonstrated an improved 5-year survival rate in their patients who had been resected by this technique as compared with patients who had been operated upon by other surgeons at the same hospital. It is not clear whether this improved survival rate was a result of the no-touch isolation technique or simply because this technique also entailed a considerably wider resection of colon and mesentery than was routinely practiced by the other surgeons. Stearns and Schottenfeld achieved almost the same survival rate in patients whose operations had not been performed by the no-touch technique, but in whom equally extensive resections had been carried out.

The no-touch technique requires that the primary tumor not be manipulated until the section of colon in which it is located has been completely isolated from all lymphovascular connections to the patient. In other words, the tumor is not to be dissected until the blood supply has been divided and ligated and the lumen of the colon has been occluded.

It seems to us that in many cases it is not particularly difficult to add the no-touch isolation technique to an extensive resection of colon and mesentery. Consequently, when an operation is done for a cure in good-risk patients, the no-touch technique is generally used for lesions proximal to the splenic flexure.

Concept: Prevention of Suture-Line Recurrence

Cole et al. stated emphatically that most suture-line recurrences were preventable. They hypothesized that cancer cells got implanted into the suture line because the needle and suture material carried the cells through the wall of the colon in the course of suturing the anastomosis. If the lumen were free of viable cancer cells at the time the anastomosis was being constructed, they asserted, this complication could be eliminated. Cole et al. demonstrated that desquamated cancer cells did not survive in the intestinal lumen for more than 20 minutes. If the surgeon would occlude the lumen of the colon proximal and distal to the tumor by applying tight ligatures of 3-mm umbilical tape, they maintained, the lumen of the colon should be free of viable cancer cells 20 minutes later, when the anastomosis was being initiated. Since the application of umbilical tape ligatures requires only a few seconds, we use them in all cases of colon malignancy.

Other data suggest that the use of the closed type of anastomosis reduces the incidence of suture-line recurrence. Perhaps this is because the mucosal sutures are omitted. If the needle never passes into the lumen in the course of the anastomosis, it eliminates one method by which cells are implanted.

In treating lesions of the lower rectum where the lumen cannot be occluded 20 minutes before the anastomosis, it is advisable to apply an occluding clamp distal to the tumor after the dissection is complete. The rectal ampulla should then be irrigated through a previously placed Foley catheter. A 1 : 1000 solution of bichloride of mercury, 40% ethyl alcohol, sterile water, or other cytotoxic agent may be used. Finally, the rectum should be transected distal to the occluding clamp.

References

Barnes JP. Physiological resection of the right colon. Surg Gynecol Obstet 1952;94:723.

Cole WH et al. Carcinoma of the colon with special reference to prevention of recurrence. JAMA 1954; 155:1549.

Goligher JC. Surgery of the anus, rectum and colon, 3rd ed. London: Bailliere Tindall; 1975.

Stearns MW, Schottenfeld D. Techniques for the surgical management of colon cancer. Cancer 1971;28:165.

Turnbull RB Jr et al. Cancer of the colon: the influence of the no-touch isolation technique on survival rates. Ann Surg 1967;166:420.

36 Right Colectomy for Cancer

Indications

A right colectomy is indicated for malignancies of the ileocecal region, ascending colon, and transverse colon.

Preoperative Preparation

(See Chap. 34.)

Pitfalls and Danger Points

Injury or inadvertent ligature of superior mesenteric vessels

Laceration of retroperitoneal duodenum

Trauma of right ureter

Avulsion of branch between inferior pancreaticoduodenal and middle colic veins

Failure of anastomosis

Operative Strategy

A dissection initiated at the origins of the middle colic and ileocolic vessels makes it possible to perform a more complete lymph-node dissection in these two critical areas. In addition, by devoting full attention to the lymphovascular pedicles early in the operation, before the anatomy has been distorted by traction or bleeding, the surgeon will gain thorough knowledge of the anatomical variations that may occur in the vasculature of the colon. In addition, the surgeon will become adept at performing the most dangerous step of this procedure—high ligation of the ileocolic vessels—without traumatizing the superior mesenteric artery and vein.

In most cases, when the vascular pedicles are ligated close to their points of origin, it can be seen that the right colon is supplied by two vessels: the ileocolic trunk and the middle colic artery. The middle colic artery generally divides early in its course into a right and left branch. The left branch forms a well-developed marginal artery, which connects with the left colic artery at the splenic flexure. When the proximal half of the transverse colon is removed, the left colic connection of this marginal artery supplies the remaining transverse colon.

Very rarely a patient may not have good arterial flow from the divided marginal artery. In such a case the splenic flexure, and sometimes the descending and sigmoid colon, may have to be resected.

After the two major lymphovascular pedicles have been divided and ligated, the remainder of the mesentery to the right colon and the mesentery to the distal segment of the ileum should be divided.

At this time, if occluding clamps are applied to the anticipated points of transection of the transverse colon and of the ileum, the entire specimen can be seen to be isolated from any vascular connection with the patient. This is all done before there is any manipulation of the tumor—hence the "no-touch" technique. The specimen may now be removed by the traditional method of incising the peritoneum in the right paracolic gutter and elevating the right colon.

(See the discussion of operative strategy for the colon anastomosis in Chap. 34.)

Operative Technique of Right and Transverse Colectomy

Incision

Make a midline incision from the midepigastrium to a point about 8 cm below the umbilicus. Explore the abdomen for hepatic, pelvic, peritoneal, and nodal metastases. A solitary hepatic metastasis may well be resected at the same time the colectomy is performed. A moderate degree of hepatic metastasis is not a contraindication to the removal of a locally resectable colon carcinoma. The primary tumor should be inspected but manipulation of it should be avoided at this stage.

Ligature of Colon Proximal and Distal to Tumor

Insert a blunt Mixter right-angle clamp through an avascular portion of the mesentery close to the colon, distal to the tumor, and draw a 3-mm umbilical tape through this puncture in the mesentery. Tie the umbilical tape firmly, to completely occlude the lumen of the colon. Carry out an identical maneuver at a point on the terminal ileum, thus accomplishing complete occlusion of the lumen proximal and distal to the tumor.

Omental Dissection

For a carcinoma located in the hepatic flexure, divide the adjacent omentum between serially applied Kelly hemostats just distal to the gastroepiploic arcade of the stomach (**Fig. 36–1**). If the neoplasm is located in the area of the cecum, however, there does not appear to be any merit in resecting the omentum, except for the portion of the omentum that may be adherent to the actual tumor. Otherwise, when a tumor is located in the cecum, the omentum may be dissected—with scalpel and Metzenbaum scissors—off the right half of the transverse colon through the avascular plane. After this has been accomplished, with the transverse colon drawn in a caudal direction the middle colic vessels can be seen as they emerge from the lower border of the pancreas to cross over the retroperitoneal duodenum.

Division of Middle Colic Vessels

In operations for carcinoma of the cecum and the proximal 5–7 cm of ascending colon, it is not necessary to divide the middle colic vessels before they branch. The left branch of the middle colic may be preserved and the right branch divided and ligated just beyond the bifurcation (**Fig. 36–2**).

In operations for tumors near the hepatic flexure of transverse colon, dissect the middle colic vessels up to the lower border of the pancreas (**Fig. 36–3**). Be careful not to avulse a fairly large collateral

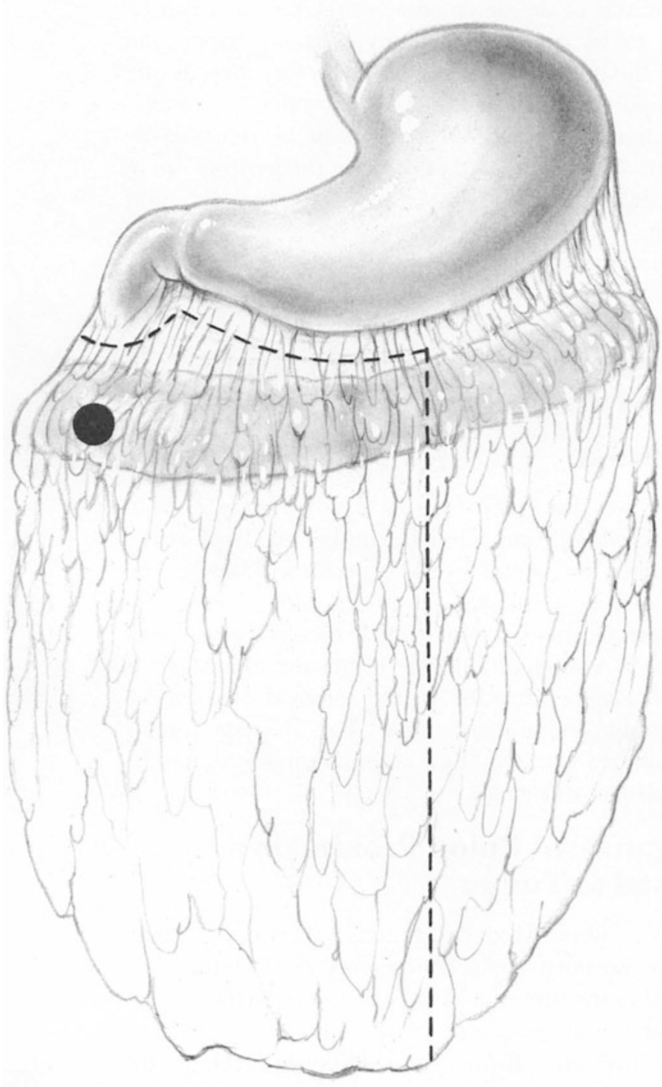


Fig. 36–1

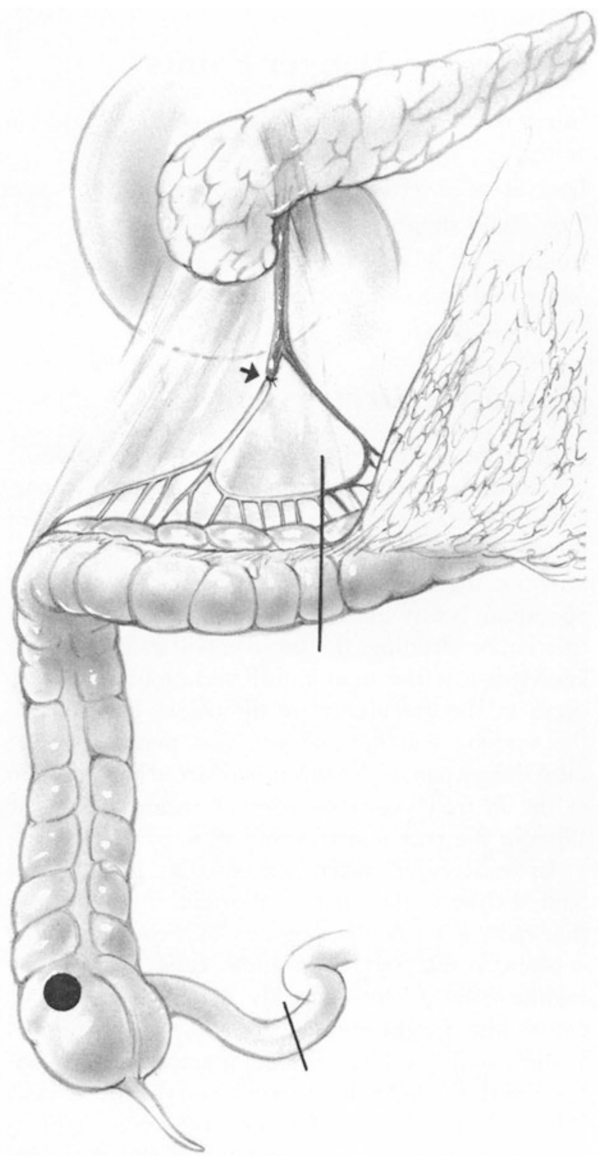


Fig. 36–2

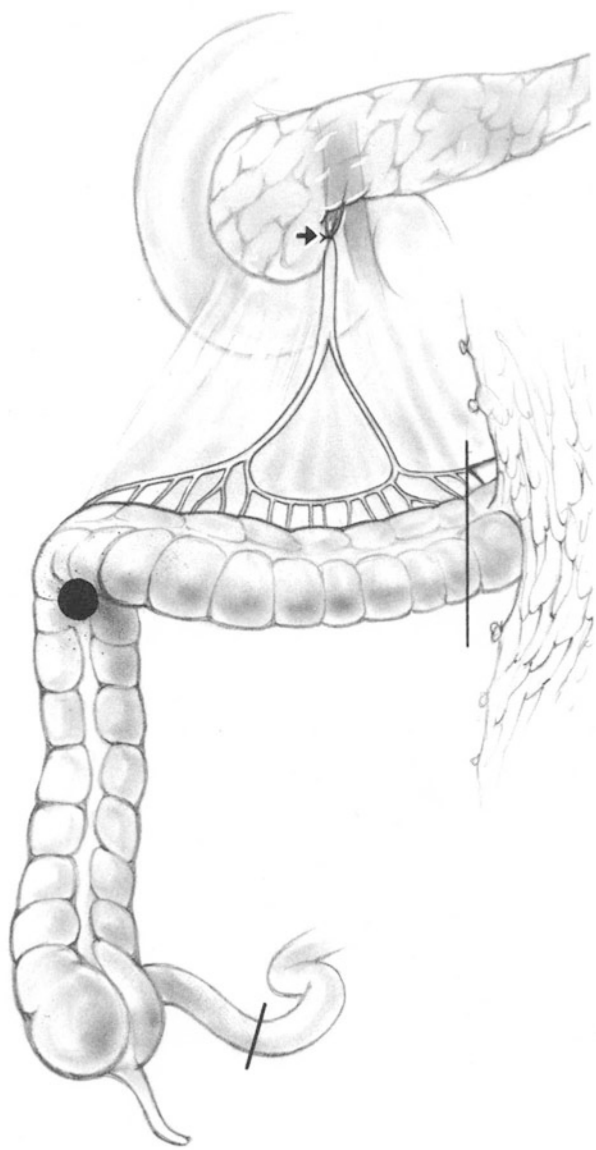


Fig. 36–3

of fat and areolar tissue in preparation for an anastomosis. Now apply an Allen clamp to the transverse colon, but to minimize bacterial contamination of the abdominal cavity do not transect the colon at this time.

Division of Ileocolic Vessels

Retract the transverse colon in a cephalad direction. Pass the left index finger deep to the right mesocolon (Fig. 36–5) by inserting the finger through the incision already made in the transverse mesocolon. Gentle finger dissection should disclose, in front of the fingertip, a fairly large artery with vigorous

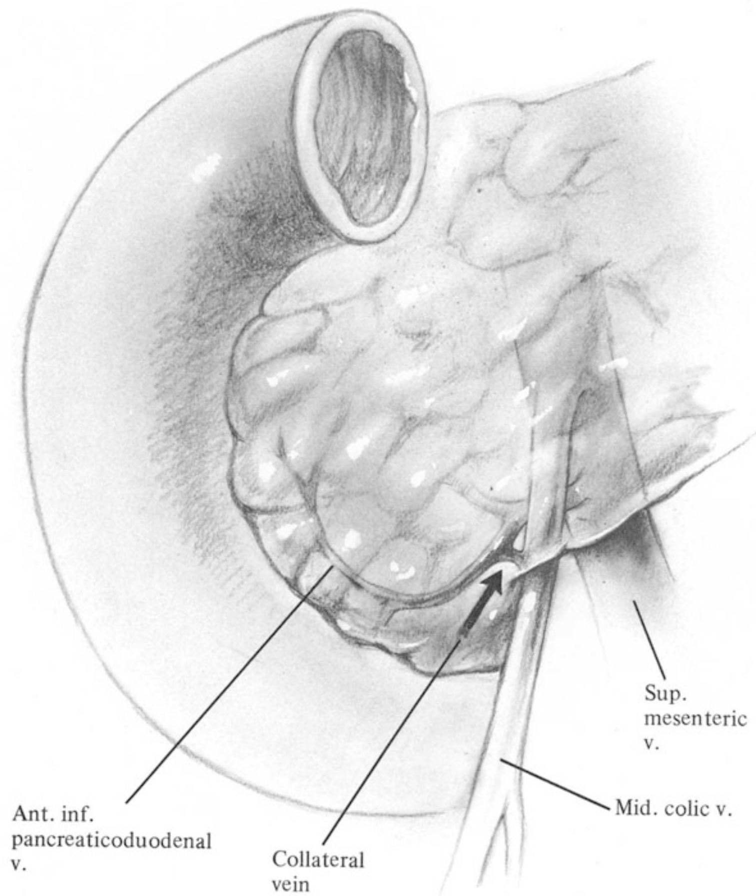


Fig. 36–4

branch that connects the inferior pancreaticoduodenal vein with the middle colic vein (**Fig. 36–4**). If this is torn, considerable bleeding follows, for the proximal end of the pancreaticoduodenal vein retracts and is difficult to locate. As these structures are fragile, gentle dissection is necessary. Place a Mixter clamp deep to the middle colic vessels at the appropriate point, draw a 2–0 silk ligature around the vessels, and ligate them. Sweep any surrounding lymph nodes down toward the specimen and place a second ligature 1.5 cm distal to the first. Divide the vessels 1 cm beyond the proximal ligature. Divide the mesocolon toward the point on the transverse colon already selected for division. Divide and ligate the marginal artery and clear the transverse colon

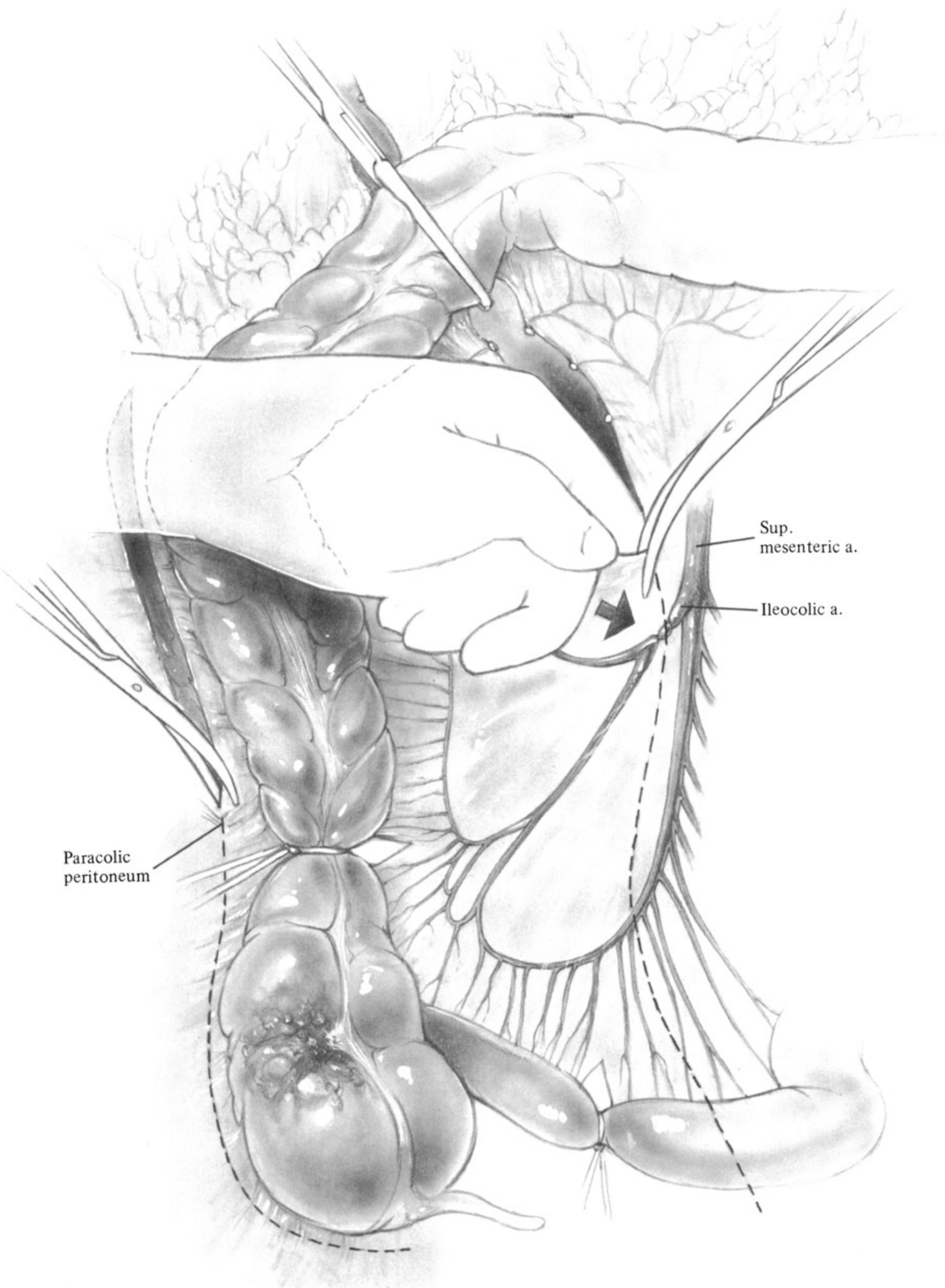


Fig. 36–5

pulsation. This is the ileocolic arterial trunk (**Fig. 36–5**). If the surgeon's index finger moves toward the patient's left, it will palpate the adjacent superior mesenteric artery. After identifying these two major vessels, it is a simple matter to incise the peritoneum overlying the ileocolic artery with a Metzenbaum scissors. By gentle dissection, remove areolar and lymphatic tissue from the circumference of the ileocolic artery and vein. After rechecking the location of the superior mesenteric vessels, pass a blunt Mixter right-angle clamp beneath the ileocolic artery and vein. Ligate the vessels individually with 2–0 silk ligatures and divide them at a point about 1.5 cm distal to their junctions with the superior mesenteric vessels.

Division of Ileal Mesentery

Pass the left index finger behind the remaining right mesocolon into an avascular area of 3–4 cm. This can be divided, and leads to the mesentery of the terminal ileum. For neoplasms close to the ileocecal junction, include 10–15 cm of ileum in the specimen. For tumors near the hepatic flexure, no more than 8–10 cm of ileum need be resected. In any case, divide the ileal mesentery between Crile hemostats, serially applied until the wall of the ileum has been encountered. After ligating each of the hemostats with 3–0 or 2–0 PG, clear the areolar tissue from the circumference of the ileum in preparation for an anastomosis and apply an Allen clamp to this area. At this point the specimen has been isolated from any vascular connection with the host.

Division of Right Paracolic Peritoneum

Retract the right colon in a medial direction and make an incision in the peritoneum of the paracolic gutter (Fig. 36–5). The left index finger may be inserted deep to this layer of peritoneum, which should then be transected over the index finger, either with Metzenbaum scissors or with electrocautery. Continue this dissection until the hepatic flexure is free of lateral attachments. Rough dissection around the retroperitoneal duodenum may lacerate it inadvertently, so be aware of its location. Next, identify the right renocolic ligament and divide it by Metzenbaum dissection. When this is accomplished, the fascia of Gerota, with perirenal fat, may be gently swept from the posterior aspect of the right mesocolon. Continue this dissection caudally and the ureter and gonadal vessel will be unroofed.

Identification of Ureter

If the location of the ureter is not immediately evident, identify the right common iliac artery. The undisturbed ureter generally crosses the common iliac artery where it bifurcates into its internal and external branches. If the ureter is not in this location, the lateral leaflet of peritoneum should be elevated, as the ureter may be adhering to the undersurface of this peritoneal flap. The ureter is often displaced by the retraction of the peritoneal flap to which it adheres. If the ureter is not present on the lateral leaflet of peritoneum, a similar maneuver should be carried out, elevating the medial leaflet of peritoneum in the search for it. Typical ureteral peristalsis should occur when the ureter is compressed with forceps.

The right colon remains attached to the peritoneum now only at the inferior and medial aspects of the cecum and ileum. There should be no difficulty in dividing this.

Insertion of Wound Protector Drape

Now that the dissection is complete, with the exception of the division of the bowel, insert a plastic ring-drape into the abdominal incision to protect the incision and subcutaneous fat from contamination during construction of the anastomosis.

Division of Ileum and Colon

Protect the abdomen with large gauze pads and remove the specimen, together with the Allen clamps that already have been applied to the ileum and transverse colon. If necessary, linen-shod Doyen noncrushing intestinal clamps may be applied to occlude the ileum and transverse colon at a point at least 10 cm from their cut edges, in prepara-

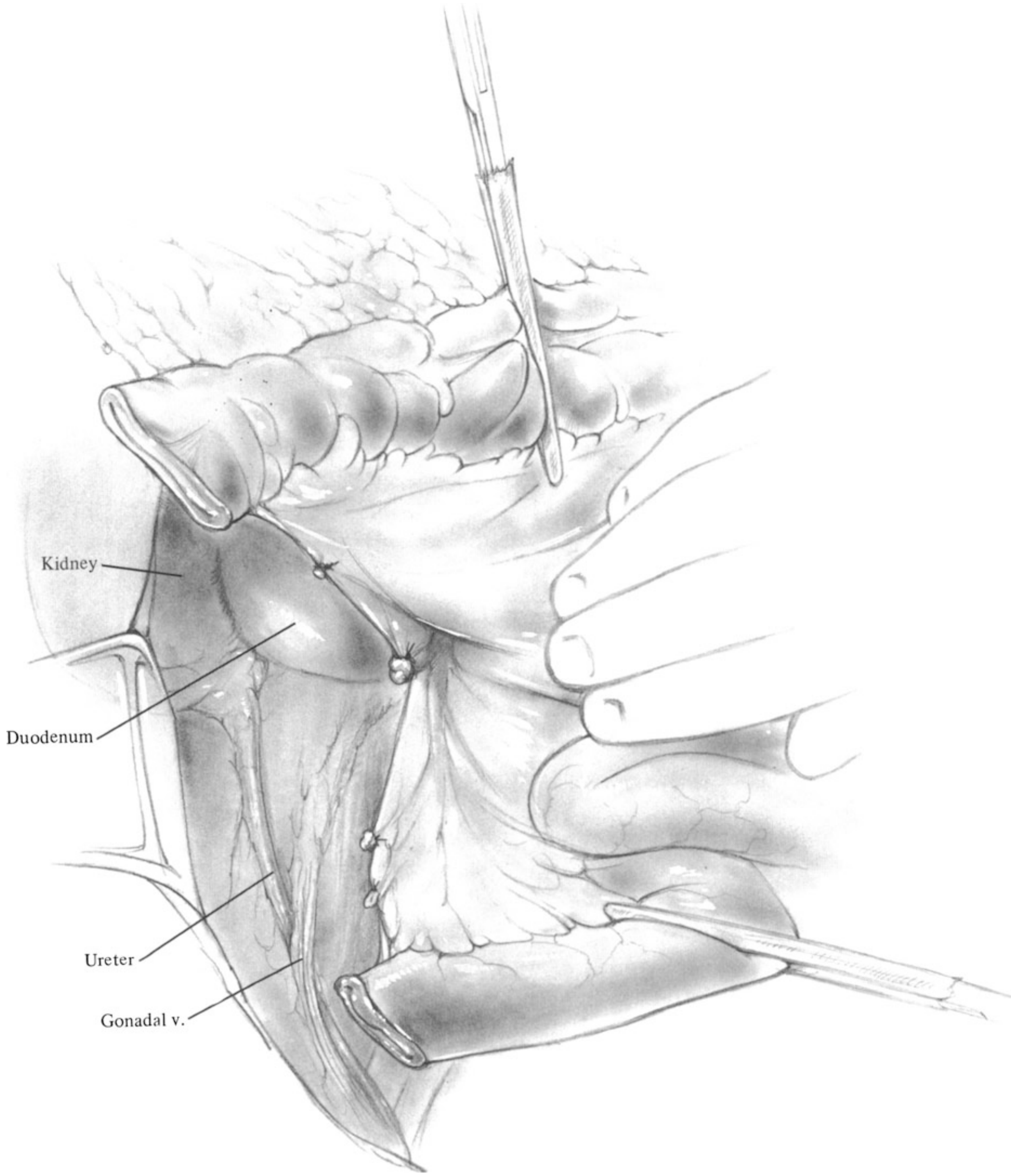


Fig. 36–6

tion for an open, two-layer end-to-end anastomosis (**Fig. 36–6**).

Before any anastomosis is begun, the blood supply should be carefully evaluated. Generally there will be no problem with the terminal ileum if no hematoma has been induced. Evaluate the adequacy of the blood supply to the cut end of the colon by palpating the pulse in the marginal artery. For additional data about the blood supply, divide a small arterial branch near the cut end of colon and observe the pulsatile arterial flow. If there is any question about the vigor of the blood supply, additional transverse colon must be resected.

Ileocolon Two-Layer End-to-End Anastomosis

Align the cut ends of the ileum and transverse colon facing each other so that their mesenteries are not twisted. Since the diameter of ileum will be narrower than that of colon, a Cheatle slit is made with a Metzenbaum scissors on the antimesenteric border of the ileum for a distance of 1–2 cm, to help equalize these two diameters (**Fig. 36–7**). The corners of the slit should not be rounded off.

Insert the first seromuscular layer of interrupted sutures, using 4–0 silk on atraumatic needles. Initiate this layer by inserting the first Lembert suture at the antimesenteric border and the second at the mesenteric border to serve as guy sutures. Attach hemostats to each of these sutures. Drawing the two hemostats apart will make insertion of additional sutures by successive bisection more efficient (**Fig. 36–8**). Now complete the *anterior seromuscular layer* of the anastomosis by inserting interrupted Lembert

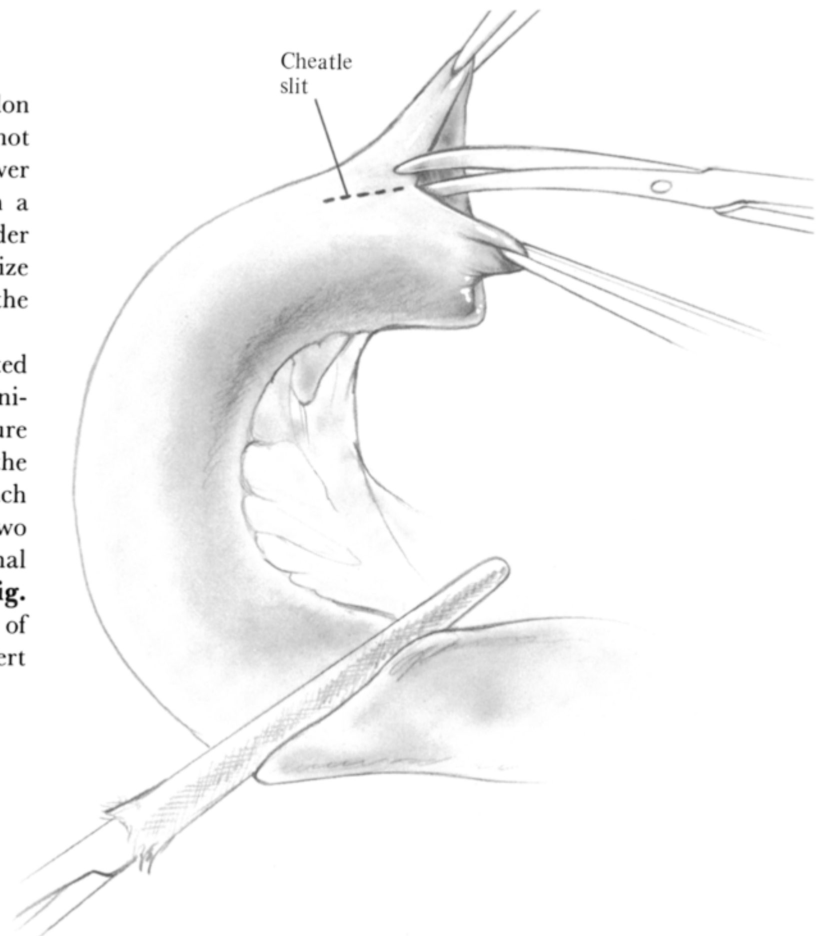


Fig. 36–7

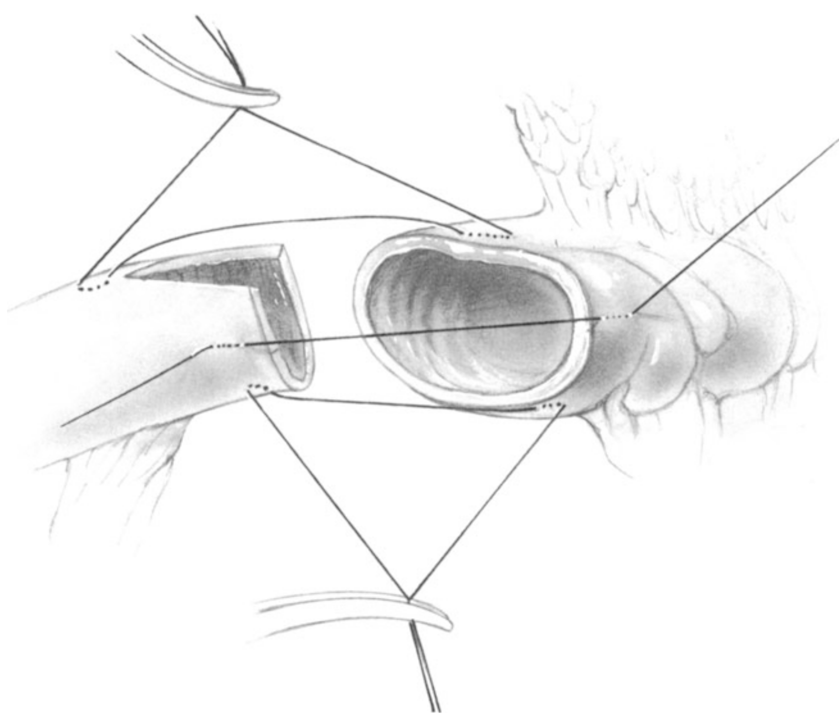


Fig. 36–8

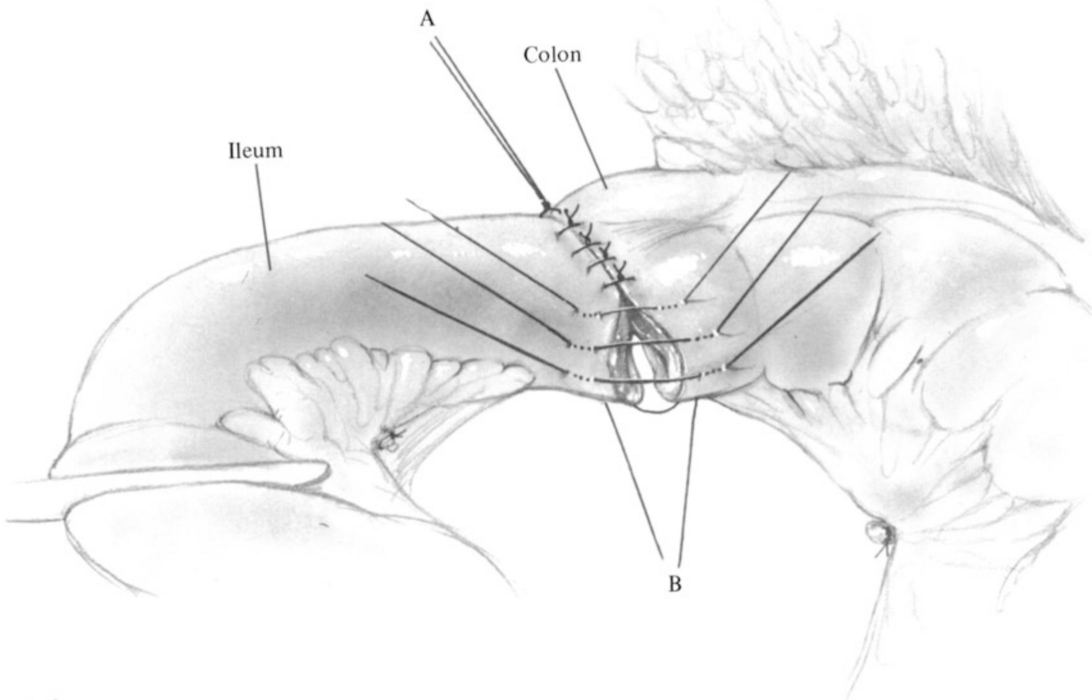


Fig. 36–9

seromuscular sutures (**Fig. 36–9**). After the entire anterior layer has been inserted and tied, cut the tails of all the sutures except for the two guy sutures.

To provide exposure for the mucosal layer, invert the anterior aspect of the anastomosis by passing the hemostat containing the antimesenteric guy suture (labeled *A* in **Fig. 36–10**) through the rent in the mesentery deep to the ileocolonic anastomosis. Then draw the mesenteric guy suture (labeled *B*) in the opposite direction and expose the mucosa for the application of the first layer of mucosal sutures (**Fig. 36–11**).

Use 5–0 Vicryl, double armed with straight needles. Begin the first suture at the midpoint (**Fig. 36–12a**). Then pass the straight needle in a continuous fashion toward the patient's right so

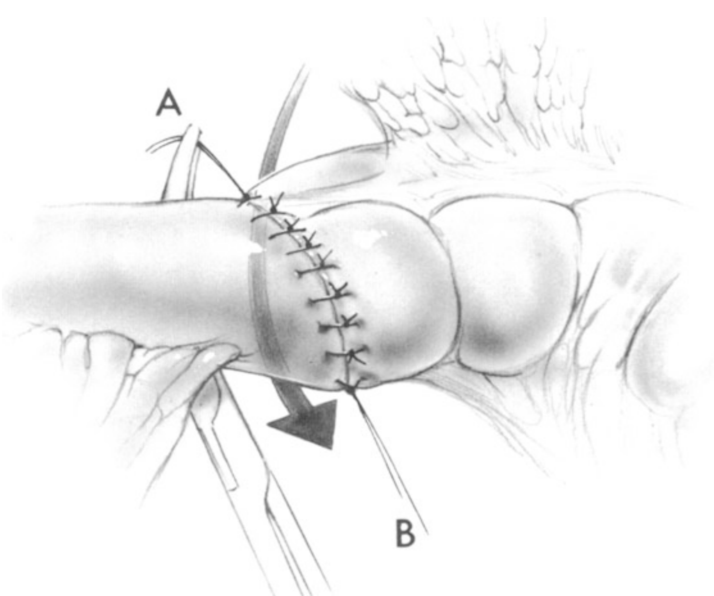


Fig. 36–10

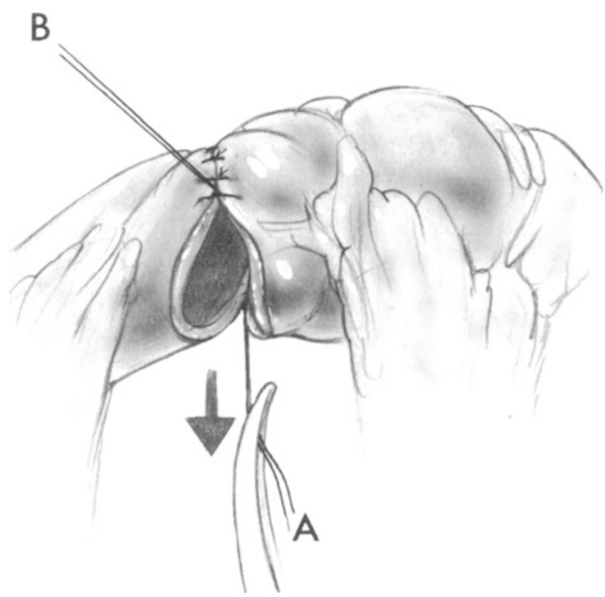


Fig. 36–11

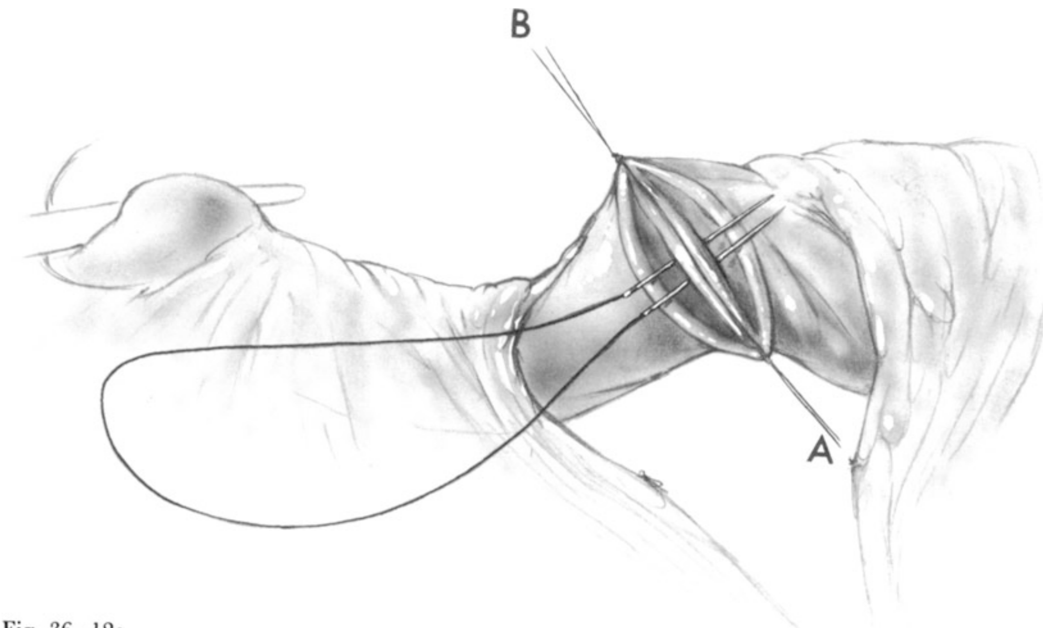


Fig. 36–12a

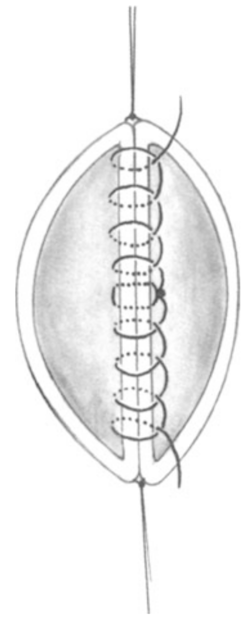


Fig. 36–12b

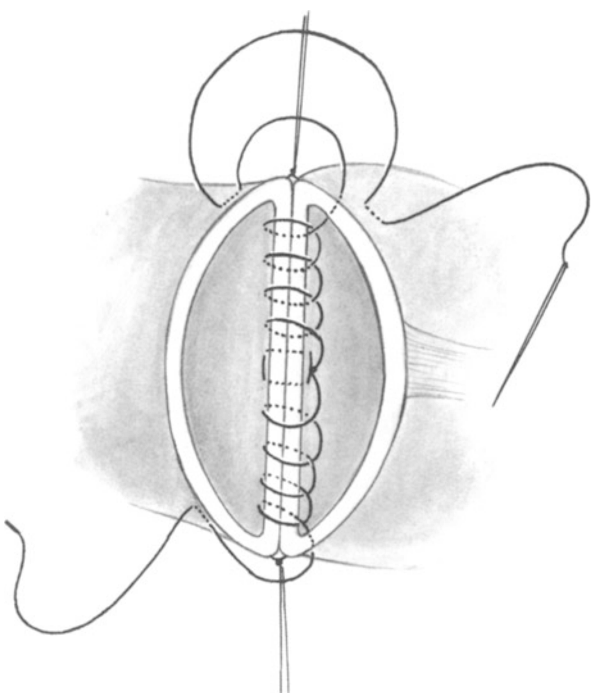


Fig. 36–12c

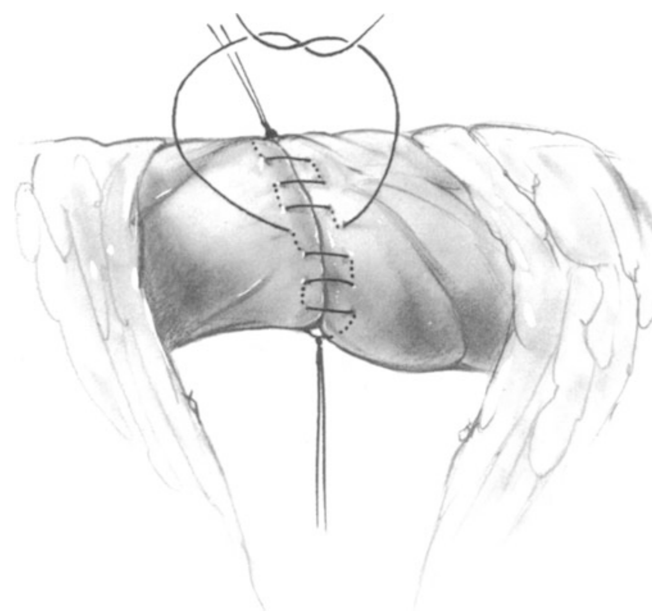


Fig. 36–13

as to lock each suture. Take relatively small bites (4 mm). When the right margin of the suture line is reached, tag the needle with a hemostat, and with the second needle initiate the remainder of the mucosal approximation, going from the midpoint of the anastomosis toward the patient's left in a continuous locked fashion (**Fig. 36–12b**). When this layer has been completed (**Fig. 36–12c**) close the superficial mucosal layer of the anastomosis with continuous Connell or Cushing sutures beginning at each end of the anastomosis. Terminate the mucosal suture line in the midpoint of the superficial layer by tying the suture to its mate (**Fig. 36–13**).

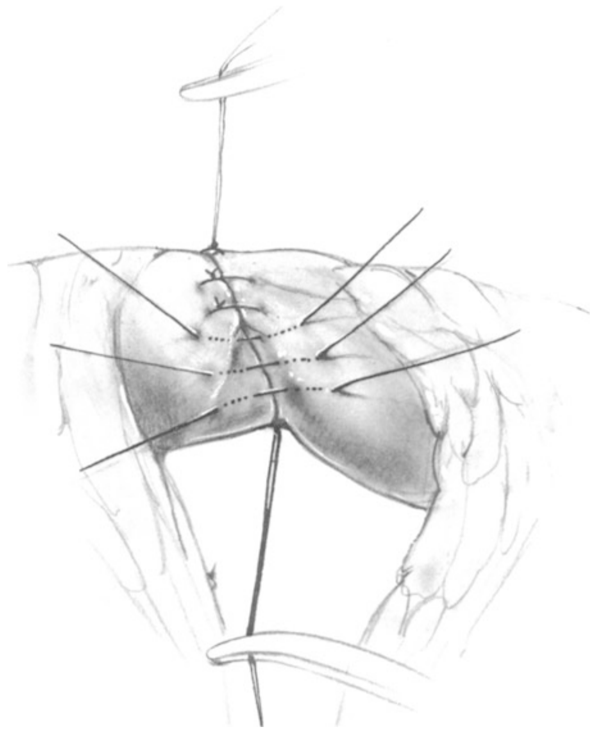


Fig. 36–14

Accomplish the final seromuscular layer by inserting interrupted 4–0 silk Lembert sutures (**Fig. 36–14**). Devote special attention to ensuring a secure closure at the mesenteric border. Then cut all the sutures and test the lumen with thumb and forefinger to gauge the width of the anastomotic stoma. It should admit the tip of the thumb.

Close the defect in the mesentery by continuous suture of 2–0 PG. Take care to avoid occluding important vessels running in the mesentery in the course of the continuous suture.

If desired, a one-layer anastomosis can be constructed by the technique described above, simply by omitting the mucosal suture. If it is accomplished without error, the result will be as successful as after the two-layer method.

Anastomosis by Stapling, Steichen Technique (Functional End-to-End)

To perform a stapled anastomosis, clear an area of mesentery and apply the TA–55 Auto Suture stapler transversely across the colon. Staples of 3.8-mm size are generally used if the bowel is not thickened. Transect the colon flush with the TA–55, using a scalpel. Carry out the identical procedure at the selected site on the ileum. Some oozing of blood should be evident despite the double row of staples. Control excessive bleeding by carefully applying electrocoagulation or by using chromic sutures. Then align the ileum and colon side-by-side and, with a heavy scissors, excise a triangular 8-mm wedge from the antimesenteric margins of both the ileum and colon (**Fig. 36–15**).

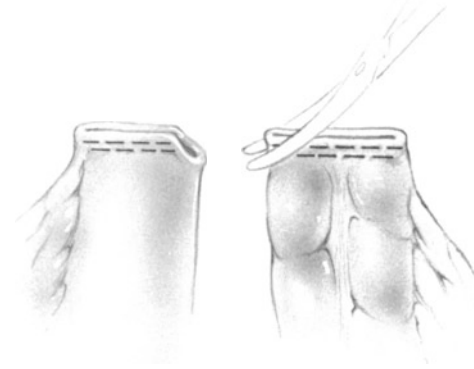


Fig. 36–15

Insert one of the two forks of the GIA anastomosing instrument into the lumen of the ileum and the other into the colon, *hugging the antimesenteric border* of each (**Fig. 36–16**). Neither segment of intestine should be stretched, as this may result in excessive thinning of the bowel, leaving inadequate substance for the staples to grasp. After ascertaining that both segments of the bowel are near the hub of the GIA instrument, fire the device; this should result in a side-to-side anastomosis 4–5 cm long. Unlock and remove the device and inspect the staple line for bleeding as well as for possible technical failure in the closing of the staples.

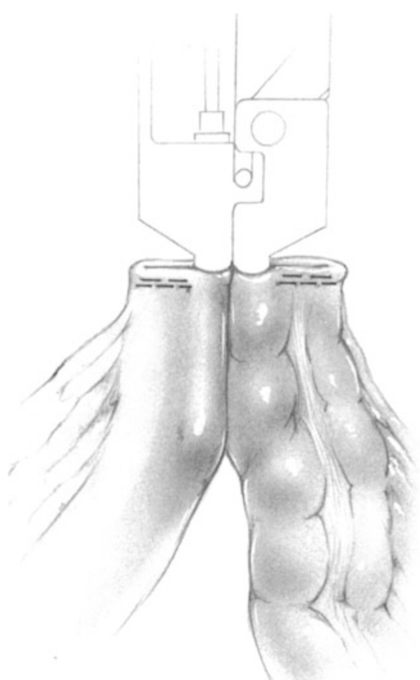


Fig. 36–16

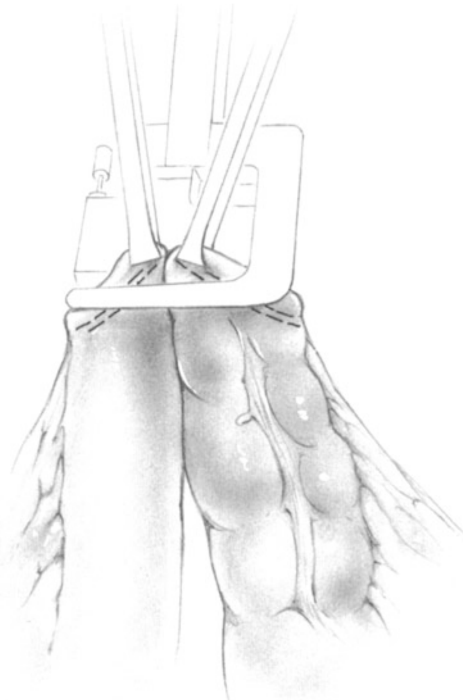


Fig. 36–17

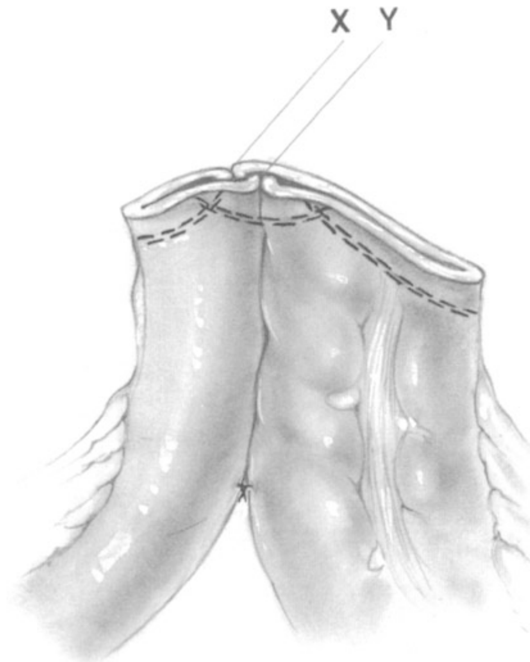


Fig. 36–19

Now apply Allis clamps to the remaining defect in the anastomosis and close it by a final application of the TA–55 instrument (**Fig. 36–17**). Take care to include a portion of *each of the previously applied staples lines* in the final application of the stapler. However, in applying the Allis clamps, do not align points *X* and *Y* (**Fig. 36–18**) exactly opposite each other, as this will result in six staple lines meeting at one point. The alignment of these two points, as shown in **Fig. 36–19**, produces the best results. Check the patency of the anastomosis by invaginating the colon through the anastomosis, which should admit the tips of two fingers. Then lightly touch the everted mucosa with the electrocoagulator. During closure of the mesentery, cover the everted staple lines with adjoining mesentery or omentum if convenient.

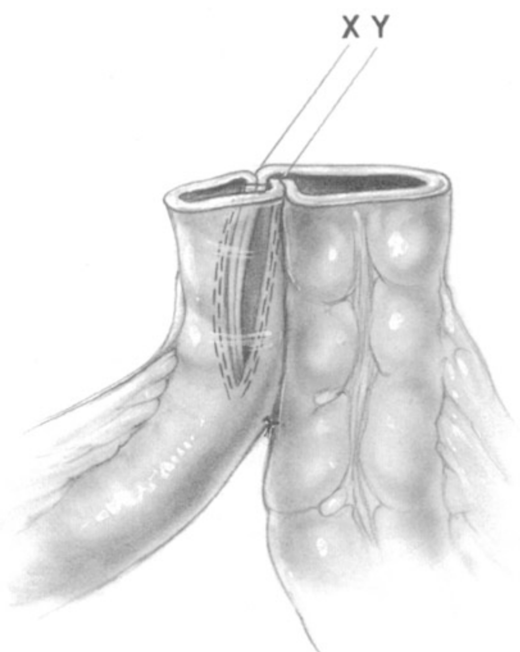


Fig. 36–18

We have modified Steichen's method of anastomosing ileum to colon, making it simpler by eliminating two applications of the stapler. In our technique the first step is to insert the GIA device, one fork into the open end of ileum and the other fork into the open colon. Fire the GIA, establishing a partial anastomosis between the antimesenteric borders of ileum and colon as seen in Fig. 36–18.

Apply four or five Allis clamps to approximate the lips of the ileum and colon (in eversion) taking care that points *X* and *Y* are not in apposition. Then apply a TA–90 stapler beneath the Allis clamps, and fire the staples. The end result is illustrated in

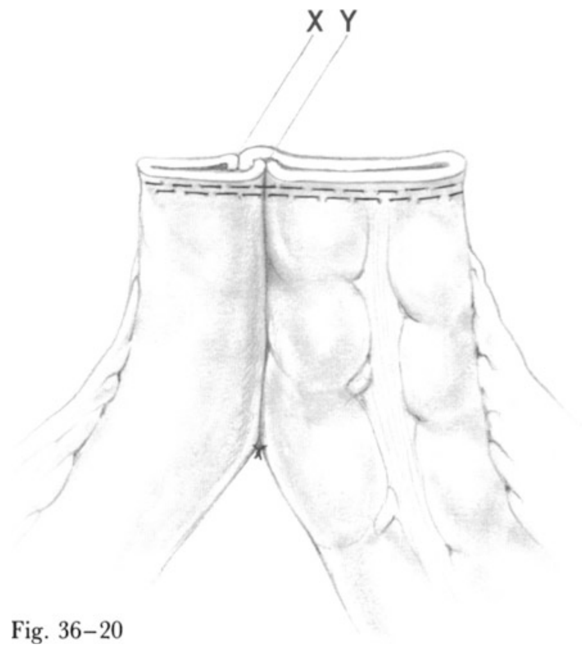


Fig. 36–20

Fig. 36–20. In our experience this is the most efficient and reliable method of constructing an ileocolonic anastomosis.

Wound Closure

Remove the Wound Protector drape. The surgical team should now change gloves and discard all instruments used up to this point. Irrigate the operative field with saline and then with a dilute antibiotic solution. Cover the anastomosis with omentum if possible. Carry out closure of the wound in routine fashion.

Postoperative Care

Continue nasogastric suction for 1–3 days.

Delay oral intake of liquid and food until the fifth or sixth postoperative day. If the patient is suffering from paralytic ileus, delay oral intake further and take steps, such as diagnostic X rays, to rule out mechanical obstruction of the small bowel.

In the absence of preoperative intraabdominal sepsis, discontinue antibiotics after the operation.

Complications

Leakage from an ileocolonic or colocolonic anastomosis may be manifested by peritonitis, colocutaneous fistula, or localized intraperitoneal abscess. The surgical team must keep alert at all times for any sign of localized or spreading peritonitis, as this complication should be managed by prompt relaparotomy and exteriorization of both ends of the anastomosis.

Sepsis in the subhepatic, subphrenic, or pelvic areas is an occasional complication of anastomoses of the colon, even in the absence of leakage. Each of these requires local drainage. CT scans are very helpful in identifying abdominal sepsis. CT-guided percutaneous catheter drainage of abdominal abscesses is generally successful.

Wound infection generally requires prompt removal of all overlying skin sutures to permit wide drainage of the entire infected area.

37 Left Colectomy for Cancer

Indications

Whereas malignancies of the proximal three-quarters of the transverse colon require the excision of the right and transverse colon, cancers of the distal transverse colon, splenic flexure, descending colon, and sigmoid are treated by left hemicolectomy (see Chap. 35).

Preoperative Preparation

(See Chap. 34.)

Pitfalls and Danger Points

Injury to spleen
Failure of anastomosis
Injury to ureter

Operative Strategy

Extent of Dissection

Lymph draining from malignancies of the left colon flows along the left colic or sigmoidal veins to the inferior mesenteric vessels. In the usual case, the inferior mesenteric artery should be divided at the aorta and the inferior mesenteric vein at the lower border of the pancreas.

Except for the treatment of lesions situated in the distal sigmoid, the lower point of division of the colon is through the upper rectum, 2–3 cm above the promontory of the sacrum (see Fig. 35–5). No presacral elevation of the rectal stump need be carried out, and the anastomosis should be intraperitoneal. The blood supply of a rectal stump of this length, arising from the inferior and middle hemorrhoidal arteries, is almost invariably of excellent quality. The blood supply of the proximal colonic segment, arising from the middle colic artery, generally is also excellent, providing that care is exercised not to damage the marginal vessel at any point in its course.

Liberation of Splenic Flexure

The splenic flexure of the colon may be completely liberated without dividing a single blood vessel if the surgeon can recognize anatomical planes accurately. The only blood vessels going to the colon are those arising from its mesentery. Bleeding during the course of this dissection arises from three sources:

1) Frequently, *downward traction on the colon and its attached omentum* avulses a patch of splenic capsule to which the omentum adheres. It is worthwhile to inspect the lower pole of the spleen at the *onset* of this dissection and to divide such areas of adhesion with a Metzenbaum scissors under direct vision before applying traction.
2) Bleeding arises when the *surgeon does not recognize the plane* between the omentum and appendices epiploica attached to the distal transverse colon. The appendices may extend 1–3 cm cephalad to the transverse colon. When they are divided inadvertently, bleeding follows. Note that the character of the fat in the omentum is considerably different from that of the appendices. The former has the appearance of multiple small lobulations, each 4–6 mm in diameter, while the appendices epiploica contain fat that appears to have a completely smooth surface. If the proper plane between the omentum and appendices can be identified, the dissection will be bloodless.
3) Bleeding can arise from the *use of blunt dissection* to divide the renocolic ligament. This ruptures a number of veins along the surface of Gerota's capsule, which overlies the kidney. Bleeding can be prevented by accurately identifying the renocolic ligament, delineating it carefully, and then dividing it with a Metzenbaum scissors along the medial margin of the renal capsule. Although the classical anatomy books do not generally describe a "renocolic ligament," this can regularly be identified as a thin structure (see Figs. 37–2 and 37–3) extending from the anterior surface of the renal capsule to the posterior surface of the mesocolon.

There are three essential steps in the safe liberation of the splenic flexure. First, the obvious one, incise the parietal peritoneum in the left paracolic gutter going cephalad to the splenic flexure. Second, dissect the left margin of the omentum from the distal transverse colon as well as from the left parietal peritoneum near the lower pole of the spleen (in those patients who have this attachment). Third, the least well understood step, identify and divide the renocolic ligament between the renal capsule and the posterior mesocolon. Then pass the index finger deep to this ligament in the region of the splenic flexure (see Fig. 37–3); this plane leads to the lienocolic ligament, which is also avascular and may be divided by a Metzenbaum scissors, provided that this ligament is separated from underlying fatty tissue by finger dissection. The fatty tissue may contain an epiploic appendix with a blood vessel. After the lienocolic ligament has been divided, the index finger should lead to the next avascular "ligament," which extends from the pancreas to the transverse colon. This pancreaticocolic "ligament" comprises the upper portion of transverse mesocolon. Dividing this frees the distal transverse colon and splenic flexure, except for the mesentery. For all practical purposes the renocolic, lienocolic, and pancreaticocolic "ligaments" are one continuous avascular membrane with multiple areas of attachment.

No-Touch Technique

Turnbull's no-touch tecnique is more difficult to apply to lesions of the left colon than to those on the right. However, in many cases it can be accomplished by liberating the sigmoid colon early in the procedure, identifying and ligating the inferior mesenteric vessels, dividing the mesocolon, all before manipulating the tumor. In some cases the tumor's location or obesity of the mesocolon make this approach more cumbersome for the surgeon, unlike the situation on the right side where the anatomy lends itself to the adoption of the no-touch method as a routine procedure. Most surgeons content themselves with minimal manipulation of the tumor while they use the operative sequence of first liberating the left colon and then ligating the lymphovascular attachments.

Technique of Anastomosis

Because the anastomosis is generally intraperitoneal and because the rectal stump is largely covered by peritoneum, there should be a leakage rate in elective cases of less than 2%. Anastomosis may be done by the end-to-end technique or by the Baker side-to-end method, at the option of the surgeon.

If a stapling technique is desired, we prefer the functional end-to-end anastomosis (Figs. 37–33 through 37–36). An EEA end-to-end stapling device (Figs. 39–23 through 39–29) may also be used, although the internal diameter of the anastomosis (2.1 cm) resulting from this technique may be slightly narrow.

Operative Technique

Incision and Exposure

Make a midline incision from a point about 4 cm below the xiphoid to the pubis (**Fig. 37–1a**) and open and explore the abdomen. Insert a Thompson retractor to elevate the left costal margin. This improves the exposure for the splenic flexure dissection. Exteriorize the small intestine and retract it to the patient's right. Apply umbilical tape ligatures to occlude the colon proximal and distal to the tumor.

Liberation of Descending Colon and Sigmoid

Standing at the patient's left, make a long incision in the peritoneum of the left paracolic gutter between the descending colon and the white line of Toldt (**Fig. 37–1b**). Use the left index finger to elevate this peritoneal layer and continue the incision upward with a Metzenbaum scissors until the right-angle curve of the splenic flexure is reached. At this point, the peritoneal incision must be moved close to the colon: otherwise, the incision in the parietal peritoneum will tend to continue upward and lateral toward the spleen.

Similarly, with the index finger leading the way, use the Metzenbaum scissors to complete the incision in a caudal direction, liberating the sigmoid colon from its lateral attachments down to the rectosigmoid region.

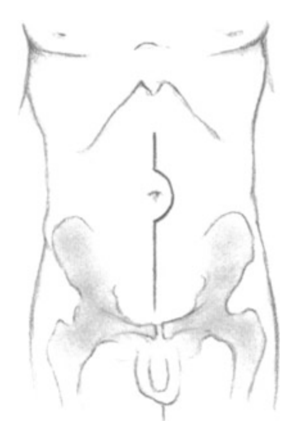


Fig. 37–1a

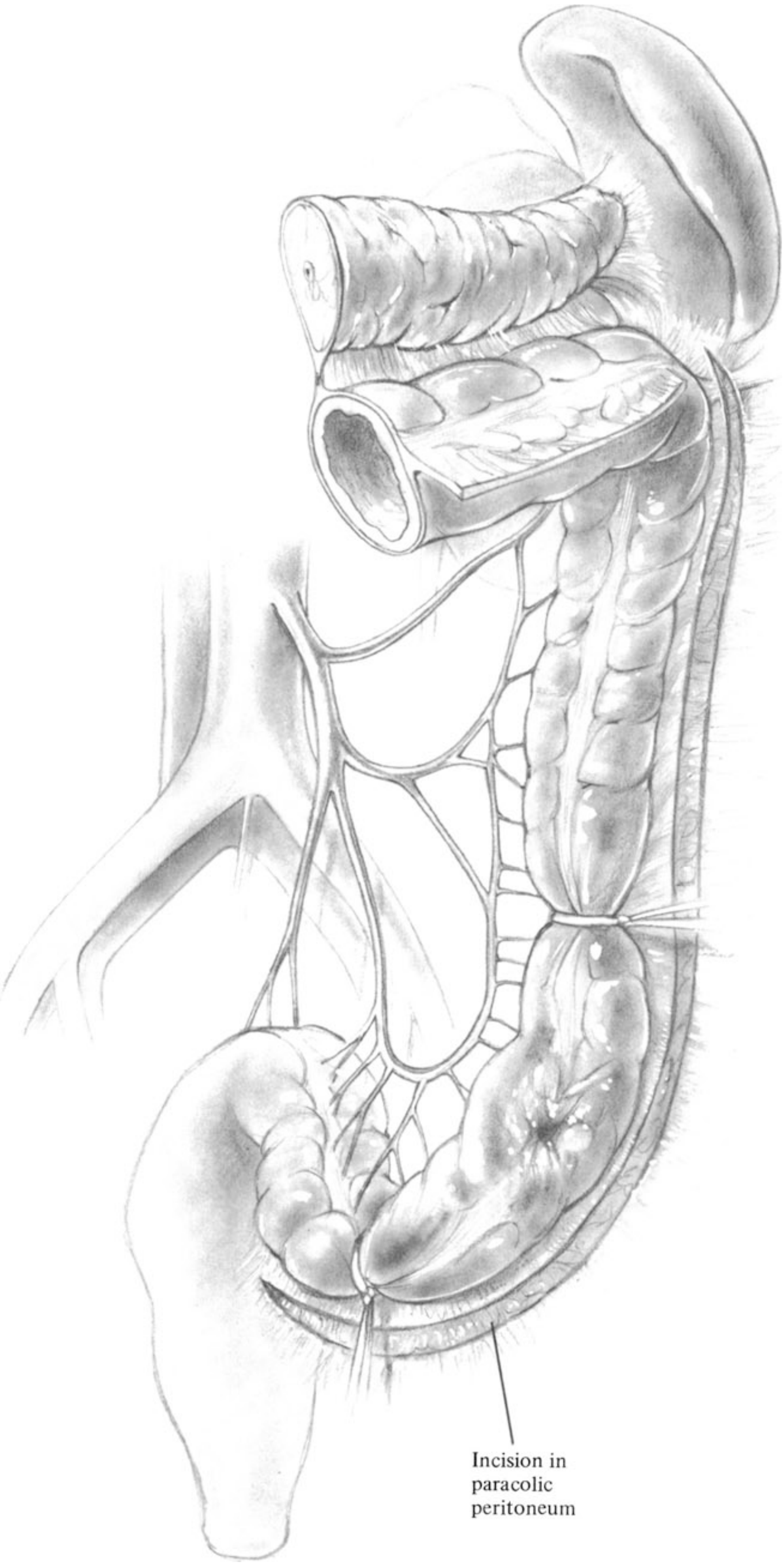


Fig. 37–1b

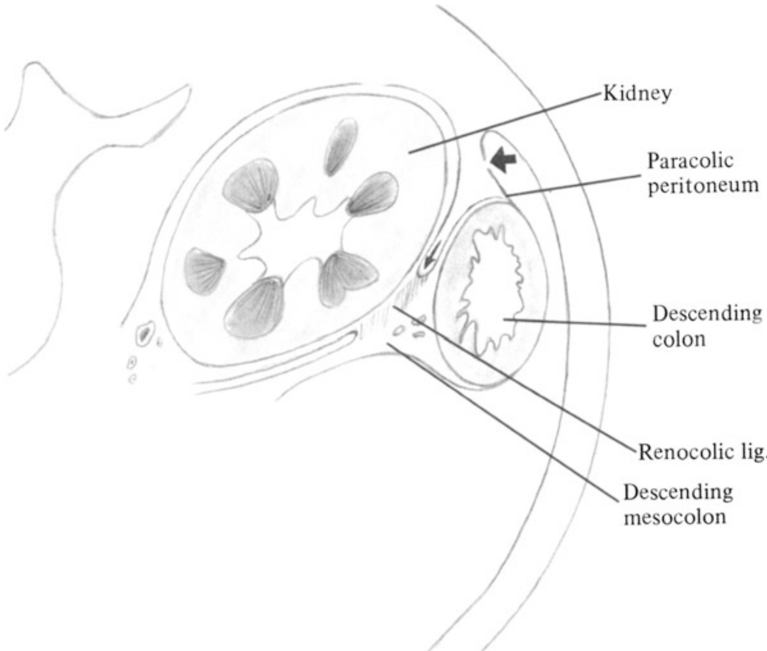


Fig. 37–2

Division of Renocolic Ligament

With the descending colon retracted toward the patient's right, a filmy attachment can be visualized covering the renal capsule and extending medially to attach to the posterior surface of the mesocolon (**Fig. 37–2**). Most surgeons bluntly disrupt this renocolic attachment, which resembles a ligament, by using a gauze pad in a sponge holder, but this maneuver often tears small veins on the surface of the renal capsule and causes unnecessary bleeding. Instead, the structure should be divided with a Metzenbaum scissors near the junction of the medial margin of the renal capsule and the adjacent mesocolon. Once the incision is initiated, the structure is best delineated by elevation over the index finger (**Fig. 37–3**). After the renocolic ligament has been divided, the upper ureter lies exposed, as does the gonadal vein. Trace the ureter down to its entrance into the pelvis and encircle it with a Vesseloop tag for future identification.

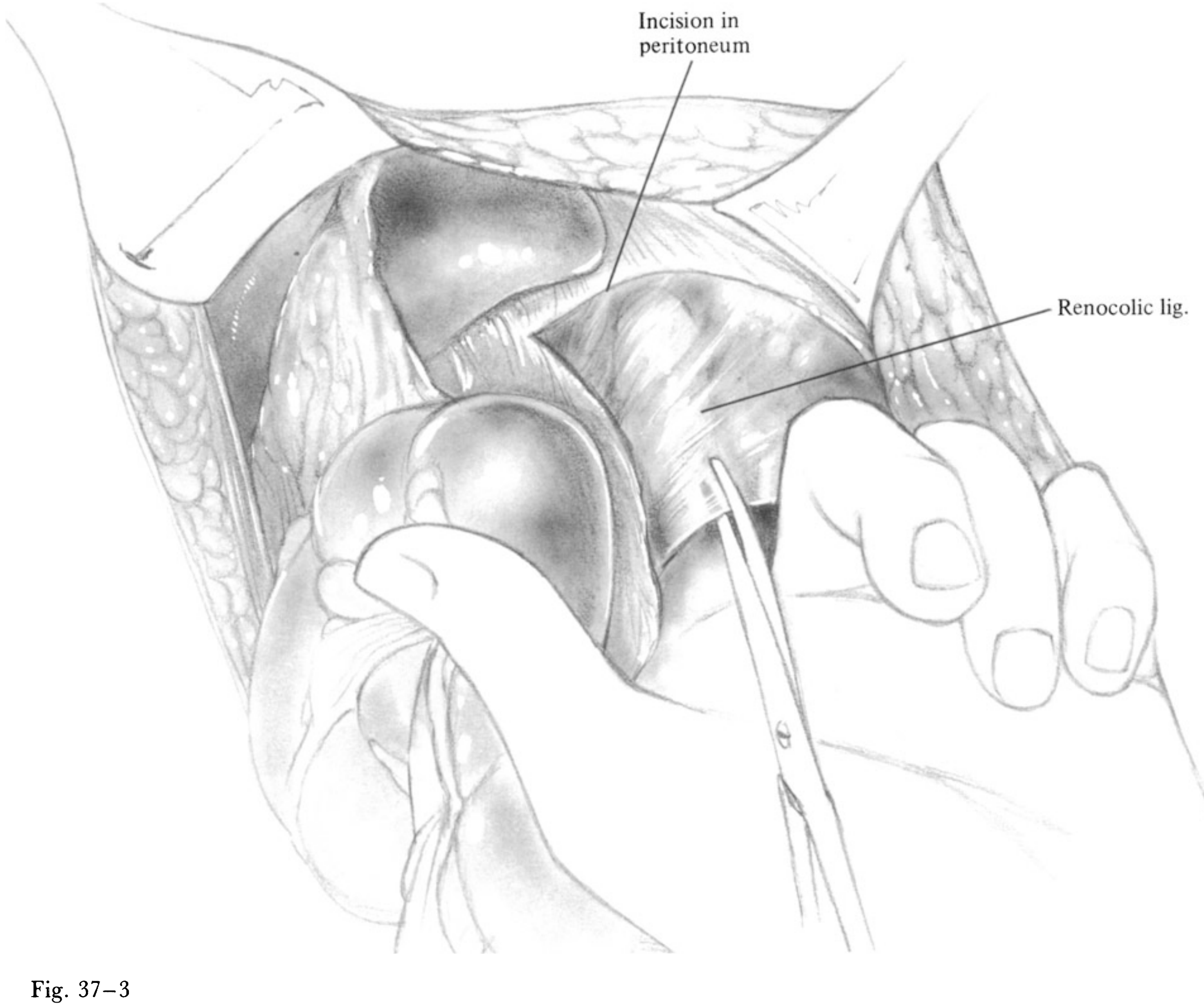


Fig. 37–3

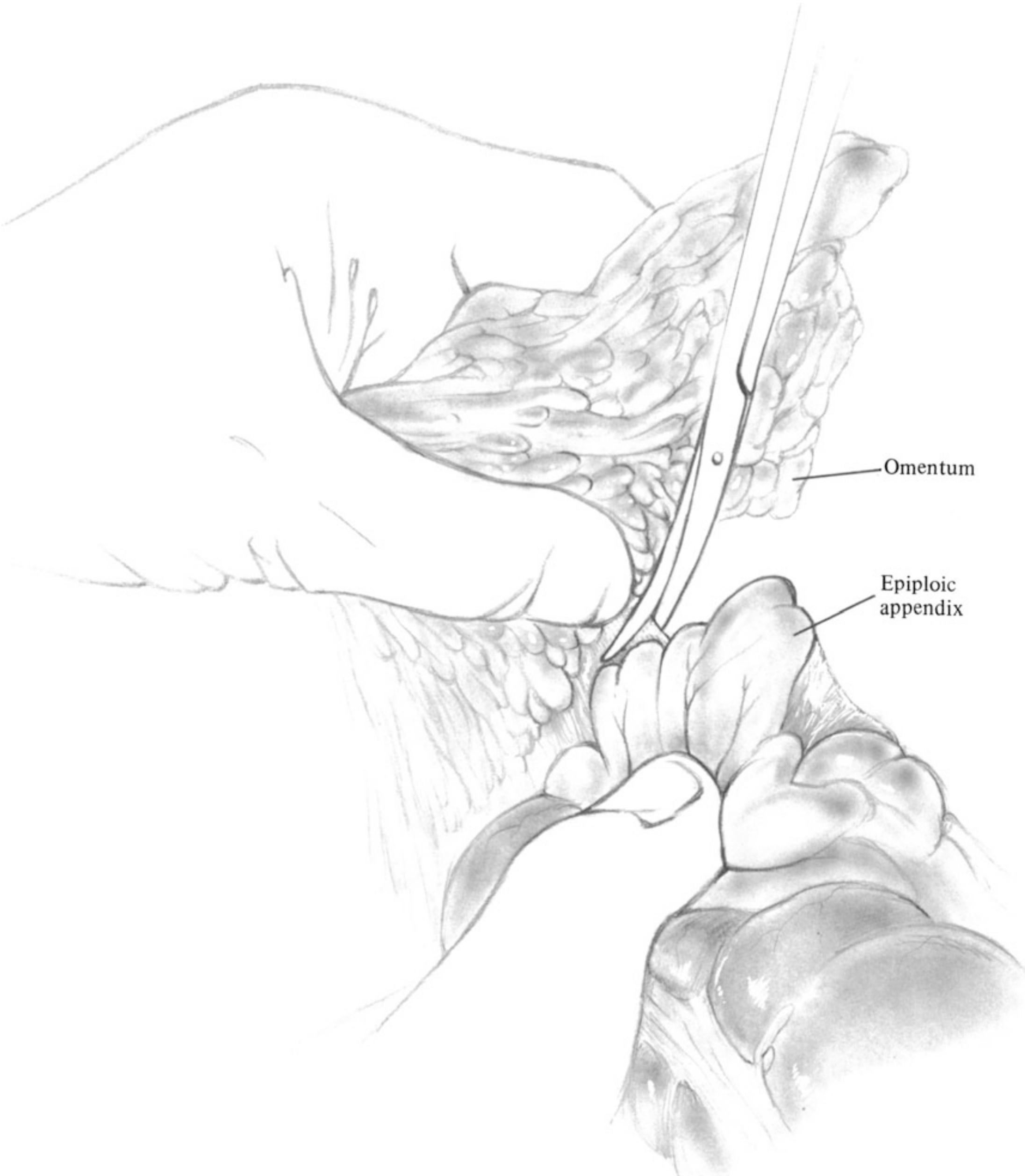


Fig. 37–4

Splenic Flexure Dissection

The lower pole of the spleen can now be seen. If there are any adhesions between the omentum and the capsule of the spleen, divide them by sharp dissection in order to avoid the inadvertent avulsion of the splenic capsule that traction on the omentum can produce. If bleeding occurs because the splenic capsule has been torn, it can usually be controlled by applying a hemostatic patch of Surgicel or Avitene. Occasionally, sutures on a fine atraumatic needle are helpful.

At this stage identify and divide the attachments between the omentum and the lateral aspect of the transverse colon. Remember to differentiate carefully between the fat of the appendices epiploica and the more lobulated fat of the omentum (see "Operative Strategy," this chapter). Free the omentum from the distal 10–12 cm of transverse colon (**Fig. 37–4**). If the tumor is located in the distal transverse colon, leave the omentum attached to the tumor and divide the omentum just outside the gastroepiploic arcade.

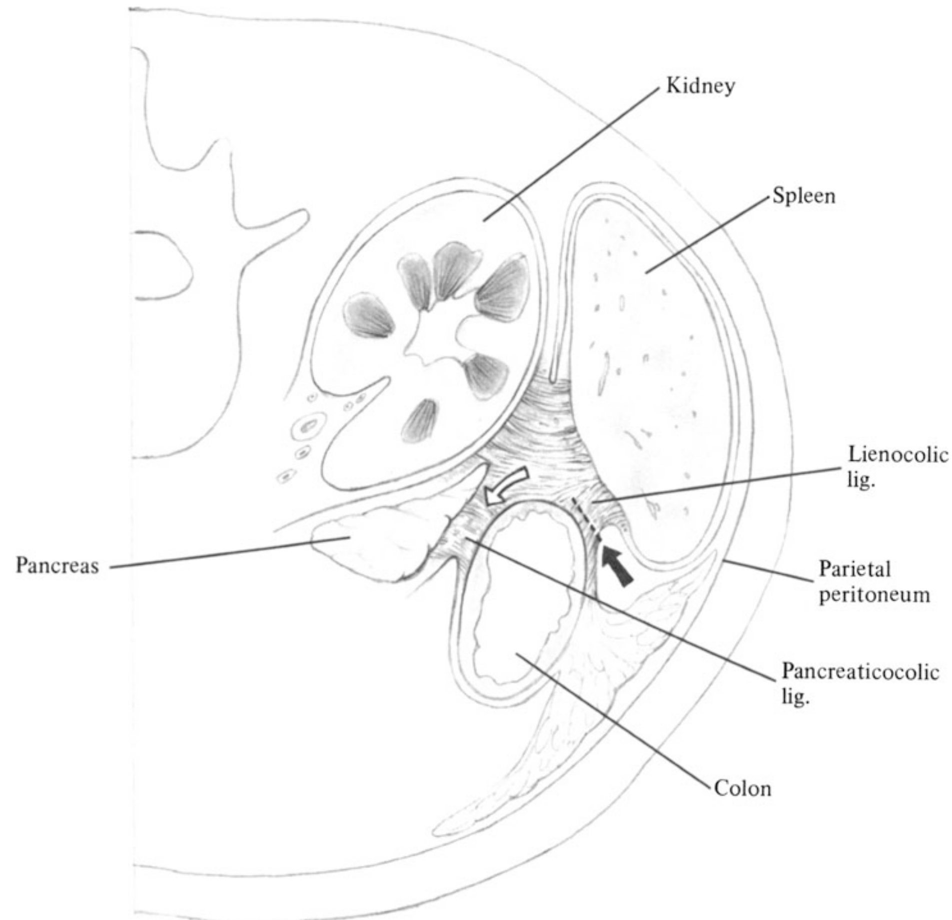


Fig. 37–5

Return now to the upper portion of the divided renocolic ligament. Insert the *right* index finger underneath the upper portion of this ligament and pinch it between the index finger and thumb; this localizes the lienocolic ligament (**Fig. 37–5**). This ligament should be divided by the first assistant, guided by the surgeon's right index finger. By inserting the index finger 5–6 cm farther medially, an avascular pancreaticocolic "ligament" (**Figs. 37–5 and 37–6**) can be identified. This is an upper extension of the transverse mesocolon. After this structure has been divided, the distal transverse colon and splenic flexure become free of all posterior attachments. If there is any bleeding in the area, correct it by using ligatures and electrocoagulation.

Ligation and Division of Inferior Mesenteric Artery

Make an incision on the medial aspect of the mesocolon from the level of the duodenum down to the promontory of the sacrum. The inferior mesenteric artery is easily identified by palpation at its origin from the aorta. Sweep the lymphatic tissue in this vicinity downward, skeletonizing the artery, which should be doubly ligated with 2–0 silk at a point about 1.5 cm from the aorta (**Fig. 37–7**) and then divided. Sweep the preaortic areolar tissue and lymph nodes toward the specimen. It is not necessary to skeletonize the anterior wall of the aorta, as this could divide the preaortic sympathetic nerves, which would result in sexual dysfunction in the male. If the preaortic dissection is carried out by gently sweeping the glands laterally, the nerves will not be divided inadvertently. Now divide the inferior mesenteric vein as it passes behind the duodenojejunal junction and pancreas.

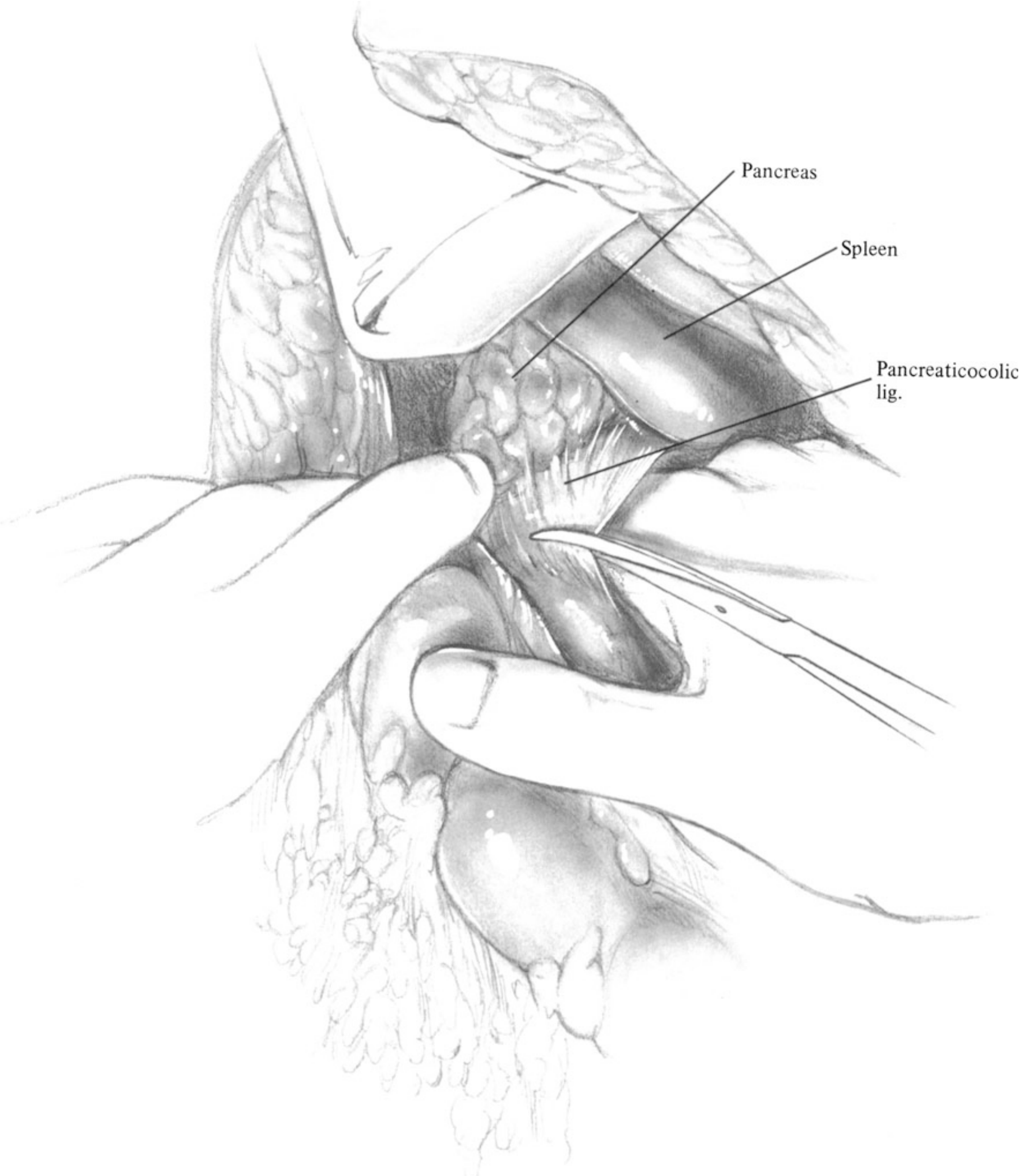


Fig. 37–6

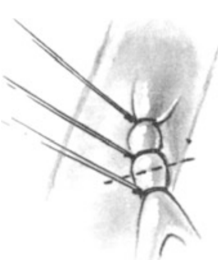


Fig. 37–7

Fig. 37–8

Division of Mesocolon

Depending on the location of the tumor, divide the mesocolon between clamps up to and including the marginal artery (**Fig. 37–8**).

Ligation and Division of Mesorectum

Separate the distal ligated pedicle of the inferior mesenteric artery and the divided mesocolon from the aorta and iliac vessels down to the promontory of the sacrum. Divide the vascular tissue around the rectum between pairs of hemostats sequentially until the wall of the upper rectum is visible. Then free the rectal stump of surrounding fat and areolar tissue at the point selected for the anastomosis. This point should be 2–3 cm above the promontory of the sacrum, where three-quarters of the rectum is covered anteriorly and laterally by peritoneum.

Insertion of Wound Protector

Insert a Wound Protector ring drape into the abdominal cavity to protect the subcutaneous panniculus from contamination when the colon is opened.

Division of Colon and Rectum

Expose the point on the proximal colon selected for division. Apply an Allen clamp to the specimen side.

Divide the colon after applying a Doyen or other type of nontraumatic clamp to avoid contamination. To prepare for the anastomosis, completely clear the areolar tissue and fat from the distal centimeter of the proximal colon so that the serosa is exposed throughout its circumference. Handle the distal end of the specimen in the same manner by applying an Allen clamp to the specimen side. Now divide the upper rectum and remove the specimen. Suction the rectum free of any contents. Apply no clamp. Fine catgut ligatures may have to be used to control bleeding from the rectal wall. Completely clear surrounding fat and areolar tissue from a cuff of rectum 1 cm in width so that seromuscular sutures may be inserted accurately.

End-to-End Two-Layer Anastomosis, Rotation Method

There are eight steps to the end-to-end two-layer anastomosis, rotation method:

1) Check the *adequacy of the blood supply* of both ends of the bowel.
2) Check whether a *cuff of at least 1 cm of serosa* has been cleared to areolar tissue and blood vessels at both ends of the bowel.
3) *Rotate the proximal colonic segment* so that the mesentery enters from the right lateral margin of the anastomosis. Leave the rectal segment undisturbed (**Fig. 37–9**).
4) If the diameter of the lumen of one of the segments of bowel is significantly narrower than the other, *make a Cheatle slit*, 1–2 cm long, on the antimesenteric border of the narrower segment of bowel (see Figs. 36–7 and 36–8).
5) *Insert the first layer of seromuscular sutures.* If the rectal stump is not bound down to the sacrum and if it can be rotated easily for 180°, it is more efficient to insert the anterior seromuscular layer as the first step in the anastomosis. Insert interrupted 4–0 silk atraumatic Lembert seromuscular guy sutures, first to the lateral border of the anastomosis and then to the medial border. By the technique of successive bisection, place the third Lembert suture on the anterior wall halfway between the first two (Fig. 37–9). Each stitch takes about 5 mm of tissue, including the submucosa, of the rectum and then of the descending colon.
6) After all the anterior sutures have been inserted, *tie them and cut all the suture tails* except for those of the two end guy sutures, which should be grasped in hemostats (**Fig. 37–10**). Pass a hemostat beneath the suture line, grasp the right

Fig. 37–9

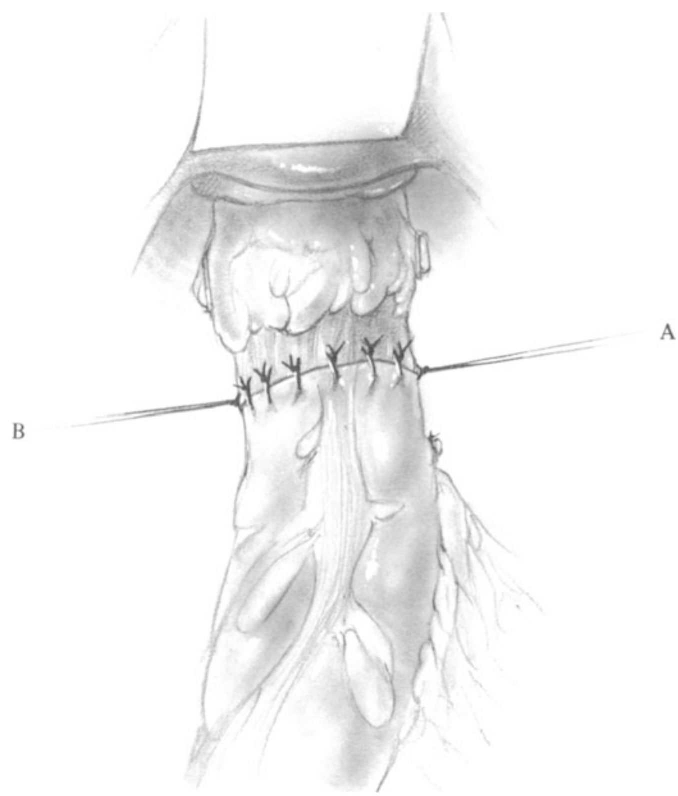


Fig. 37–10

lateral stitch (labeled *A* in **Fig. 37–11**), and rotate the anastomosis 180° (**Fig. 37–12**).

7) Place a double-armed 5–0 Vicryl or PG *suture in the middle of the deep mucosal layer* (**Fig. 37–13a**). Complete this layer with a continuous locked suture through the full thickness of the bowel (**Fig. 37–13b**). Then, with the same two needles, using a continuous Connell or Cushing suture complete the remainder of the mucosal approximation (**Fig. 37–14**).
8) Approximate the *final seromuscular layer* with interrupted 4–0 atraumatic Lembert silk sutures (**Fig. 37–15**). After all the suture tails are cut, permit the anastomosis to rotate back 180° to its normal position.

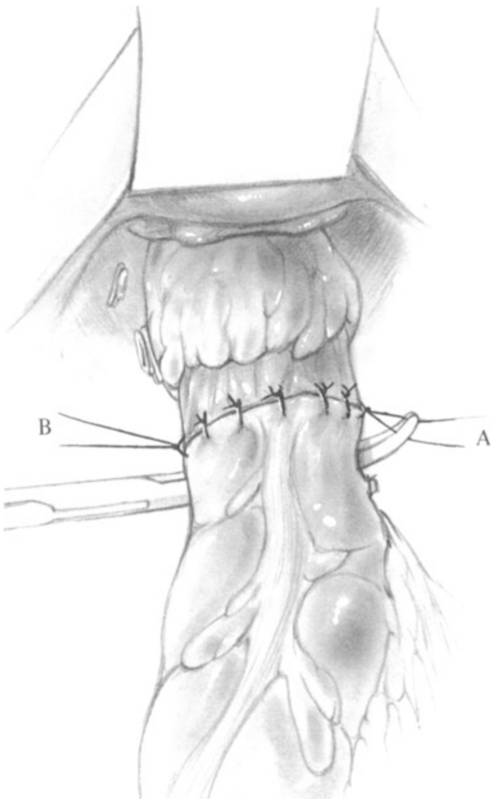


Fig. 37–11

Fig. 37–13a

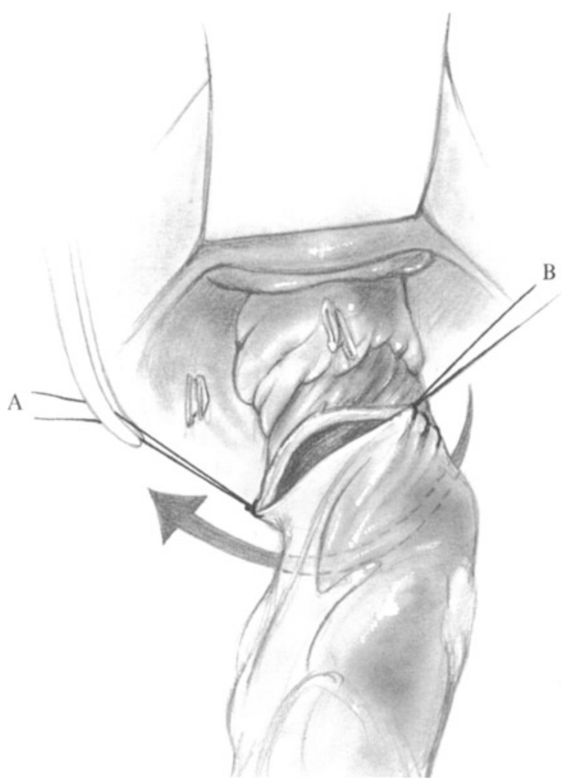


Fig. 37–12

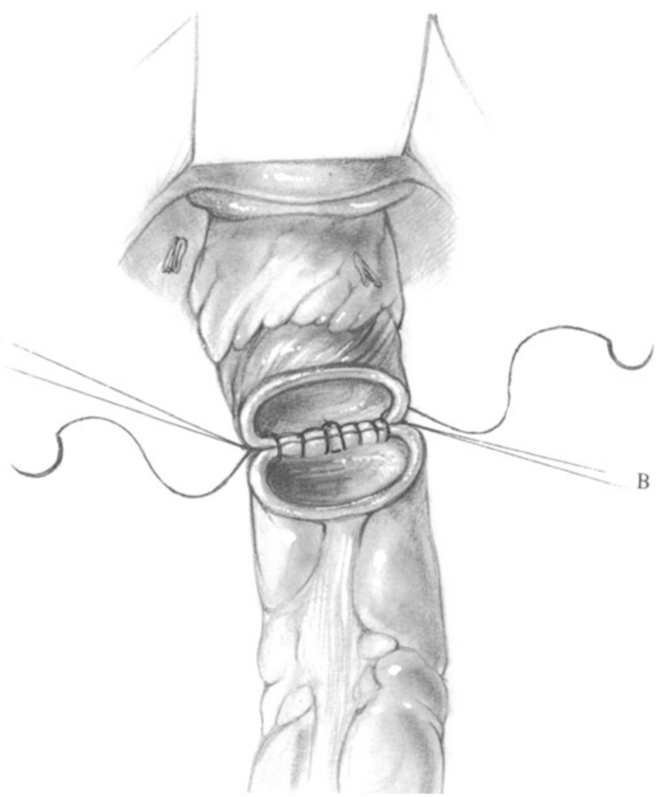


Fig. 37–13b

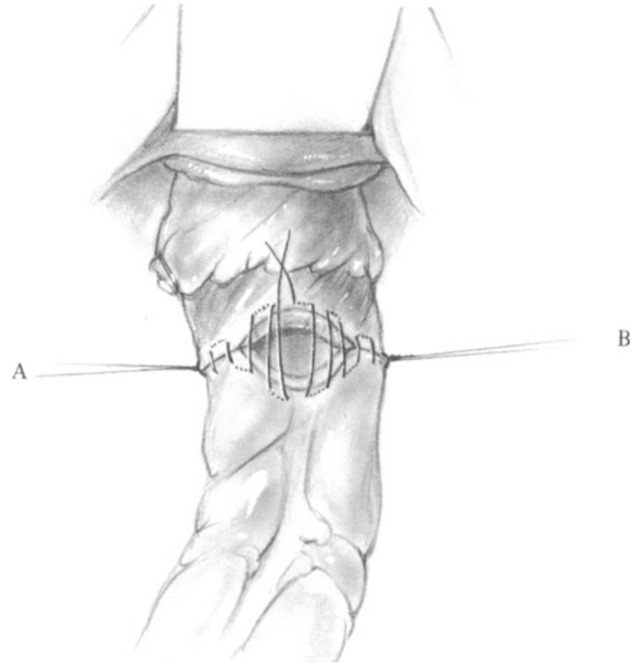


Fig. 37–14

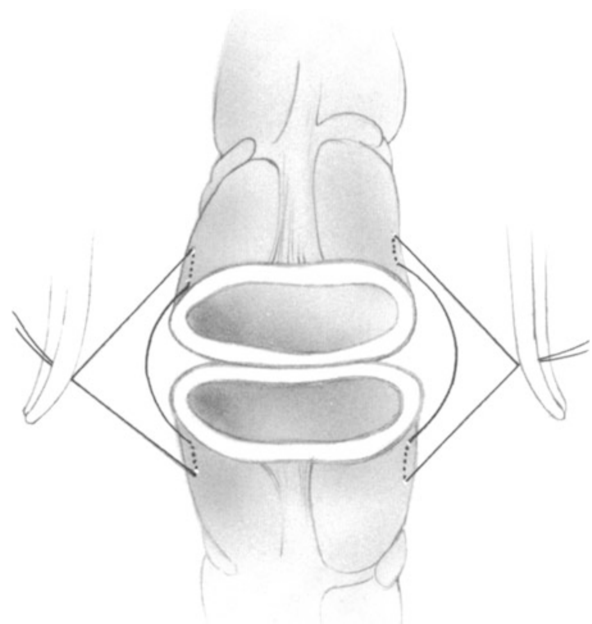


Fig. 37–16

End-to-End Anastomosis, Alternative Technique

When the rectum and colon cannot be rotated 180°, as required for the method described above, an alternative technique must be used, in which the posterior seromuscular layer is inserted first. To do this, insert a seromuscular suture of 4–0 silk into the left side of the rectum and of the proximal colon. Do not tie this suture; grasp it in a hemostat; use it as the left guy suture. Place a second suture of the identical type on the right lateral aspects of the rectum and proximal colon and similarly hold it in a hemostat (**Fig. 37–16**).

Insert interrupted 4–0 silk seromuscular Lembert sutures (**Fig. 37–17**) to complete the posterior layer.

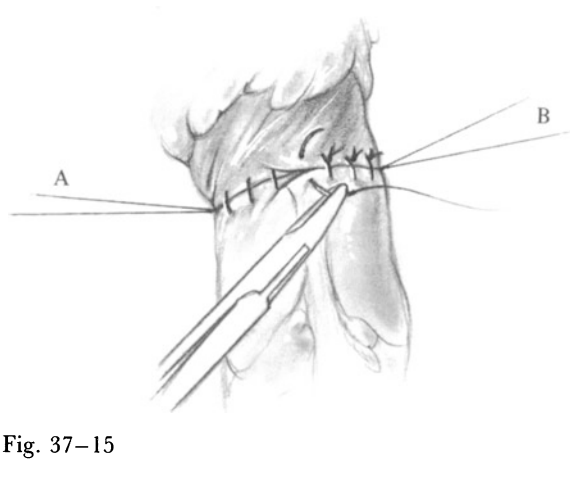


Fig. 37–15

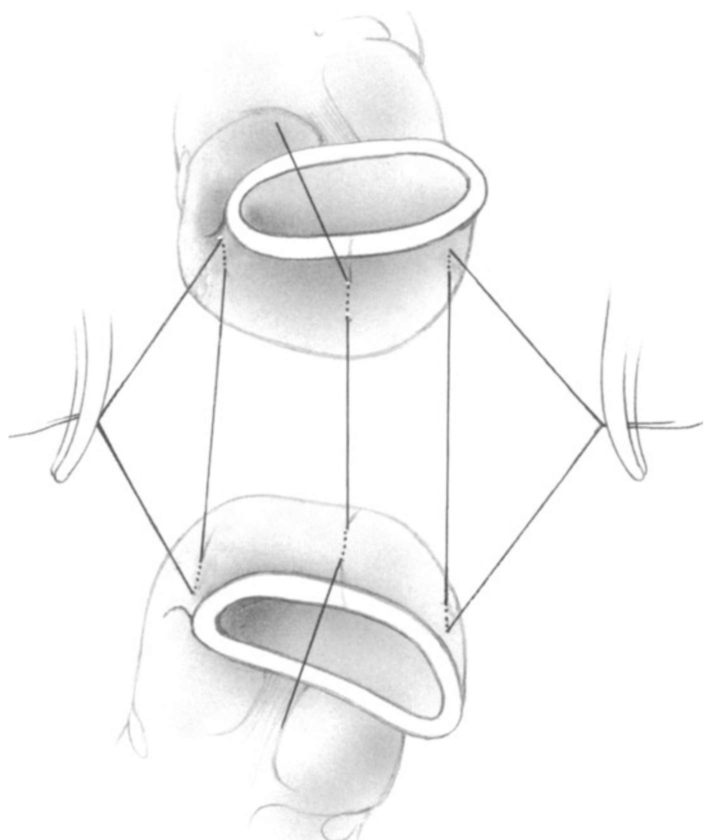


Fig. 37–17

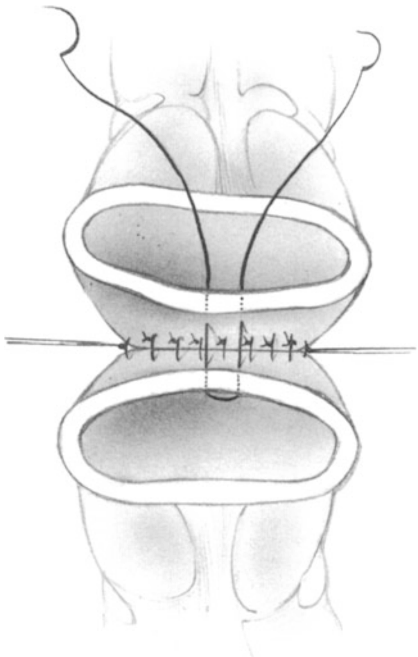


Fig. 37–18

This is done preferably by the successive bisection technique. As each suture is inserted, attach it to a hemostat until the layer is completed. At the conclusion of the layer, tie all the sutures and cut all the tails except for those of the two lateral guy sutures.

Initiate the posterior mucosal layer with a double-armed atraumatic suture of 5–0 Vicryl. Insert the

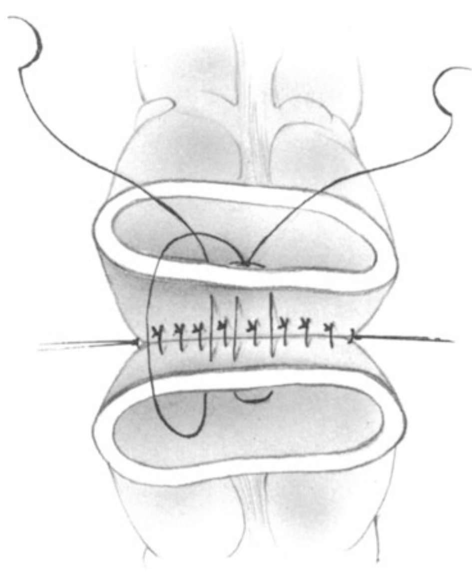


Fig. 37–19

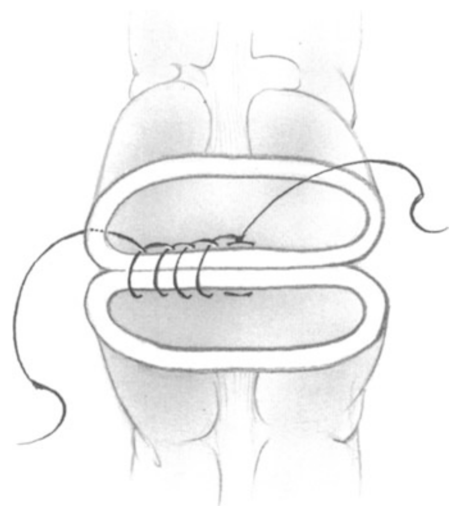


Fig. 37–20

suture in mattress fashion in the midpoint of the posterior layer of mucosa and tie it (**Fig. 37–18**). If the exposure is good, straight needles may be used. In patients who have a deep pelvis, curved needles are preferable. In either case, use one needle to initiate a continuous locked suture, taking bites averaging 5 mm in diameter and going through all the coats of bowel (**Fig. 37–19**). Continue this in a locked fashion until the left lateral margin of the anastomosis is reached (**Fig. 37–20**). At this point pass the needle from inside to the outside of the rectum and hold it temporarily in a hemostat.

Grasp the remaining needle and insert a continuous locked suture of the same type, beginning at the midpoint and continuing to the right lateral

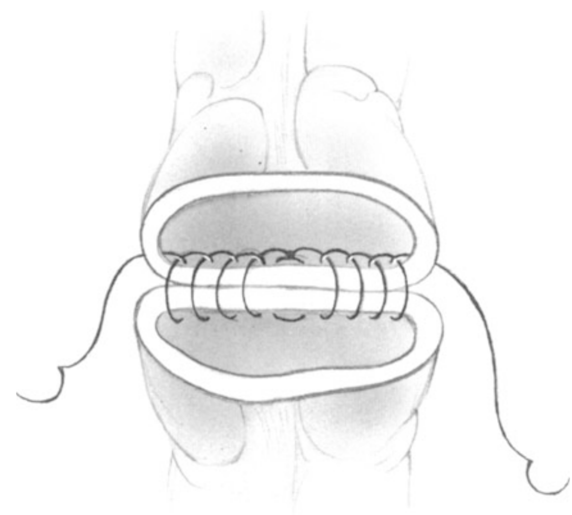


Fig. 37–21

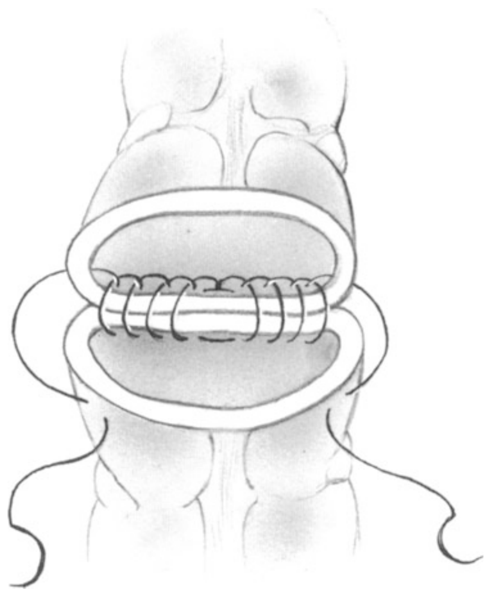


Fig. 37–22

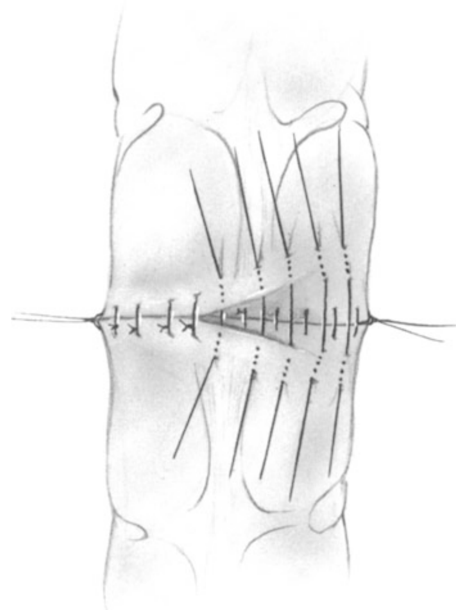


Fig. 37–24

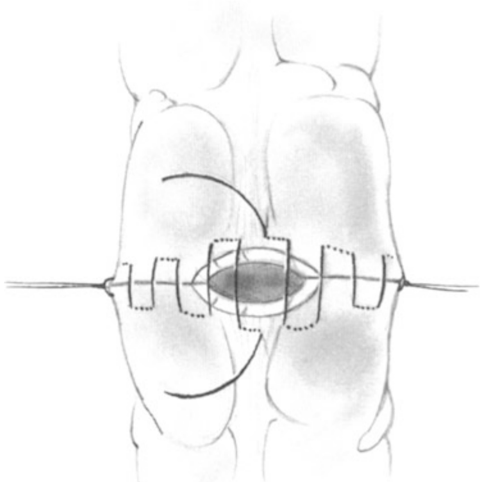


Fig. 37–23

margin of the bowel. Here, pass the needle through the rectum from inside out (**Fig. 37–21**).

Standing on the left side of the patient, use the needle on the right lateral aspect of the anastomosis to initiate the anterior mucosal layer. Insert continuous sutures of either the Cushing or Connell type to a point just beyond the middle of the anterior layer. Then grasp the needle emerging from the left lateral margin of the incision and insert a similar continuous Connell or Cushing stitch. Complete the anterior mucosal layer by tying the suture to its mate and cutting the tails of these sutures (**Figs. 37–22 and 37–23**).

Complete the anterior seromuscular layer by inserting interrupted 4–0 silk atraumatic Lembert sutures (**Fig. 37–24**).

Now carefully rotate the anastomosis to inspect the integrity of the posterior layer. Test the diameter of the lumen before closing the mesentery by invaginating the colon through the lumen gently with the thumb and forefinger. Then close the mesentery

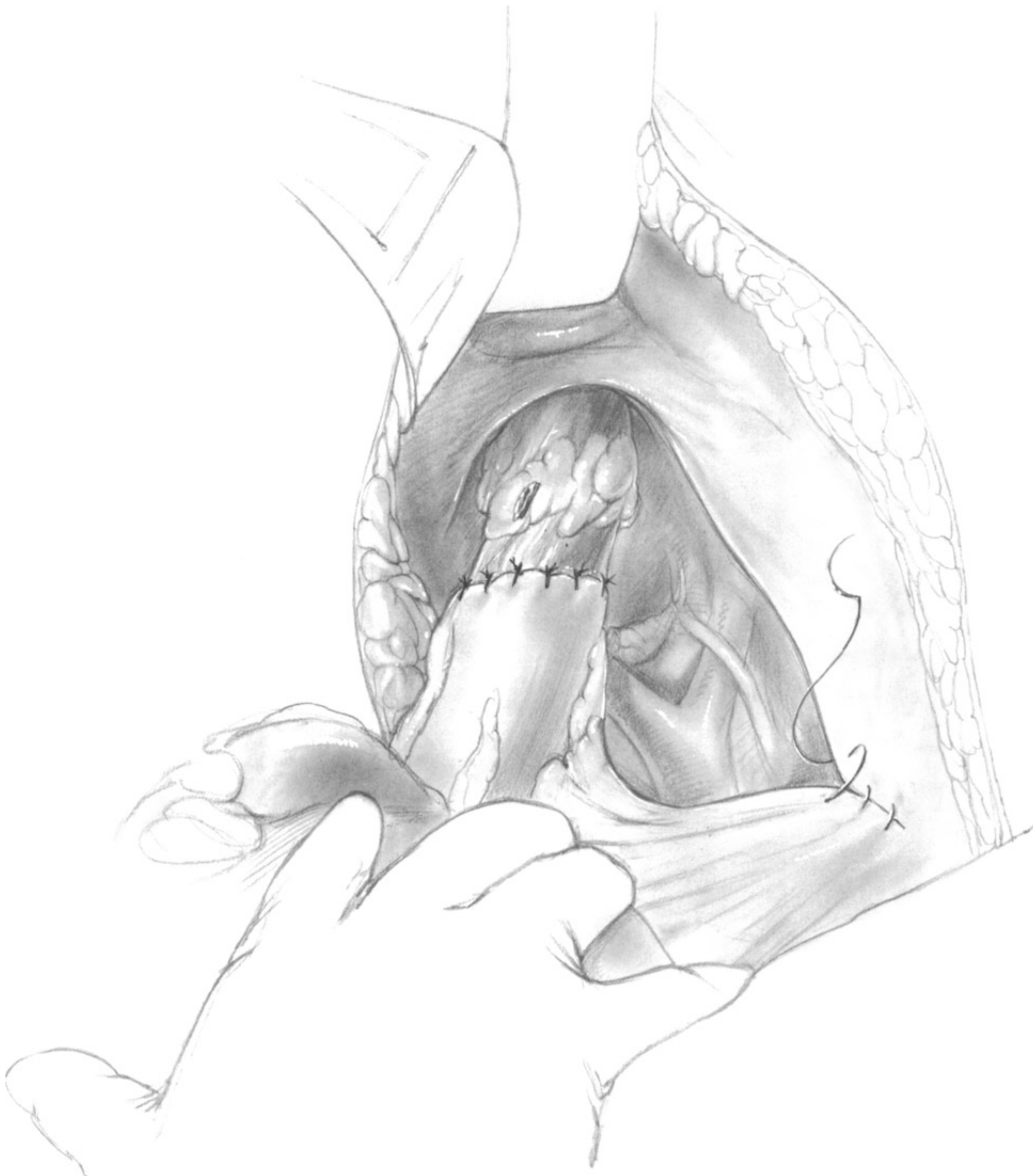


Fig. 37–25

with a continuous 2–0 PG suture (**Fig. 37–25**). Leave the peritoneal defect in the left paracolic gutter unsutured.

Stapled Colorectal Anastomosis, Technique of Weakley

In the Weakley technique of stapled colorectal anastomosis, step 1 of the rotation method is modified in that the proximal descending colon is stapled closed by the TA–55 stapling device (**Fig. 37–26**).

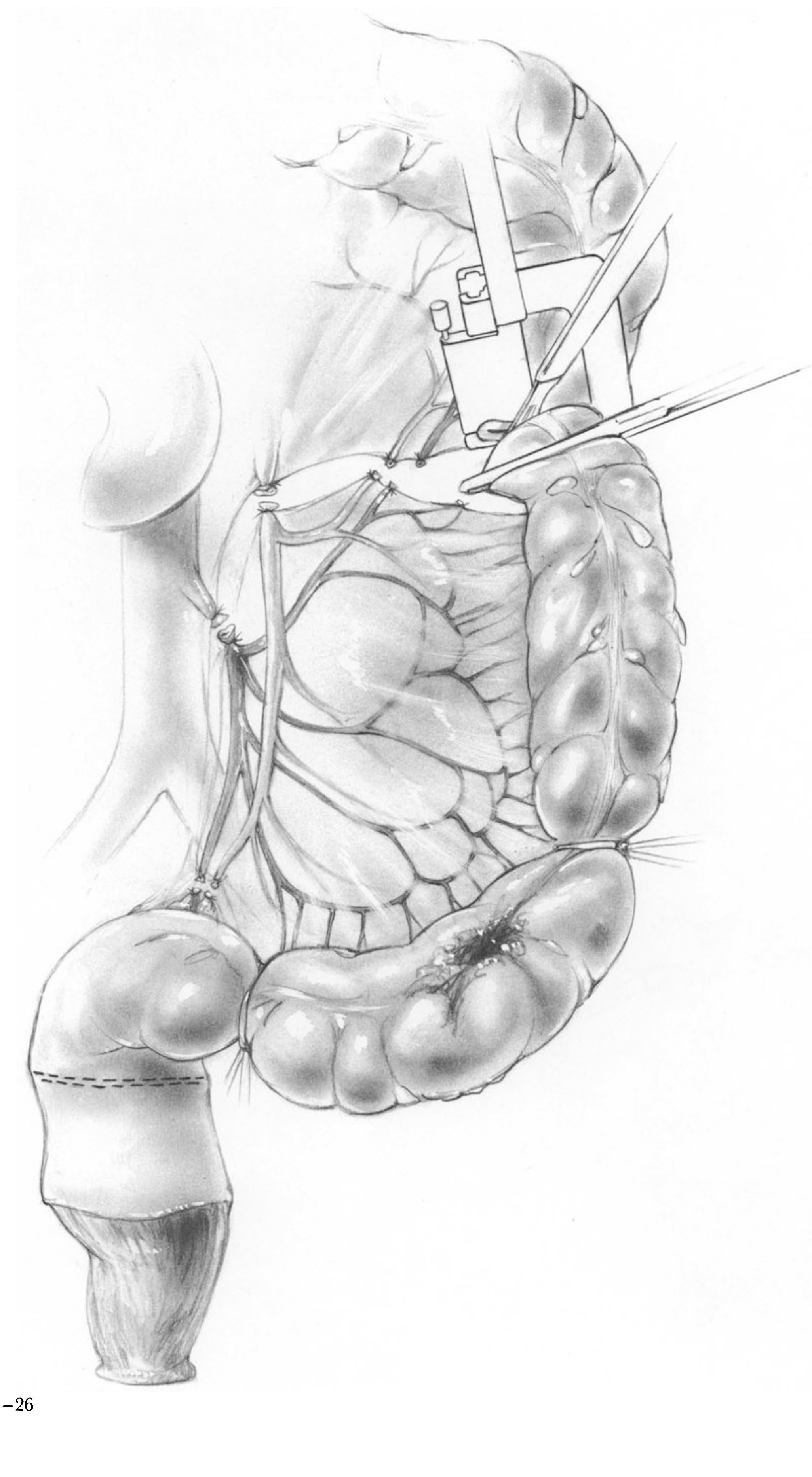


Fig. 37–26

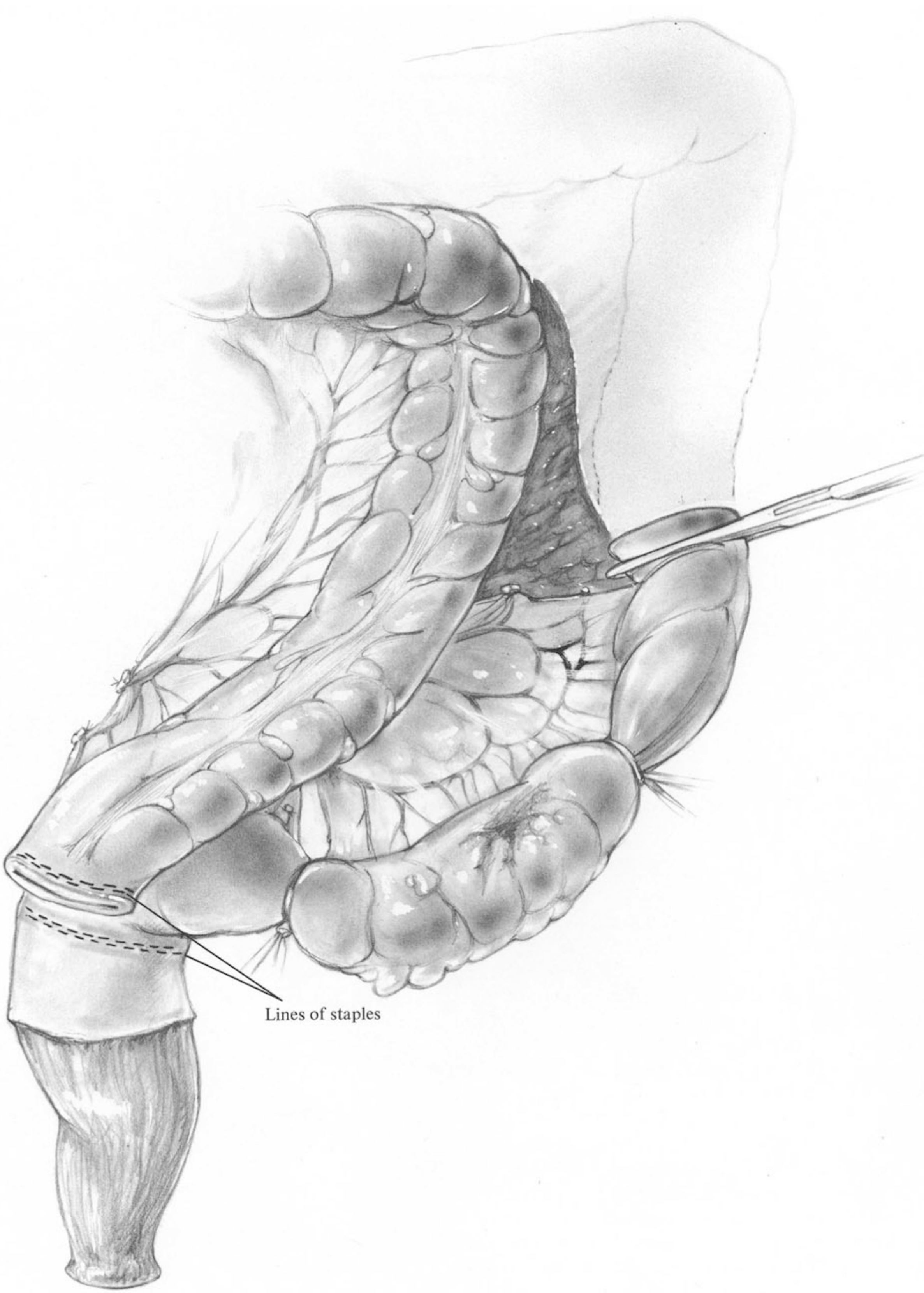


Fig. 37–27

Fig. 37–28

Fig. 37–29

To carry out this procedure, apply an Allen clamp to the specimen side and divide the colon flush with the stapler. Remove the stapler (**Fig. 37–27**). Replace the Allen clamp with an umbilical tape ligature covered with a sterile rubber glove (**Figs. 37–28 and 37–29**). Then direct attention to the rectum, a segment of which previously has been cleared of surrounding fat and vascular tissue. Use the TA–55 device, generally with 3.5-mm staples (Fig. 37–26), to apply a layer of staples to this segment of rectum. Do not remove the specimen; retain it so that mild upward traction on it can stabilize the rectum during the application of the stapling device (Fig. 37–27).

Make a stab wound on the antimesenteric border of the proximal colon at a point 5–6 cm proximal to the staple line. Either a scalpel blade or electrocautery may be used to make this incision. Make a second stab wound in the anterior wall of the rectal stump at a point 1 cm distal to the staple line already in place (**Fig. 37–30**). Approximate the two stab

Fig. 37–30

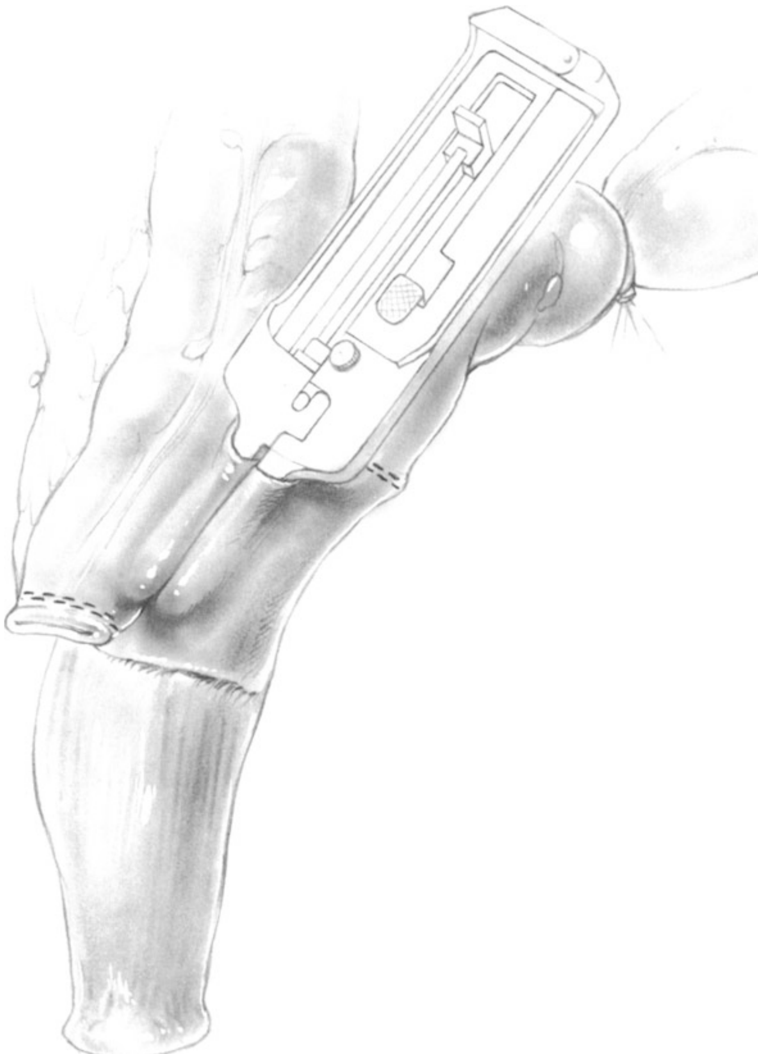


Fig. 37–31

wounds opposite each other, placing the proximal colonic segment anterior to the rectal stump. Insert the GIA device, one fork into the rectal stump and the other into the proximal colonic segment (**Fig. 37–31**). Allis clamps or guy sutures may be used to approximate the rectum and colon in the crotch of the GIA device. Fire and remove the GIA stapler; then carefully inspect the staple line for any defects or bleeding. Close the remaining defect with a continuous inverting 4–0 PG atraumatic suture to the mucosa. Reinforce this closure with a layer of interrupted 4–0 silk atraumatic seromuscular Lembert sutures (**Fig. 37–32**). Carefully inspect all the staple lines to ascertain that the staples have closed properly into the shape of a B. Bleeding points may require careful electrocoagulation or fine suture-ligatures. The rectosigmoid is transected just above the rectal staple line (Fig. 37–32) with the removal of the specimen.

Stapled Colocolonic Functional End-to-End Anastomosis, Chassin's Method

When the lumen of one segment of bowel to be anastomosed is *much* smaller than the other, as in many ileocolonic anasatomoses, the stapling technique illustrated in Figs. 36–18 and 36–20 is the simplest method. When a stapled anastomosis is constructed distal to the sacral promontory, the EEA technique (see Chap. 39) is much preferred. However, for all other intraperitoneal anastomoses of small and large bowel, we have developed a modification of the end-to-end anastomosis. This modification, described in the following steps, avoids the possibility that six rows of staples may be superimposed, one upon the other, as may happen in the Steichen method:

1) Align the two open ends of bowel to be anastomosed side by side, with the antimesenteric borders of each in contact.
2) Insert the GIA instrument, placing one fork in each lumen (**Fig. 37–33**). Draw the mesenteric borders of the bowel in the direction opposite to the location of the GIA device. Avoid bunching too much tissue in the crotch of the GIA. Lock and fire the instrument.
3) After unlocking the GIA instrument, withdraw the GIA from the bowel. Apply an Allis clamp to one extremity of the GIA staple line (point *A* in Fig. 37–34). Apply a second Allis clamp to the opposite end of the GIA staple line (point *B* in Fig. 37–34). These two Allis clamps should then be drawn apart as shown in **Fig. 37–34**.
4) Apply additional Allis clamps to close the remaining defect in the anastomosis by approximating mucosa to mucosa, as in **Fig. 37–35**.
5) Close the remaining defect in an everting fashion by either a single application of the TA-90 device or by two applications of the TA-55. Fig. 37–35 illustrates the complete closure of the defect with one application of the TA-90 just deep to the Allis clamps. Be sure that the TA-90 staple line includes both point *A* and point *B*, which mark respectively the near and far terminations of the GIA staple line. Unless the GIA and the TA-90 staple lines overlap, there exists the possibility of a gap in the stapled closure.

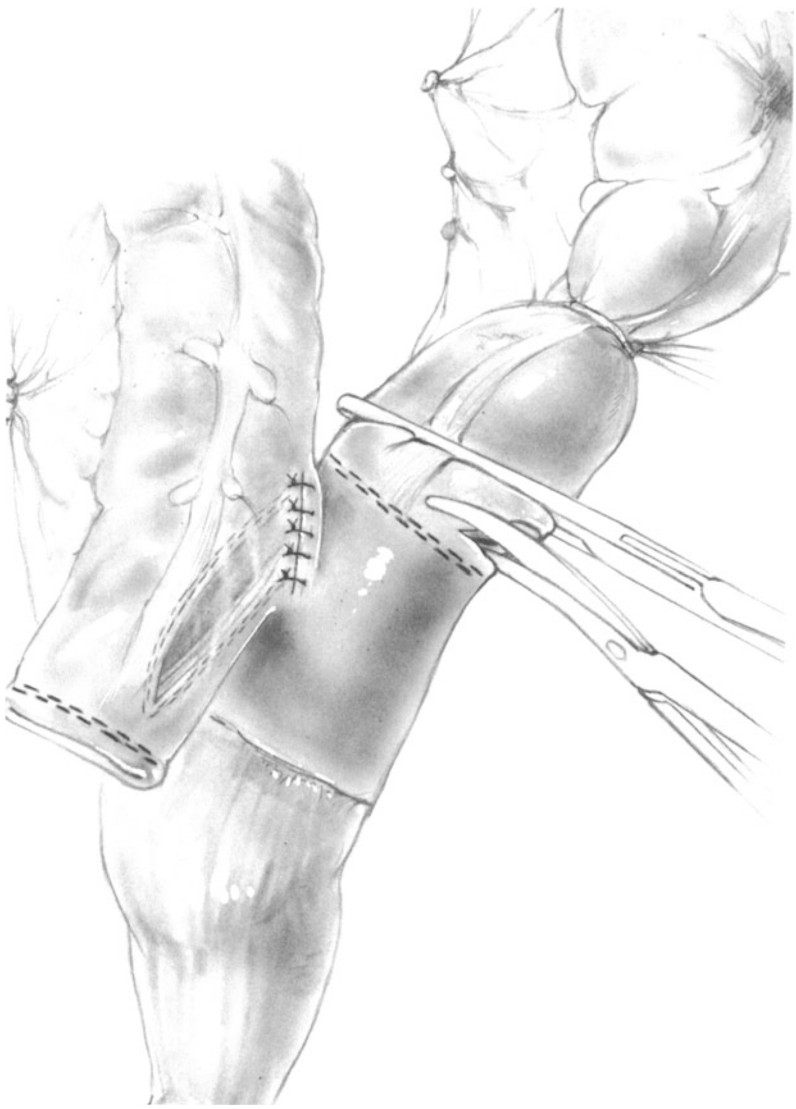


Fig. 37–32

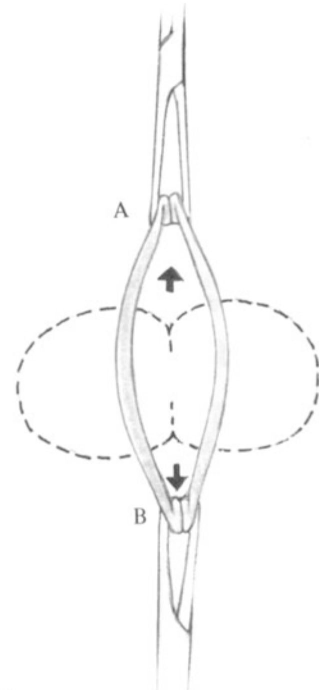


Fig. 37–34

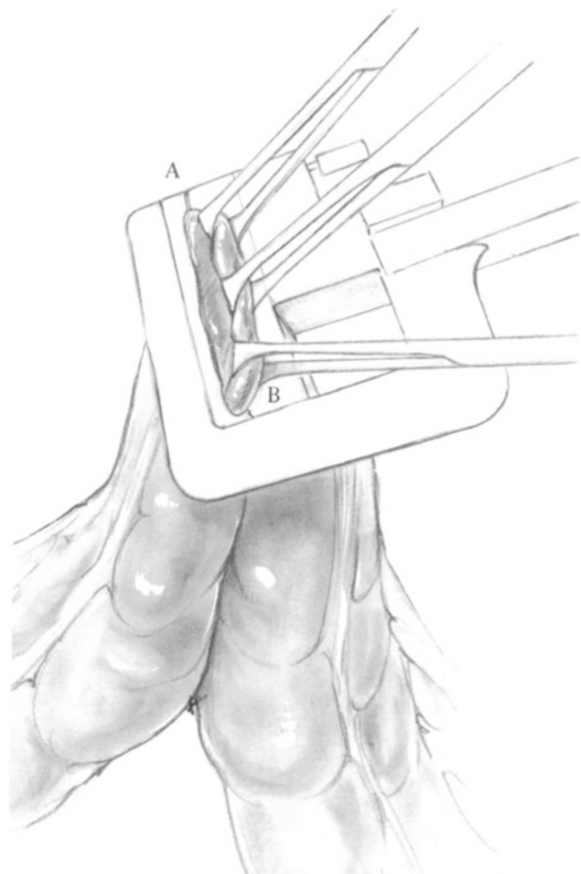


Fig. 37–35

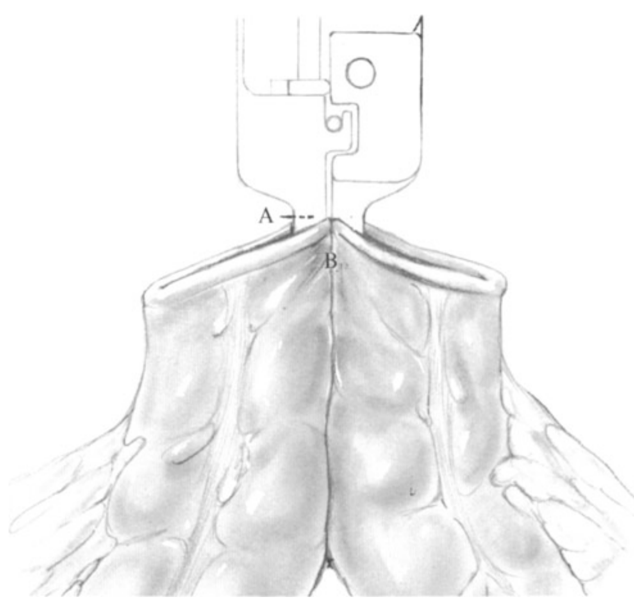


Fig. 37–33

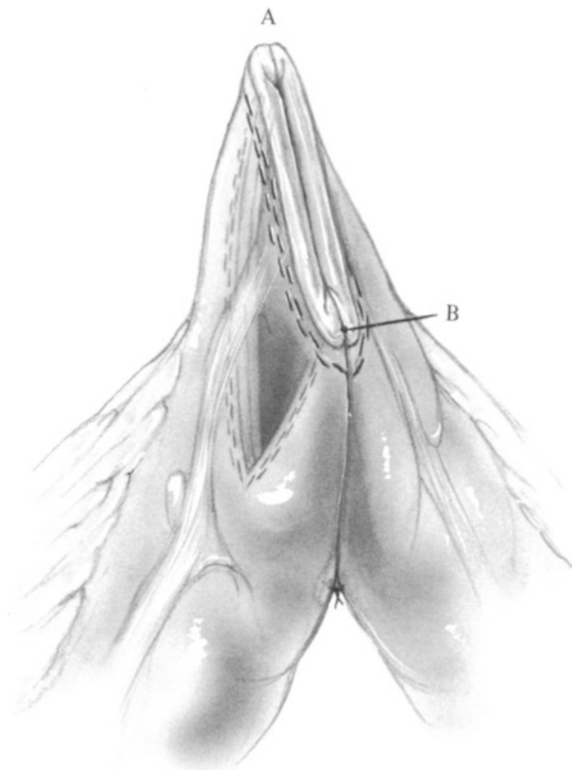


Fig. 37–36

6) After the TA–90 device has been placed in the proper position, fire the device. Excise the redundant bowel with a Mayo scissors and lightly electrocoagulate the everted mucosa. Remove the TA–90 (**Fig. 37–36**) and carefully inspect the entire anastomosis for the proper B formation of staples.

Finally, insert a single 4–0 atraumatic silk seromuscular Lembert suture at the base of the GIA staple line (Fig. 37–36). This prevents any undue distracting force from being exerted on the stapled anastomosis.

Antibiotic Irrigation

After the surgical team removes the Wound Protector drape and discards all surgical gloves and instruments, the abdominal cavity and the subcutaneous panniculus should be irrigated with an antibiotic solution.

Wound Closure

Most surgeons prefer to close the defect in the mesocolon (Fig. 37–25). A continuous suture of 2–0 PG is suitable for this purpose. However, the defect is usually so large that omitting this step does not seem to lead to internal bowel herniation. Close the abdominal incision in routine fashion without placing any drains into the peritoneal cavity.

Postoperative Care

(See Chap. 36.)

Complications

(See Chap. 36.)

38 Operations for Rectal Cancer

Concept: Selection of Operation for Cancer 0–6 cm from Anal Verge

Method of Measuring Length from Anal Verge

Measurements of the location of malignancies in the rectum are generally made by placing the patient in the knee-chest position, inserting a proctosigmoidoscope, and reading off the number of centimeters indicated by the markers on the outside of the scope at the point where the perianal skin meets the scope. This measures the distance between the anal verge and the lower border of the tumor where the tip of the proctoscope has been inserted. Remember that when a measurement is cited taking the anal verge as the point of reference, it does not refer to the rectum alone but includes the length of the anal canal in the calculation. The rectal mucosa meets the squamous epithelium of the anal skin at the "dentate line." This line is 2–3 cm above the anal verge and about 1 cm below the upper border of the sphincter muscles of the anal canal. The length of the anal canal is about 4 cm. All the measurements cited below are made from the reference point of the anal verge.

Electrocoagulation

To treat a malignancy in the distal rectum (0–6 cm), the surgeon's choice lies between performing an abdominoperineal proctectomy and some local procedure such as electrocoagulation or excision. Coagulation is effective and has been followed by minimal mortality when applied to lesions that are anatomically suited to this technique. Unfortunately, even in cases when fulguration may eliminate the primary carcinoma, there is no way of ascertaining that the lymph nodes are free of metastases. For this reason, a large body of follow-up data will have to be accumulated before fulguration can be recommended as the treatment of choice for patients in whom abdominal surgery is not contraindicated by severe systemic illness. If on digital rectal examination, metastatic lymph nodes can be palpated in the presacral space, fulguration for cure is contraindicated. When one excludes operations for palliation, abdominoperineal proctectomy is the operation of choice for tumors at the 0–6 cm level.

If electrocoagulation is to be used to manage rectal cancer, the ideal lesion for treatment would be a non-fixed non-ulcerated tumor of small size (3–5 cm diameter) with a well-differentiated cell type, located preferably on the posterior wall of the lower rectum. For the rare patient whose medical condition contraindicates major surgery, and for those who already have an identifiable distant metastasis, electrocoagulation may be used to treat tumors that are less than ideal in size and location. This modality should never be applied to malignancies that are circumferential in location, as this will result in complete stenosis during the healing process. Nor should it be used in tumors above the 9–10 cm level especially on the anterior aspect of the rectum.

Local Excision

Those small rectal cancers that are suitable for electrocoagulation can also be managed by local excision via a per-anal approach, as described by Parks and Thompson. A circular incision, including at least a 1-cm margin of normal tissue, is made with the electrocautery knife. In the posterior rectum, do not hesitate to take the full thickness of rectum. Then pin the specimen to a cardboard. This will allow the pathologist to orient the specimen and to determine if the tumor excision was a complete excision. In case of a small tumor, the defect in the rectum can be sutured closed with absorbable suture material. On the posterior wall of the lower rectum, the defect may safely be left unsutured.

Radiotherapy for Cure

Another effective modality for the local control of rectal lesions no larger than 3 cm wide is Papillon's technique of intensive intraluminal irradiation of non-fixed, well-differentiated adenocarcinomas of the rectum. This therapy is administered through a proctoscope. Preliminary studies show good results in selected cases.

Preoperative Adjuvant Radiotherapy

Although considerable data have been accumulated, it is not yet clear whether preoperative radiation therapy improves the prognosis of patients suffering from rectal cancer. Dosages of 2000–5000 rads have been given before surgery is undertaken, and some tumors do shrink following therapy. For lesions that on preoperative physical examination appear to be fixed to the presacral space posteriorly or to the prostate anteriorly, preoperative radiation may occasionally result in sufficient shrinkage to convert what would be an inoperable lesion into a resectable one. This course should be followed for patients who have such lesions (Marks et al.). For patients with Duke's B2 and C lesions, postoperative radiotherapy reduces the incidence of local recurrence.

Abdominoperineal Proctectomy

With rare exceptions, abdominoperineal proctectomy is the operation of choice for cancer of the lower third of the rectum, 0–6 cm above the anal verge. Using proper technique the mortality rate should be no more than 1%–2% following operations done for cure.

Concept: Selection of Operation for Carcinoma 6–11 cm from Anal Verge

Requirements for Maintaining Normal Fecal Continence

Using the coloanal or the EEA stapler operation, it is often technically possible to resect lesions of the lowermost rectum and to perform an anastomosis at the mucocutaneous junction of the anus. However, normal fecal continence seems to require 1–2 cm of residual rectal wall above the dentate line, as well as normally functioning internal sphincter and puborectalis muscles. Following "pull-through" operations of the Bacon or Cutait-Turnbull type, the patient may lose the proprioceptive sensation that warns of an impending movement of stool or flatus. A normal individual, if a toilet is not immediately at hand, can occlude the anus by tensing the voluntary external sphincter muscle. This voluntary constriction can last for 40 to 60 seconds, until fatigue sets in. But usually, before that time elapses, the crest of the peristaltic wave ebbs and the rectum undergoes a period of relaxation before the next peristaltic contraction. True fecal continence thus requires the presence of a sense of proprioception as well as the ability to contract the external sphincter. After a pull-through operation, however, sometimes the patient's first hint that the colon is about to evacuate stool comes when liquid stool or flatus touches the perianal skin. It is only at this point that the patient is aware of the need to constrict the voluntary sphincter. As a consequence, control of liquid stool or flatus is often defective. Defective control will also follow complete excision of the internal sphincter, which has the function of keeping the rectum closed except when peristalsis propels a bolus of stool. Creating an ileoanal pouch after rectal mucosectomy will preserve fecal continence (see Chap. 42).

Carcinomas above the 6-cm level are often amenable to low anterior resection accompanied by satisfactory fecal continence. But it should be noted that for many months following resection, patients who undergo this procedure do not possess a real rectal reservoir function. In the normal rectum, peristaltic contraction in the process of evacuation is accompanied by a *reflex relaxation in the tone of the internal sphincter* and puborectalis muscles. Following resection of the rectal wall in the region 3–6 cm above the anal verge, this reflex relaxation fails, according to Bennett et al. After the operation, patients complain of incomplete evacuation and of having many small formed stools during the course of the day. In some cases severe constipation ensues. However, within 6 months to a year following surgery almost all these patients develop quite satisfactory function in evacuating the rectum and in control of flatus or liquid stool. Since postoperative survival following resection of a carcinoma of the midrectum is no worse than that following total proctectomy, resection and anastomosis is the preferable alternative if these are feasible technically. A margin is needed of 2–3 cm of rectum distal to the tumor and an additional 1–2 cm of residual rectal wall above the dentate line to assure proprioception and fecal continence.

Anterior Resection

Skilled and experienced surgeons can accomplish anterior resection with anastomosis for cancer as low as 6 cm from the anal verge in women and 8 cm in some men. This technique requires complete dissection of the rectum down to the levator diaphragm and to the distal margin of the prostate anteriorly in males. Anastomosis is contraindicated for patients who have a narrow pelvis or are obese. It is also contraindicated in any case in which the exposure is inadequate to insert sutures with accuracy. Under these conditions, the surgeon must turn to an alternative method. A stapled anastomosis using the EEA device can often be accomplished at a level 2–3 cm lower than can be achieved by suturing from the anterior approach. If this alternative is not suitable a coloanal anastomosis may be performed.

It should be recognized that the postoperative five-year survival of patients who are operated on for lesions above the 6-cm level appears to be the same whether abdominoperineal proctectomy is performed or resection and anastomosis is accomplished. Malignancies located 0–6 cm from the anus may have lymphatic extension in both cephalad and caudal directions. Above the 6-cm level, extension is exclusively cephalad unless the proximal lymph channels are already blocked with cancer.

Akwari and Kelly found that, 2 years after the resection and anastomosis of tumors at the 6–10 cm level, the results were just as good as those following the same operation for cancers at the 10–20 cm and over 20-cm levels.

Low Colorectal Anastomosis Using EEA Stapling Technique

The Auto Suture CEEA and EEA stapling devices enable the surgeon to construct an end-to-end anastomosis at a level much lower than is practicable by hand suturing. This device permits a safe anastomosis after resection of tumors situated as low as 6 cm from the anal verge. However, there are many pitfalls of a technical nature in the EEA method, and the technique must be mastered before consistent success can be achieved.

The CEEA technique is admirably suited to low colorectal anastomosis—those at or below the peritoneal reflection, where suturing may be difficult.

Total Proctectomy With Colonal Anastomosis

Cohen, Enker, and Minsky reported resection of rectal carcinoma situated 3–7 cm above the anal verge, performing a mucosal proctectomy, and then anastomosing the colon to the anus at the dentate line with satisfactory functional results. The technique is similar to that used to accomplish the anastomosis of an ileal pouch to the anus after total coloproctectomy for inflammatory bowel disease as described in Chap. 42. While this method requires further study, it appears to be a method of achieving a very low anastomosis when the rectal remnant is too low for the CEEA stapling technique.

Low Colorectal Anatomosis Using Combined Abdominal and Sacral Approaches

Localio et al. have reported excellent results after resecting lesions in the 6–11 cm range by mobilizing the rectum through the abdominal approach and then performing the colorectal anastomosis through a posterior incision with coccygectomy. However, this is a complex operation, not suitable for the occasional operator. The same low resection and anastomosis can be accomplished with greater efficiency by proper use of the EEA stapling technique, although Marks and associates are using this operation together with preoperative radiation for lower-third rectal cancer.

References

Akwari OE, Kelly K. Anterior resection for adenocarcinoma of the distal large bowel. Am J Surg 1980;139:88.

Bennett RC et al. The physiologic status of the anorectum after pull-through operations. Surg Gynecol Obstet 1973;136:907.

Cohen AM, Enker WE, Minsky BD. Proctectomy and coloanal reconstruction for rectal cancer. Dis Colon Rectum 1990;33:40–43.

Localio SA et al. Abdominosacral resection for carcinoma of the midrectum: ten years' experience. Ann Surg 1978;188:475.

Marks G, Mohiuddin M, Eitan A et al. High-dose preoperative radiation and radical sphincter-preserving surgery for rectal cancer. Arch Surg 1991;126:1534–1540.

Parks AG, Thomson JPS. Per-anal endorectal operative techniques. In: Rob C, Smith R, eds. Operative surgery, colon, rectum and anus. 3rd ed. London: Butterworth; 157.

39 Low Anterior Resection for Rectal Cancer

Indications

Low anterior resections are performed to treat malignant tumors of the middle and upper thirds of the rectum, 6–14 cm from the anal verge.

Preoperative Preparation

(See Chap. 34.)

Pitfalls and Danger Points

Anastomotic failure
Presacral hemorrhage
Trauma to rectal stump during presacral dissection
Ureteral damage

Operative Strategy

Prevention of Anastomotic Complications

When a high anterior resection is performed in conjunction with an intraperitoneal colorectal anastomosis, the incidence of postoperative complications of the anastomosis is minimal. On the other hand, a low anterior resection with a colorectal anastomosis below the peritoneal reflection reportedly is followed by *clinical* leakage rates of 10.4% (Schrock et al.) and 27% (Goligher et al.). When Goligher et al. tested the low anastomosis radiographically by performing a Hypaque enema on the 14th postoperative day, they found a leakage rate of 69%.

The numerous factors that contribute to anastomotic failure are discussed in Chap. 34. For several reasons, the low colorectal anastomosis offers additional difficulty.

1) *Anatomical exposure is often difficult.* This is especially true of males whose pelvis is narrow and of obese patients. Consequently, it is easy to make small tears in the rectum when inserting sutures, especially as the difficulty in exposure often requires the surgeon's hand to be held at an awkward angle.
2) Due to the lack of serosal cover over the retroperitoneal rectum, *it is very easy to mistake mucosa for the muscular layer.* If sutures or staples are erroneously inserted into the mucosal instead of the submucosal and muscular layers, the anastomosis will leak because the mucosa itself possesses little tensile strength. Identify the longitudinal muscle covering the rectum and be sure to incorporate this layer in the suture line!
3) The *diameter of the rectal ampulla frequently measures in excess of 5–6 cm,* while the lumen of the proximal colon, after proper bowel preparation, is often half this size. The anastomotic technique used must be capable of correcting this disparity.
4) When the surgeon has not achieved perfect hemostasis in the pelvis, the *presacral space frequently becomes the site of a postoperative hematoma* that becomes infected and develops into an abscess. This abscess may erode through the colorectal suture line.
5) If the pelvic peritoneal floor is closed above the colorectal anastomosis, dead space may surround the anastomosis. This is especially conducive to leakage in the anastomosis. The peritoneal pelvic floor is not resutured after the colorectal anastomosis is completed.
6) It is important not to leave any empty space in the hollow of the sacrum behind a low anastomosis. For most low anterior resections, we will free the attachments of the splenic flexure (Figs. 37–2 to 37–6) so that the descending colon will have sufficient redundancy that relaxed colon will fill the sacral space behind the anastomosis. If this step cannot be accomplished, the empty space in the pelvis should be filled by lengthening the omentum sufficiently so that it can be delivered to the presacral space.
7) We have virtually eliminated leakage by adopting the side-to-end colorectal technique of anastomosis advocated by Baker, and by Zollinger and Sheppard. This permits the anastomosis to be exactly equal in diameter to the lumen of the commodious rectal ampulla. Healthy-sized bites of tissue may be enclosed in the sutures without any danger that postoperative stenosis will result. In effect, at the conclusion of the anastomosis, *the rectal ampulla has been invaginated into*

the side of the proximal colon (see Fig. 39–21). Placing the anastomosis within 1 cm of the closed end of proximal colon eliminates the danger the patient will develop a blind-loop syndrome.

8) Following a low anastomosis we routinely insert into the presacral space a multiperforated plastic tube for closed-suction drainage. The Jackson-Pratt Silastic tube is brought out through a puncture wound in the left lower quadrant and is attached to a sterile, closed plastic container for continuous suction. To help prevent an infected hematoma from developing in the pelvis, 50 mg of kanamycin in 50 ml of sterile saline is injected through the suction catheter every 8 hours for 5 days.
9) While the use of staples for low colorectal anastomoses has been demonstrated to be safe by numerous studies, it is important to observe all of the precautions described below to assure uneventful healing when using this technology (also see Chap. 34).

Which Colorectal Anastomosis: Sutured, EEA Stapled, or CEEA Double Stapled?

Sutured colorectal anastomoses, described below, have been demonstrated to be safe when performed with delicacy of technique by a skilled surgeon on well dissected healthy tissues. Lesions at 9–10 cm can generally be removed and a sutured colorectal anastomosis performed. However, when the surgeon resects lesions lower than 10 cm from the anal verge, suturing the colorectal anastomosis can be quite difficult. Insertion of the EEA stapler into the rectum will allow the construction of a safe colorectal stapled anastomosis with greater ease for the surgeon than is true of the sutured anastomosis.

If the cancer resection has left a rectal stump that is situated so low in the pelvis that even insertion of the purse-string suture will be difficult (lesions at the 6–8 cm level), then use the Roticulator 55 stapler (U.S. Surgical Corp.) to close the proximal edge of the rectal stump rather than a purse-string suture. Passing a CEEA stapler into the rectum will permit you to construct a circular colorectal anastomosis through the Roticulator 55 staple line that now serves to close the proximal edge of the rectal stump. The CEEA-Roticulator method is especially suitable for the lowest colorectal anastomoses.

Extent of Lymphovascular Dissection

Goligher (1975) advocated the routine ligation of the inferior mesenteric artery at the aorta not only for lesions of the descending colon but for rectal cancer also. When this is done, the entire blood supply of the proximal colon must come through the marginal artery all the way from the middle colic artery. Although this proves adequate in the majority of patients, there is a danger that the surgeon may not recognize those patients whose blood supply is not quite sufficient. We believe the risk of this occurring is greater than the benefits that may accrue to the patient by routinely amputating the extra 3 cm of inferior mesenteric artery. It is important that the blood supply to the proximal colon undergoing anastomosis not only be adequate but be optimal before this segment is used in a low colorectal anastomosis. Consequently, in the usual case of rectal cancer we transect the inferior mesenteric artery just distal to the origin of the left colic vessel (see Fig. 35–6). Even if only the ascending branch of the left colic is preserved, there usually is vigorous arterial pulsation in the mesentery of the descending colon. For obese patients, transillumination of the mesentery is helpful in identifying the junction between the inferior mesenteric and left colic arteries.

If the inferior mesenteric artery is ligated proximal to the take-off of the left colic artery, be sure always to liberate the splenic flexure and resect the majority of the descending colon unless it can be proven that the circulation through the marginal artery at a lower level is vigorous. This can be accomplished only by demonstrating pulsatile flow from a cut arterial branch at the proposed site of the transection of the colon. *Poor blood flow leads to poor healing.*

In the usual rectal cancer case the sigmoid colon is removed and the descending colon is used for anastomosis. This generally requires the liberation of the splenic flexure, which can be accomplished in a few minutes once the surgeon has mastered the technique.

Goligher et al. (1970) found that 51% of the patients in their series of 73 anterior resections (both high and low) experienced postoperative leakage, as determined by radiological examination. In 62 consecutive sutured colorectal anastomoses following anterior resection done under our supervision in accordance with the principles outlined in this chapter, only two leaks were detected radiographically when routine Hypaque enema X rays were done in each case on the tenth postoperative day.

Indications for Complementary Colostomy

When there is difficulty in constructing a low colorectal anastomosis and it is likely the surgeon has created a less-than-perfect anastomosis, a complementary right transverse colostomy should be constructed. If this is immediately matured by suturing the mucosa to the subcuticular layer of the skin, it is possible to close the colostomy about 2 weeks after the tumor has been resected if a barium colon enema shows a normal anastomosis. Thus, closure of the colostomy can be accomplished during the same hospital admission as the anterior resection.

Presacral Dissection: Prevention of Hemorrhage

Contrary to what apparently is a widely held perception, radical cancer surgery does *not* require stripping the tissues off the sacrum down to the periosteum. The dissection of the perirectal tissues proximal to the carcinoma is necessary for the removal of *tumor emboli* within the lymph nodes and lymphatic channels. If tumor has invaded widely into the mesorectum and presacral tissues, the lesion is generally beyond cure by radical surgery.

There is a network of veins lying on the presacral periosteum that drain into the sacral foramina (see Fig. 39–6b). When these are torn by blunt dissection, clamping or ligation to control the hemorrhage that results often is impossible, since the torn vessel retracts into the foramen. The massive venous hemorrhage that will follow may not be stemmed by ligating the hypogastric arteries. Most intraoperative fatalities during total proctectomy are caused by this type of presacral venous hemorrhage.

Nivatvongs and Fang described a new method of controlling massive hemorrhage from a torn presacral branch of the basivertebral vein. Because the blood pours out of one of the sacral foramina, they proposed occluding the foramen with a titanium thumbtack (Hemorrhage Occluder Pin, Surgin Co., Placentia, CA 92670) that is left permanently in place. To accomplish this step effectively, first demonstrate that the blood is emerging from a single foramen. If the bleeding is controlled by applying the fingertip to one foramen, then applying the thumbtack will be effective. In some cases stuffing some cottonoid Oxycel (oxidized cellulose) into the foramen before inserting the thumbtack may be helpful.

If the surgeon cannot *very quickly* control lacerated presacral veins with a stitch, a thumbtack, or bone wax, the bleeding area should be covered with a sheet of Surgicel over which a large gauze pack should be placed, filling the sacral hollow. This almost always controls the hemorrhage.

Unless the presacral vessels are directly invaded by a bulky tumor of the midrectum, massive presacral venous hemorrhage is entirely preventable. Blunt hand dissection of the presacral space is not a desirable technique. The surgeon's hand does not belong in this area until scissors or electrocautery dissection under direct vision has freed all the perirectal tissues from any posterior attachments to the sacrum. This should be done with a long Metzenbaum scissors, combined with gentle upward traction on the rectum. As the scissors are inserted on each side of the midline, the perirectal tissues can easily be lifted in an anterior direction *without removing the thin layer of endopelvic fascia that covers the presacral veins.* When the presacral dissection stays in the proper plane, the presacral veins are hidden from view by this layer of fascia, as Fig. 39–6a shows. Occasionally, branches of the middle sacral vessels enter the perirectal tissues from behind. These may be divided by electrocoagulation.

This dissection is easily continued down to the area of the coccyx, where the fascia of Waldeyer becomes somewhat dense as it goes from the anterior surfaces of the coccyx and sacrum to attach to the lower rectum (see Fig. 39–8). Attempts to penetrate this fascia by blunt finger dissection may rupture the rectum rather than the fascia, which is strong. This layer must be incised sharply with a scissors or scalpel, after which one can see the levator diaphragm. When the posterior dissection has for the most part been completed, only *then* should the surgeon's hand enter the presacral space to sweep the dissection toward the lateral pelvic walls. This maneuver helps define the lateral ligaments. The dissection should be bloodless.

Other points of hemorrhage in the pelvic dissection may occur on the lateral walls. These can usually be readily identified and occluded by ligature. Close attention should also be paid to the left iliac vein, which may be injured in the course of the dissection. As most serious bleeding in pelvic dissections is of venous origin, ligation of the hypogastric arteries is rarely indicated.

Presacral Dissection: Preservation of Hypogastric Nerves

As the rectum is elevated from the presacral space and the anterior surface of the aorta cleared of areolar and lymphovascular tissue, a varying number of preaortic sympathetic nerves of the superior hypogastric plexus can be identified. These are the contribution of the sympathetic nervous system to the bilateral inferior hypogastric (pelvic) plexuses. In males their preservation is necessary for normal ejaculation. After they cross the region of the aortic bifurcation and sacral promontory, they coalesce into two major nerve bundles, called the hypogastric nerves. Each nerve, which may have 1–3 strands, runs toward the posterolateral wall of the pelvis in the vicinity of the hypogastric artery (see Figs. 39–2 and 39–4). We agree with Goligher (1975) that in most malignancies of the distal rectum, these nerves can be preserved without compromising the patient's chances of cure.

After the inferior mesenteric artery and vein are divided and the lymphovascular tissues elevated from the bifurcation of the aorta by blunt dissection, the sympathetic nerves remain closely attached to the aorta and need not be damaged if the dissection is gently performed. At the promontory of the sacrum, if the rectum is dissected as described above, the right and left hypogastric nerves can be seen posterior to the plane of dissection and can be preserved—provided there is a sufficient distance separating them from the tumor. There also seems to be a diminution in the incidence of bladder dysfunction after nerve preservation.

Ureteral Dissection

To prevent damage to the ureters, these delicate structures must be identified and traced well down into the pelvis. The normal ureter crosses the common iliac artery at the point this structure bifurcates into its external and internal branches. Because the ureter and a leaf of incised peritoneum are often displaced during the course of dissection, if the ureter is not located in its usual position the undersurfaces of both the lateral and medial leaves of peritoneum should be inspected. The identity of the ureter can be confirmed if pinching or touching the structure with a forceps results in typical peristaltic waves. If doubt exists, the anesthesiologist may be instructed to inject indigo carmine dye intravenously; this stains the ureter blue, unless the patient is oliguric at the time of injection. The ureter should be traced into the pelvis beyond the point at which the lateral ligaments of the rectum are divided.

Operative Technique

Incision and Position

Patients who have lesions within 14 cm of the anal verge should be placed in the same modified lithotomy position, utilizing Lloyd-Davies or Allen leg rests, as is described in Chap. 40 for the abdominal-perineal proctectomy (**Figs. 39–1a and 39–1b**). The second assistant should stand between the patient's abducted thighs for the pelvic portion of the operation while the surgeon works from the patient's left. Using this position, the surgeon may judge, after the tumor is mobilized, whether the patient is suitable for an anterior anastomosis, abdominal-perineal proctectomy, or end-to-end anastomosis with the EEA stapling device. All these techniques are best done with the patient in this position.

For the anterior resection, a midline incision is preferable, extending from a point about 6 cm below the xiphoid process down to the pubis.

Exploration and Evisceration of Small Bowel

Palpate and inspect the liver. A moderate amount of metastasis is not a contraindication to a conservative version of the anterior resection. Explore the remainder of the abdomen and then eviscerate the small bowel into a Vi-Drape plastic intestinal bag or moist gauze pads.

Mobilization of Sigmoid

Expose the left lateral peritoneal gutter. Occlude the lumen of the colon by ligating the distal sigmoid with umbilical tape. By drawing the sigmoid colon medially, several congenital attachments between the mesocolon and the posterolateral parietal peri-

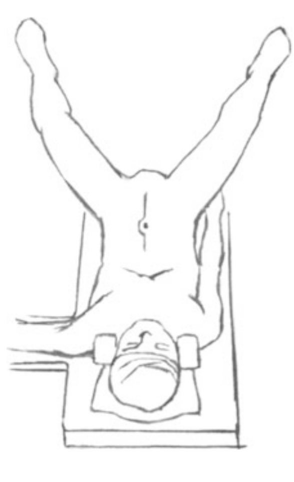


Fig. 39–1a

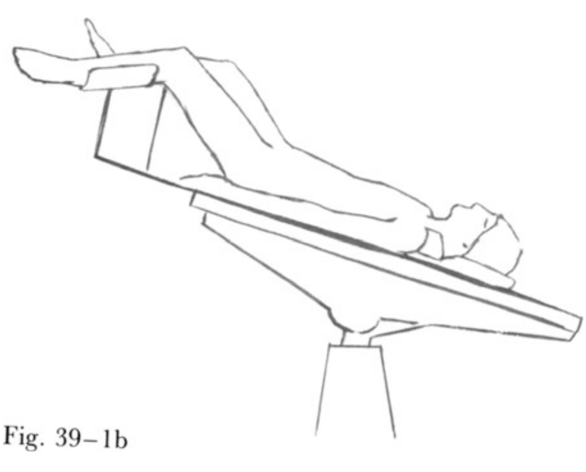


Fig. 39–1b

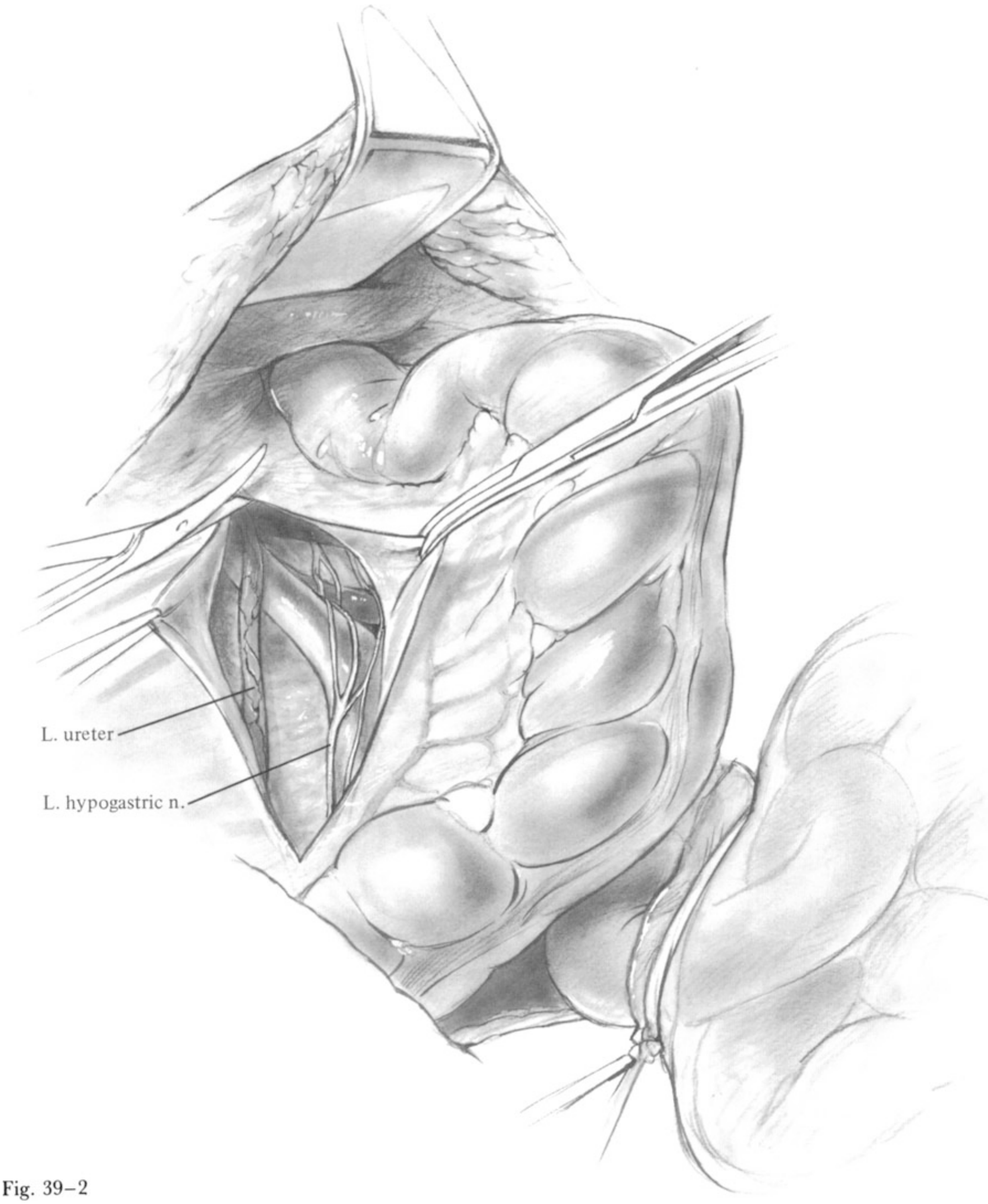


Fig. 39–2

toneum can be divided with a scissors (**Fig. 39–2**). Extend the incision in the peritoneum cephalad as far as the splenic flexure.

Identify the left ureter and tag it with a Vesseloop for later identification.

Use a scissors to continue the peritoneal incision along the left side of the rectum down to the rectovesical pouch. Identify the course of the ureter well down into the pelvis. Now retract the sigmoid to the patient's left and make an incision on the right side of the sigmoid mesocolon. The incision should begin at a point overlying the bifurcation of the aorta and should continue in a caudal direction along the line where the mesosigmoid meets the right lateral leaf of peritoneum in the presacral space. After the right ureter has been identified, carry the incision down toward the rectovesical pouch (**Figs. 39–3 and 39–4**).

If exposure is convenient, incise the peritoneum of the rectovesical pouch, or rectouterine pouch in the female (Fig. 39–3). If exposure is not convenient, this step should be delayed until the presacral dissection has elevated the rectum sufficiently to bring the rectovesical pouch easily to the field of vision.

Lymphovascular Dissection

Apply skyward traction to the colon, gently separate the gonadal vein from the lateral leaf of the mesocolon, and allow it to fall to the posterior. Insert an index finger between the deep margin of the mesosigmoid and the bifurcation of the aorta to feel the pulsation of the inferior mesenteric artery lying superficial to the finger. In patients who are markedly obese, this vessel may be divided and ligated at the level of the aortic bifurcation without further dissection. In most patients, however, it is quite simple to incise the peritoneum overlying the origin of the inferior mesenteric artery, and to sweep the areolar and lymphatic tissue downward until one sees the point at which the inferior mesenteric artery gives off the left colic branch (Fig. 39–5).

In routine cases divide the inferior mesenteric vessels between 2–0 ligatures just distal to this

Fig. 39–3

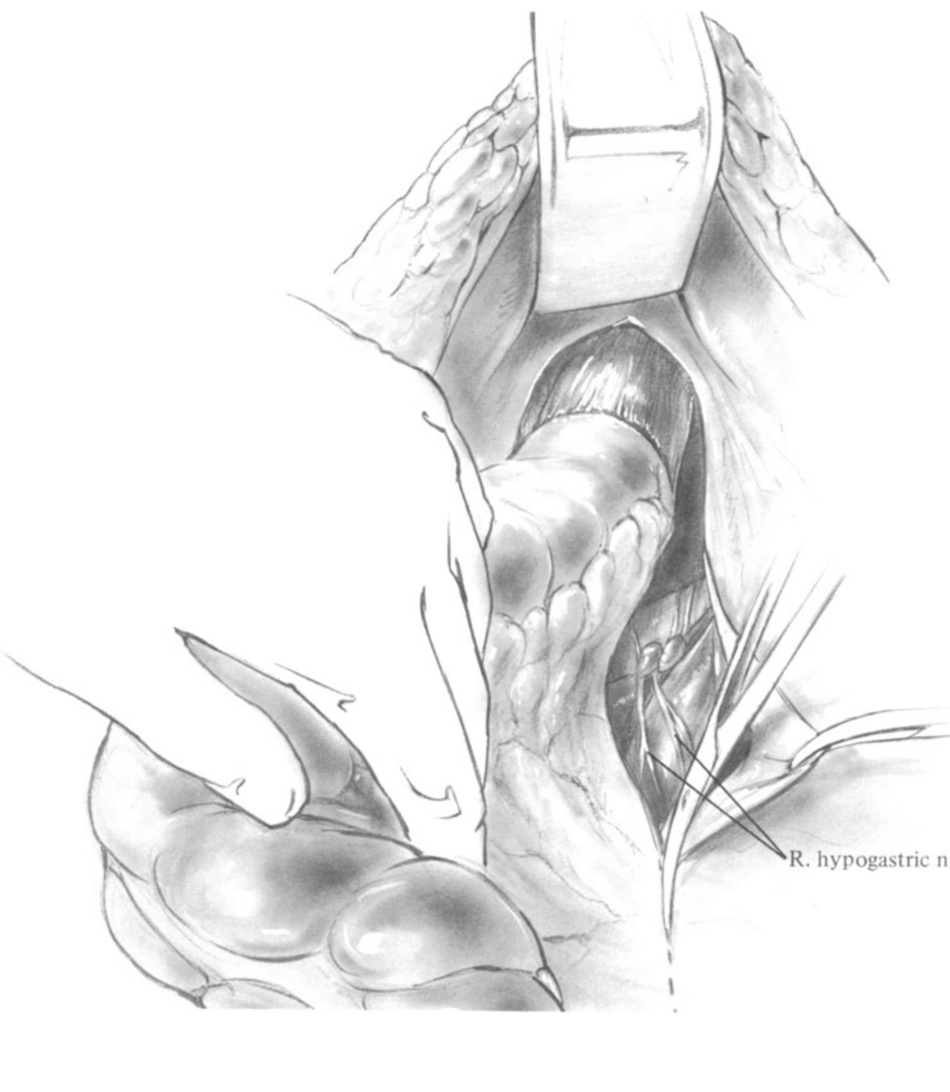


Fig. 39–4

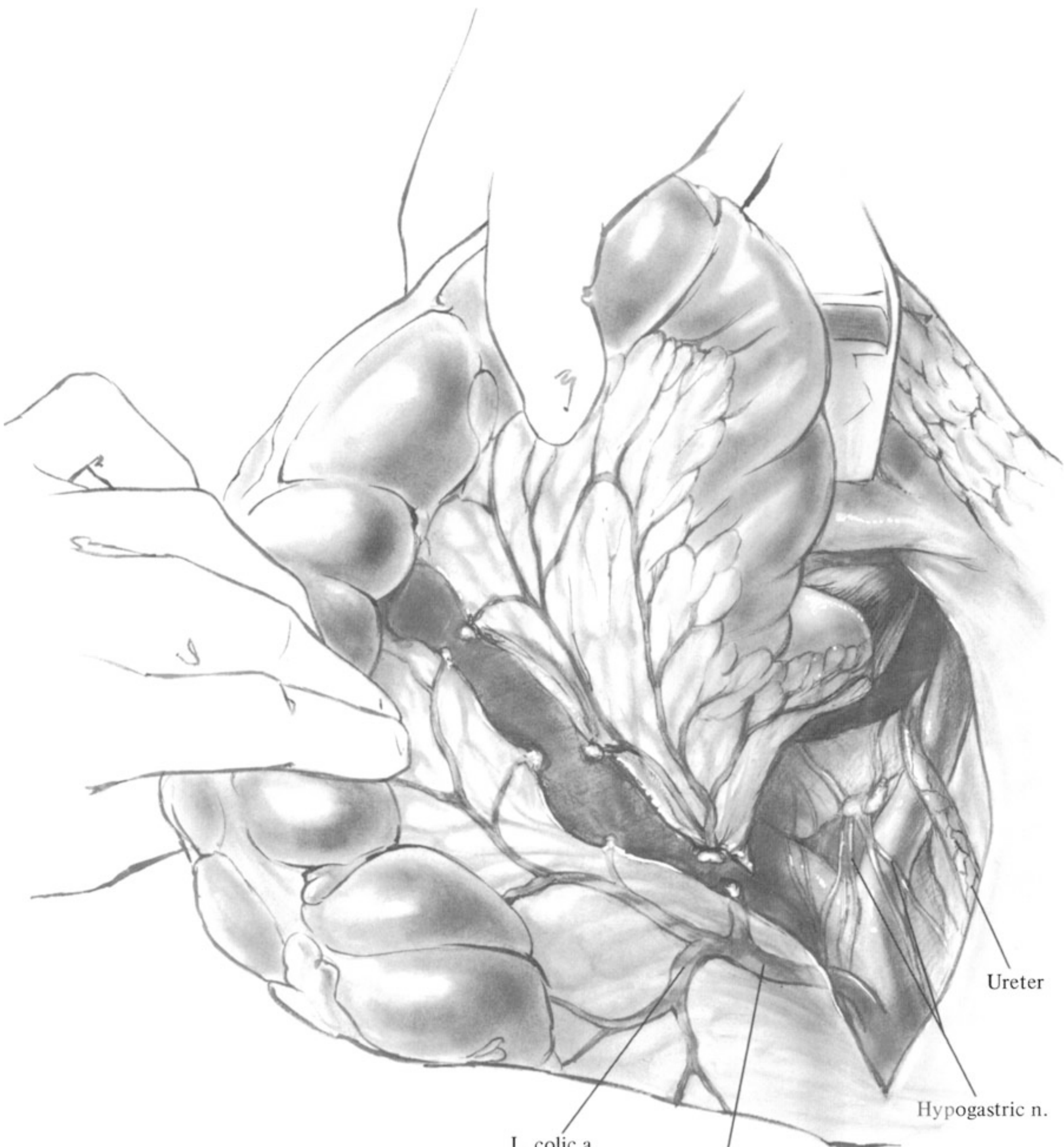


Fig. 39–5

junction. Then make a superficial scalpel incision along the surface of the mesocolon: begin at the point where the inferior mesenteric vessels were divided and continue to the descending colon or upper sigmoid. Complete the division of the mesentery along this line by dividing it between serially applied Kelly hemostats and then ligating with 2–0 silk or PG (**Fig. 39–5**). In nonobese patients it is feasible to incise the peritoneum up to the point where a vessel is visualized and then to apply hemostats directly to each vessel as it is encountered. With this technique, the surgeon will encounter only one or two vessels on the way to the marginal artery of the colon.

Sweep the mesosigmoid and the lymphovascular bundle distal to the ligated inferior mesenteric vessels off the anterior surfaces of the aorta and common iliac vessels by blunt dissection. Leave the preaortic sympathetic nerves intact. To minimize the time during which the patient's abdomen is exposed to possible fecal contamination, do not divide the descending colon at this stage.

Presacral Dissection

With the lower sigmoid on steady upward retraction, it becomes evident that there is a band of tissue extending from the midsacral region to the posterior rectum and mesorectum. On either side of this dense band there is only areolar tissue. Any tendency on the part of the surgeon to insert a hand into the presacral space should be stoutly resisted. Instead, a long, closed Metzenbaum scissors should be used as a blunt dissector (Fig. 39–6a). Insert it first to the right of the midline behind the rectum, and by gently elevating the mesorectum the proper presacral plane will be entered. Repeat this maneuver identically on the left side of the midsacral line. Then direct attention to the remaining band of tissue, which contains branches of the middle sacral artery, and divide it with the electrocoagulator (**Fig. 39–6a**).

At this time the surgeon will see a thin layer of fibroareolar tissue covering the sacrum. If a shiny layer of sacral periosteum, ligaments, or the naked presacral veins can be seen (**Fig. 39–6b**), the plane of dissection is *too deep*, presenting the danger of major venous hemorrhage.

Elevate the *distal* rectum from the lower sacrum with gauze in a sponge holder. If the dissection has been completed properly, as described, note that the preaortic sympathetic nerves divide into two major trunks in the upper sacral area and then continue laterally to the right and left walls of the pelvis (see Figs. 39–2 and 39–4). Gently dissect these nerves off the posterior wall of the specimen, unless the nerves have been invaded by tumor.

Now the surgeon may insert a hand into the presacral space, with the objective not of penetrating more deeply toward the coccyx, but rather of extending the presacral dissection laterally to the right and to the left, so that the posterior aspect of the specimen is elevated from the sacrum as far as the lateral ligaments on each side. Place the lateral ligament on the left side on stretch by applying traction to the rectum toward the right. Place a right-angle Mixter

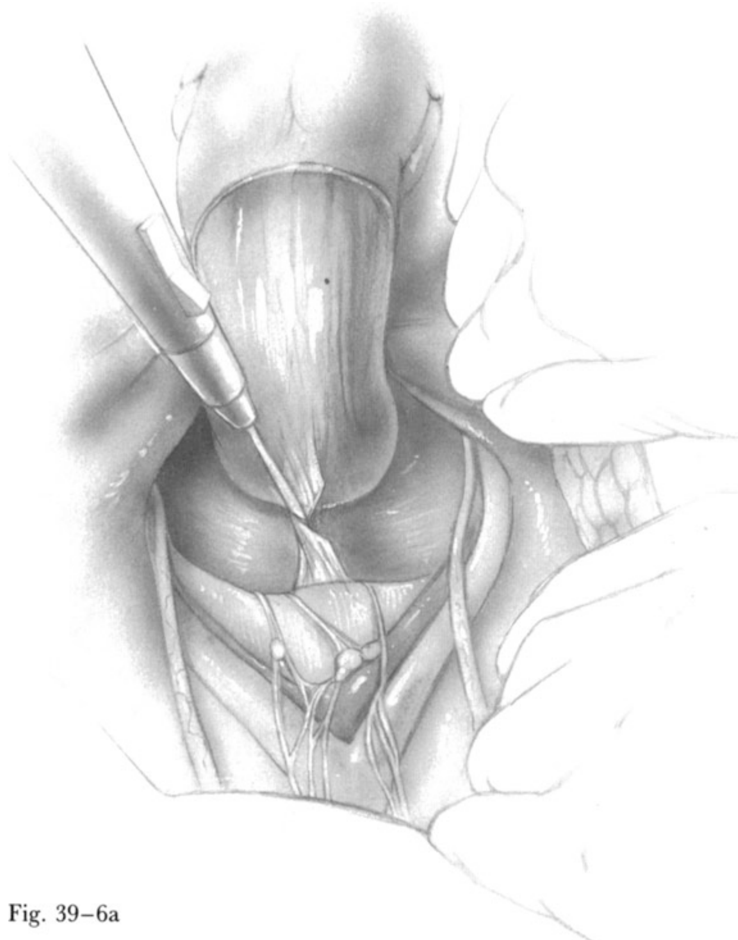


Fig. 39–6a

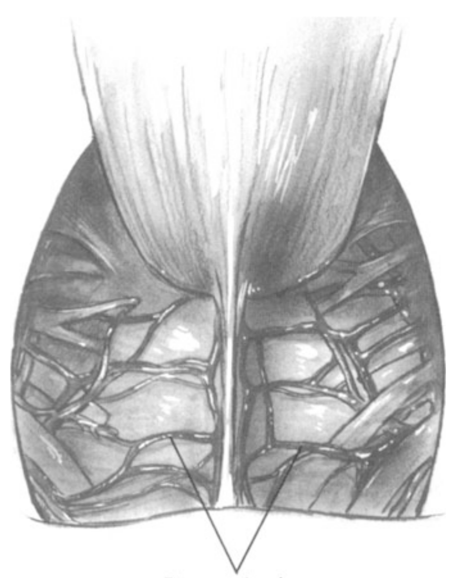


Fig. 39–6b

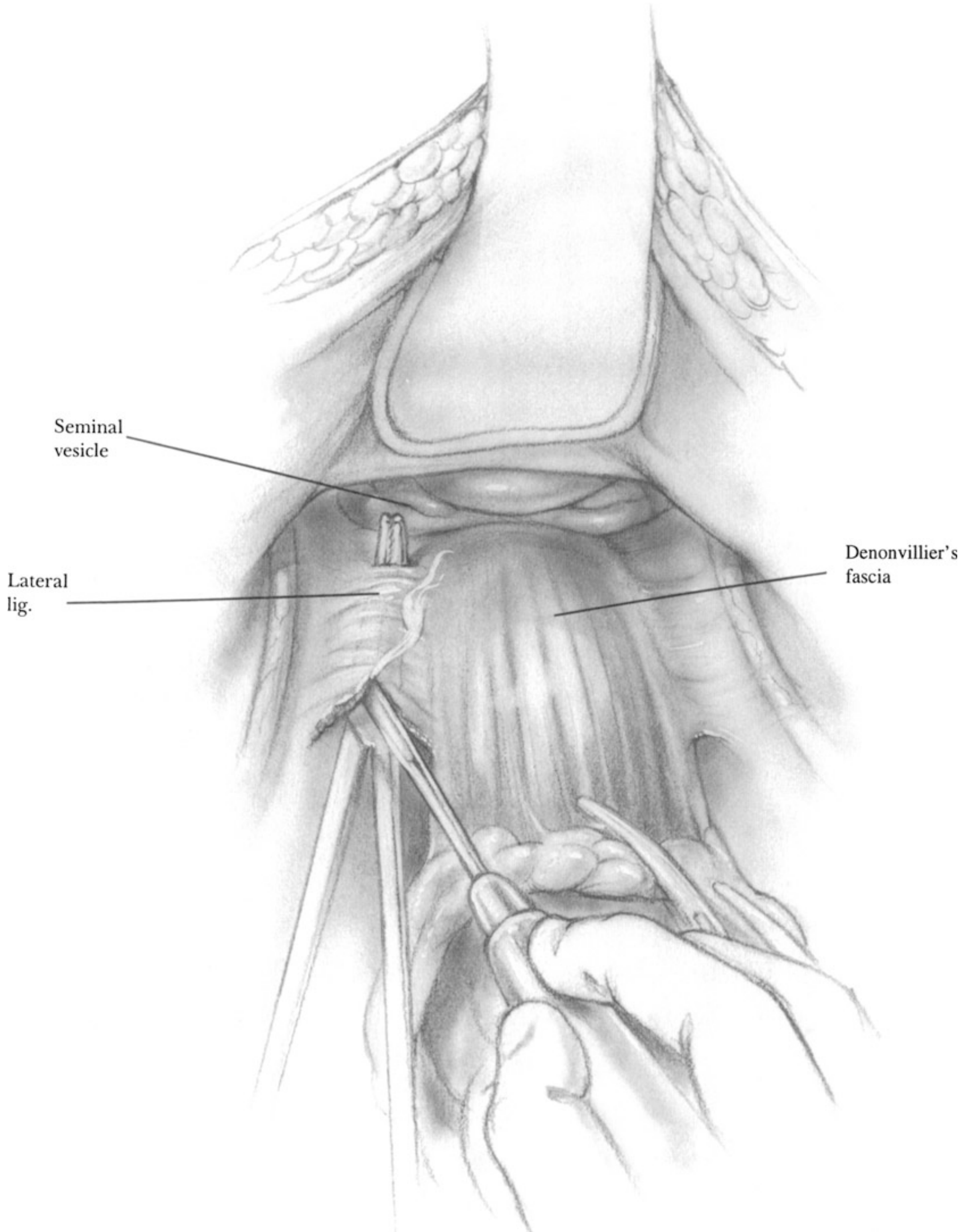


Fig. 39–7

clamp beneath the lateral ligament and divide the tissue with an electrocoagulator (**Fig. 39–7**).

Carry out a similar maneuver to divide the right lateral ligament. Before dividing each lateral ligament, recheck the position of the respective ureter and hypogastric nerve to be certain they lie away from the point of division. Then divide the fascia of Waldeyer, which extends from the coccyx to the posterior rectal wall (**Fig. 39–8**).

Now direct attention to the anterior dissection. Use a Lloyd-Davies bladder retractor to pull the bladder (in women, the uterus) in an anterior and caudal direction. If the peritoneum of the rectovesical pouch has not already been incised, perform this maneuver now, thereby connecting the incisions in the pelvic peritoneum previously made on the right and left sides of the rectum (**Fig. 39–9a**). Apply one or more long hemostats or forceps to the posterior lip

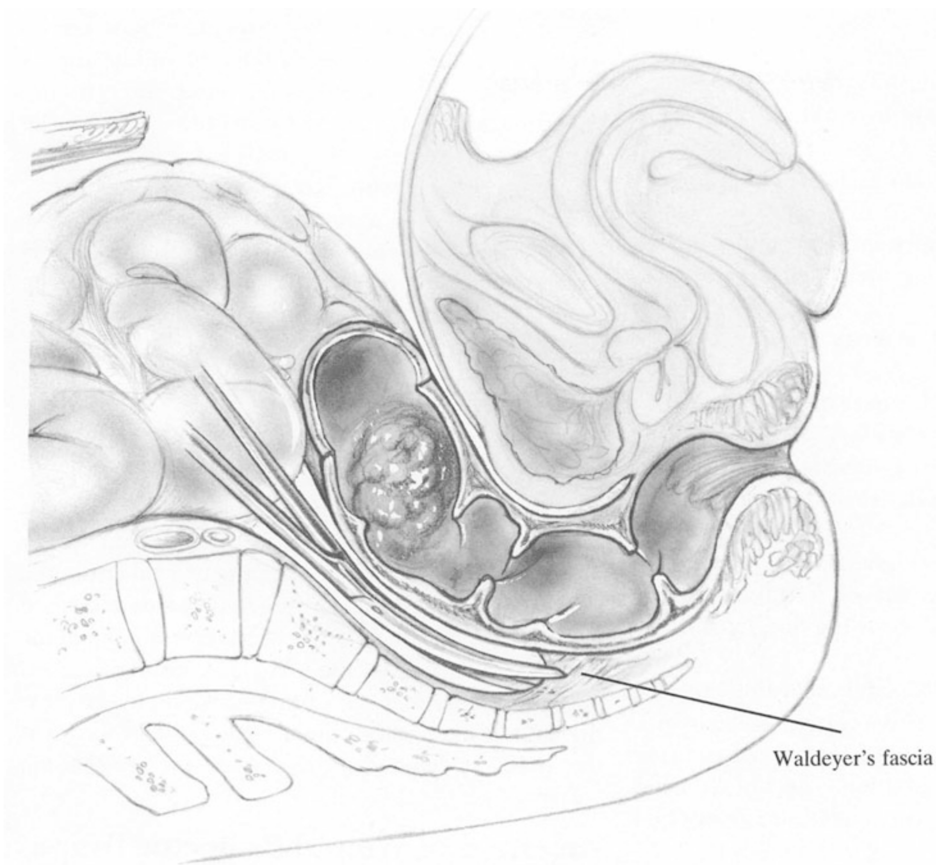


Fig. 39–8

Fig. 39–9a

of the incised peritoneum of the rectovesical pouch. Place traction on these hemostats to draw the peritoneum and Denonvilliers' fascia in a cephalad and posterior direction, and use Metzenbaum scissors dissection to separate the rectum from the seminal vesicles and prostate (**Fig. 39–9b**). Use blunt finger dissection to further separate the rectum from the posterior wall of the prostate. Finally, secure hemostasis in this region by electrocoagulating multiple bleeding points.

In female patients the anterior dissection is somewhat simpler. With a Harrington retractor elevating the uterus, use scalpel dissection to initiate the plane of dissection separating the peritoneum and fascia of Denonvilliers from the posterior lip of the cervix until the proximal vagina has been exposed. Some surgeons routinely perform bilateral salpingo-oophorectomy in women who have rectal and sigmoid cancer, because the ovaries are sometimes a site of metastatic deposit. Whether this step is of value has not been ascertained. We do not perform this maneuver in the absence of visible metastasis to the ovaries.

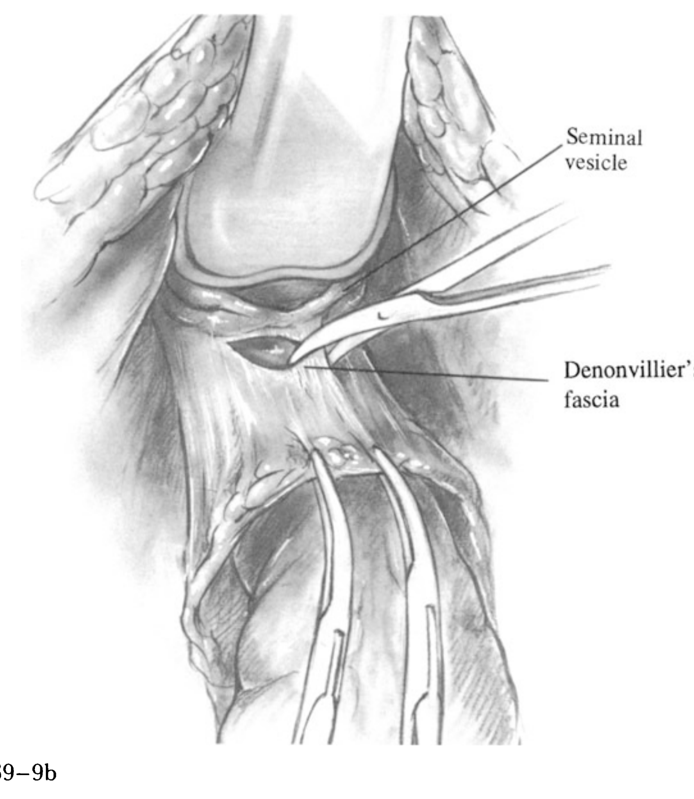


Fig. 39–9b

Pelvic Hemostasis

The entire pelvic dissection, if properly performed, should entail minimal blood loss. While Hemoclips may control clearly identified vessels along the lateral wall of the pelvis, they are not useful in the presacral area. Here the vessels consist of thin-walled veins, which are easily torn by metallic clips either at the time of application or during the act of sponging the area later.

Except in the case of a small, clearly defined bleeding point that can be held in a forceps, electrocoagulation may also be hazardous, as the coagulating tip may act as a scalpel and convert the bleeding point into a major venous laceration. Here a ball-tipped electrode is safer than those with sharp tips.

Also see the discussion above under "Operative Strategy" concerning the use of a thumbtack to control massive presacral bleeding localized to a single foramen.

Almost invariably, presacral bleeding results from a tear in one or more of the veins that drain into a sacral foramen. When hemorrhage occurs, the area of bleeding should be covered by a sheet of oxidized cellulose (surgicel) over which pressure is applied with a large gauze pack. Place omentum between the pack and the anastomosis. If the area of bleeding is only 1–2 cm in diameter, at a later stage in the operation an attempt may be made to remove the gauze pack, leaving the small patch of Surgicel. Alternatively, microfibrillar collagen (Avitene) may be used in this situation. Unless the Surgicel or Avitene produces complete hemostasis, replace the gauze pack in the presacral space and leave it there for 24–48 hours. Then remove it by relaparotomy under general anesthesia.

Mobilization of Proximal Colon

If the previously selected point on the descending colon does not easily reach down into the pelvis, mobilize the remainder of the descending colon by incising first the peritoneum in the paracolic gutter and then the "renocolic" ligament. Liberate the entire splenic flexure according to the steps described in Chap. 37. By dividing the transverse branch of the left colic artery (see Fig. 35–7), considerable additional length may be obtained. Completely clear the fat and mesentery from a 1-cm width of serosa at the point selected for division of the descending colon.

Insertion of Wound Protector Drape

At this point insert the plastic ring drape into the abdominal incision to protect the subcutaneous panniculus from contamination.

Preparation of Rectal Stump

When the rectum is divided at a low level, the mesorectum is no longer a single pedicle traveling along the posterior surface of the rectum. Rather, it fans out into multiple branches. Select a point 4–5 cm distal to the lower border of the tumor and seek the plane between the muscularis of the rectum and the surrounding blood vessels. This plane can

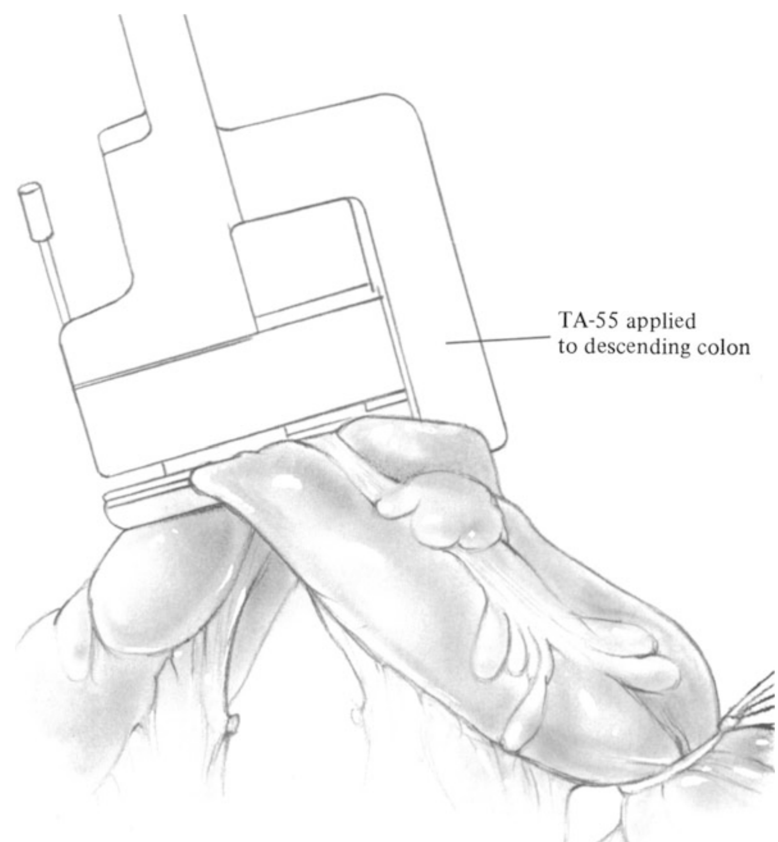


Fig. 39–10

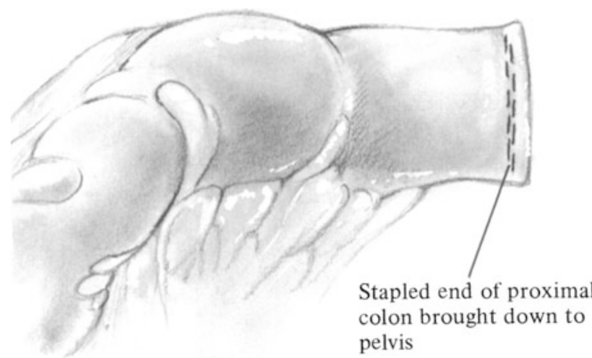


Fig. 39–11

sometimes be palpated with the finger; at other times a large blunt-nosed hemostat can be insinuated into it. In most patients this vascular layer can be divided by electrocoagulation after passing a right-angle clamp between the vasculature and the rectal wall.

Well-delineated longitudinal muscle fibers should now be visible all around the lower rectum at the site selected for the anastomosis. At this time place a large right-angle clamp across the entire lumen of the rectum below the tumor.

Irrigation of Rectal Stump

Insert a Foley catheter with a 5-ml bag into the rectum. Attach the catheter to plastic tubing so as to permit the intermittent inflow and drainage of 500 ml of sterile water. Other tumoricidal solutions such as 1:1000 mercuric bichloride or 40% alcohol may be used at the surgeon's option. After the irrigation is completed and the rectum emptied, remove the catheter, and apply a large right-angle clamp distal to the tumor to occlude the rectal lumen.

Selection of Technique for Anastomosis

The side-to-end suture technique should be elected if a low colorectal anastomosis is attempted where the suture line is at or below the peritoneal reflection. Alternatively, an EEA or CEEA stapling device may be used. At higher levels, the techniques described in Chap. 37 are also suitable. Also see discussion in the section on "Operative Strategy" near the beginning of this chapter.

Side-to-End Low Colorectal Anastomosis (Baker)

Turn to the previously cleared area on the descending colon that will be used for the anastomosis. Apply a TA–55 stapler across this cleared area and fire the staples (**Fig. 39–10**). Place an Allen clamp 1 cm distal to the TA–55 to occlude the specimen side. Divide the colon flush with the stapling device, using a scalpel, and lightly electrocoagulate the everted mucosa (**Fig. 39–11**). Ligate the specimen side with umbilical tape. After the Allen clamp is removed, apply a sterile rubber glove over the ligated end and tie the rubber glove in place with another umbilical tape ligature (**Figs. 39–12a and 39–12b**). Retain this segment of colon, containing the specimen, temporarily to provide traction on the rectal stump.

Bring the stapled end of the proximal colon down into the pelvis and line it up tentatively with the

Fig. 39–12a

Fig. 39–12b

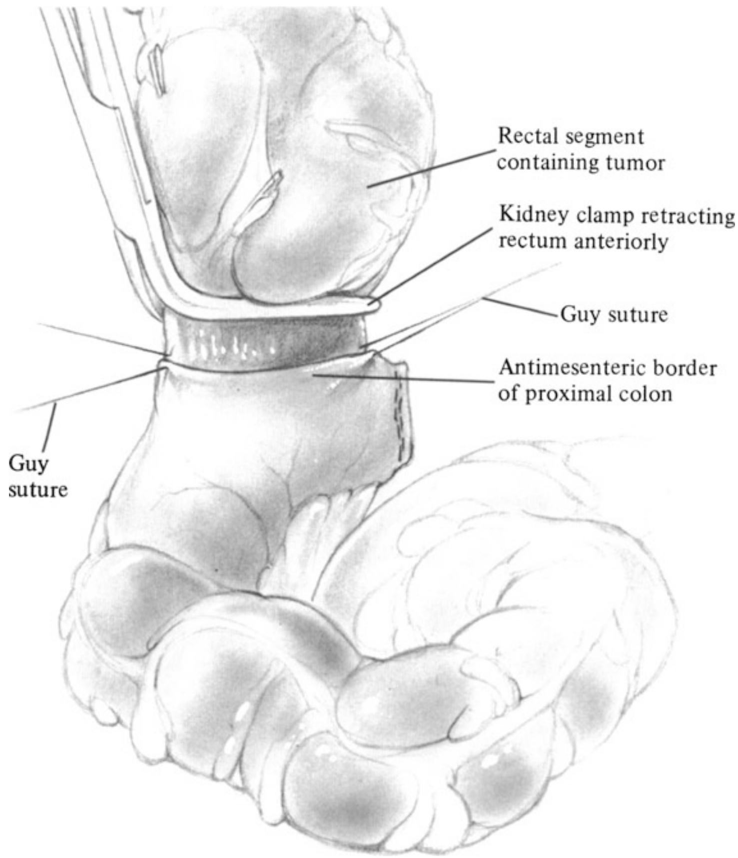


Fig. 39–13

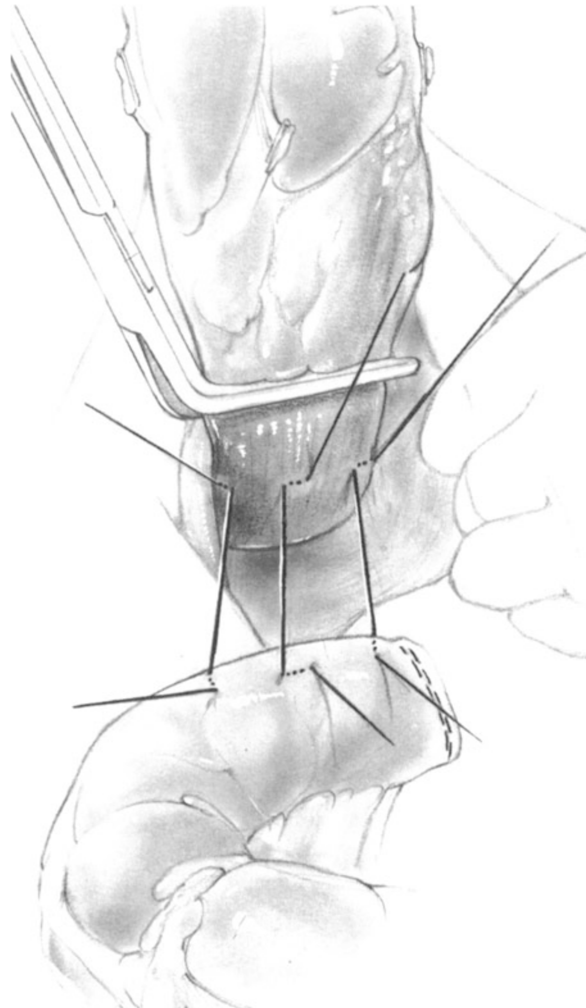


Fig. 39–14

rectal stump 4–5 cm beyond the tumor. Place a scratch mark along the antimesenteric border of the descending colon beginning at a point 1 cm proximal to the stapled end and continuing cephalad for a distance equal to the diameter of the rectal stump.

Now insert a lateral guy suture into the left lateral margin of the rectal stump and the proximal colon and hold this suture in a hemostat. Place a second guy suture in a similar fashion between the right lateral margin of the rectum and the colon and hold it in a hemostat too (**Fig. 39–13**).

Approximate the posterior muscular layer with interrupted 4–0 silk Cushing sutures, taking bites, 5-mm wide, of colon and of rectum. Use a Stratte or a Finochietto angled needle-holder (see Glossary) when sewing deep in the pelvis—this will enhance the smooth insertion of the curved needle. Insert these sutures 6–7 mm behind the anticipated lines of transection of the colon and rectum. The preferred technique is the one of successive bisection (**Figs. 39–14 and 39–15**). Tie none of these sutures until all have been placed. When the anastomosis is at a very low level, it is convenient to keep the proximal colonic segment well above the promontory of the sacrum until all the posterior seromuscular sutures have been inserted. Be sure that these stitches catch the longitudinal muscle of the rectum. If only mucosa is used for the anastomosis, failure is likely.

Incise the previous scratch mark in the proximal colonic segment with a scalpel and a Metzenbaum scissors (**Fig. 39–16**). Make a similar incision along a line 6–7 mm proximal to the sutures already placed in the rectum.

If exposure is difficult, it is sometimes helpful to maintain gentle traction on the tails of the Cushing sutures to improve exposure while suturing the mucosa. Then cut the tails of the Cushing sutures successively as the mucosal sutures are inserted. Otherwise, cut all the Cushing sutures at one time, except for the two lateral guy sutures, which should be retained for the moment.

Begin the posterior mucosal closure at the midpoint of the posterior layer, using an atraumatic suture 5–0 Vicryl. Start a continuous locked suture at the midpoint and continue it to the right lateral margin. The second suture of the same material should progress from the midpoint toward the left lateral margin of the suture line (**Fig. 39–17**).

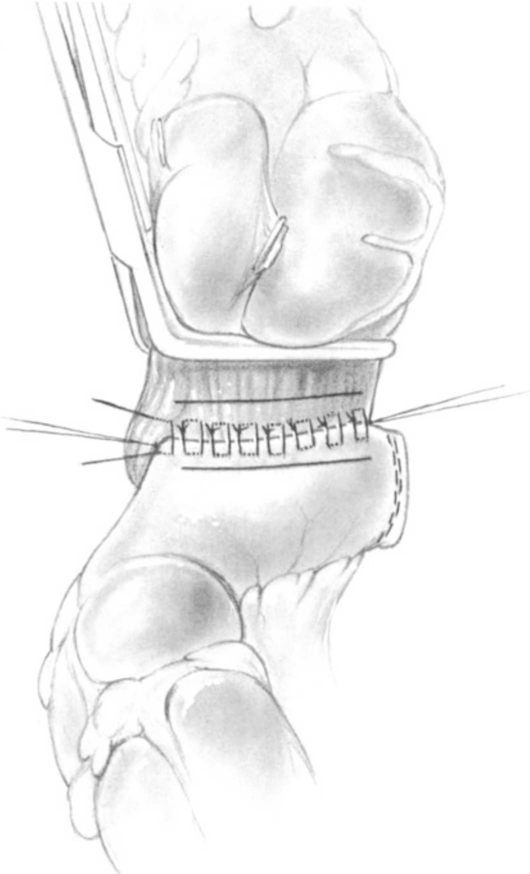


Fig. 39–15

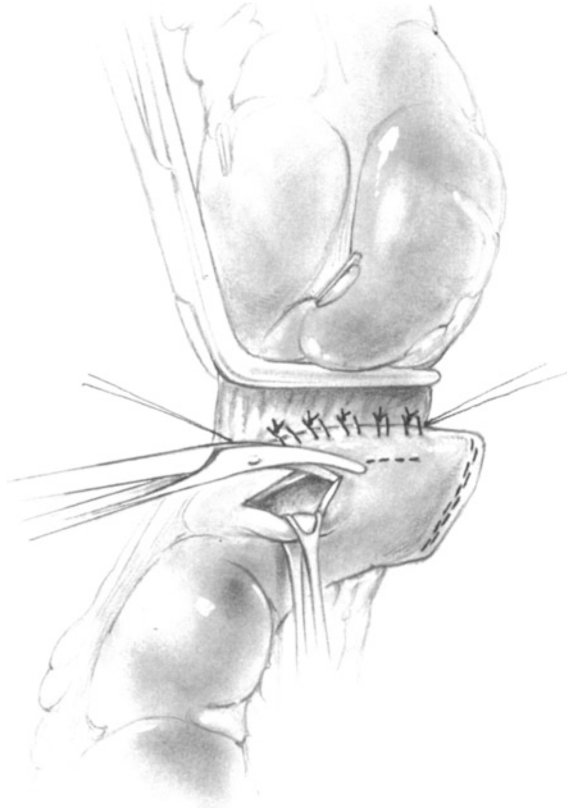


Fig. 39–16

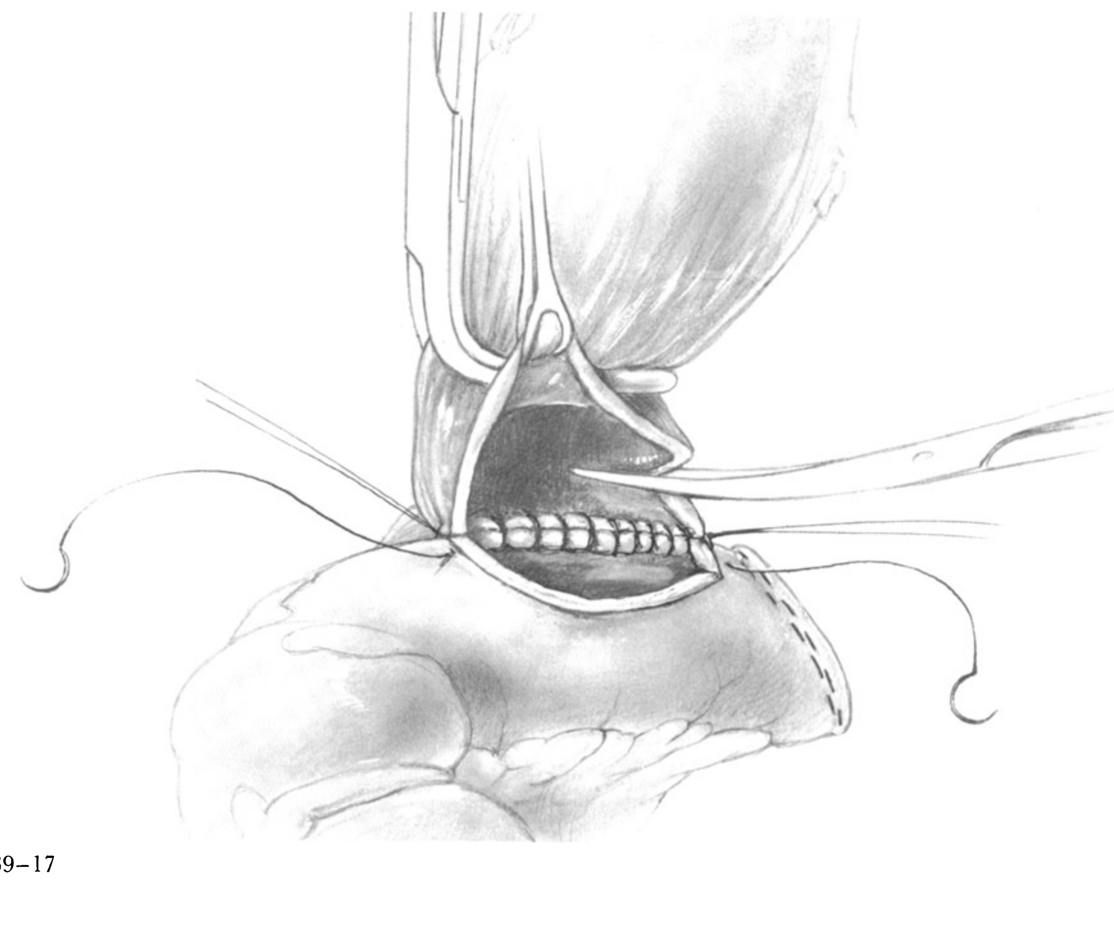


Fig. 39–17

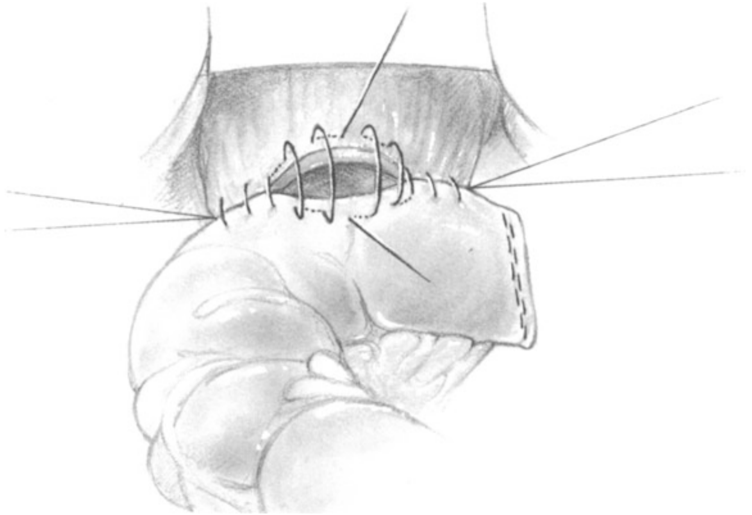


Fig. 39–18

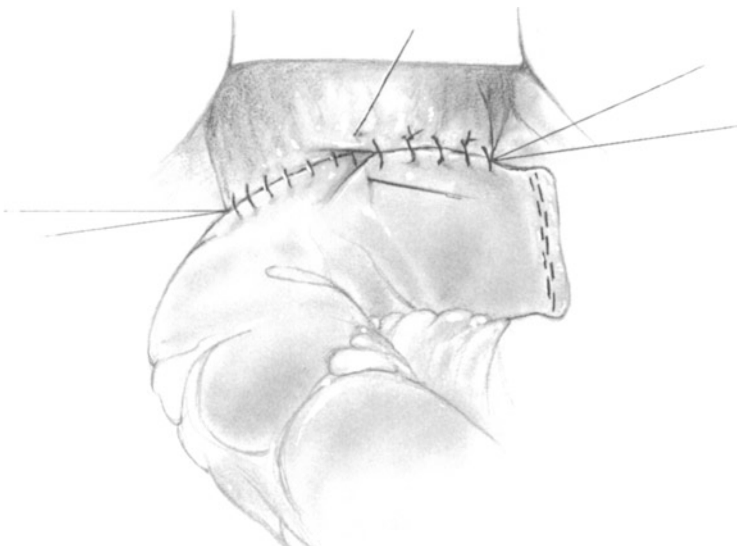


Fig. 39–19

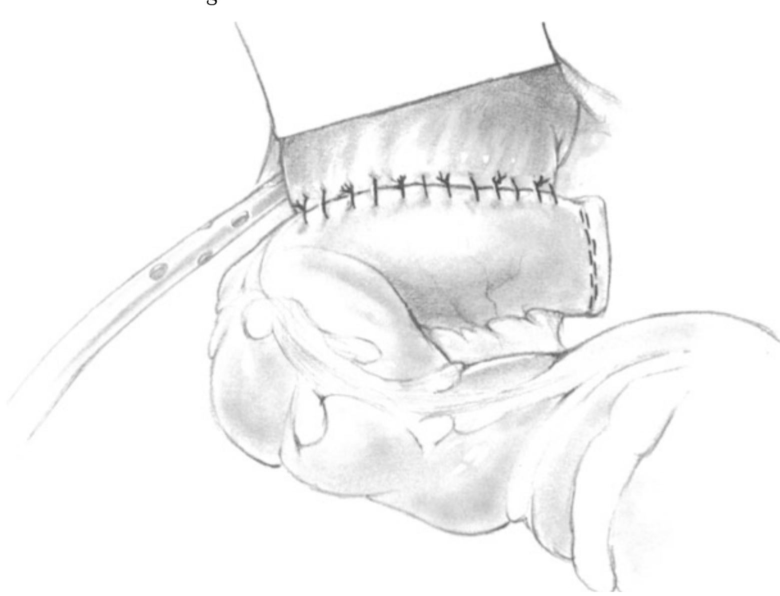


Fig. 39–20

Divide the anterior wall of the rectum below the large right-angle clamp and remove the specimen. Request an immediate frozen-section histological examination of the distal margin of the specimen to rule out the presence of cancer. If tumor cells are found at the margin, resection of additional rectum is indicated.

Now approximate the anterior mucosal layer by a continuous suture of the Connell or Cushing type (**Fig. 39–18**). Accomplish this by grasping the needle, which has completed the posterior mucosal layer and is now in the lumen at the right margin of the anastomosis, and passing it from inside out through the rectum. The suture line should progress from the right lateral margin toward the midpoint of the anterior layer. When this has been reached, grasp the second needle, located at the left lateral margin of the posterior mucosal layer. Use this needle to complete the anterior mucosal layer from the left lateral margin to the midpoint where the anterior mucosal layer is terminated with the mucosa completely inverted (Fig. 39–18).

Close the anterior muscular layer with interrupted 4–0 atraumatic silk Lembert or Cushing sutures (**Figs. 39–19 and 39–20**). Insert this row of sutures about 6 mm away from the mucosal suture line to accomplish a certain amount of invagination of the rectum into the colon. Because the side-to-end lumen is large in dimension, narrowing will not result. A sagittal section of the anastomosis in **Fig. 39–21** illustrates this point. After the anastomosis is completed, carefully inspect the posterior suture line for possible defects, which can be corrected by additional sutures.

At this point cut the sutures and thoroughly irrigate the pelvis with a dilute solution of antibiotics.

The large defect in the peritoneum need not be closed. This omission has brought no noticeable ill

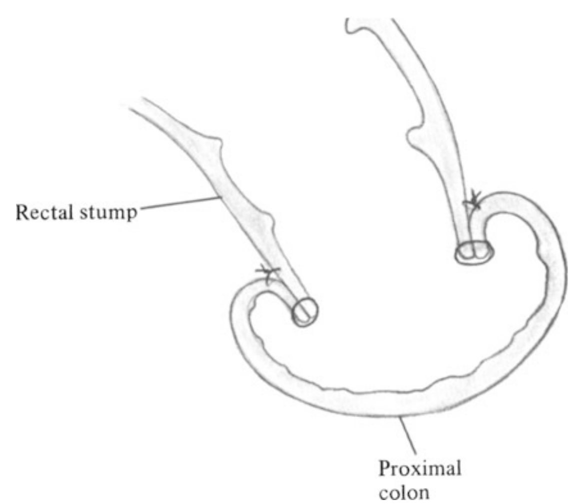


Fig. 39–21

effect, probably because the defect is so large as not to permanently entrap any small intestine.

Make a final check to ensure there is no tension on the colorectal suture line. If there is, additional proximal colon must be liberated. There must be sufficient slack so that the colon *fills up the hollow of the sacrum* on its way to the anastomosis, thus eliminating any dead space.

Alternative Method of Colorectal Side-to-End Anastomosis

When the surgeon does not find it practicable to leave the specimen attached to the rectal stump for purposes of traction, the preferred technique that is described above, then an alternative method may be used for the anastomosis.

After the first step in the Baker method (see Fig. 39–10) has been completed, remove the specimen by a scalpel incision across the rectum distal to the right-angle clamp. This leaves the rectal stump wide open. To prevent the short rectal stump from retracting beyond the prostate, apply long (30 cm) Allis clamps to the right and left corners of the rectal stump. Insert a Lloyd-Davies bladder retractor deep to the prostate for purposes of exposure.

Bring the previously prepared segment of descending colon down to the sacral promontory. The end of this segment of colon should have already been occluded by an application of the TA-55 stapling device. Make an incision on the antimesenteric border of the colon beginning 1 cm from the stapled end and continuing proximally for 4–5 cm, which is the approximate diameter of the rectal ampulla.

Insert a guy suture of atraumatic 4–0 silk from the left lateral wall of the rectal stump to the termination of the incision in the colon. Grasp this suture in a hemostat without tying it. Place a similar suture in the right lateral walls of the rectal stump and colon.

Close the remainder of the posterior wall with interrupted horizontal mattress sutures of atraumatic 4–0 silk. Place the first suture at the midpoint of the posterior layer. Using a curved needle, begin the stitch on the mucosal side of the proximal colon and go from inside out through all the layers of colon. Then pass the needle from outside in into the rectal stump. It is vitally important that the muscularis of the rectum be included in this bite. Often the muscularis retracts 1 cm or more beyond the protruding rectal mucosa.

Bring the same needle back from inside out on the rectal stump and then from outside in on the proximal colon. Leave this suture untied but grasp it in a hemostat. When it is tied at a later stage in the procedure, the knot will lie on the mucosa of the colon.

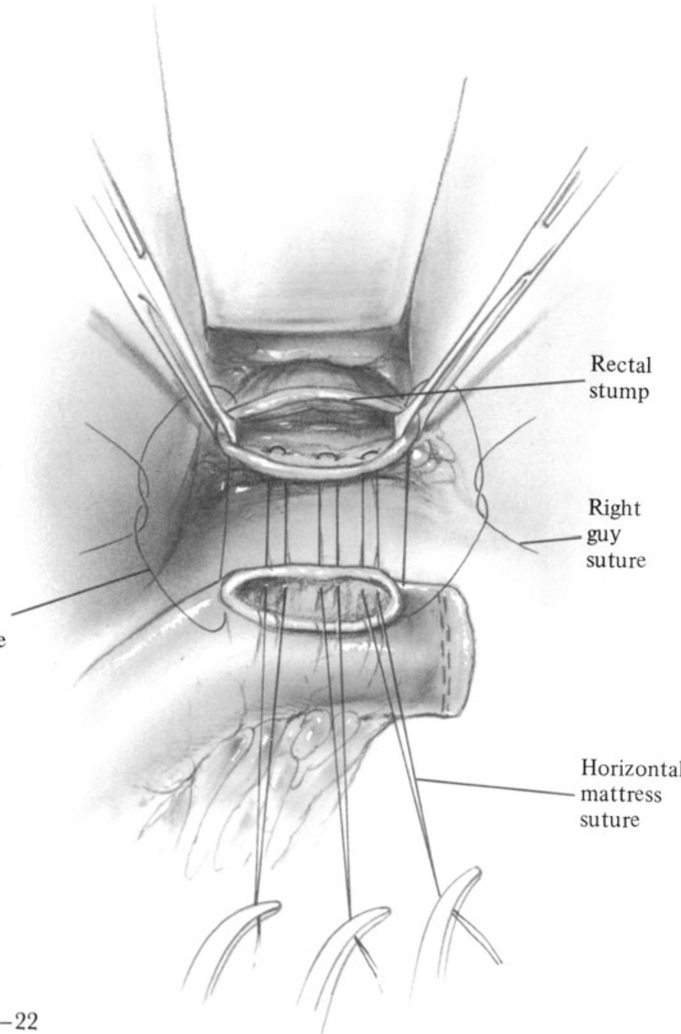


Fig. 39–22

Place the second horizontal mattress suture halfway between the first suture and the *left* lateral guy suture by the same technique. Place the third suture so that it bisects the distance between the midpoint of the posterior layer and the *right* lateral guy suture. Place the remaining stitches by the technique of successive bisection until this layer is complete (**Fig. 39–22**).

The colon should slide down against the rectal stump while the assistant holds the ends of all the sutures taut. Tie the sutures and leave the tails long, grasping each again in a hemostat. Retaining the long tails of these stitches and applying mild upward traction improves the exposure for insertion of the mucosal sutures.

The remainder of the anastomosis is similar to that described above in the Baker technique.

EEA Stapled Low Colorectal Anastomosis

In the EEA stapling technique for low colorectal anastomosis, place the patient in the Lloyd-Davies position, with thighs abducted, anus exposed, and sacrum elevated on a small sandbag.

For tumors situated 6–9 cm above the anal verge, it will be necessary to dissect the rectum down to the levator diaphragm. This requires complete division of Waldeyer's fascia posteriorly, dissection of the anterior rectum away from the prostate to the level of the urethra, and division of the lateral ligaments down to the levators.

Unless the patient has a narrow pelvis the entire levator diaphragm comes into view (**Fig. 39–23**). All of the perirectal lymphatics will readily peel off from the levator musculature. Then, follow the posterior wall of the rectum down to puborectalis muscle, which marks the cephalad margin of the anal canal. Take care not to continue dissecting beyond the puborectalis as it is easy to enter the intersphincteric plane and to liberate the rectum down to the anal verge. An anastomosis to the skin of the anal canal is technically feasible but would result in excision of the internal sphincter together with the specimen, because the intersphincteric space is the natural plane of dissection which one enters from above.

Place a large right-angle renal pedicle clamp across the rectum about 1 cm beyond the lower edge of the tumor.

Then divide the upper colon between Allen clamps at the site previously selected for this purpose. Ligate the cut distal end of the descending colon with umbilical tape and cover it with a sterile rubber glove (see Fig. 39–12a and b).

Bring the proximal colon down into the pelvis. There should be sufficient slack in the colon to fill the hollow of the sacrum on its way to the site of the anastomosis. If there is not, then liberate the transverse colon to achieve sufficient slack.

Next, remove the Allen clamp and gently dilate the colon to 3.2 cm, which is the outer diameter of the EEA cartridge. This may be accomplished by digital dilatation or by gentle stretching with a rectal speculum, a Foley catheter, or the "sizing" device offered by the manufacturer. Sometimes, dilating the colon may prove the most frustrating step in the entire operation. Be careful *not to produce any serosal*

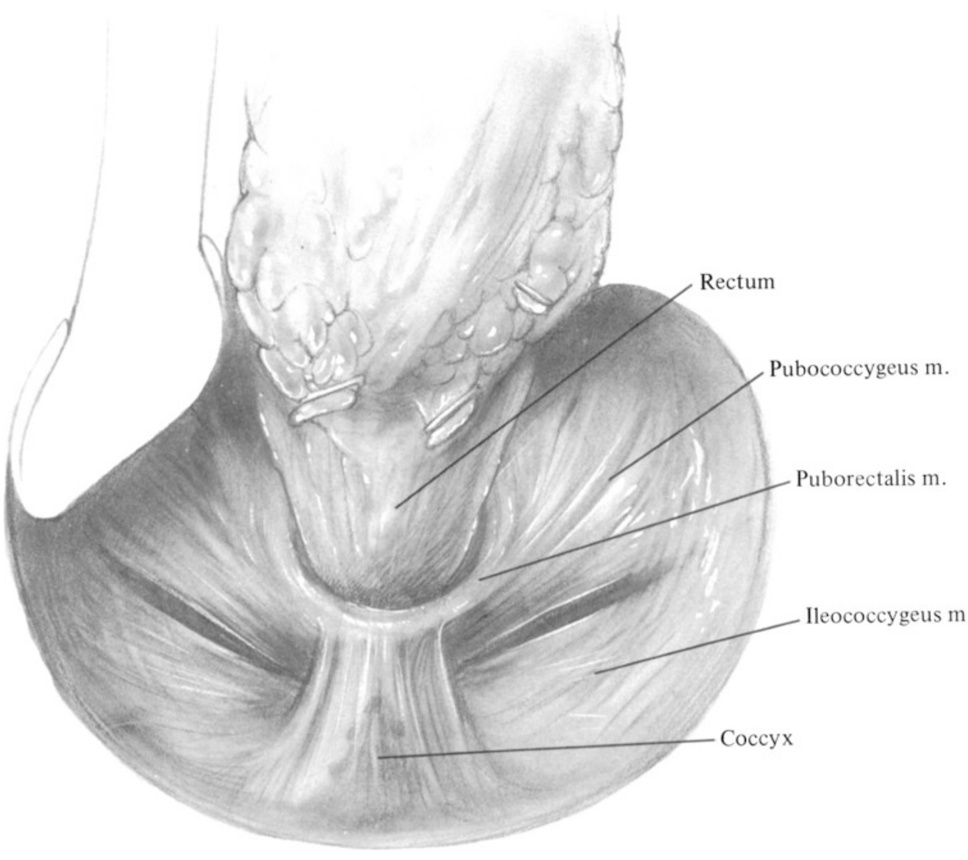


Fig. 39–23

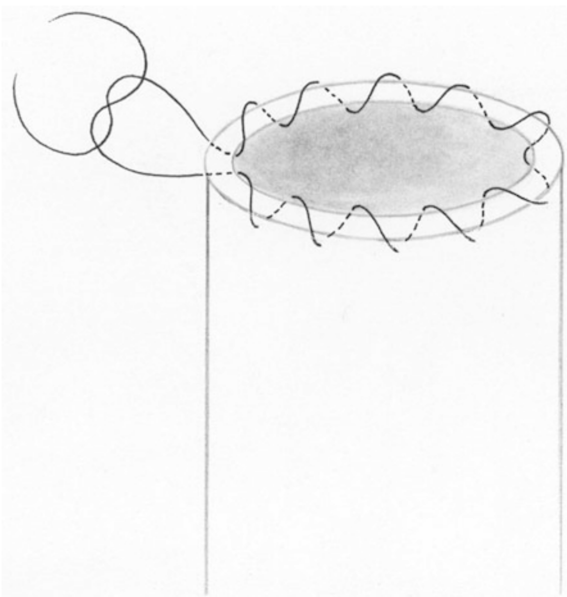


Fig. 39–24a

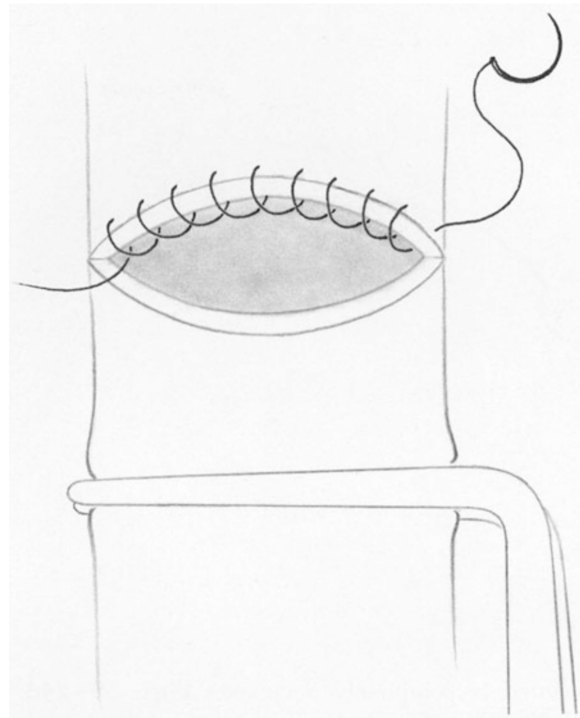


Fig. 39–24c

tears by this maneuver. If dilatation to a 3.2-cm diameter cannot be achieved, try the EEA-28 size. Use of EEA cartridges of sizes smaller than EEA-28 may not be advisable because the diameter of the anastomotic lumen produced by the next smaller cartridge may be too small for optimal function of the rectum, and a stricture may result.

Then insert a 2–0 Prolene continuous over-and-over whip-stitch starting at the left margin of the proximal cut end of the colon (**Fig. 39–24a**). Ascertain that all fat and mesentery have been dissected off the distal 1.5 cm of colon so that there will be no fat or blood vessels interposed between the layers of bowel that will be included in the staple line. If blood vessels are trapped in the staple line, firing the EEA may produce significant bleeding in the rectal lumen. This will be difficult to control. Alternatively, the Auto Suture purse-string intrument (see Fig. D–33) may be used instead of a whip-stitch.

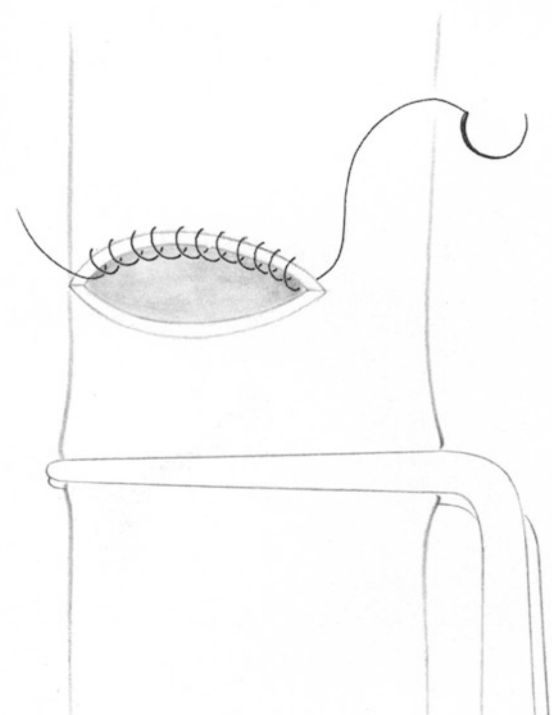


Fig. 39–24b

Insert a sterile short proctoscope into the anal canal and aspirate the rectum of its contents. Thoroughly irrigate the rectum with sterile water to wash out any desquamated tumor cells, and remove the proctoscope.

Next, insert an over-and-over whip-stitch into the rectal stump. To accomplish this, make an incision through the full thickness of the rectal wall on its left anterolateral aspect, leaving a margin of 4 cm beyond the tumor. Place traction on the right-angle clamp to maintain exposure of the lower rectum. Initiate a 2–0 atraumatic Prolene over-and-over whip-stitch at the left lateral corner of the rectal stump (**Fig. 39–24b**). As this stitch progresses along the anterior wall of the rectum toward the patient's right, divide more and more rectal wall (**Fig. 39–24c**). Continue the same suture circumferentially along the posterior wall of the rectum until the point of origin at the left lateral wall is reached and the

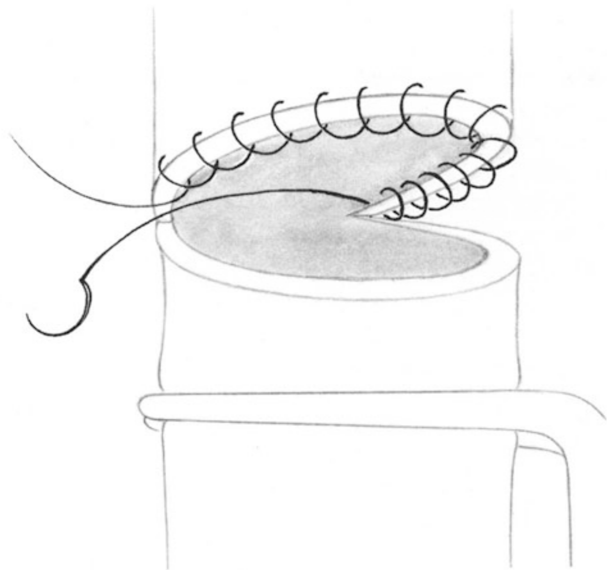


Fig. 39–24d

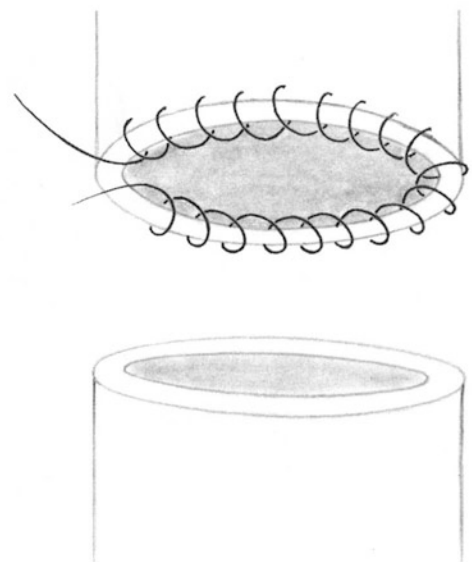


Fig. 39–24e

specimen is completely detached (**Figs. 39–24d and 39–24e**). Do not attempt to insert the whip-stitch *after* the specimen has been detached because the rectal stump will retract beyond the prostate and suturing from above will be impossible in the case of tumors of the mid-rectum (6–10 cm above the anal verge). Each bite should contain 4 mm of full thickness of rectal wall, and the stitches should be no more than 6 mm apart to prevent gaps when the suture is tied. A 1.5–2.0 cm width of muscular wall of rectum behind the whip-stitch should be cleared of fat, blood vessels, and areolar tissue. When the staples are fired, there should be no fat or mesentery between the muscular wall of the rectum and seromuscular wall of proximal colon. Grasp both ends of the Prolene purse-string suture in a hemostat. Irrigate the pelvis with a dilute antibiotic solution.

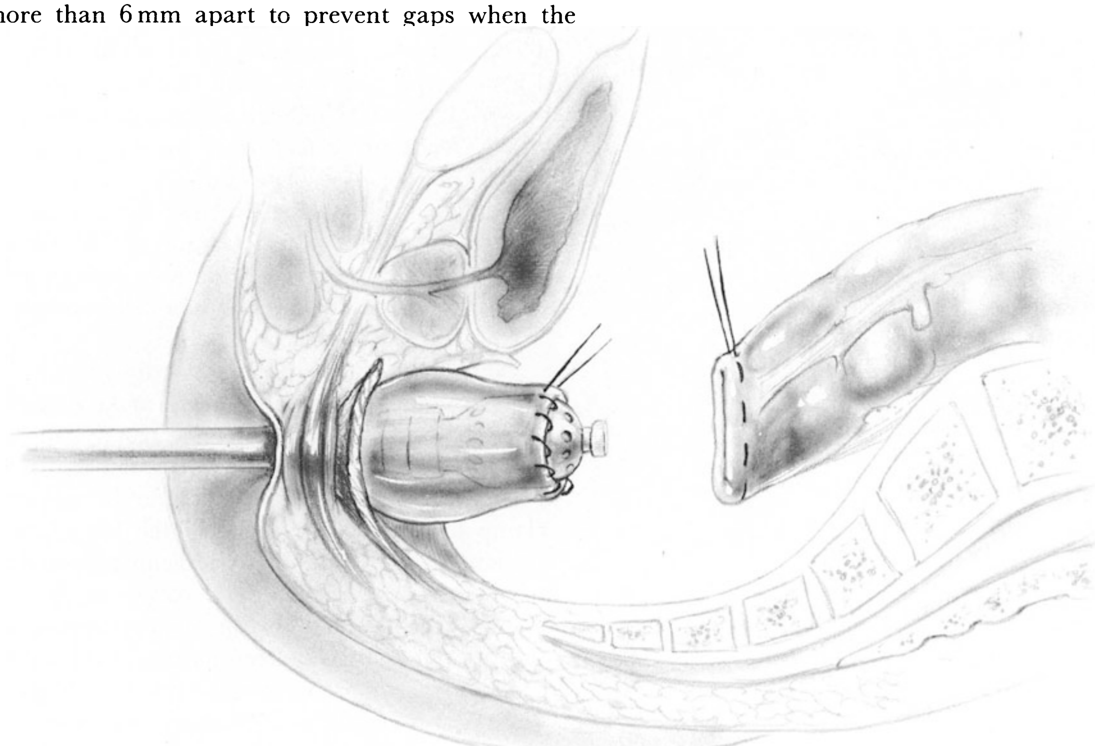


Fig. 39–25

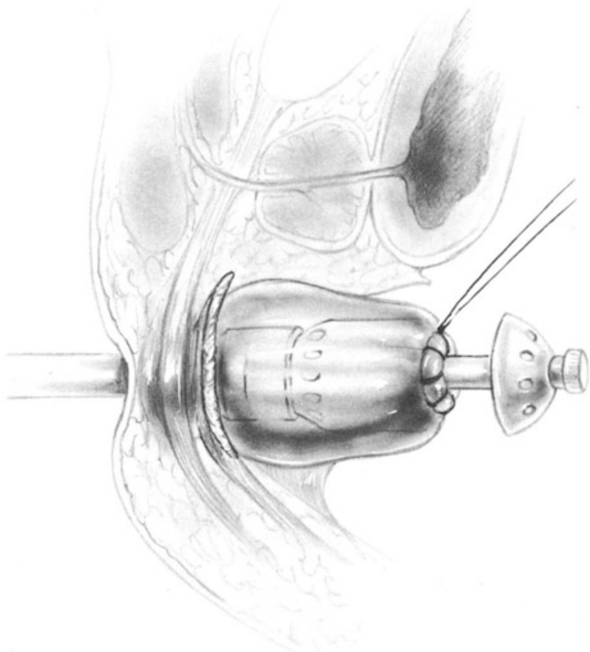


Fig. 39–26

Now move to the perineal portion of the operative field. Check to be sure the screw that caps the anvil is on tightly. If it is not, there will be too much space between the anvil and the staples. This will prevent the staples from closing properly. Lubricate the tip of the EEA device with sterile surgical jelly. Insert the device into the anal canal and into the rectum with the trigger handles pointing anteriorly (**Fig. 39–25**). Slowly push the anvil of the EEA device through the lower rectal purse-string, then rotate the wing nut at the end of the EEA counterclockwise until the device is wide open. Tie the rectal purse-string firmly around the shaft of the EEA (**Fig. 39–26**) and cut the tails 5 mm from the knot.

Apply three Allis clamps in triangular fashion to the cut end of the proximal colon, the lumen of which has been dilated so that the colon may be brought over the cap of the EEA. When this has been accomplished, tie the colonic purse-string suture and cut its tails 5 mm from the knot (**Fig. 39–27**).

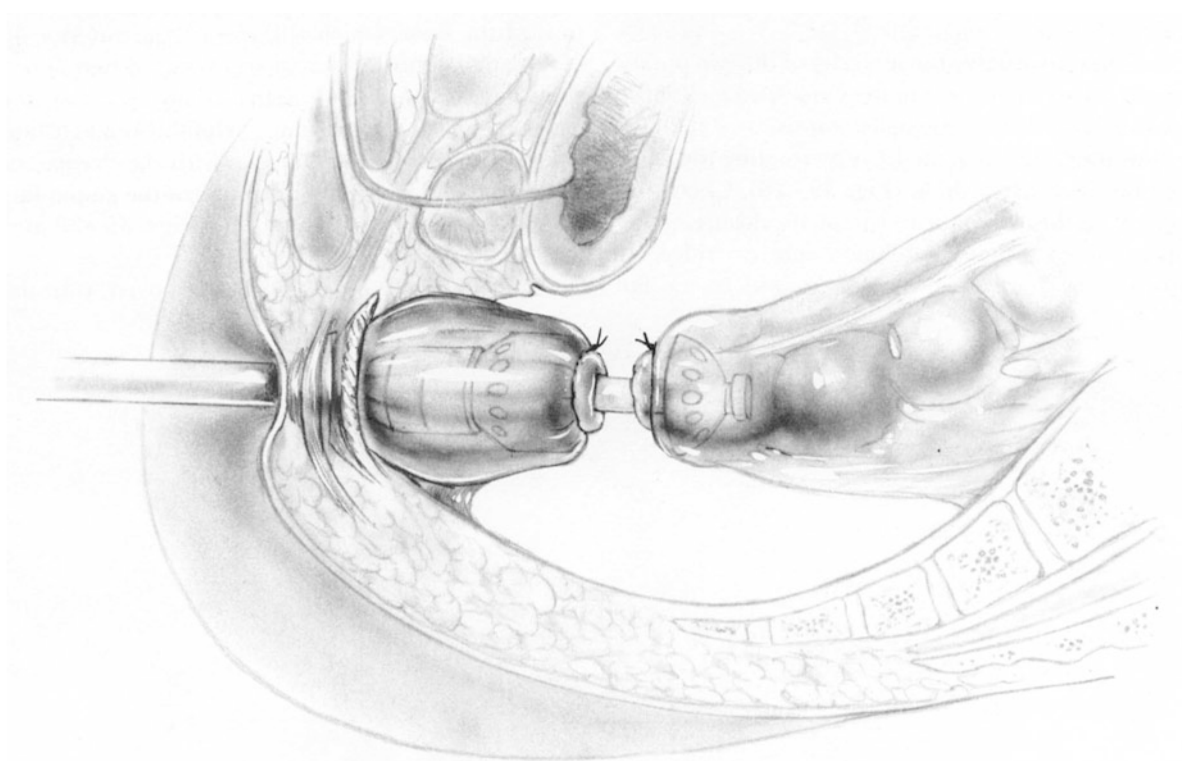


Fig. 39–27

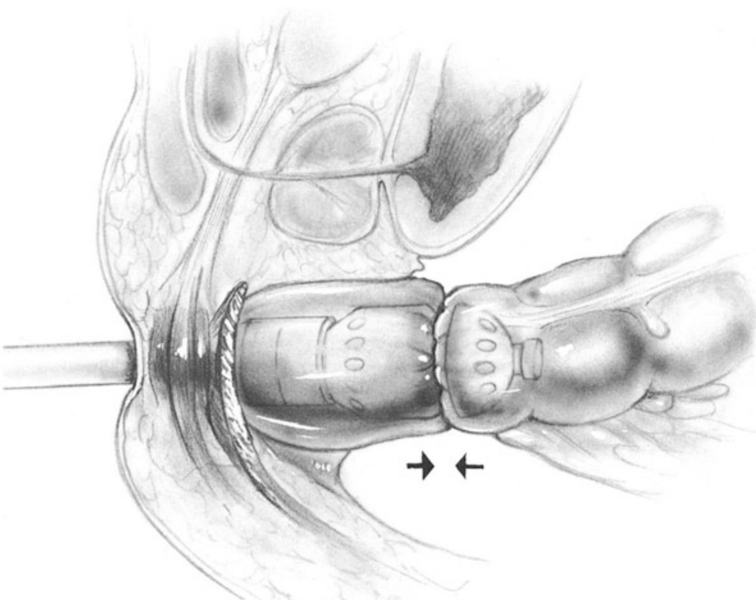


Fig. 39–28

It is vital to observe the integrity of the two purse-string sutures, as any gap in the purse-string closures will cause a defect in the anastomosis.

Now *completely* close the EEA by rotating the wing nut in a clockwise fashion (**Fig. 39–28**). Check the vernier marks to confirm complete closure. This approximates the anvil to the staple cartridge. If closure is not complete, the staples will be too far from the anvil and will not close to form the B shape. Be sure that the vagina, the bladder, and the ureters are not grasped between the anvil and the cartridge during this step.

Unlock the trigger handles, then strongly compress them by applying a very firm grip (**Fig. 39–29**). Check the strength of the compression by observing if the black mark on the shaft of the instrument is in the proper location. If this step is done properly, two circular concentric rows of staples are fired against an anvil while a circular scalpel blade excises the tissues compressed by the two purse-string sutures in the rectum and colon. This results in a circular anastomosis with an internal diameter of 2.1 cm.

Now rotate the wing nut counterclockwise for seven half-turns to separate the anvil from the cartridge. Rotate the EEA at least 180° to the right and then to the left. Remember that the anvil-cap for an EEA-28 device measures 3.2 cm in diameter and that it must be extracted through a stapled anastomosis that has a diameter of only 2.1 cm. Accomplish this by depressing the EEA handle toward the floor, which will elevate the anterior lip of the anvil. This lip should be extracted first. Then the posterior lip can be delivered by elevating the EEA handle. It is sometimes helpful if the assistant grasps the anterior rectal stump with a gauze pad or inserts a Lembert suture to stabilize the staple line while the anvil is being extracted (**Figs. 39–30 and 39–31**).

After the instrument has been removed, turn the

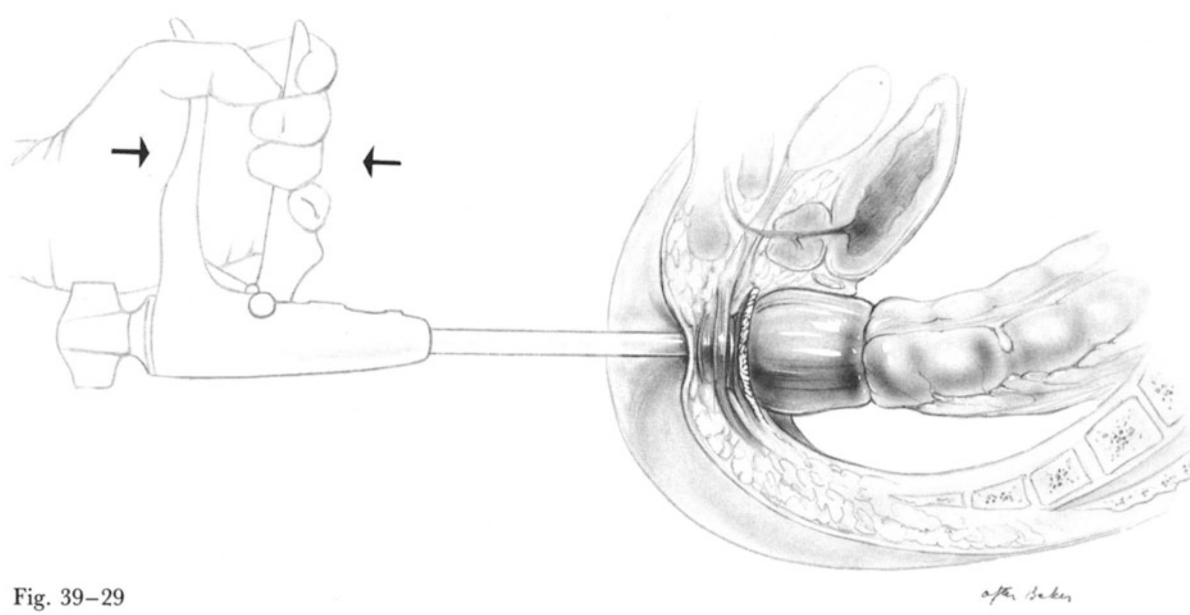


Fig. 39–29

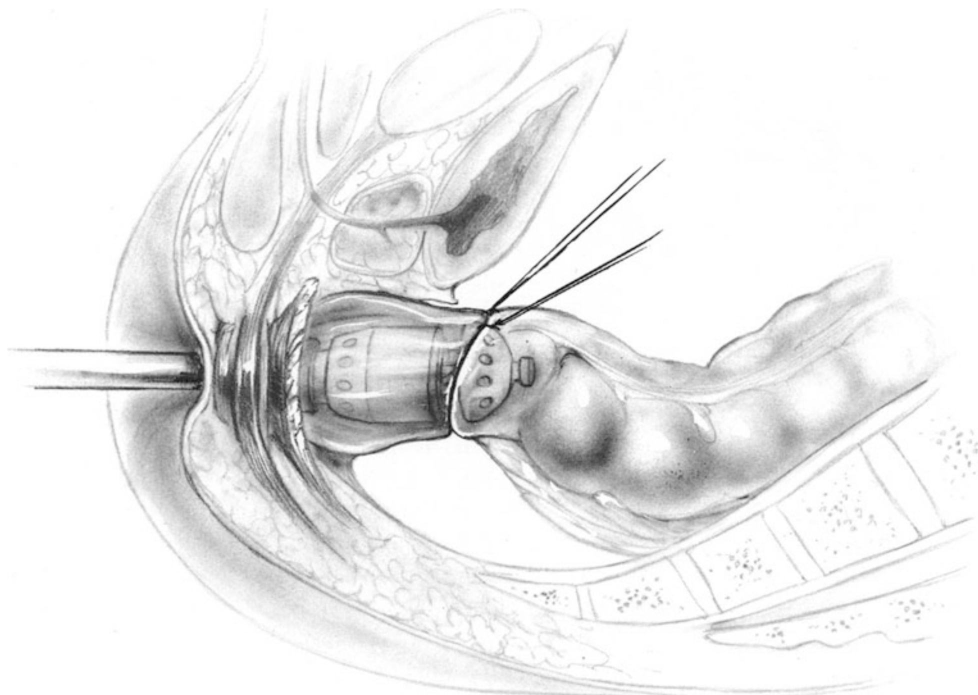


Fig. 39–30

thumb screw on the cap of the staple cartridge counterclockwise, and remove the cap containing the anvil to reveal the segments of rectum and colon that have been amputated. The cartridge should contain two complete circles, each resembling a small doughnut. One represents the proximal margin of the rectum, and the other represents the distal margin of the proximal colon. Any gap in either of the two circles of bowel indicates a defect in the stapled anastomosis, caused by the bowel pulling out of the purse-string before being stapled. The surgeon should seek to locate the repair such defects. A complementary colostomy should also be considered.

The integrity of the stapled anastomosis should now be checked by digital examination. An additional test of integrity is to flood the pelvis with sterile saline. Wait until all air bubbles have disappeared. Apply an atraumatic Doyen clamp to the colon above the anastomosis. The assistant then inserts an Asepto type syringe or a Foley catheter into the anus and pumps air into the rectum while the surgeon palpates the colon. When the colon is inflated with air under only a moderate degree of pressure, observe the pool of saline for air bubbles. Absence of air bubbles is fairly reliable evidence of an intact anastomosis. If air bubbles are detected, attempt to find the source of the leak and repair it with sutures. Create a transverse colostomy if the leak cannot be located or if the suture repair seems unreliable. Another method is to insert a Foley catheter into the rectum and, through it, instill a sterile solution of methylene blue dye. Inspect the

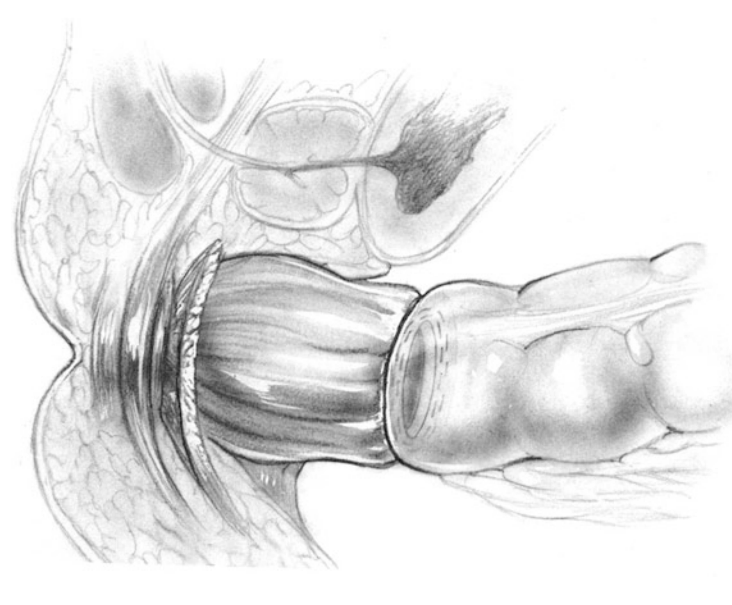


Fig. 39–31

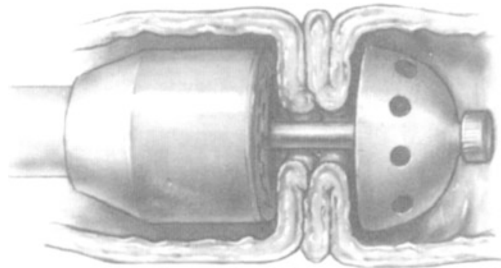


Fig. 39–32

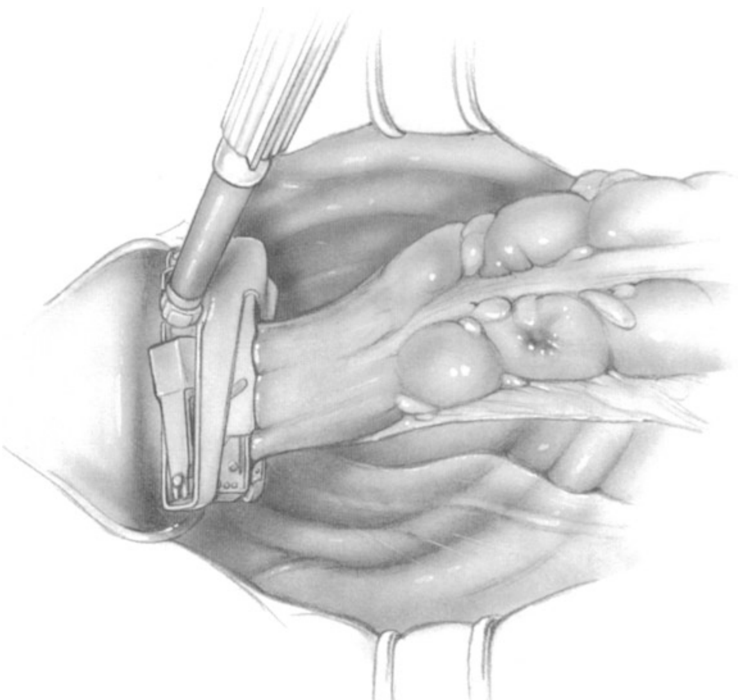


Fig. 39–33

anastomosis for leakage of the dye. Use a sterile angled dentist's mirror to help observe the posterior aspect of the anastomosis.

CEEA Roticulator Technique for Very Low Colorectal Stapled Anastomosis

There are several situations in which the CEEA method of making a colorectal anastomosis is advantageous: First, when the rectum is unusually thick or large, even the EEA-31 cartridge is too small to accommodate the large bulk of tissue in this case. Forcing this large bulk of tissue into the cartridge will result in the extrusion of some of the tissue between the colon and rectum being anastomosed (**Fig. 39–32**). Since the tissue is devitalized, it may interfere with healing and cause leakage. When the rectum is bulky, instead of a purse-string suture, apply the Roticulator-55 stapler and close the rectum with a line of staples. Then amputate the specimen. Now, if a CEEA device is inserted into the rectum, the circular stapled colorectal anastomosis will not encompass a large bulk of rectum, but only a relatively thin circle of rectum, as seen in Fig. 39–36. Second, it is possible to close the rectal stump at a significantly lower level when the Roticulator-55 is used, as it is much simpler to apply in this location than is the insertion of a purse-string suture. Third, in patients who have had a Hartmann operation performed, in performing the colorectal anastomosis to the stump of rectum left behind after the Hartmann operation, inserting the CEEA device into the rectal stump makes the reversal of the Hartmann operation much simpler than would the construction of a sutured colorectal anastomosis.

The anterior resection of the rectum proceeds in the same manner as described above, except that the dissection generally continues further into the pelvis than the average case, as the Roticulator-55 can be inserted closer to the anal canal than other methods of excising the rectum. After dissection has been completed, using the usual retractors on the bladder or uterus, apply the Roticulator-55 to encompass the entire lower rectum and no adjacent pelvic tissues (**Fig. 39–33**). The rectum should be dissected down to the longitudinal muscle on all sides. After firing the stapler, apply a long angled clamp to occlude the proximal rectum and then use the scalpel to divide the rectum flush with the proximal margin of the Roticulator device (**Fig. 39–34**). Locate the upper end of the specimen. Divide the colon and remove the specimen. Insert a 2–0 Prolene purse-string suture close to the cut margin of the colon. Then insert the detached anvil into the colon and tie the purse-string suture (**Fig. 39–35**).

Insert the CEEA cartridge, with the shaft containing the trocar recessed, through the anus into the rectum. Advance the instrument cautiously to the staple line of the closed rectal stump. Rotate the wing nut at the base of the stapler in order to advance the trocar through the rectal stump. Aim at a spot just anterior to the midpoint of the staple line. When the trocar has emerged through the rectal stump, remove the trocar (Fig. 39–35). Now engage the anvil shaft into the cartridge shaft. Under direct vision, slowly close the wing nut in such fashion that the anvil and the cartridge will be properly approximated (**Fig. 39–36**). Then fire the stapler (**Fig.

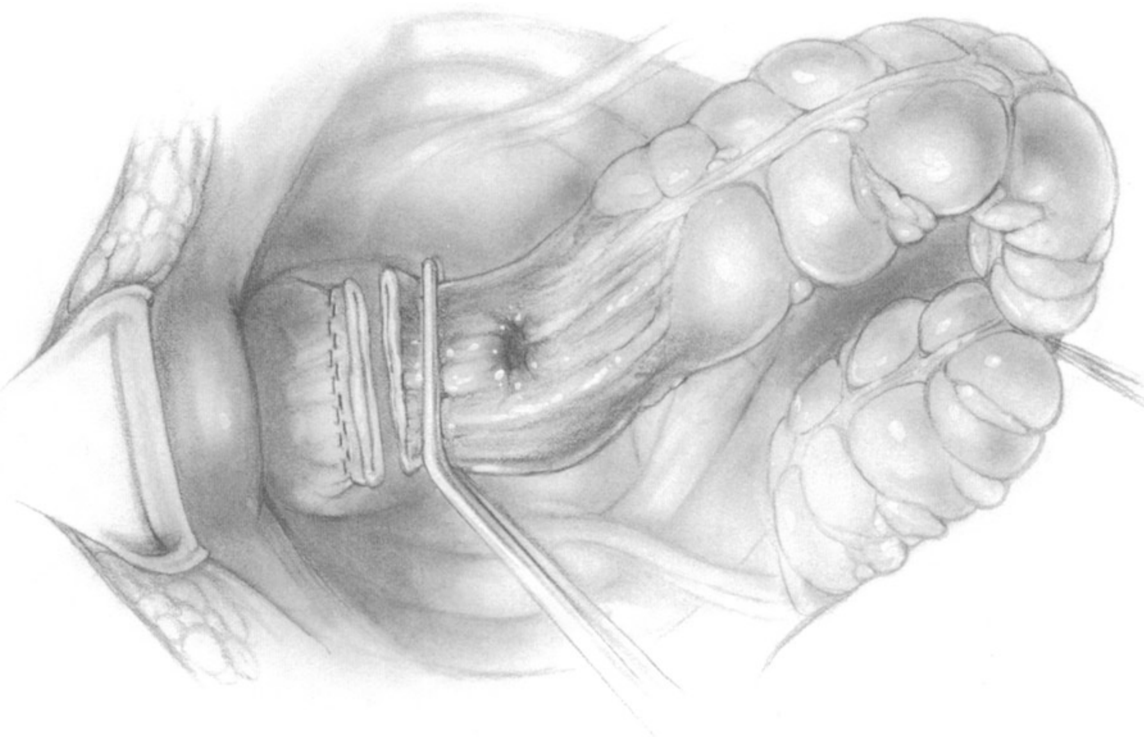


Fig. 39–34

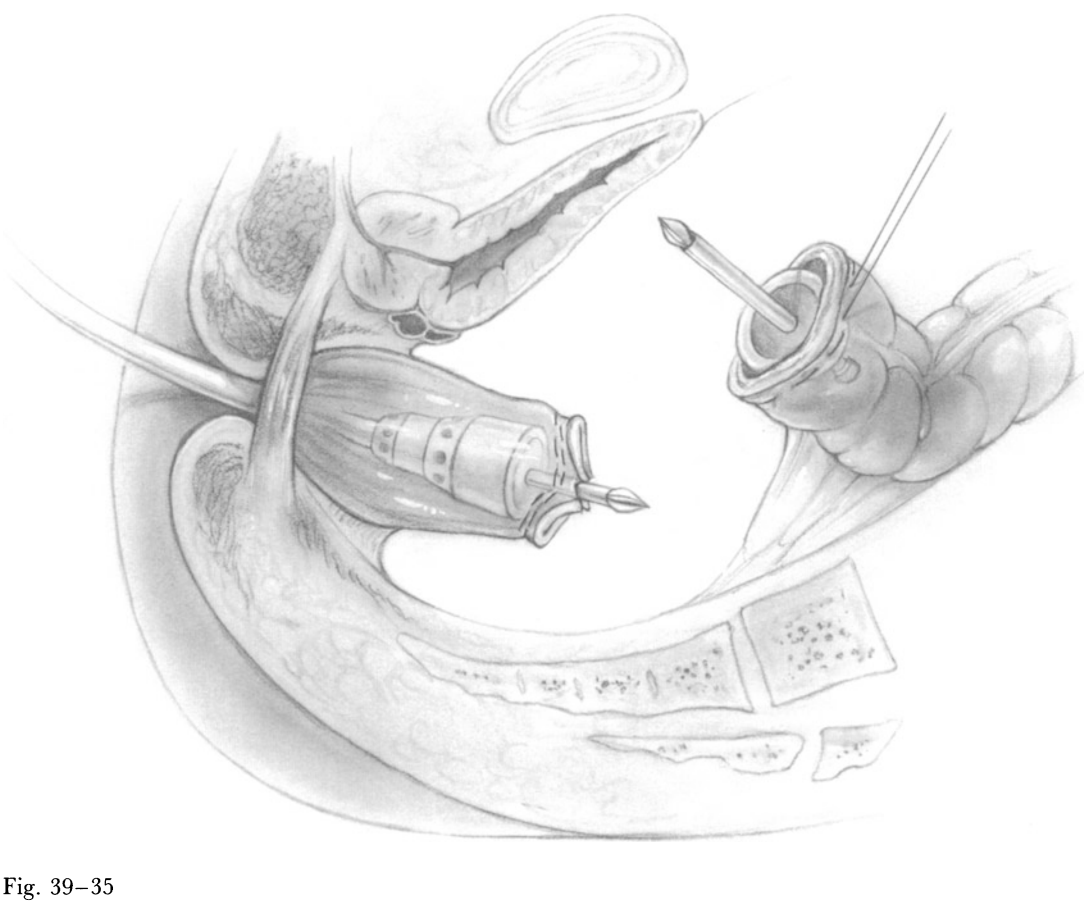


Fig. 39–35

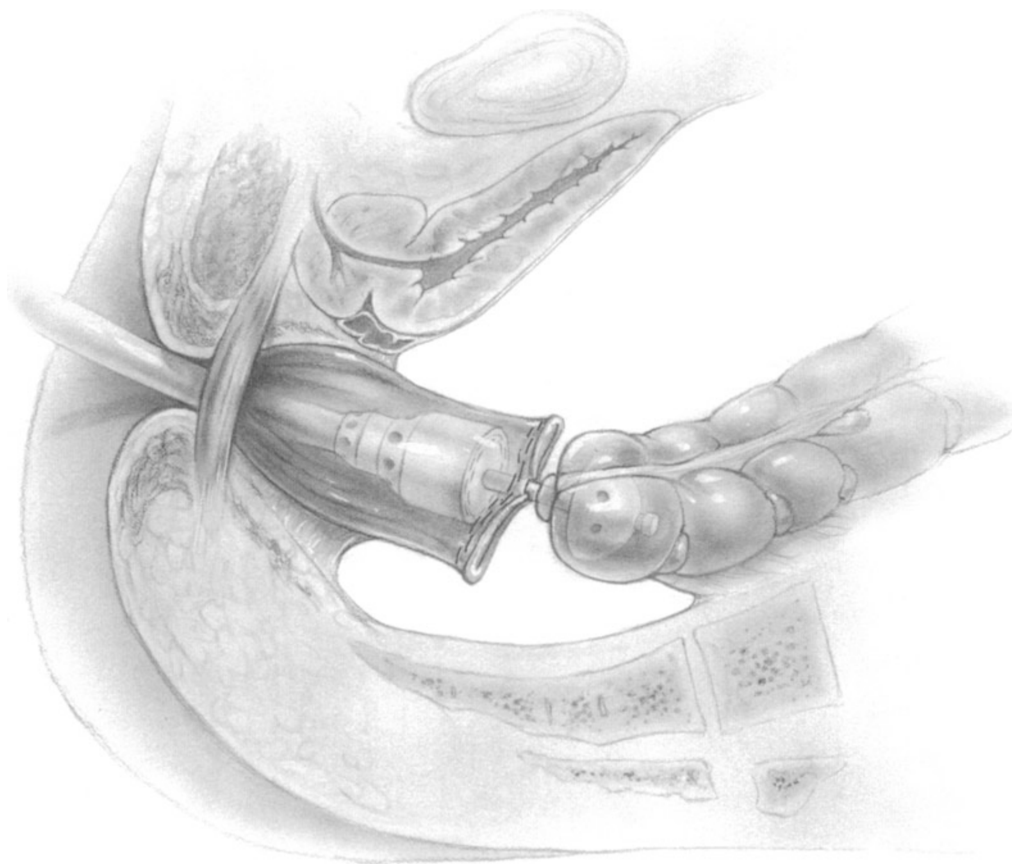


Fig. 39–36

39–37). Now turn the wing nut counterclockwise seven half-turns, thereby separating the anvil from the cartridge. Rotate the CEEA instrument and manipulate the shaft anteriorly and posteriorly to bring the anvil through the anastomosis into the rectum. It may be helpful to insert a single suture around the anterior portion of the anastomosis to apply traction in an anterior direction as the anvil is drawn caudally. Remove the device through the anus. Carefully inspect the anastomosis on all sides. A good way to determine whether the anastomosis is intact is to apply a Doyen atraumatic clamp to the descending colon. Then instill air into the anus with an Asepto syringe, thereby distending the rectum and descending colon. At the same time, fill the pelvis with warm saline. If no air bubbles appear in the saline, the anastomosis would appear to be watertight.

Now disengage the anvil from the CEEA instrument and identify the two doughnuts, one being a circle of rectum and the other being a doughnut of descending colon. If each is intact, it is another indication that the anastomosis has been properly constructed.

If the installation of air into the rectum results in bubbles emerging from the anastomosis, try to locate the source of the bubbles from a defect in the staple line. If it is located, close the defect with Lembert interrupted sutures. If the source of the bubbles cannot be located because of the extremely low location of the staple line, a diverting transverse colostomy is indicated.

Pitfalls and Danger Points of EEA Colorectal Anastomosis

Most defects in the staple line are the result of an imperfect purse-string suture. If the purse-string does not hold the entire cut end of the bowel close to the shaft of the EEA instrument, then the staples cannot catch the complete circumference of the colon or rectum. This results in a defect and postoperative leakage. If complete doughnut-like circles of full thickness of rectum as well as of colon can be identified after the device has been fired, this indicates that the staples have passed through complete circles of bowel and that there should be no defect.

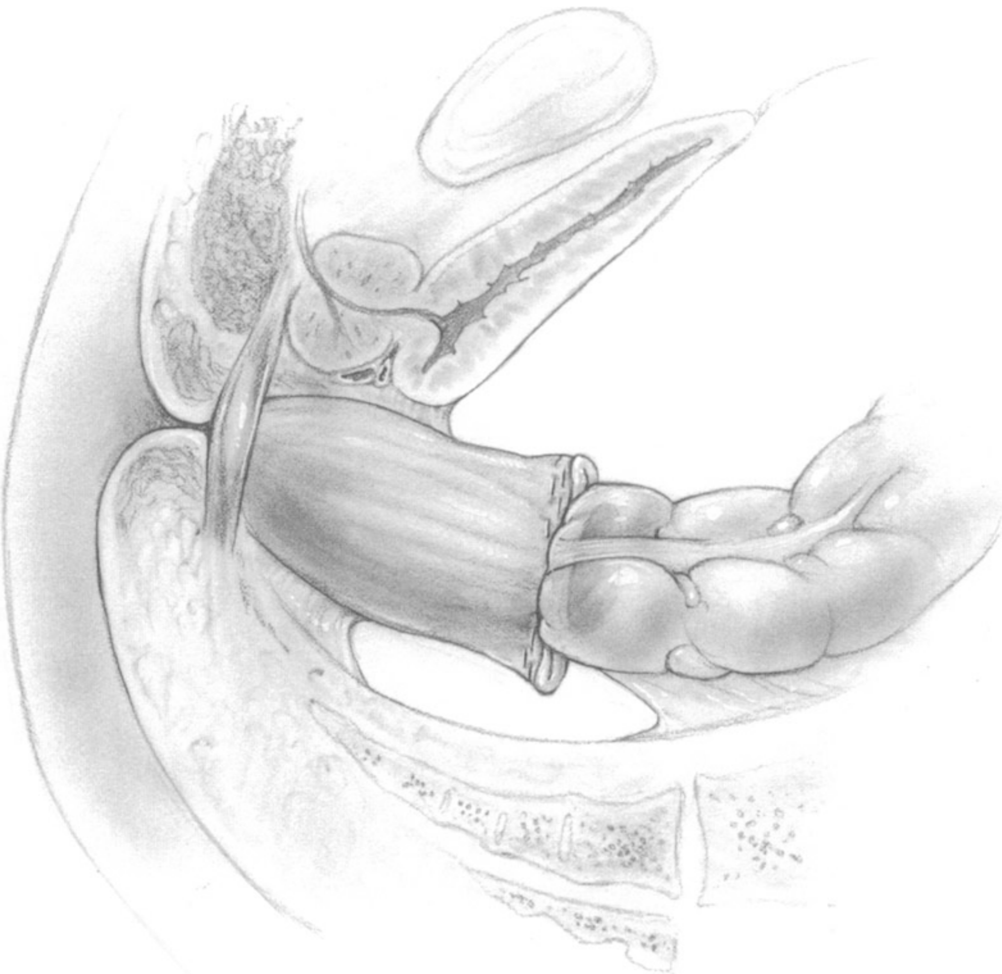


Fig. 39–37

Low colorectal EEA anastomoses fail also when too much bowel is left beyond the purse-string sutures. When an excessive volume of tissue is admitted into the cartridge, the capacity of the cartridge is exceeded. This results in extrusion of tissue when the cartridge is compressed against the anvil. The devitalized extruded tissue may emerge between the two walls of stapled bowel and interfere with healing. It is also essential to remove fat from the two bowel walls in the area where the staples are to be inserted.

One important exception to the use of the whip-stitch is in the case where the rectal diameter is quite large. When a whip-stitch is used to compress a large rectum, it is sometimes impossible to snug the entire diameter up close to the shaft of the EEA. In this case apply a TA–55 or Roticulator stapler to close the rectal stump and use the CEEA technique.

An additional pitfall should be noted. If the trigger handles of the instrument are not compressed fully, the circular scalpel blade fires incompletely. The staples may be driven home, but the redundant colon and rectum within the anvil *do not get cut.* Forceful removal of the EEA device under these conditions will disrupt the entire anastomosis.

When the anvil cannot be disengaged easily, do not use force as this will disrupt the entire anastomosis. Rather, make a colotomy incision on the antimesenteric border of the upper colon 3–4 cm above the staple line. Then, unscrew and remove the anvil through the colotomy. Extracting the EEA device from the anus will now be a simple matter. Inspect the interior of the anastomosis through the colotomy opening. If a septum of inverted bowel remains in the lumen inside the circle of staples, excise the septum using a Potts angled scissors. Close the colotomy with the TA–55 stapler.

An obvious cause of EEA failure is the erroneous use of a cartridge that has been fired already. In this case the circular blade may function, but there are no staples; the surgeon is left with two cut ends of bowel, but no anastomosis. To avoid this error, before attaching the anvil look closely into the cartridge to be certain that it is properly loaded with staples and a circular blade.

Unless the wing nut is loosened by seven counterclockwise half-turns, the EEA cannot be removed from the rectum after firing the staples. This mishap occurs because the anastomosed bowel is still being grasped between the staple cartridge and the anvil, and forceful attempts to dislodge the EEA will disrupt the anastomosis.

As mentioned above, if the screw that caps the anvil is not screwed on tightly, or if the wing nut near the handle is not completely closed before the staples are fired, then the space between the staple cartridge and the anvil will be excessive. This will prevent proper closure of the legs of the staples, in which case the anastomosis may pull apart at the slightest stress.

Never use Hemoclips on any part of the colon or rectum that may possibly be included in the stapled anastomosis because these metal clips will prevent proper function of the staples and the EEA blade.

Intraluminal hemorrhage following an EEA anastomosis occurs if mesenteric blood vessels have been trapped in the staple line and are transected by the blade. Control of bleeding may be achieved by cautious electrocoagulation through a proctoscope or by inserting sutures through a proximal colotomy.

When the stapled anastomosis is situated at or above the cephalad margin of the anal sphincter muscles, i.e., at or above the puborectalis component of the levator muscle, fecal continence will not be lost. However, because the proximal colon segment does not function as a reservoir, the patient will defecate frequently during the first few months. Each peristaltic contraction results in the evacuation of a small, formed stool, but there is no inadvertent loss of stool or liquid.

On the other hand, if the anastomosis is at or below the dentate line, the loss of the internal sphincter results in some degree of fecal incontinence for 3–6 months and *sometimes permanently*.

Goligher (1979) described the insertion of the purse-string suture into the rectal stump by a transanal approach after dilating the anus and inserting a self-retaining bivalve Parks rectal retractor. Goligher recommends this maneuver in cases where the purse-string suture cannot be inserted from the abdominal approach. Unfortunately, the technique of Goligher (1979) results in the excision of the internal sphincter muscle and produces some degree of fecal incontinence if the stapled anastomosis is placed at or below the dentate line. If the transanal approach is used, make every effort to insert the purse-string or whip-stitch into the rectal stump in the upper segment of the anal canal so as to insure retention of the internal sphincter muscle. If proper application of the rectal stitch cannot be achieved, then one can perform a transanal end-to-end sutured anastomosis by the method of Parks, which makes a point of preserving the internal sphincter muscle. *A coloanal anastomosis may be constructed by a technique similar to that described in Chap. 42 for the ileoanal pouch.*

When the rectal stump is too short to insert a purse-string stitch from above, it is usually possible to use the Roticulator stapler instead (see Fig. 39–33).

We are enthusiastic about the CEEA device for colorectal anastomoses that are so low that it would be difficult to use sutures. We have resected tumors 6 cm from the anal verge, using the CEEA with a 2-cm margin of normal tissue, doing a successful stapled anastomosis flush with the upper margin of the anal canal.

Complementary colostomy and presacral drainage should be used following an EEA stapled anastomosis under the same conditions that would lead the surgeon to use these modalities following a sutured colorectal anastomosis. In general, we have not performed complementary colostomy, but routinely employ closed-suction presacral drainage for low extraperitoneal anastomoses.

For stapled intraperitoneal anastomoses above the pelvis, we prefer a functional end-to-end (see Figs. 37–33 through 37–36) or (see Figs. 36–18 and 36–19) anastomosis rather than the EEA procedure. The latter often takes more time and is prone to more technical complications than the functional end-to-end method.

Wound Closure and Drainage

Remove the Wound Protector drape. The surgical team should change its gloves and discard all contaminated instruments. Thoroughly irrigate the abdominal cavity and wound with an antibiotic solution.

Close the incision in the usual fashion.

Postoperative Care

Nasogastric suction for 3–5 days

No oral intake for the first 4–6 days

Continuation of perioperative antibiotics for 24 hours

Constant bladder drainage via Foley catheter for 6–7 days

Presacral suction catheters attached to closed suction drainage

Injection into catheters of 25 ml sterile kanamycin solution every 8 hours

Drainage catheter removed after 5 days unless there is significant volume of drainage

Radiation therapy for Duke's B2 and C cases

Complications

1) *Bladder dysfunction* following low anterior resection may take place, especially in males with prostatism, but it is much less common than after abdominoperineal proctectomy. Generally, after 6–7 days of bladder drainage, function will resume.
2) *Pelvic sepsis* secondary to anastomotic leakage is the most common serious complication following low colorectal anastomosis. Any patient who has fever, leukocytosis, and ileus following low anterior resection should be assumed to have a leaking anastomosis and a pelvic abscess. Clinical manifestations of this complication commonly occur between the sixth and ninth postoperative days. Cautious digital examination of the rectum by the surgeon may prove to be diagnostic if the finger discloses a defect in the suture line, generally on its posterior aspect. Careful proctoscopic examination may disclose evidence of a defect in the suture line.

   The presence of pelvic sepsis can almost always be confirmed by a pelvic CT and can often be treated by CT-guided percutaneous catheter drainage.

   A patient may have sustained a pelvic abscess even in the absence of a definite defect in the suture line. Consequently, a patient who is febrile and toxic should undergo drainage of any septic process if CT-guided percutaneous catheter drainage is not successful. In some cases the patient will also require a transverse colostomy.

   Patients who have mild systemic symptoms and who are suspected of having pelvic infection may be treated by withdrawing food, administering intravenous antibiotics, and hyperalimentation. Occasionally, a presacral abscess drains into the rectum through the anastomosis without making the patient seriously ill. It should be remembered, however, that anastomotic leakage and pelvic sepsis constitute potentially lethal complications that often require vigorous management.
3) *Sexual dysfunction* in the male may follow low anterior resection, especially in patients who have large tumors and require extensive dissection of the presacral space, the lateral ligaments, and the prostatic area.

References

Baker JW. Low end to side rectosigmoidal anastomosis. Arch Surg 1950;61:143.

Goligher JC et al. Anastomotic dehiscence after anterior resection of the rectum and sigmoid. Br J Surg 1970; 57:109.

Goligher JC. Surgery of the anus, rectum and colon. 3rd ed. London: Bailliere, Tindall; 1975:662.

Goligher JC. Use of circular stapling gun with peranal insertion of anorectal purse-string suture for construction of very low colorectal or colo-anal anastomoses. Br J Surg 1979;66:501.

Nivatvongs S, Fang DT. The use of thumbtacks to stop massive presacral hemorrhage. Dis Colon Rectum 1986;29:589–590.

Parks AG, Thomson JPS. Per-anal endorectal operative techniques. In: Rob C, Smith R, eds. Operative surgery, colon, rectum and anus. 3rd ed. London: Butterworth; 1977:157.

Schrock TR et al. Factors contributing to leakage of colonic anastomoses. Ann Surg 1973;177:513.

Zollinger RM, Sheppard MH. Carcinoma of the rectum and the rectosigmoid, a review of 729 cases. Arch Surg 1971;102:335.

40 Abdominoperineal Proctosigmoidectomy for Cancer

Indications

Adenocarcinoma of distal rectum

Carcinoid of lower rectum if invasive or over 1.8 cm in diameter

Squamous carcinoma of anus near dentate line if recurrent after radiation and chemotherapy

Preoperative Preparation

Sigmoidoscopy and biopsy

Barium colon enema or colonoscopy

Correction of anemia if necessary

Intravenous pyelogram if indicated by tumor size or location

Bowel preparation as outlined in Chap. 34

Indwelling Foley catheter in bladder

Nasogastric tube

Perioperative antibiotics

Pitfalls and Danger Points

Hemorrhage

Presacral veins

Left iliac vein

Middle hemorrhoidal artery

Hypogastric arterial branches

Gastrointestinal

Rupture of rectum during dissection

Colostomy ischemia, producing postoperative necrosis

Colostomy under excessive tension, leading to postoperative retraction and peritonitis

Separation of pelvic peritoneal suture line, causing herniation and obstruction of small intestine; inadequate mobilization of pelvic peritoneum, resulting in failure of newly constructed pelvic floor to descend completely; resulting empty space encourages sepsis

Genitourinary

Ureteral trauma, especially during dissection in vicinity of lateral ligaments of rectum; inadvertent ureteral ligation; especially during reconstruction of pelvic floor

Urethral laceration during dissection of perineum in males

Operative Strategy

Abdominal Phase

Presacral Dissection: Prevention of Hemorrhage

Contrary to what apparently is a widely held perception, radical cancer surgery does *not* require stripping the presacral region down to the periosteum. The dissection of the perirectal tissues proximal to the carcinoma is necessary for the removal of *tumor emboli* within the lymph nodes and lymphatic channels. If tumor has invaded widely into the mesorectum and presacral tissues, the lesion is generally beyond cure by radical surgery.

There is a network of veins lying on the presacral periosteum that drain into the sacral foramina (see Fig. 40–6b). When these are torn by blunt dissection, clamping or ligation to control the hemorrhage that results often is impossible, since the torn vessel retracts into the foramen. The massive venous hemorrhage that can follow cannot be stemmed by ligating the hypogastric arteries. Most intraoperative fatalities during total proctectomy are caused by this type of presacral venous hemorrhage.

Nivatvongs and Fang described a new method of controlling massive hemorrhage from a torn presacral branch of the basivertebral vein. Because the blood pours out of one of the sacral foramina, they proposed occluding the foramen with a titanium thumbtack (Hemorrhage Occluder Pin, Surgin Co., Placentia, CA 92670) that is left permanently in place. To accomplish this step effectively, first demonstrate that the blood is emerging from a single foramen. If the bleeding is controlled by applying the fingertip to one foramen, then applying the thumbtack will be effective. In some cases stuffing some cottonoid Oxycel (oxidized cellulose) into the foramen before inserting the thumbtack may be helpful.

If the surgeon cannot very quickly control lacerated presacral veins with a thumbtack, a suture, or bone wax, the bleeding area should be covered with a sheet of Surgicel, over which a large gauze pack should be placed, filling the sacral hollow. This almost always controls the hemorrhage.

Unless the presacral vessels are directly invaded by a bulky tumor of the midrectum, massive presacral venous hemorrhage is entirely preventable. Blunt hand dissection of the presacral space is not a desirable technique. The surgeon's hand does not belong in this area until scissors or electrocoatery dissection under direct vision has freed all the perirectal tissues from any posterior attachments to the sacrum. This should be done with a long Metzenbaum scissors, combined with gentle upward traction on the rectum. As the scissors are inserted on each side of the midline, the perirectal tissues can easily be lifted in an anterior direction *without removing the thin layer of endopelvic fascia that covers the presacral veins*. When the presacral dissection stays in the proper plane, the presacral veins are hidden from view by this layer of fascia, as Fig. 40–6a shows. Occasionally, branches of the middle sacral vessels enter the perirectal tissues from behind. These may be divided with the cautery.

This dissection is easily continued down to the area of the coccyx, where the fascia of Waldeyer becomes dense as it goes from the anterior surfaces of the coccyx and sacrum to attach to the lower rectum (see Fig. 40–8). Attempts to penetrate this fascia by blunt finger dissection may rupture the rectum rather than the fascia, which is strong. This layer must be incised sharply with a scissors or scalpel. When the posterior dissection has for the most part been completed, only *then* should the surgeon's hand enter the presacral space to sweep the dissection toward the lateral pelvic walls. This maneuver helps define the lateral ligaments. If this is done properly, the presacral veins will be covered by a thin layer of tissue and will not be visible. The dissection should be bloodless.

Other points of hemorrhage in the pelvic dissection may occur on the lateral walls. These can usually be readily identified and occluded by ligation or Hemoclips. Close attention should also be paid to the left iliac vein, which may be injured in the course of the dissection. As most serious bleeding in pelvic dissections is of venous origin, we do not ligate the hypogastric arteries routinely.

Presacral Dissection: Preservation of Hypogastric Nerves

As the rectum is elevated from the presacral space and the anterior surface of the aorta cleared of areolar and lymphovascular tissue, a varying number of preaortic sympathetic nerves of the superior hypogastric plexus can be identified. These are the contribution of the sympathetic nervous system to the bilateral inferior hypogastric (pelvic) plexuses. In males their preservation is necessary for normal ejaculation. After they cross the region of the aortic bifurcation and sacral promontory, they coalesce into two major nerve bundles, called the hypogastric nerves. Each nerve, which may have 1–3 strands, runs toward the posterolateral wall of the pelvis in the vicinity of the hypogastric artery (see Figs. 40–2 and 40–4). We agree with Goligher (1975) that in most malignancies of the distal rectum, these nerves can be preserved without compromising the patient's chances of cure.

After the inferior mesenteric artery and vein are divided and the lymphovascular tissues elevated from the bifurcation of the aorta by blunt dissection, the sympathetic nerves remain closely attached to the aorta and need not be damaged if the dissection is gently performed. At the promontory of the sacrum, if the rectum is dissected as described above, the right and left hypogastric nerves can be seen posterior to the plane of dissection and can be preserved—provided there is a sufficient distance separating them from the tumor. There also seems to be a diminution in the incidence of bladder dysfunction after nerve preservation.

Ureteral Dissection

To prevent damage to the ureters, these delicate structures must be identified and traced well down into the pelvis. The normal ureter crosses the common iliac artery at the point this structure bifurcates into its external and internal branches. Because the ureter and a leaf of incised peritoneum are often displaced during the course of dissection, if the ureter is not located in its usual position, the undersurfaces of both the lateral and medial leaves of peritoneum should be inspected. The identity of the ureter can be confirmed if pinching or touching the structure with a forceps results in typical peristaltic waves. If doubt exists, the anesthesiologist may be instructed to inject indigo carmine dye intravenously; this stains the ureter blue, unless the patient is oliguric at the time of injection. The ureter should be traced into the pelvis beyond the point at which the lateral ligaments of the rectum are divided.

Inferior Mesenteric Artery Ligation and Preaortic Node Dissection

The highest point to which it is practical to extend the lymph node dissection in patients who have rectal cancer is the junction of the inferior mesenteric artery and the aorta. Ligation of the artery at this point, together with a preaortic lymph node dissection, has been recommended as a routine procedure. There are not yet sufficient data on postoperative survival to validate this level of ligation. The generally accepted apex point of the dissection (inferior mesenteric artery just distal to the takeoff of the left colic) (see Fig. 35–6) is located only about 4 cm from the aorta. Most of the lymphatic tissue in the intervening 3–4 cm can usually be swept downward with the specimen. On the other hand, if the surgeon notes that the lymph nodes near the aorta contain metastases in the proximal portion of the mesentery, then high ligation of the inferior mesenteric artery at the aorta may be performed (see Fig. 35–7).

Colostomy

The colostomy may be brought out through the left lower quadrant musculature, through the midline abdominal incision, or through the belly of the left rectus muscle. If the colostomy is brought out laterally, either the 3–5 cm gap between the colon and the lateral portion of the abdominal wall should be closed or a retroperitoneal colostomy should be performed. Otherwise the small bowel may become incarcerated in the lateral space. On the other hand, if the colostomy is brought out somewhere near the midline of the abdomen, there is no need to close this space, which becomes so large that movement of small bowel can take place freely without complication.

Goligher (1958) reported a method of bringing the colostomy through a retroperitoneal tunnel to the opening in the abdominal wall sited in the lateral third of the rectus muscle a few centimeters below the umbilicus. When the peritoneal pelvic floor is suitable for closure by suturing, this technique is another satisfactory method of creating the sigmoid colostomy (see Figs. 40–29 to 40–32).

To prevent necrosis of the colostomy, one must be certain there is adequate arterial blood flow to the distal portion of the exteriorized colon, just as would be required if an anastomosis were made at this point. Even in the presence of adequate arterial flow, ischemia of the colostomy may occur if an obese mesentery is constricted by a tight colostomy orifice.

Postoperative retraction of the colostomy may be brought on by abdominal distention that causes migration of the abdominal wall in an anterior direction. For this reason the limb of colon to be fashioned into a colostomy should protrude without tension for a distance of 5 cm beyond the level of the abdominal skin before any suturing takes place.

Immediate maturation of a colostomy, accomplished by inserting a mucocutaneous suture line between the colon and the subcuticular layer of the skin, has resulted in the virtual elimination of postoperative stricture and prolapse. If the maturation procedure is performed, retraction will not occur even though *no* additional sutures other than those attaching the colon to the subcuticular region are used.

Pelvic Floor

Because intestinal obstruction due to herniation of the ileum into a defect in the reconstructed pelvic floor is a serious complication, a number of surgeons now omit the step of resuturing the pelvic peritoneum. If no attempt is made to reperitonealize the pelvic floor, the small bowel will descend to the level of the sutured levators or subcutaneous layers of the perineum. Intestinal obstruction in the immediate postoperative period does not appear to be very common following this technique. However, if intestinal obstruction does occur at a later date, it becomes necessary to mobilize considerable small bowel, which is bound down by dense adhesions in the pelvis. This often results in damage to the intestine, requiring resection and anastomosis to repair it. Thus it appears logical to attempt primary closure of the pelvic peritoneum to prevent this complication, provided enough tissue is available for closure without undue tension. The peritoneal floor should be *sufficiently lax to descend to the level of the reconstructed perineum.* This eliminates the dead space between the peritoneal floor and the other structures of the perineum. As total proctectomy is done primarily to remove lesions of the lower rectum, there is no need for a radical resection of the perirectal peritoneum. One should conserve as much of this layer as possible. If it appears that a proper closure will not be possible, it is preferable to leave the floor entirely open. Otherwise the dead space between the peritoneal diaphragm and the perineal floor often leads to disruption of the peritoneal suture line and to bowel herniation.

Creating a vascularized pedicle of omentum is a good way to fill the pelvic cavity with viable tissue and to prevent the descent of small bowel into the pelvis.

Perineal Phase

Position

Turning the patient to a prone position provides the best exposure for the surgeon, but imposes a number of disadvantages upon the patient. First, circulatory equilibrium may be disturbed by turning the patient who is under anesthesia. Also, changing positions prolongs the operative procedure, as it is not possible to have one member of the surgical team close the abdominal incision while the perineal phase is in process. Similar objections can be raised about the lateral Sims position.

In recent years we have favored the position described by Lloyd-Davies, in which the patient lies supine, with the sacrum elevated on a folded sheet or sandbag and the lower extremities supported by Lloyd-Davies leg rests, causing the thighs to be widely abducted but flexed only slightly, while the legs are supported and moderately flexed. The mild flexion of the thighs does not interfere in any way with the abdominal procedure, and the second assistant can stand comfortably between the patient's legs while retracting the bladder (see Figs. 40–1a and 40–1b).

This position is identical with that used for the synchronous two-team method of performing a total proctectomy. Whether the abdominal and perineal phases are carried on synchronously by two operating teams or whether one team does the complete procedure, positioning the patient in this manner gives the surgeon the option of doing some portions of the procedure from below and then switching to the abdominal field in response to the exigencies of a particular step. This facilitates the safe lateral dissection of large tumors, as well as the achievement of complete hemostasis in the pelvis. Some vessels may be easier to control from below and some should be clamped from above. In addition, after the surgeon has completed suturing the pelvic peritoneum, suction can be applied from below to determine if there is a dead space between the pelvic floor and the perineal closure. After removing the specimen it is fairly simple to have closure of both the abdomen and perineum proceed simultaneously.

Closure of Perineum

Traditionally, after the perineal excision of the rectum the surgeon inserted a large gauze pack into the presacral space and closed the perineal skin loosely around the pack. The gauze was removed somewhere between the third and seventh postoperative day. This resulted in a huge open perineal wound, which required repeated irrigations, sitz baths, and a number of months for complete healing. Secondary infection of the large cavity was not uncommon.

If there has been no fecal spillage in the pelvis during the course of resection, and if good hemostasis has been accomplished, there is no need to leave the perineal wound open. Primary healing has been obtained in the vast majority of our patients operated upon for malignancy when the perineum is closed per primam with the insertion of a closed-suction drainage catheter. Kanamycin in a dose of 25 mg in 25 ml saline is injected into the catheter every 8 hours for the first 5 days. This serves the dual purpose of keeping the catheter open and instilling antibiotics into the retroperitoneal space. Suction applied to the catheter draws the reconstructed peritoneal pelvic floor downward to eliminate any empty space.

In patients who are experiencing major presacral hemorrhage, the area should be tamponaded with a sheet of Surgicel covered by a large gauze pack, which is brought out through the perineum. The gauze should be removed in the operating room on the first or second postoperative day.

In patients who have experienced contamination of the pelvis during the operation, the perineum should be closed only partially and drained with both latex and sump drains, followed by frequent postoperative irrigations with an antibiotic solution.

In female patients, management of the perineum depends on whether one has elected to remove the posterior vagina. For small anterior malignancies, the adjacent portion of the posterior vagina may be removed with the specimen, leaving sufficient vagina for primary closure of this organ with PG. When the entire posterior vaginal wall has been removed along with large anterior lesions, the perineum should be closed with sutures to the levator muscles, the subcutaneous fat, and the skin. This leaves a defect at the site of the vaginal excision, through which loose gauze packing should be inserted. If there is primary healing of the perineal floor, granulation will fill up this cavity and vaginal epithelium will regenerate in 1–3 months. Vaginal resection need not be done in cases of tumors confined to the posterior portion of the rectum.

Dissection of Perineum

The most serious pitfall in the perineal dissection is an inadvertent transection of the male urethra. This may be avoided if the anterior part of the dissection is delayed until the levator muscles have first been divided throughout the remainder of the circumference of the pelvis and the prostate identified. It is important not to divide the rectourethralis muscle at a point more cephalad than the plane of the posterior wall of the prostate (see Fig. 40–21). Alternatively, one should identify the transverse perineal muscles. If the dissection is kept on a plane posterior to these muscles, the urethra is out of harm's way.

Hemostasis

All bleeding during the perineal dissection can be controlled by the accurate application of electrocoagulation. Here, as elsewhere in abdominal surgery, if electrocoagulation is applied to a vessel that is well isolated from surrounding fat, ligature will not be necessary. Whether electrocoagulation is applied directly to a bleeding point or to a forceps or hemostat depends on the preference of the surgeon. With the cautery device it is possible to obtain complete control of bleeding in this area without undue loss of blood or time.

Operative Technique

Position

Place the patient in the supine position, with the sacrum elevated on several folded sheets or a sandbag and the thighs flexed only slightly but abducted sufficiently to allow adequate exposure of the perineum. The legs should be flexed slightly and the calves padded with foam rubber and supported in Lloyd-Davies leg rests (**Figs. 40–1a and 40–1b**). If the thighs are not flexed excessively, there will be no interference with the performance of the abdominal phase of the operation. The second assistant should stand between the patient's legs during the abdominal phase. Bring the indwelling Foley catheter over the patient's groin and attach it to a plastic tube for gravity drainage into a bag calibrated to facilitate measurement of hourly urine volume. In males fix the scrotum to the groin with a suture. Close the anal canal with a heavy purse-string suture.

Carry out routine skin preparation of the abdomen, perineum, and buttocks. Drape the entire area with sterile sheets. After these steps have been completed, the operation can be performed either with two teams working synchronously or one team alternating between the abdomen and the perineum.

Incision and Exploration: Operability

Make a midline incision beginning at a point 8 cm above the umbilicus and continuing to the pubis (see Fig. 40–1a). Separate the pyramidalis muscles as the pubis is approached, for coming an extra 1–2 cm closer to the pubis improves the exposure significantly. Open the peritoneum and carry out general exploration. If one or two isolated liver metastases are identified and the patient has an otherwise resectable lesion, the solitary metastases should be individually excised, as the 5-year survival rate in cases of this type has been reported by Foster and Berman to approach 20%.

In most cases the resectability of a rectal carcinoma cannot generally be determined until a later step in the operation, when the presacral space is open. If the liver is heavily invaded by metastases, a proctectomy should not be performed. One exception to this rule is patients who are experiencing severe tenesmus or bleeding, as these symptoms are not usually relieved by colostomy alone. If the prognosis is that the patient will survive for more than 1 year, proctectomy should be performed when it is anatomically feasible.

As for anatomical resectability, when a tumor invades the sacrum posteriorly or the prostate anteriorly, attempting to core out the rectum by forcing a plane through the tumor is a fruitless and sometimes dangerous endeavor. If much tumor is left behind in the presacral space, then the palliation attained is negligible, for if it should invade the presacral nerves it will produce the most distressing of all symptoms in this disease, extreme perineal pain. On the other hand, many tumors may be firmly adherent to the sacrum without actually having invaded it. These should be resected. Cases of borderline resectability may benefit from a course of radiation prior to operation.

Patients who suffer from obstruction secondary to nonresectable rectal cancer may benefit from endoscopic laser therapy, which can often maintain colorectal patency.

Local invasion of the ureter does not contraindicate resection, as the divided ureter at this low level can be implanted into the bladder.

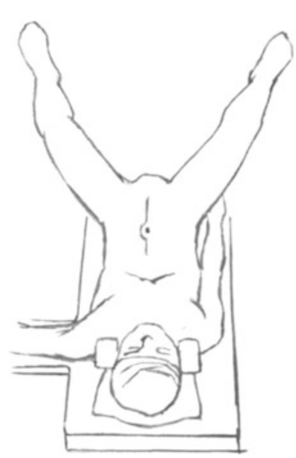


Fig. 40–1a

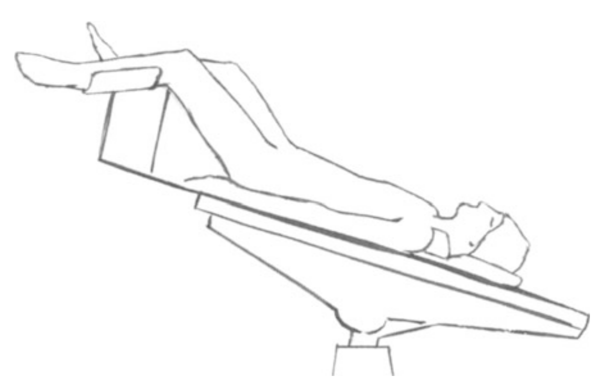


Figure 40–1b

Mobilization of Sigmoid

With the patient in the Trendelenburg position, exteriorize the small intestine. By drawing the sigmoid colon medially, several congenital attachments between the mesocolon and the posterolateral parietal peritoneum can be divided up to the mid-descending colon (**Fig. 40–2**). After doing so, identify the left ureter. If its course has not been altered by surgical dissection or pathological changes, the ureter crosses the common iliac artery at the point where the iliac artery bifurcates into its internal and external branches. Tag the ureter with a Vesseloop for later identification.

Use a scissors to continue the peritoneal incision along the left side of the rectum down to the recto-

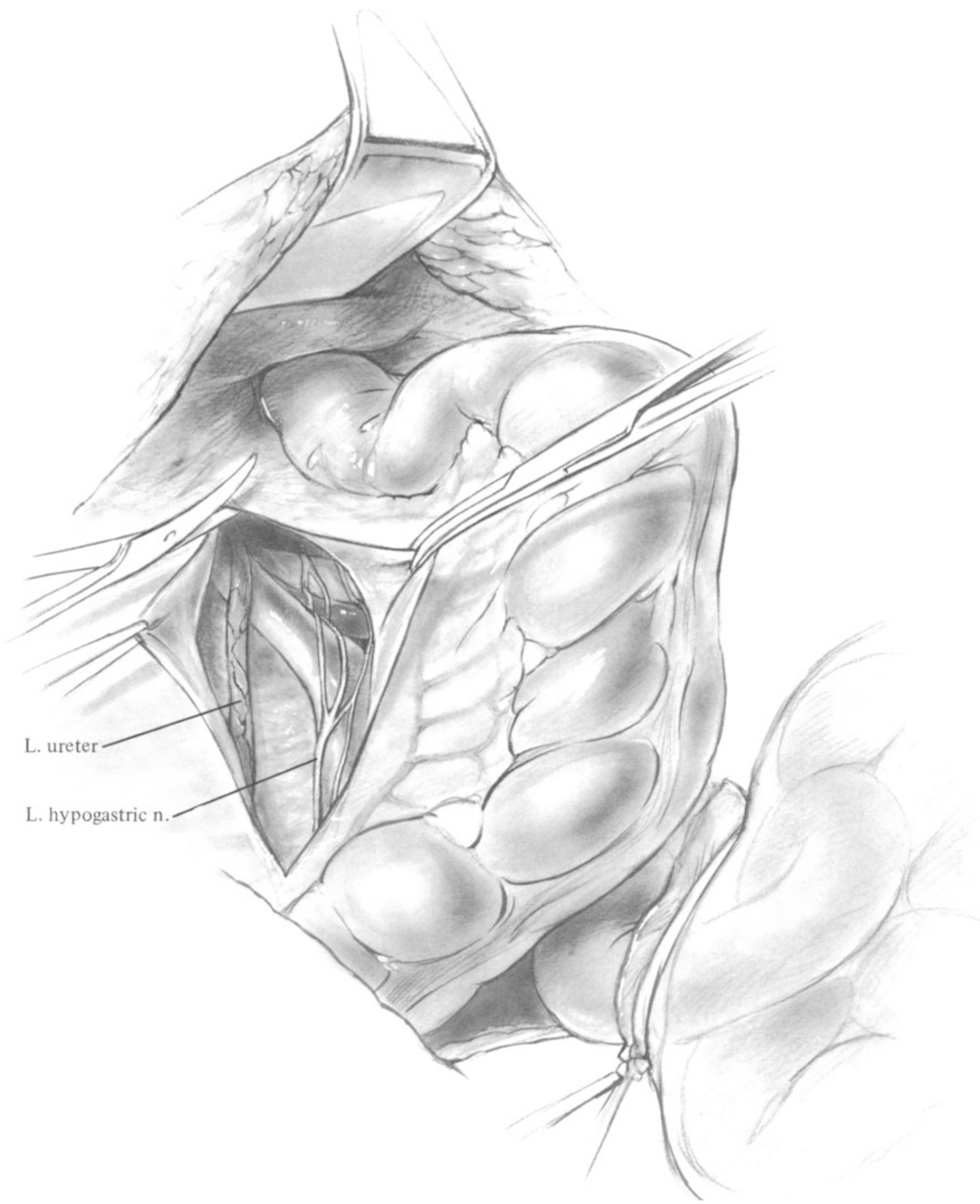


Fig. 40–2

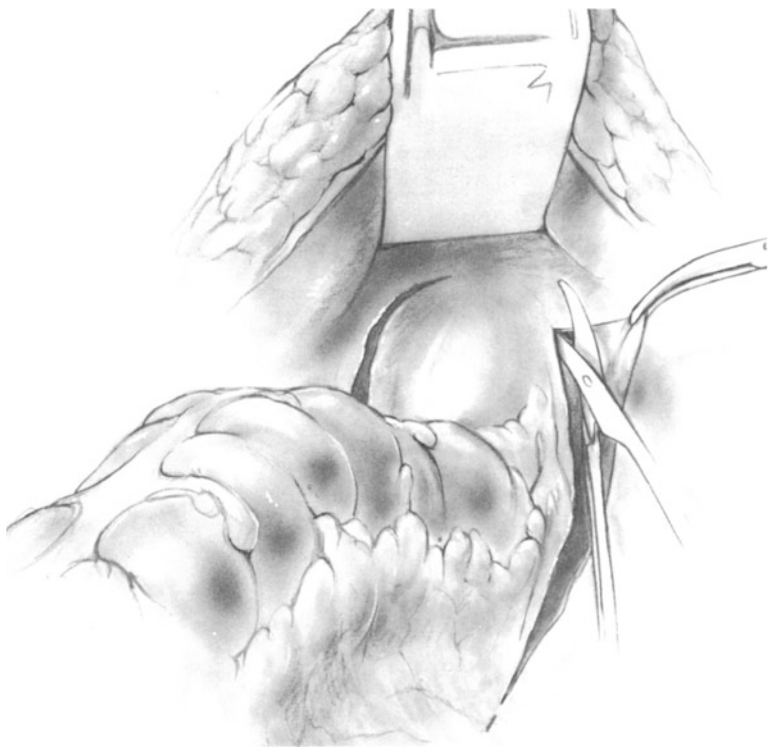


Fig. 40–3

vesical pouch (**Fig. 40–3**). Identify the course of the ureter well down into the pelvis. Tumors that are managed by total proctectomy nowadays are located below the peritoneal reflection. In operating on them, the incision in the peritoneal floor of the pelvis should be designed to preserve as much peritoneum as possible.

Retract the sigmoid to the patient's left and make an incision on the right side of the sigmoid mesocolon. Begin at a point overlying the bifurcation of the aorta and continue in a caudal direction along the line where the mesosigmoid meets the right lateral leaf of peritoneum in the presacral space. Carry this incision down toward the rectovesical pouch after the right ureter has been identified (Fig. 40–3).

If exposure is convenient, incise the peritoneum of the rectovesical pouth, or rectouterine pouch in the female (**Fig. 40–4**). If exposure is not convenient, this step should be delayed until the presacral dissection has elevation the rectum suffciently to bring the rectovesical pouch easily into the field of vision.

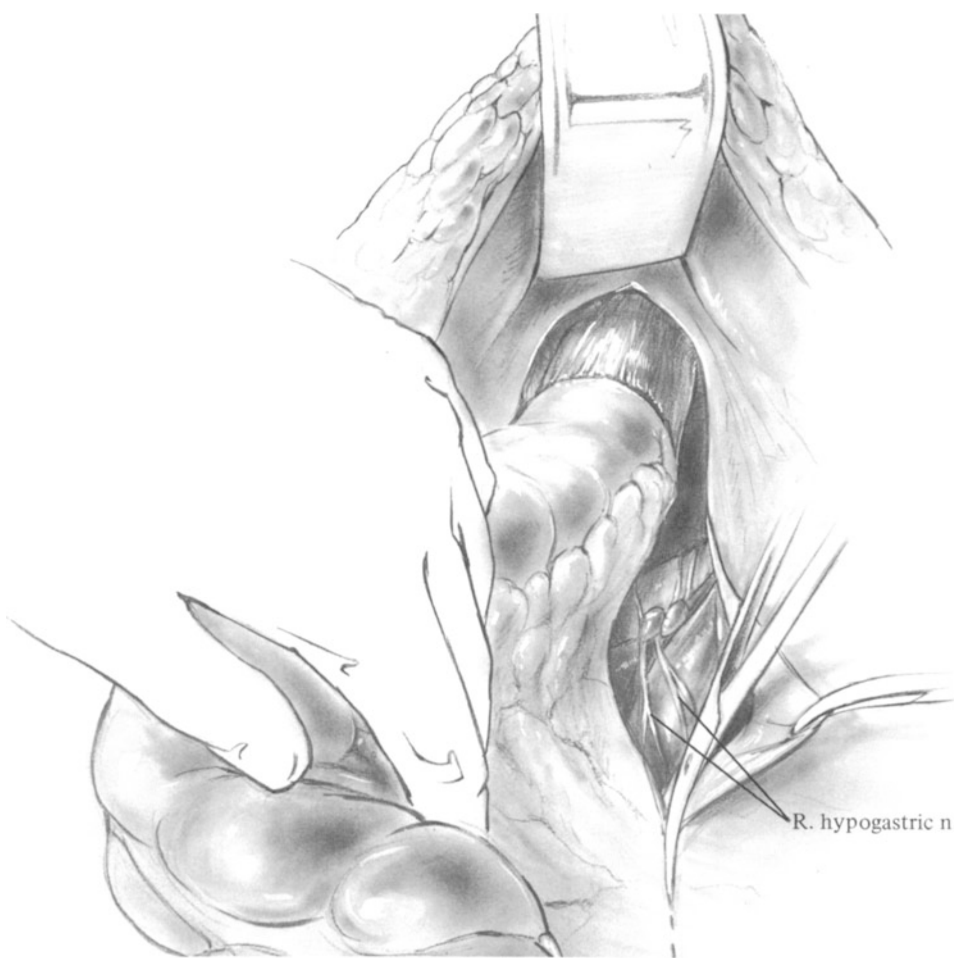


Fig. 40–4

Lymphovascular Dissection

Apply skyward traction to the colon, gently separate the gonadal vein from the lateral leaf of the mesocolon, and allow it to fall to the posterior. Insert an index finger between the deep margin of the mesosigmoid and the bifurcation of the aorta to feel the pulsation of the inferior mesenteric artery lying superficial to the finger. In patients who are markedly obese this vessel may be divided and ligated at the level of the aortic bifurcation without further dissection. In most patients, however, it is quite simple to incise the peritoneum overlying the origin of the inferior mesenteric artery, and to sweep the areolar and lymphatic tissue downward until one sees the point at which the inferior mesenteric artery gives off the left colic branch (Fig. 40–5).

In routine cases divide the inferior mesenteric vessels between 2–0 ligatures just distal to this junction. Then make a superficial scalpel incision along the surface of the mesosigmoid: begin at the point where the inferior mesenteric vessels were divided and continue to the wall of the sigmoid. Complete the division of the mesentery along this line by dividing it between serially applied Kelly hemostats and then ligating with 2–0 PG (**Fig. 40–5**). In nonobese patients it is feasible to incise the peritoneum up to the point where a vessel is

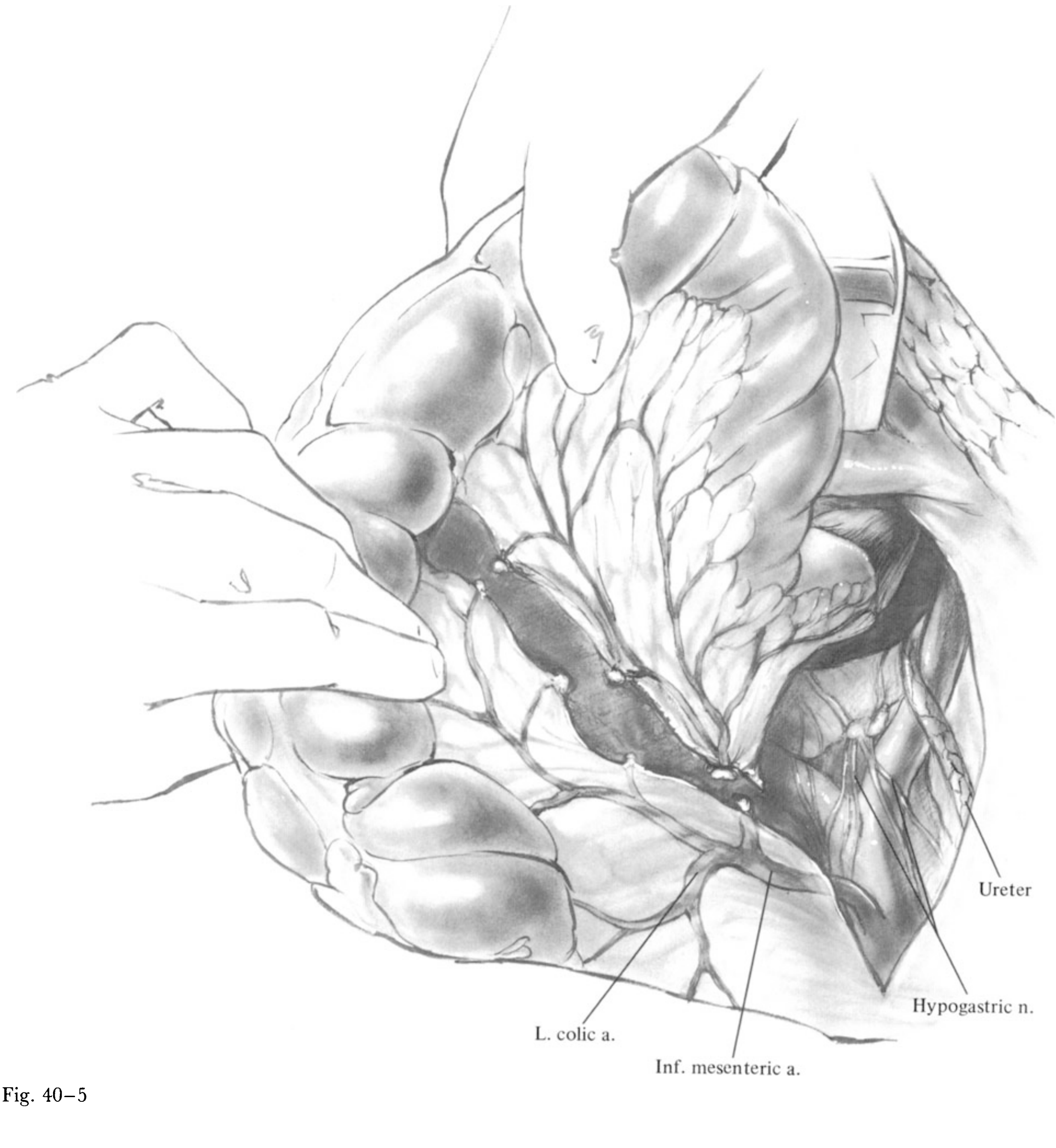


Fig. 40–5

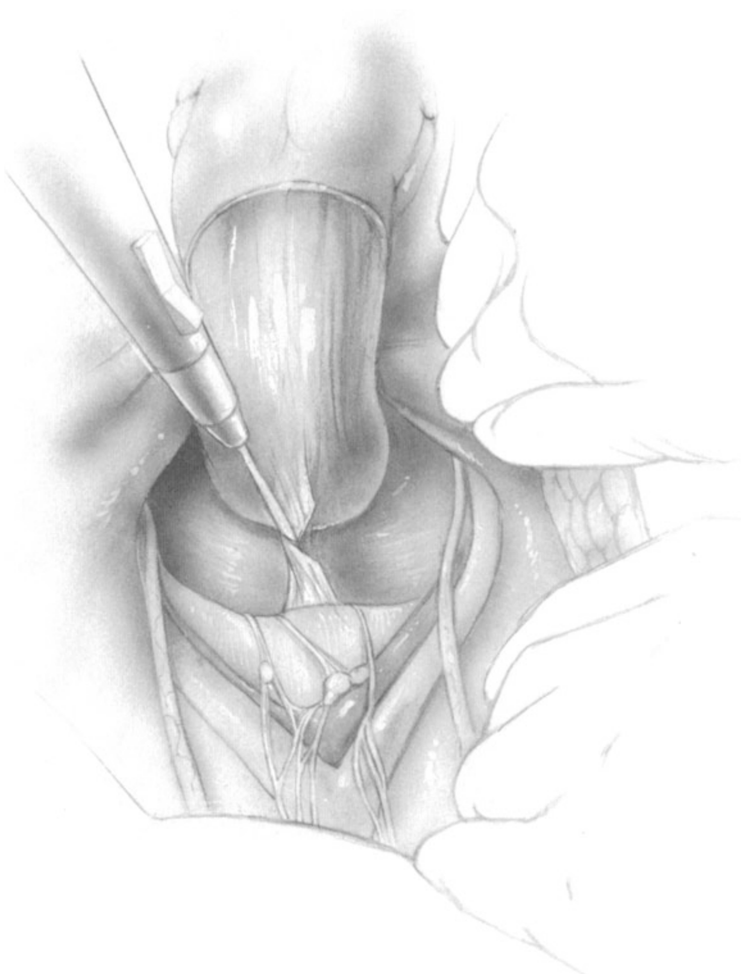


Fig. 40–6a

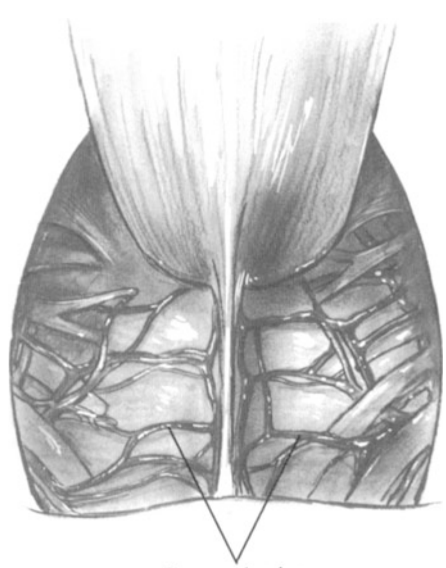


Fig. 40–6b

visualized and then to apply hemostats directly to each vessel as it is encountered. With this technique, the surgeon will encounter only one or two vessels on the way to the marginal artery of the colon.

Sweep the mesosigmoid and the lymphovascular bundle (distal to the ligated inferior mesenteric vessels) off the anterior surfaces of the aorta and common iliac vessels by blunt dissection. Leave the preaortic sympathetic nerves intact. To minimize the time during which the patient's abdomen is exposed to possible fecal contamination, do not divide the sigmoid colon at this stage.

Presacral Dissection

With the lower sigmoid on steady upward retraction, it becomes evident that there is a band of tissue extending from the sacrum to the posterior rectum. On either side of this band there is only areolar tissue. Any tendency on the part of the surgeon to insert a hand into the presacral space at this stage should be stoutly resisted. Instead, a long, closed Metzenbaum scissors should be used as a blunt dissector (Fig. 40–6a). Insert it first to the right of the midline behind the rectum, and by gently elevating the mesorectum the proper presacral plane will be entered.

Repeat this maneuver identically on the left side of the midsacral line. Then direct attention to the remaining band of tissue, which contains branches of the middle sacral artery, and divide it with an electrocautery (**Fig. 40–6a**).

At this time the surgeon will see a thin layer of fibroareolar tissue covering the sacrum. If a shiny layer of sacral periosteum, ligaments, or the naked presacral veins can be seen (**Fig. 40–6b**), the plane of dissection is *too deep*, presenting the danger of major venous hemorrhage. Elevate the *distal* rectum from the lower sacrum with gauze in a sponge holder. If the dissection has been completed properly, as described, note that the preaortic sympathetic nerves divide into two major trunks in the upper sacral area and then continue laterally to the right and left walls of the pelvis (Fig. 40–6a). Gently dissect these off the posterior wall of the specimen, unless the specimen has been invaded by tumor.

Now the surgeon may insert a hand into the presacral space, with the objective not of penetrating more deeply toward the coccyx, but rather of extending the presacral dissection laterally to the right and to the left, so that the posterior aspect of the specimen is elevated from the sacrum as far as the lateral ligament on each side. Place the lateral ligament on the left side on stretch by applying

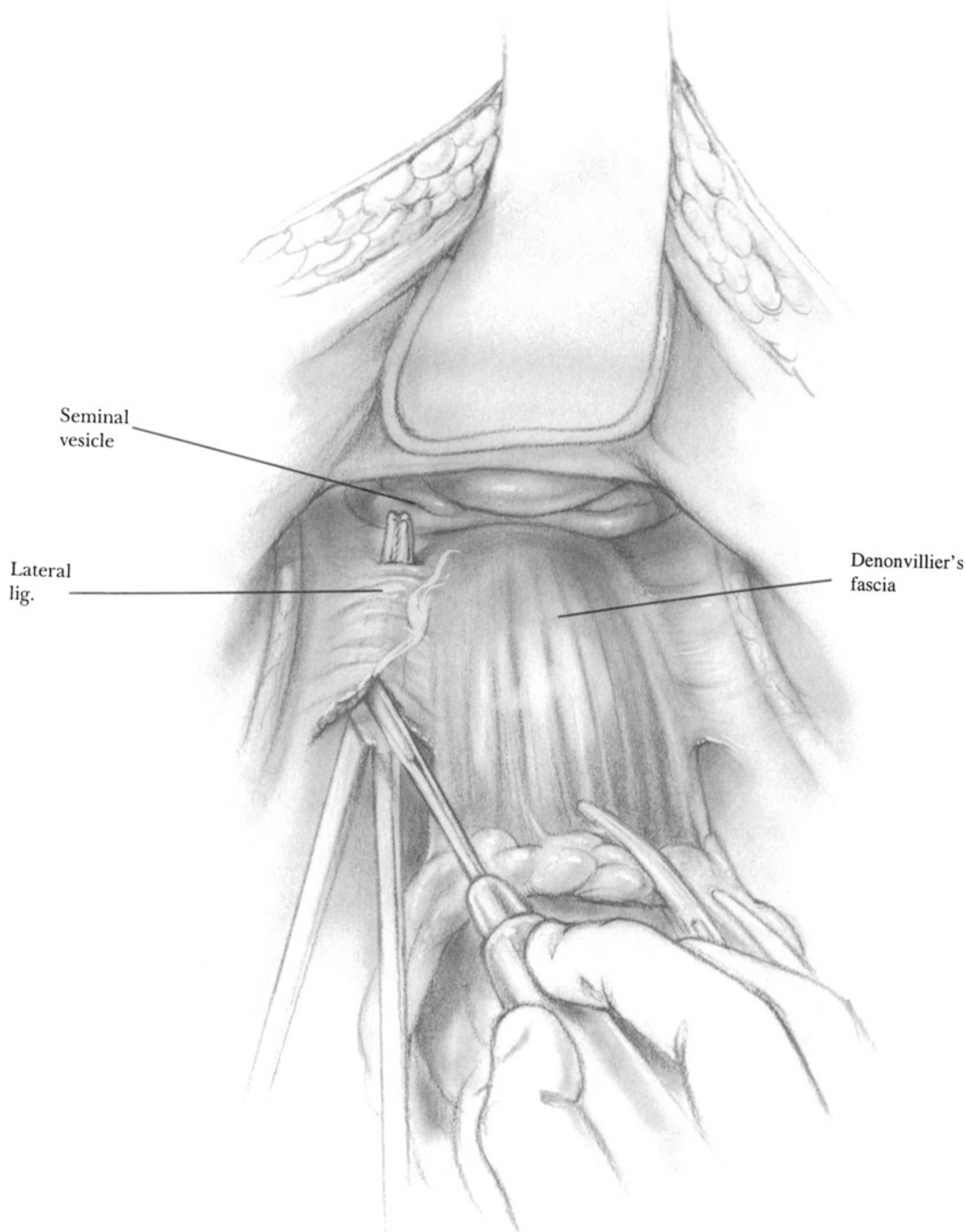


Fig. 40–7

traction to the rectum toward the right. Place a right-angle Mixter clamp beneath the lateral ligament and divide the tissue with an electrocoagulator (**Fig. 40–7**).

Carry out a similar maneuver to divide the right lateral ligament. Before dividing each lateral ligament, recheck the position of the respective ureter and hypogastric nerve to be certain they lie lateral to the point of division. If for some reason difficulty is encountered in performing this step, division of the lateral ligaments may be delayed until perineal exposure has been achieved. This will permit clear identification of the ligaments by simultaneous visualization from above and from below.

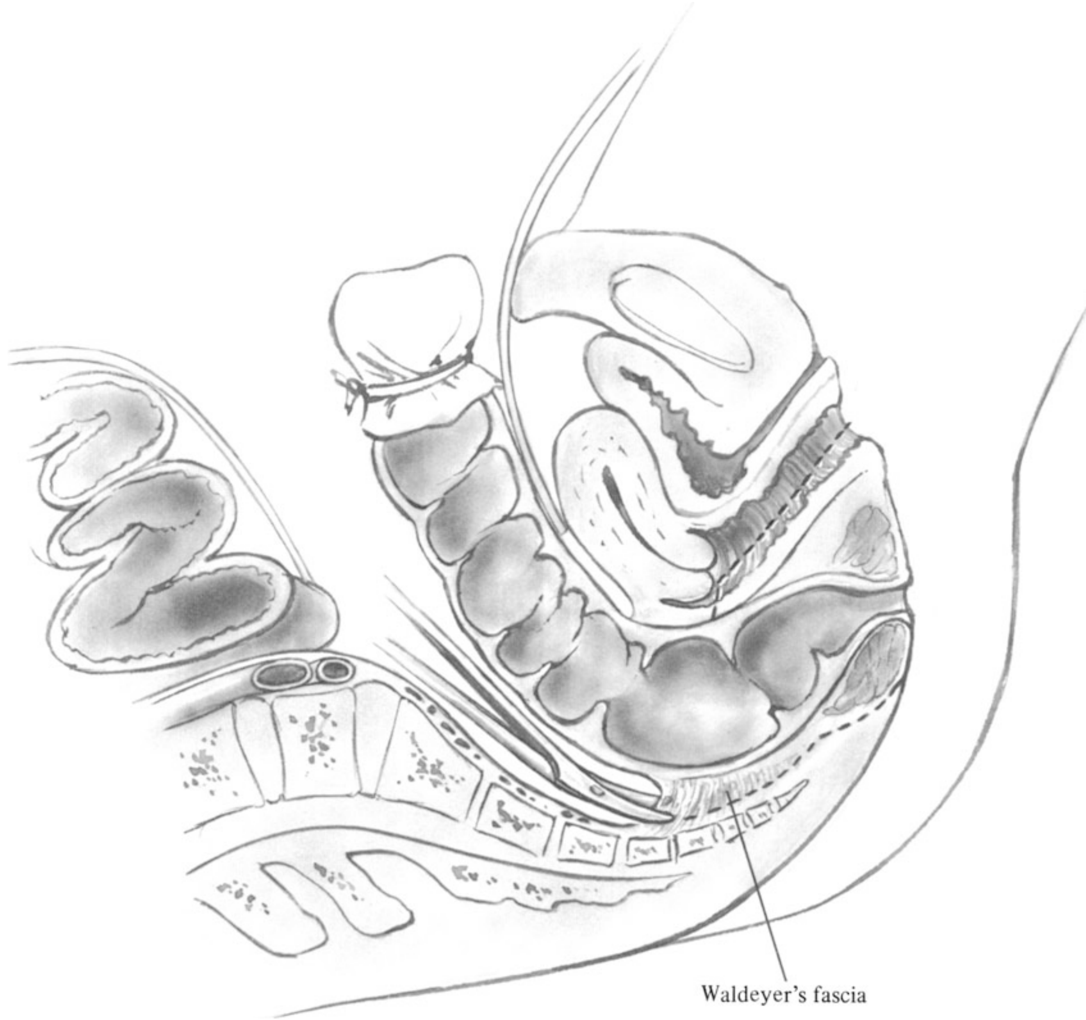


Fig. 40–8

The next step in exposing the levator diaphragm from above is to divide the fascia of Waldeyer, which extends from the coccyx to the posterior rectal wall (**Fig. 40–8**). This structure blocks the surgeon's hand from passing beyond the coccygeal area. Incise the fascia with a long Metzenbaum scissors. Do not injure the veins that run along the surface of the coccyx when incising this fascia.

Now direct attention to the anterior dissection. Use a Lloyd-Davies retractor to pull the bladder (in women, the uterus) in an anterior and caudal direction. If the peritoneum of the rectovesical pouch has not already been incised, perform this maneuver now, thereby connecting the incisions in the pelvic peritoneum previously made on the right and left sides of the rectum (see Fig. 40–4). Apply one or more long hemostats or forceps to the posterior lip of the incised peritoneum of the rectovesical pouch. Place traction on these hemostats to draw the peritoneum and Denonvilliers' fascia in a cephalad and posterior direction, and use Metzenbaum scissors dissection to dissect this layer from the seminal vesicles and prostate (**Figs. 40–9a and 40–9b**). Use blunt finger dissection to separate the rectum from the posterior wall of the prostate. Finally, secure hemostasis in this region by electrocoagulating multiple bleeding points.

In female patients the anterior dissection is somewhat simpler. With a Harrington retractor elevating the uterus, use scalpel dissection to initiate the plane of dissection elevating the peritoneum and fascia of Denonvilliers from the posterior lip of the cervix until the proximal vagina has been exposed. If it is elected to remove the posterior wall of the vagina along with the specimen, this is more easily done during the perineal dissection. Some surgeons routinely perform bilateral salpingo-oophorectomy in women who have rectal and sigmoid cancer, because the ovaries are sometimes a site of metastatic deposit. Whether this step is of value has not been ascer-

Fig. 40–9a

tained. We do not perform this maneuver in the absence of visible metastasis to the ovaries.

The last step in the abdominal portion of the procedure is to divide the sigmoid colon at a point that will permit the proximal colon to be brought out of the abdominal incision with at least 5 cm of slack. Use the GIA stapling device; it will simultaneously apply staples and divide the colon (**Figs. 40–10a and 40–10b**). Tie a rubber glove over the end of the distal sigmoid to preserve sterility (**Figs. 40–11a and 40–11b**). After this step abandon the

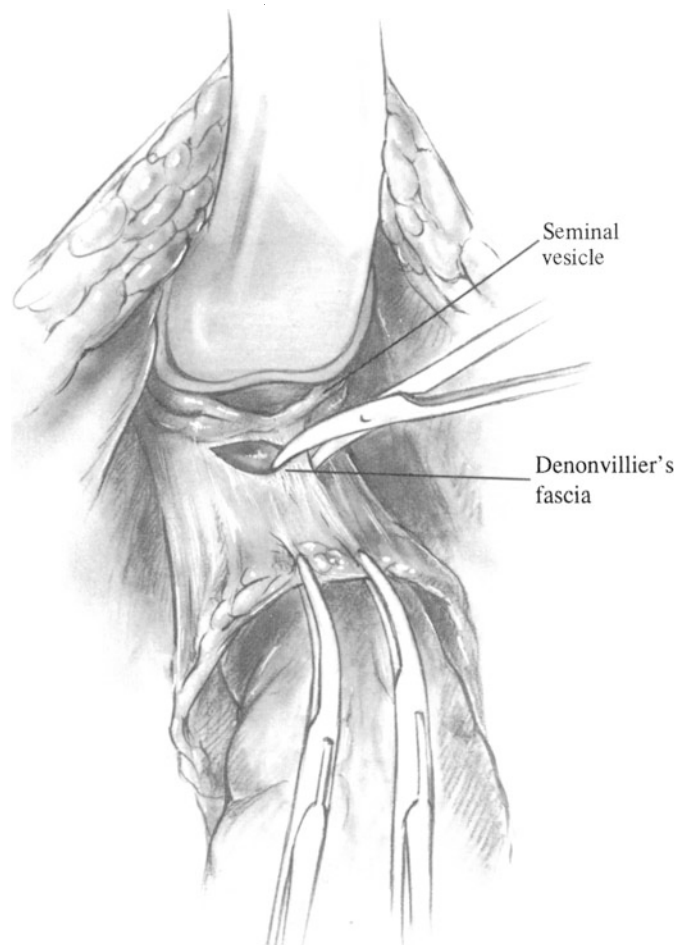


Fig. 40–9b

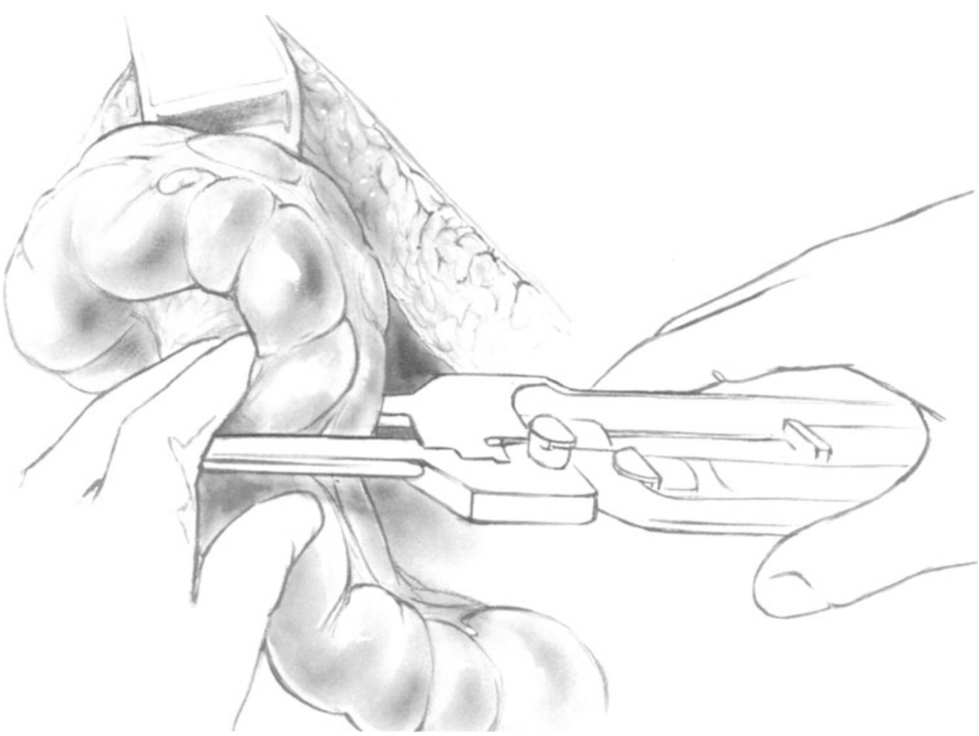


Fig. 40–10a

Fig. 40–10b

Fig. 40–11a

Fig. 40–11b

abdominal dissection temporarily and initiate the perineal stage.

Pelvic Hemostasis

The entire pelvic dissection, if properly performed, should entail minimal blood loss. While Hemoclips may control clearly identified vessels along the lateral wall of the pelvis, they are rarely useful in the presacral area. Here the vessels consist of thin-walled veins, which are easily torn by metallic clips either in the act of application or during the act of sponging the area later. Except for a small, clearly defined bleeding point that can be held in a forceps, electrocoagulation may also be hazardous, as the coagulating tip may act as a scalpel and convert a small bleeding point into a major venous laceration. Here, a ball-tipped electrode is safer than those with sharp tips. Also see the discussion under "Operative Strategy" above concerning the use of a thumbtack to control localized presacral hemorrhage.

Almost invariably, presacral bleeding is the result of a tear in one of the veins that drain into the presacral foramina. If the hemorrhage cannot be controlled *promptly* with a stitch or a hemostat, the area of bleeding should be covered by a sheet of Surgicel over which pressure should be applied with a large gauze pack. If the area of bleeding is only 1–2 cm in diameter, at a later stage in the operation an attempt may be made to remove the gauze pack, leaving the small piece of cellulose. This may result in complete hemostasis. If not, leave the gauze pack in the presacral space for 24–48 hours; then remove it under direct vision and under general anesthesia via the reopened perineal incision.

Perineal Dissection

The anus is already closed by a heavy, silk pursestring suture. In male patients make an elliptical incision in the skin beginning at a point 3–4 cm anterior to the anal orifice and terminating at the tip of the coccyx (**Fig. 40–12**). In females who have small posterior lesions make the incision from a point just behind the vaginal introitus to the tip of the coccyx. For anterior lesions in women, leave a patch of posterior vagina, including the posterior portion of the vaginal introitus, attached to the rectum in the region of the tumor (**Figs. 40–13 and 40–14**).

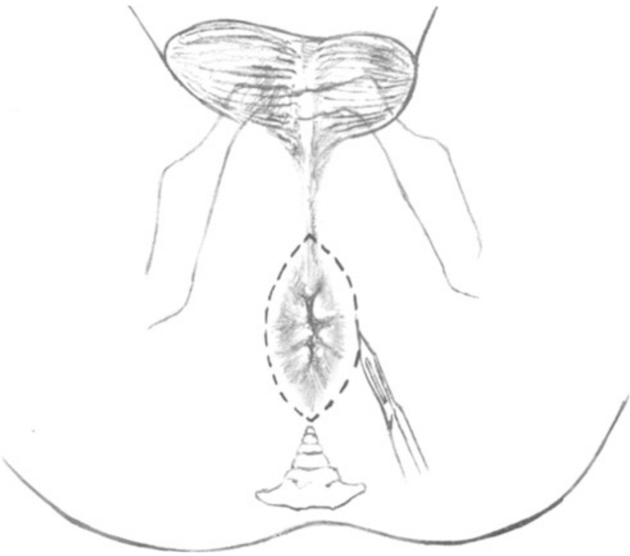


Fig. 40–12

Fig. 40–13

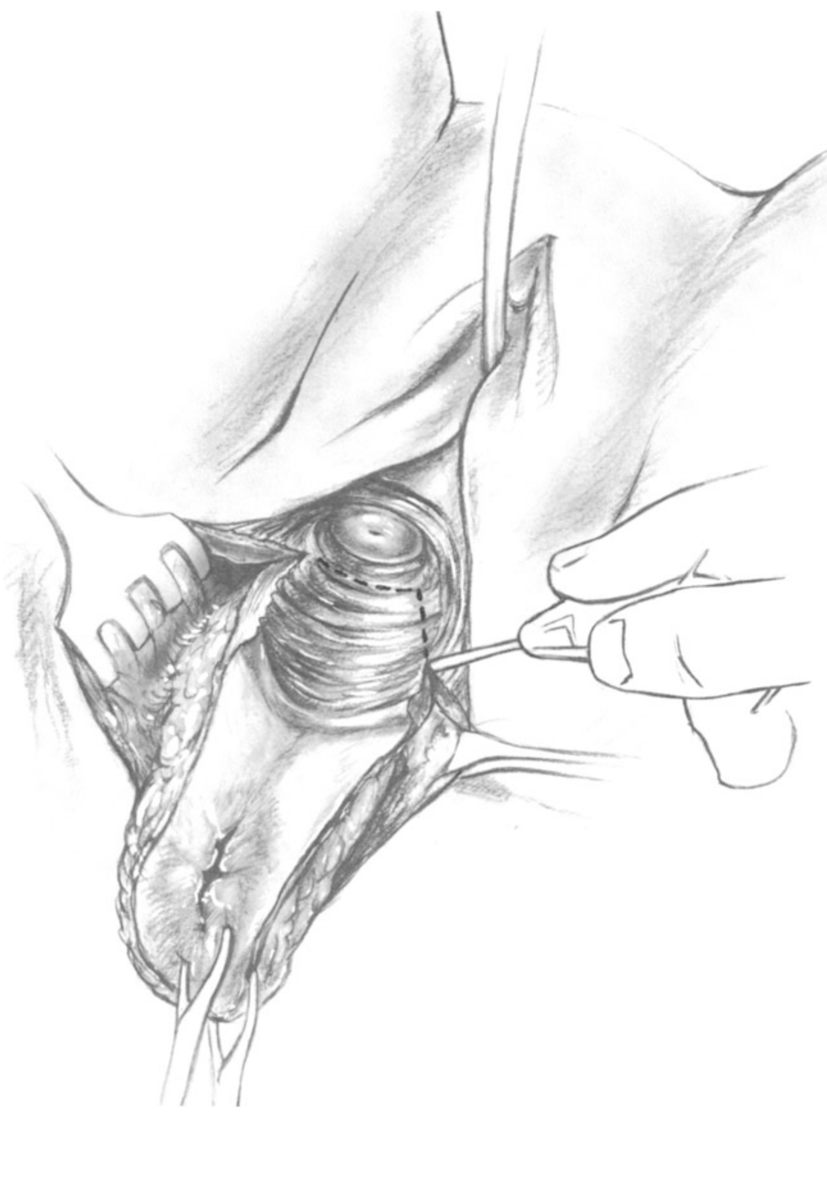


Fig. 40–14

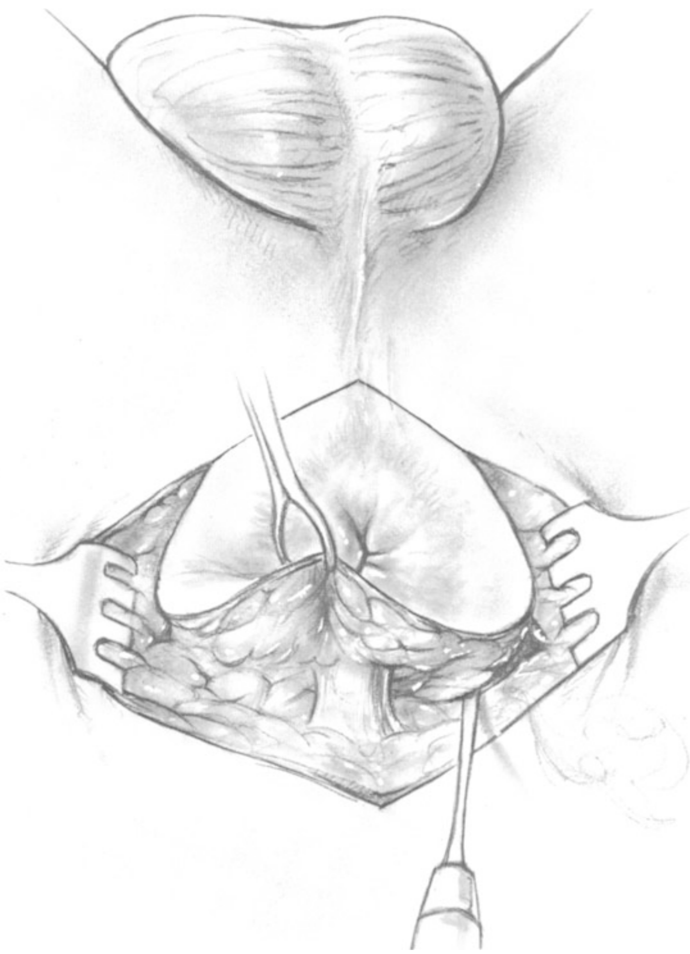


Fig. 40–15

In all cases carry the scalpel incision down into the perirectal fat and then grasp the ellipse of skin to be removed in three Allis clamps. While the anus is retracted to the patient's right, have the assistant insert a rake retractor to draw the skin of the perineum to the patient's left. Then incise the perirectal fat down to the levator diaphragm (**Fig. 40–15**). Generally, two branches of the inferior hemorrhoidal vessels will appear in the perirectal fat just superficial to the levators. Each may be occluded by electrocoagulation. Accomplish the identical procedure on the right side of the perineum.

After identifying the anococcygeal ligament at the tip of the coccyx, use the electrocoagulator to divide this ligament transversely from its attachment to the tip of the coccyx (**Figs. 40–16 and 40–17**). Note at this point that if the surgeon's index finger is inserted anterior to the tip of the coccyx, it may be unable to enter the presacral space. A dense condensation of fascia (Waldeyer's fascia) attaches the posterior rectum to the presacral and precoccygeal area. If this fascia is torn off the sacrum by blunt technique, the presacral venous plexus may be entered, producing hemorrhage. Therefore, Waldeyer's fascia must be incised either at the termination of the abdominal portion of the presacral dissection or at the present stage in the perineal dissection. From the perineal aspect this is a simple maneuver, as it requires only sharp division of the fascia with a scalpel or electrocautery in the plane just deep to the anococcygeal ligament. As soon as this is accomplished it becomes evident that the abdominal and perineal phases of the dissection have joined.

The surgeon should then insert the left index finger beneath the left side of the levator diaphragm, and with the electrocoagulating current transect the levator muscles upward beginning from below, leaving a portion of the diaphragm attached to the specimen (Fig. 40–17). Continue this incision in the muscular diaphragm up to the region of the puborectalis sling on the anterior aspect of the perineum, but not through it.

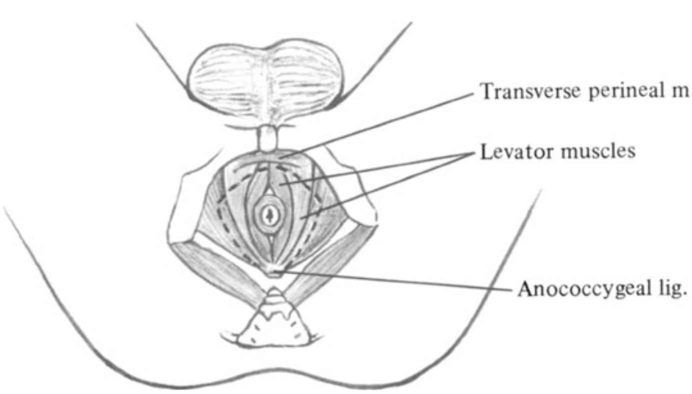


Fig. 40–16

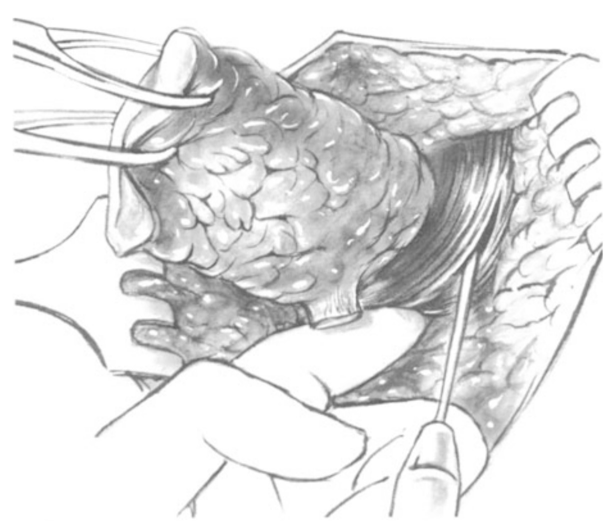


Fig. 40–17

Fig. 40–18

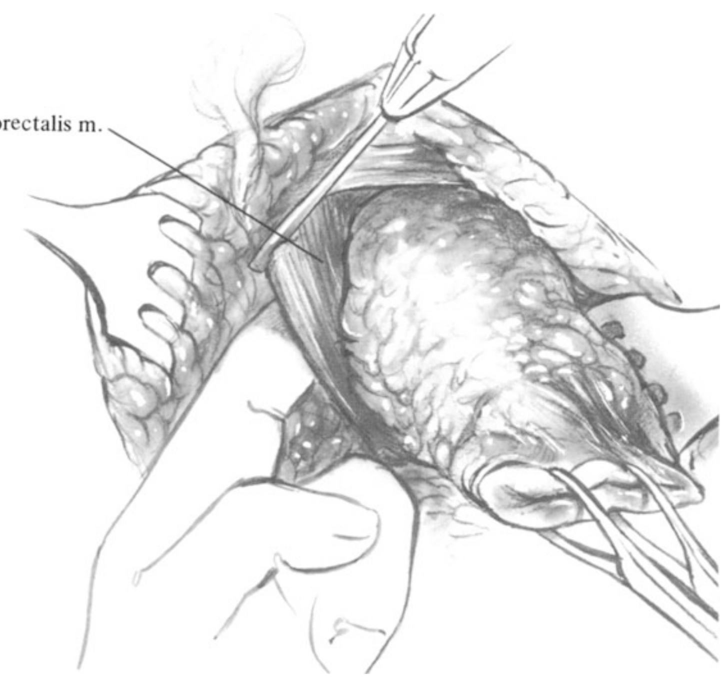


Fig. 40–19

Use the identical procedure to divide the right-hand portion of the levator diaphragm.

Because the greatest danger of the perineal dissection in males is the risk of traumatizing the urethra, the anterior portion of the dissection should be delayed until all the other landmarks in this area have been delineated. To facilitate this delineation, the transected rectosigmoid specimen may be delivered through the opening in the posterior perineum at this time (**Fig. 40–18**). Insert an index finger beneath the puborectalis muscle and transect it with the electrocoagulator (**Figs. 40–18 and 40–19**). The prostate will have been exposed during the abdominal dissection; at this time palpate it and visualize it from below. Make a projection of the plane along the posterior aspect of the prostate gland

Fig. 40–20

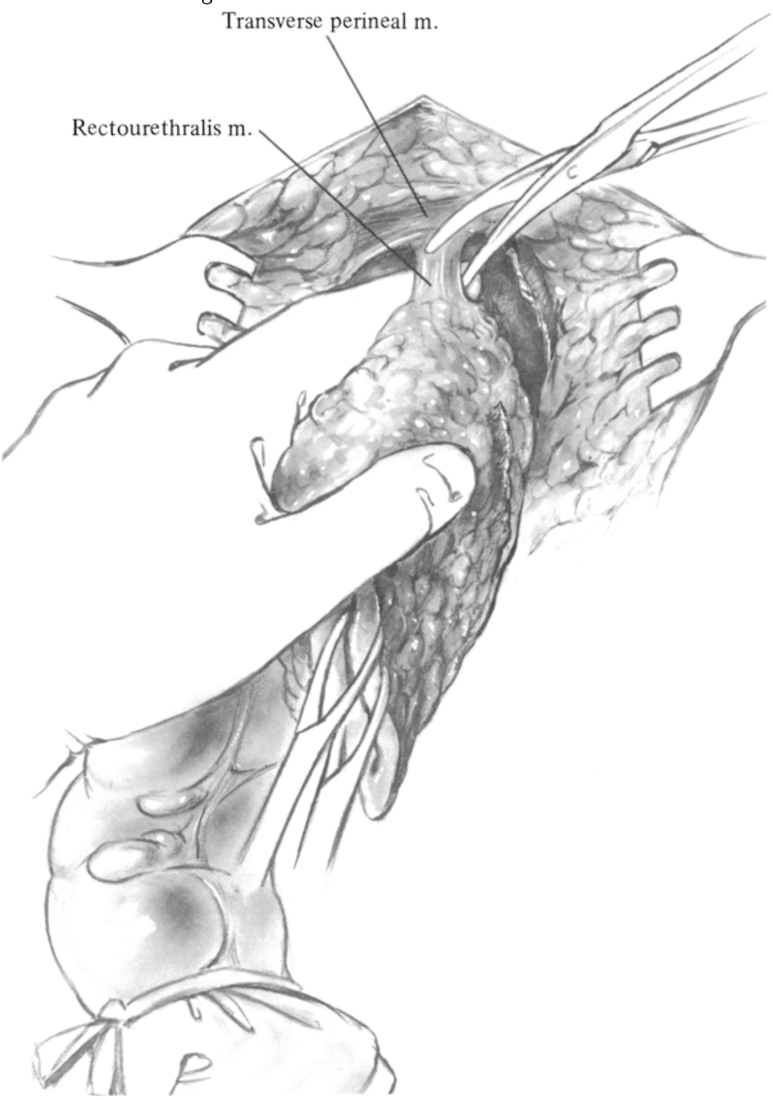


Fig. 40–21

(**Fig. 40–20**). Where this plane crosses the rectourethralis muscle, the muscle may be transected safely and the specimen removed (**Fig. 40–21**). Another landmark, which is sometimes difficult to identify in obese patients, is the superficial transverse perineal muscles. The anterior plane of dissection should be posterior to these muscles. Finally, divide the remaining attachments to the prostate (**Fig. 40–22**) and remove the specimen.

In females the above precautions do not apply. If the vagina is to be preserved, the anterior dissection should follow a plane just posterior to the vagina. The wall of the vagina should not be traumatized or devascularized during this dissection, as this may well lead to perineovaginal fistula, which is difficult to manage. It is better to excise the posterior wall of the vagina than to partially devascularize it during the dissection. If the posterior wall of the vagina is to be removed, use the electrocautery to continue the perineal skin incision across the vaginal introitus (Fig. 40–14). When the vagina is incised by electrocoagulation, complete hemostasis is easily attained, Leave a patch of vagina of appropriate dimensions attached to the specimen.

Irrigate the presacral space with a dilute antibiotic solution. Hemostasis should be absolute and complete. This is easily accomplished using electrocoagulation and ligatures as one assistant works from above and the surgeon works from below.

Management of Pelvic Floor

In females whose posterior vaginal wall remains intact, and in all males, the perineum may be closed per primam if there has been no fecal contamination and if hemostasis is excellent. First, accomplish presacral drainage by inserting one or two closed-suction drainage catheters, each 6 mm in diameter. Introduce one catheter through a puncture wound of the skin in the posterior portion of the perineum about 4 cm to the left of the coccyx, and a second through a similar point at the right. Suture each catheter to the skin surrounding its exit wound (**Fig. 40–23**). Place the tips of the catheters in the presacral space. In some cases the posterior levator diaphragm may be partially reconstructed, using 2–0 PG sutures. Accomplish the remainder of the perineal closure with one or two layers of interrupted PG to the subcutaneous fat and a subcuticular suture of 4–0 PG to close the skin. As soon as the abdominal surgeon has closed the pelvic peritoneum, apply continuous suction to the two drainage catheters in order to draw the peritoneum down to the newly reconstructed pelvic floor. The surgeon's aim must be to *eliminate any possible dead space* between the peritoneal closure and the pelvic floor.

Fig. 40–22

Another good method of draining the presacral space is to bring a closed-suction catheter out from the pelvis via a stab wound in the lower abdominal wall area.

When the posterior vaginal wall and the specimen have been excised, attempt to fabricate a substitute posterior wall with interrupted PG sutures to the perineal fat and to the residual levator muscle (**Fig. 40–24**). If this can be accomplished, within a few months after the operation the vaginal mucosa

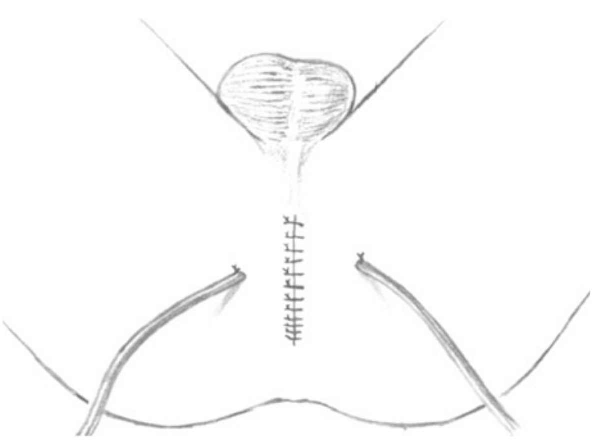


Fig. 40–23

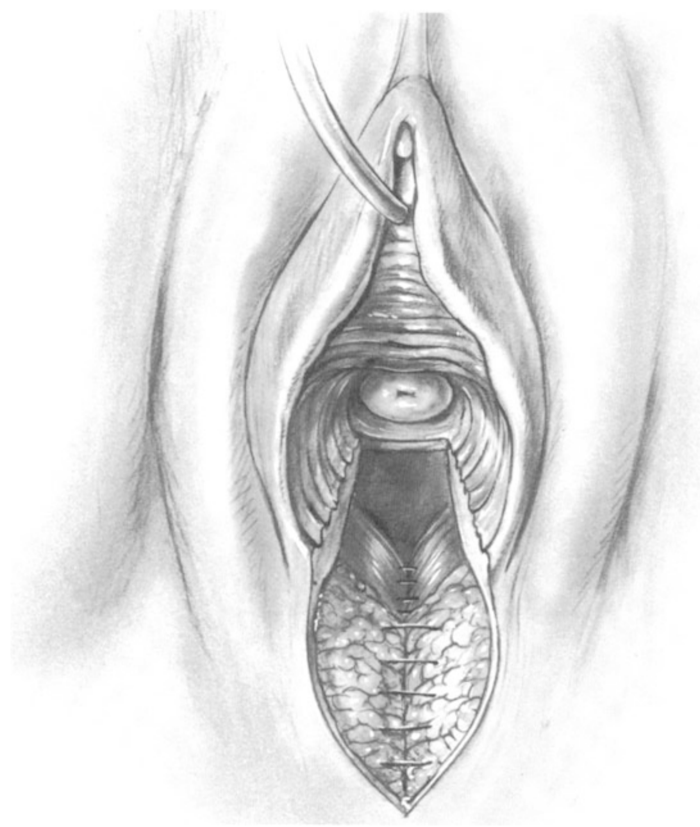


Fig. 40–24

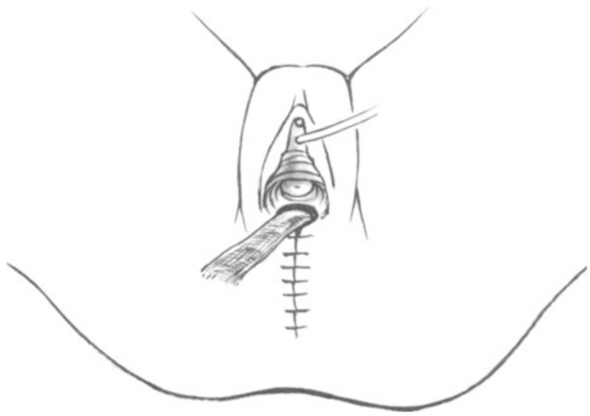


Fig. 40–25

will grow over this newly constructed pelvic floor, restoring the vaginal tube. Pack the posterior defect loosely with sterile gauze. This should be brought out through the newly reconstructed vaginal introitus after the remainder of the perineal fat and skin have been closed, as described above (**Fig. 40–25**). If it is deemed desirable, a sump catheter can be brought out from the presacral space through the same defect, but this is not a routine procedure.

While the assistant is closing the perineum, the surgeon should return to the abdominal approach to dissect the pelvic peritoneum free from its surrounding attachments to the lateral pelvic walls and bladder. This enables the peritoneum to be closed without tension (**Fig. 40–26**). Use a continuous

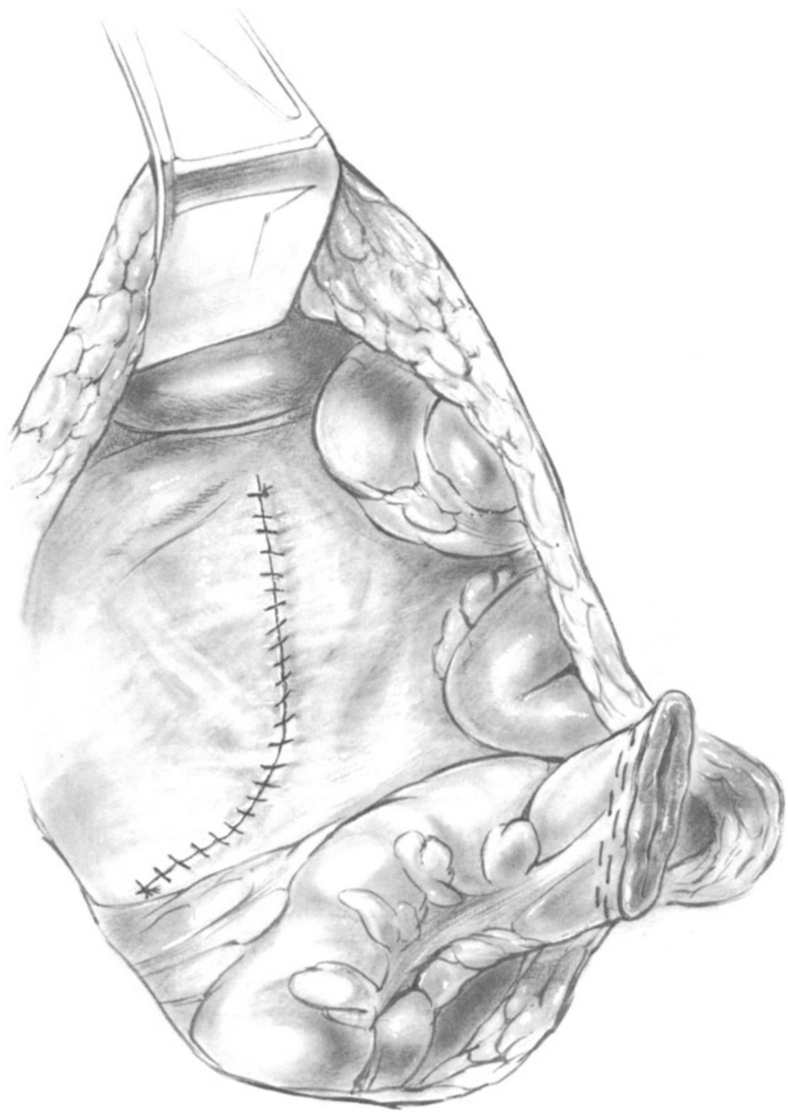


Fig. 40–26

Fig. 40–27

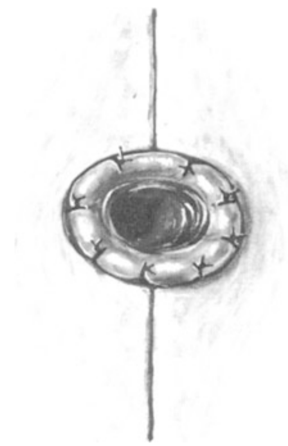


Fig. 40–28

atraumatic suture of 2–0 PG. If there is insufficient peritoneum to permit the peritoneal diaphragm to descend to the level of the newly constructed perineal floor, leave the peritoneum completely unsutured.

Colostomy

The colostomy may be brought out through the upper portion of the midline incision, in which case it is not necessary to close the intraperitoneal gap lateral to the colostomy. Through the midline incision, at a point where 5 cm will protrude from the anterior abdominal skin surface without tension, bring out the segment of colon previously selected for formation of the colostomy. If this point is near the umbilicus, excise the umbilicus for greater postoperative cleanliness. Close the abdominal wall with one layer of monofilament 1–0 PDS; an index finger should fit without tension between the colostomy and the next adjoining suture. Close the skin above and below the colostomy with a continuous subcuticular suture of 4–0 PG. Before closing the skin, irrigate with a dilute antibiotic solution.

After all these steps have been completed, excise the line of staples previously used to occlude the colon. Immediately mature the colostomy, using interrupted or continuous sutures of 4–0 PG to attach the full thickness of the colon to the subcuticular plane of the skin (**Figs. 40–27 and 40–28**). No additional sutures are necessary to attach the colon to the fascia or to any other layer of the abdominal wall.

When the peritoneal pelvic floor is suitable for reconstruction by suturing, the retroperitoneal type of colostomy may be performed. Elevate the previously incised peritoneum of the left paracolic gutter from the lateral abdominal wall by finger dissection. Continue until a hand is freely admitted up to the point in the lateral portion of the rectus muscle that has been previously selected for the

Fig. 40–29

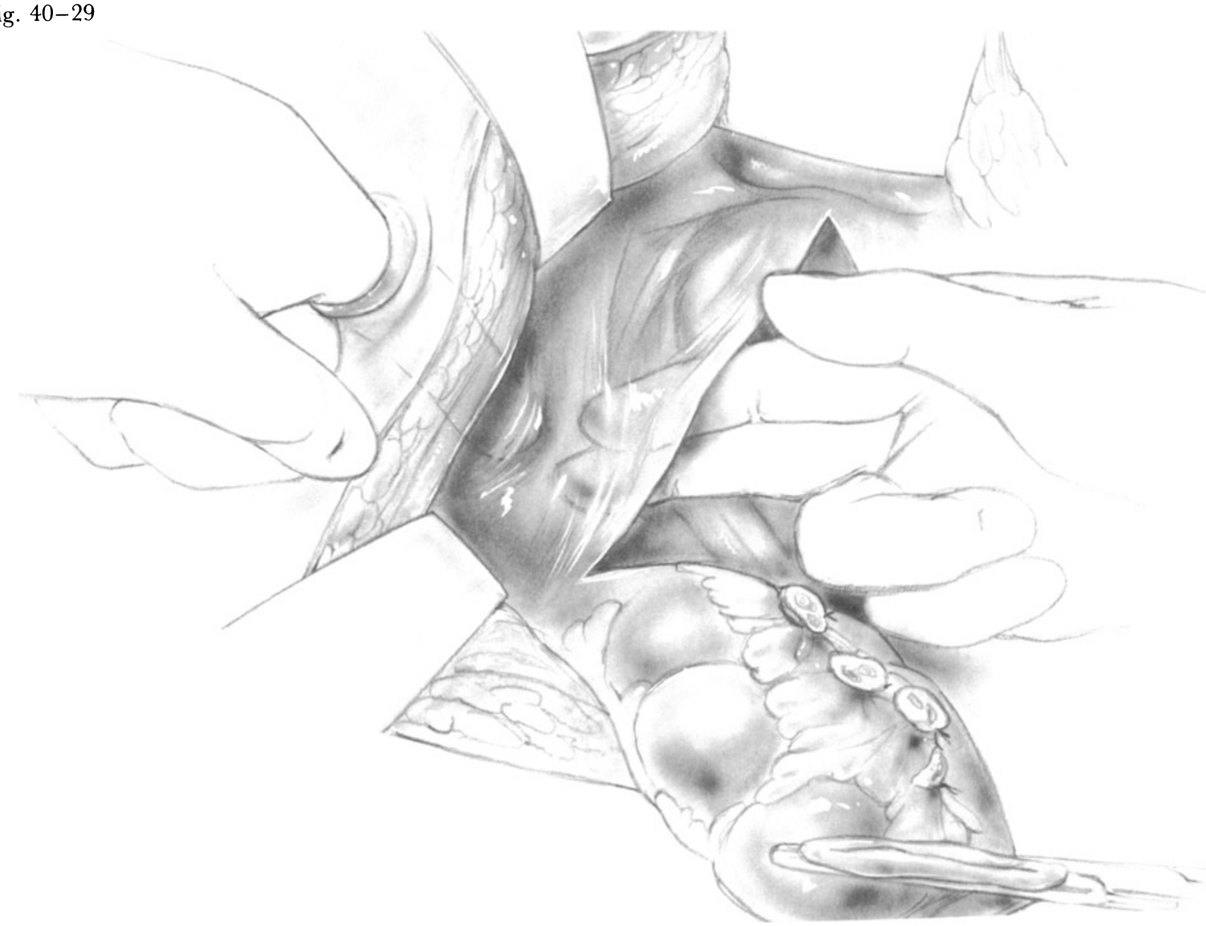


Fig. 40–30

colostomy (**Figs. 40–29 and 40–30**). This is generally about 4 cm below the level of the umbilicus.

Excise a circle of skin about the size of a nickel and expose the fascia of the left rectus muscle. Make cruciate incisions in the anterior rectus fascia, separate the rectus muscle fibers bluntly, and incise the underlying posterior rectus sheath and peritoneum. The aperture in the abdominal wall should be large enough to admit two fingers.

Bring the colon through the retroperitoneal tunnel and out the opening made for the colostomy (**Fig. 40–31**). Begin the suture line closing the pelvic peritoneum near the bladder. Continue this suture of 2–0 atraumatic PG in a cephalad direction, closing the entire defect by suturing the free edge of the peritoneum to the anterior seromuscular wall of the sigmoid colon as it enters the retroperitoneal tunnel to become a colostomy (**Fig. 40–32**). Then close the abdominal incision. Mature the colostomy by a mucocutaneous suture as described above. Attach a temporary colostomy bag to the abdominal wall at the conclusion of the operation.

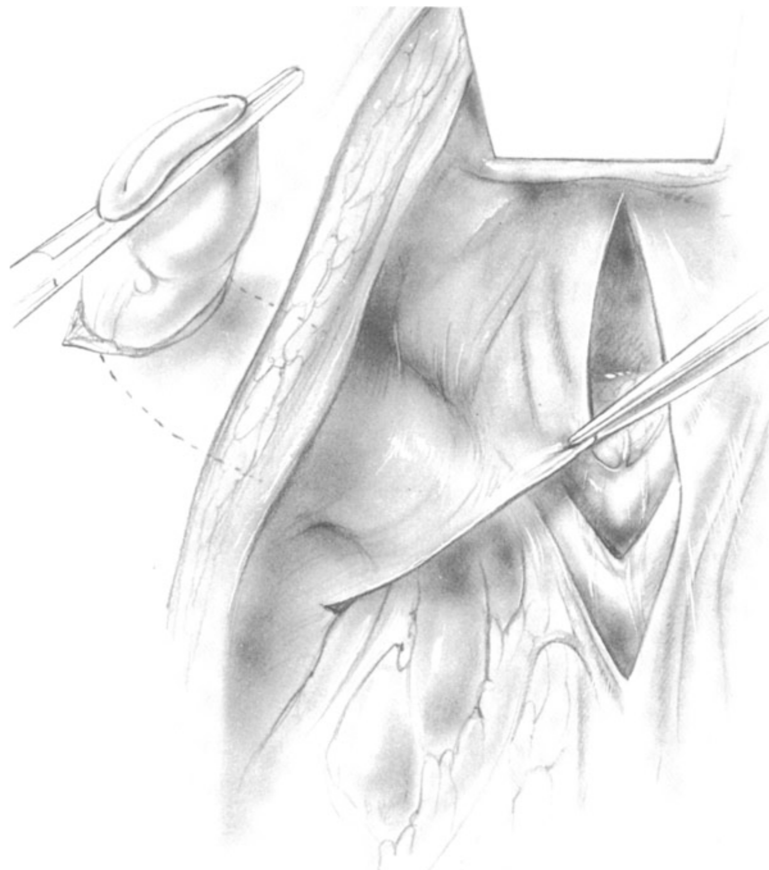


Fig. 40–31

Fig. 40–32

Postoperative Care

Antibiotics

Continue perioperative antibiotic therapy, which had been initiated an hour before the start of operation, for 6 hours postoperatively.

Nasogastric Suction

Discontinue nasogastric suction in 24 hours unless patient develops abdominal distention.

Bladder Drainage

The Foley catheter in the bladder should generally remain until the seventh postoperative day. At that time, inject sterile saline into the bladder through the catheter until the patient feels slightly uncomfortable. Then remove the catheter. If the patient cannot void within 1–2 hours, promptly replace the catheter for an additional period of 3 days, giving the patient 15 mg bethanechol chloride three times daily to stimulate bladder tone.

Perineal Care

Patients who have undergone excision of the posterior vagina have a small amount of gauze packing inserted into the perineum through the residual vaginal defect. This gauze should be removed on the third day, followed by daily saline irrigation of the area. As soon as the patient can sit comfortably, initiate sitz baths daily and discontinue irrigation.

Those patients who have had large gauze packs inserted in the presacral region to control hemorrhage should be brought back to the operating room on the first or second postoperative day so that the pack can be removed under general anesthesia. The sheet of oxidized cellulose, which had been applied to the sacrum, is left undisturbed. The patient should be observed briefly to ascertain that the hemorrhage is under complete control. If the abdominal contents descend to occupy the cavity in the presacral space that had been created by the gauze packing, then the perineal floor can be closed tightly around two closed-suction drains, as described above. If a large dead space remains, insert a sump and several latex drains and close the pelvic floor loosely around them. Administer postoperative irrigations with 0.1% kanamycin solution through the sump catheter every 8 hours.

Most of our patients leave the operating room with the perineum closed per primam. Every 8 hours, 25 ml of 0.1% kanamycin solution should be injected into each of the two closed-suction catheters that exit from puncture wounds in the perineal skin. Except for 20 minutes following each injection, the catheters should be subjected to constant suction. After perineal drainage ceases, generally on the fifth postoperative day, remove the catheters. Administer sitz baths twice daily to provide symptomatic relief of perineal soreness.

Chronic perineal sinus may occur, especially following a proctectomy for colitis. The etiology of this complication, which may persist for years, is not clear, but chronic sepsis and inadequate drainage are the probable causes. Local treatment by curettage, irrigations with a pulsating water jet as noted by Sohn and Weinstein, and perineal hygiene will remedy most chronic sinuses. Frequent shaving is necessary to prevent loose hair from entering deep into the sinus and producing a foreign-body granuloma.

Colostomy Care

Observe the colostomy daily through the transparent bag to detect signs of possible necrosis. That the colostomy does not function during the first 6–7 days following the operation need not be a cause for concern, if the patient does not develop abdominal distention or cramps. If there is no function beyond this date, abdominal X rays must be performed to rule out an obstruction of the small bowel.

The patient should begin receiving instructions in daily colostomy irrigations during the second week of hospitalization. No patient should leave the hospital before acquiring the skills necessary to perform the irrigations effectively.

It is important to understand that the aim of colostomy irrigation is not simply to wash out the distal few inches of colon. Patients sometimes insert a catheter a few inches into the colon, and when the water runs into the colon they permit it promptly to run out alongside the catheter. This is ineffective. Water is instilled into the distal colon for the purpose of dilating the area sufficiently to produce a reflex peristaltic contraction that evacuates the entire distal colon. For many patients this may require the injection of over a liter of water before they begin to feel "crampy" discomfort. At this point the catheter should be removed and the patient encouraged to keep the colostomy orifice occluded for a few more minutes, until peristalsis is well under way.

Some patients use a cone-shaped device, through which the fluid channel passes, to occlude the lumen. In other cases, the patient may be able to occlude the lumen by lightly grasping and manually compressing the abdominal wall around the inflow catheter or cone. There are many variations in devices and techniques in colostomy management: when any of them fails, however, it usually is because the patient has not retained the injected fluid long enough for distention of the distal colon to occur. Without this distention there can be no reflex peristaltic contraction.

All patients must be urged to exercise extreme caution in passing the catheter or any other irrigating device, so as to avoid the possibility of perforating the colon. This complication may occur even in patients who have had 15–20 years of experience in irrigating their colostomy. It is generally heralded promptly by the onset of severe abdominal pain during the irrigation. The patient should be urged to report *immediately* for examination if pain occurs at any time during irrigation.

Postoperative Complications

Acute Intestinal Obstruction

The small intestine may become obstructed either by adhesion to the pelvic suture line or herniation through a defect in the pelvic floor. Adhesions elsewhere in the abdomen, which may occur after any abdominal procedure, can also cause obstruction. If colostomy function has not begun by the sixth or seventh postoperative day, X rays of the abdomen should be taken. If small bowel obstruction appears to have occurred, and there is no evidence of strangulation, a *brief* trial of a long intestinal tube may be initiated. If this is not promptly successful (3–4 days), secondary laparotomy for the relief of the obstruction is indicated.

Hemorrhage

Hemorrhage should be extremely rare in properly managed cases. If there is evidence of significant bleeding, either by vital signs and laboratory tests, or by visible bleeding from the perineal drains, prompt reoperation is preferable to expectant management.

Sepsis

Sepsis that occurs following primary closure of the perineal wound is generally not difficult to detect. It is accompanied by fever, local pain, and purulent drainage through the suction catheters. Under these conditions the perineal incision should be opened sufficiently to insert two fingers, a sump, and several latex or Penrose drains. Intermittent or continuous irrigations with an antibiotic solution should be instituted promptly. If this is not successful in relieving the infection quickly, the entire wound may be reopened and a gauze pack inserted. The gauze should be changed at least once daily.

Bladder Obstruction

Because many men who undergo proctocolectomy for carcinoma are at an age when prostatic hypertrophy is common, this factor, combined with the loss of bladder support in the absence of the rectum, as well as some degree of nerve injury, leads to a high incidence of urinary tract obstruction. If the obstruction cannot be managed by conservative means, urological consultation and prostatectomy may be necessary.

Sexual Impotence

Some studies have indicated that virtually all operations for the radical removal of malignancies in the middle and lower rectum of males have been followed by sexual impotence, although Goligher's findings were not so bleak. This complication has been rare after operations for benign disease when special precautions are observed (see Chap. 46).

Colostomy Complications

Postoperative pericolostomy sepsis has been rare following immediate maturation of the colostomy. This technique has virtually eliminated the late complications of stricture formation and prolapse.

Chronic Perineal Sinus

Although a persistent perineal sinus is rare after a properly managed resection for carcinoma, it appears to be common following operations for inflammatory bowel disease. If all the local measures fail and the sinus persists for several years, Silen recommends a saucerization procedure consisting of excision of the coccyx and the chronically infected wall of the sinus down to its apex. After saucerization is done, persistent attention to encouraging healing from the bottom has proved successful. Another technique, suggested by Turnbull, is the insertion of a perforated split-thickness skin graft following local debridement and cleansing.

References

Anderson R, Turnbull RB Jr. Grafting the unhealed perineal wound after coloproctectomy for Crohn's disease. Arch Surg 1976;111:335.

Foster JH, Berman MM. Solid liver tumors. Philadelphia: Saunders; 1977:225.

Goligher JC. Extraperitoneal colostomy or ileostomy. Br J Surg 1958;46:97.

Goligher JC. Surgery of the anus, rectum and colon. 3rd ed. London: Baillière, Tindall; 1975:76.

Nivatvongs S, Fang DT. The use of thumbtacks to stop massive presacral hemorrhage. Dis Colon Rectum 1986;29:589–590.

Silen W, Glotzer DJ. The prevention and treatment of the persistent perineal sinus. Surgery 1974;75:535.

Sohn N, Weinstein MA. Unhealed perineal wound lavage with a pulsating water jet. Am J Surg 1977;134:426.

41 Subtotal Colectomy with Ileoproctostomy or Ileostomy and Sigmoid Mucous Fistula

Indications

Familial polyposis

Chronic ulcerative colitis

Toxic megacolon, unresponsive to medical management

Intractable systemic complications such as arthritis, pyoderma gangrenosum, or liver disease

Threat of carcinoma, especially after 10 years of pancolitis or dysplasia

Intractable symptoms

Crohn's colitis

Perforation

Obstruction

Inflammatory mass unresponsive to conservative management

Intractable colonic fistulas to skin, small intestine, bladder, perineum

Massive hemorrhage

Concept: Choice of Operation

In the surgical management of inflammatory bowel disease, the surgeon must choose among (1) total colectomy with proctectomy; (2) subtotal colectomy with ileoproctostomy; or (3) total colectomy, ileostomy, mucosal proctectomy, and ileoanal pouch formation. Occasionally cases of localized Crohn's colitis will respond, at least temporarily, to a segmental resection of the colon with anastomosis.

Familial polyposis requires total removal or destruction of the colorectal mucosa in order to avoid the later development of carcinoma, a complication that generally afflicts these patients by the age of 40. Formerly, these patients were treated by total colectomy and ileostomy, or by subtotal colectomy with low ileoproctostomy combined with electrocautery destruction of the remaining polyps in the rectum. Currently, most patients with familial polyposis are treated by a total colectomy, mucosal proctectomy, and the creation of an ileoanal pouch.

With Crohn's colitis, the latter operation is contraindicated because of the risk of Crohn's disease developing in the ileoanal pouch.

Patients suffering from ulcerative colitis can sometimes be treated successfully by a subtotal colectomy and an ileoproctostomy if the rectal disease appears to be relatively mild. However, many of these patients will develop active inflammatory disease in the rectal stump and require further surgery.

A patient who suffers from Crohn's colitis that is intractable to medical treatment may require a total coloproctectomy to alleviate the condition. If there is extensive perineal disease with multiple fistulas extending for 5–10 cm beyond the anus, Sher, Bauer, Gorphine et al. have recommended that such patients be treated by permanent ileostomy and subtotal colectomy with a low Hartmann resection of the rectosigmoid, leaving a rectal cuff about 5 cm in length. In their patients treated in this manner, 60% healed the perineum completely by the end of 6 months. The other 40% required intersphincteric resection of the rectal stump by perineal approach. These authors emphasize that in the past, patients subjected to one-stage coloproctectomy suffered from an unhealed perineum at the end of 6–12 months in 42.6% to 72.1% of cases, according to five previously published reports. Concomitant with the Hartmann coloproctectomy, these authors also eradicated fistulous tracts and drained perirectal abscesses. Over the long term, 22 of their 25 patients treated in this manner remained well with a completely healed perineum.

Patients with ulcerative colitis who are suffering from acute toxic megacolon unresponsive to medical management can generally be managed by a coloproctectomy in one stage. If the disease in the rectum is not especially severe, it may be possible to preserve the rectum after a subtotal colectomy in the hope of performing mucosal proctectomy and an ileoanal pouch at a later date. Also, in patients with major hemorrhage from inflammatory bowel disease, either a subtotal or total coloproctectomy is performed, depending on the severity of the rectal component of the disease.

Total colectomy, including mucosal proctectomy by the Soave technique, leaving intact the muscular layer (serosa) of the rectum and the sphincter muscles, followed by an ileoanal anastomosis, is an old operation that has been revived. Martin et al. and Ravitch and Sabiston have reported that the preserved sphincter mechanism produces fairly satisfactory results in these cases (see Chap. 42).

Kock has described an ileostomy pouch which does not require that the patient wear a bag to contain the ileal excretions. As this operation produces many complications that require reoperation, the Kock ileostomy cannot be recommended for general use.

Preoperative Preparation

The preoperative care of patients who undergo *elective* surgery is the same as that used when the colon is resected for malignancy, except that colitis patients who have cachexia may require preoperative total parenteral nutrition. For *emergency* colectomy, restitution with blood and electrolytes should be accomplished. Colitis cases complicated by toxic megacolon or perforation require appropriate antibiotic therapy.

Pitfalls and Danger Points

Operative contamination of the peritoneal cavity with colonic contents, leading to sepsis (in toxic megacolon)

Improper construction of ileostomy

Operative Strategy

Sepsis is not uncommon following an emergency colectomy for inflammatory bowel disease and its complications. In Crohn's disease one often finds a fistula to the adjacent bowel or to the skin. In some cases paracolic abscesses are encountered, making gross contamination of the peritoneal cavity inevitable. In operations for fistula, abscess, or toxic megacolon, intensive preoperative treatment with systemic antibiotics as well as frequent intraoperative irrigations with an antibiotic solution are indicated. When performing a resection for toxic megacolon, the surgeon should be aware that the colon, especially the distal transverse colon and splenic flexure, may have the consistency of wet tissue paper and may be ruptured by even minimal manipulation. This will cause massive and sometimes fatal contamination of the abdominal cavity. It must be avoided. No attempt should be made to dissect the omentum off the transverse colon, as this may unseal a perforation. Elevation of the left costal margin by a Thompson retractor will generally provide good exposure of the splenic flexure.

Another precaution to take to help prevent perforating the colon during the operation is to pass a 40F catheter through a purse-string suture in the ileum. Pass the tube into the ascending colon and, by gravity, drain the semiliquid contents of the colon out into a plastic bag away from the operative field.

Accomplish technical simplification of the colectomy by dividing the mesentery at a point of convenience nearer to the colon than would be the case in resections for carcinoma. Extensive mesenteric excision is not necessary.

Postoperative ileostomy complications have been reduced remarkably by the adoption of the immediate maturation technique, which uses the mucocutaneous suture. Stricture and prolapse are rare after primary healing of this suture line has been accomplished. Peristomal skin erosions and other difficulties with ileostomy appliances can be minimized if the surgeon constructs an ileostomy that protrudes permanently from the abdominal wall, like a cervix, for 2 cm. This helps prevent the contents of the small bowel from leaking between the appliance and the peristomal skin. It also greatly simplifies the patient's task of placing the appliance accurately. Finally, the gap between the cut edge of ileal mesentery and the lateral abdominal wall may be closed to avoid internal herniation.

Operative Technique

Placement of Ileostomy

On the day before the operation the surgeon should obtain a face plate from an ileostomy appliance, or some facsimile, and apply it tentatively to the patient's abdominal wall. Test proper placement with the patient sitting erect. In some patients, if the appliance is not properly placed, the rim may strike the costal margin or the anterior spine of the ilium. Generally, the proper location is somewhere near the outer margin of the right rectus muscle, about 5 cm lateral to the midline and 4 cm below the umbilicus. In this position the face plate will generally not impinge upon the midline scar, the umbilicus, the anterior superior spine, or the costal margin no matter what position the patient assumes. If the wafer will cover the incision, we prefer a subcuticular skin closure for better skin approximation. The stoma should also be sited so that the patient can see it when he or she is erect.

Operative Position

If there is a possibility that both colectomy and total proctectomy will be performed in one stage, position

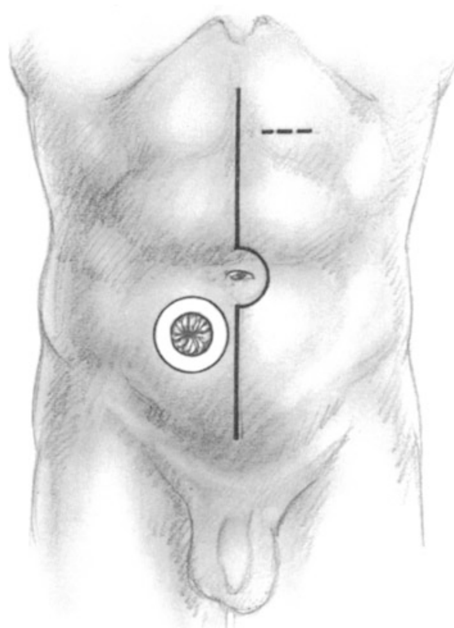


Fig. 41–1

the patient in Lloyd-Davies leg rests (see Figs. 40–1a and 40–1b). Otherwise, the usual supine position is satisfactory.

Incision

We prefer a midline incision because it does not interfere with the ileostomy appliance. It also leaves the entire left lower quadrant free of scar, in case, in the future, ileostomy revision and reimplantation may become necessary. On the other hand, many surgeons use a left paramedian incision to permit a wider margin between the ileostomy and the scar. The incision should extend from the upper epigastrium down to the pubis (**Fig. 41–1**). Since the splenic flexure is foreshortened in many cases of ulcerative colitis and toxic megacolon, exposure for this area is often good, with the Thompson retractor applied to the left costal margin.

Evacuation of Stool

For patients undergoing an operation for acute toxic megacolon, insert a heavy purse-string suture on the anterior surface of the terminal ileum. After applying a Wound Protector ring drape to the abdominal wall, incise the ileum and insert a large 40F multiperforated tube through the purse-string suture into the ascending colon. Permit the semiliquid content of the distended colon to drain by gravity into a bag away from the operative field. After the colon has been adequately decompressed, remove the tube and tie the purse-string suture.

Dissection of Right Colon and Omentum

Make an incision in the right paracolic peritoneum lateral to the cecum and insert the left index finger to elevate the avascular peritoneum, which should be divided by scissors in a cephalad direction (**Fig. 41–2**). If local inflammation has produced increased vascularity in this layer, use the electrocoagulator to carry out the division. Throughout the dissection, keep manipulation of the colon to a minimum. Continue the paracolic incision around the hepatic flexure, exposing the anterior wall of the duodenum.

In emergency operations for toxic megacolon, divide the omentum between Kelly hemostats 5 cm above its line of attachment to the transverse colon. In some cases, if the omentum is fused to the transverse mesocolon, it may be divided simultaneously with the mesocolon, in one layer. In most *elective* operations, the omentum can be dissected off the transverse colon through the usual avascular plane (**Fig. 41–3**).

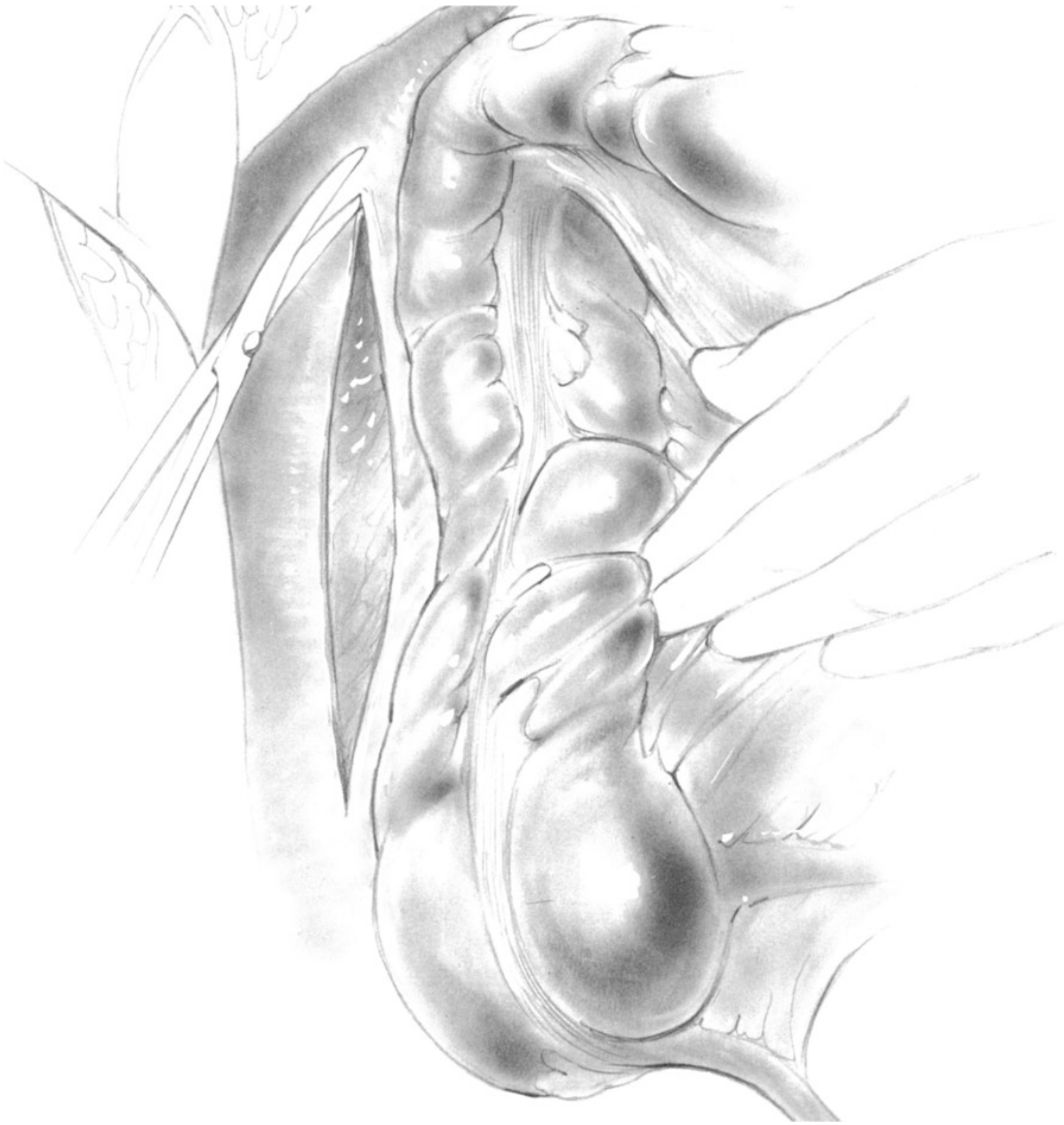


Fig. 41–2

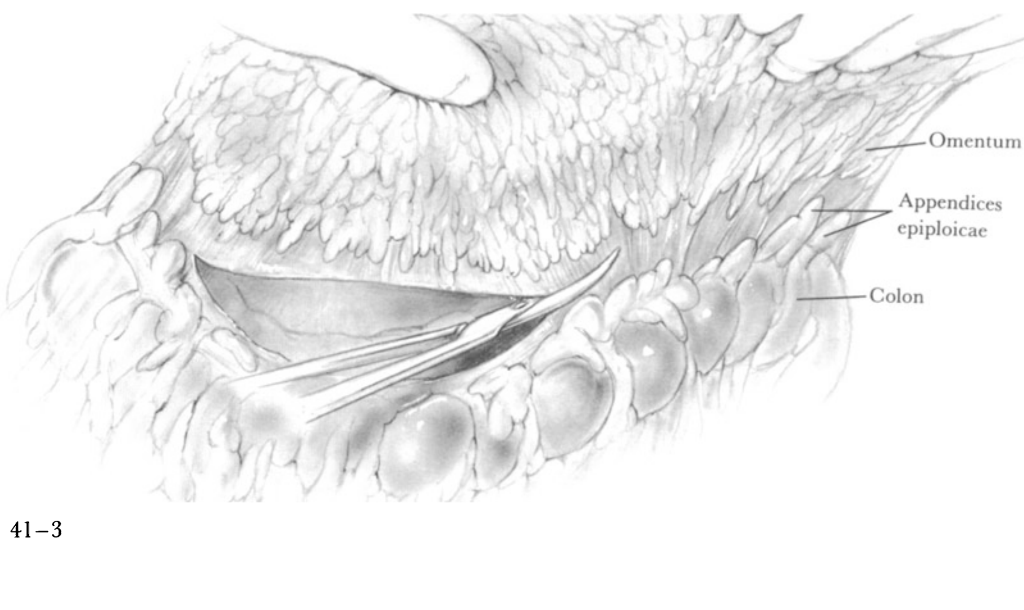


Fig. 41–3

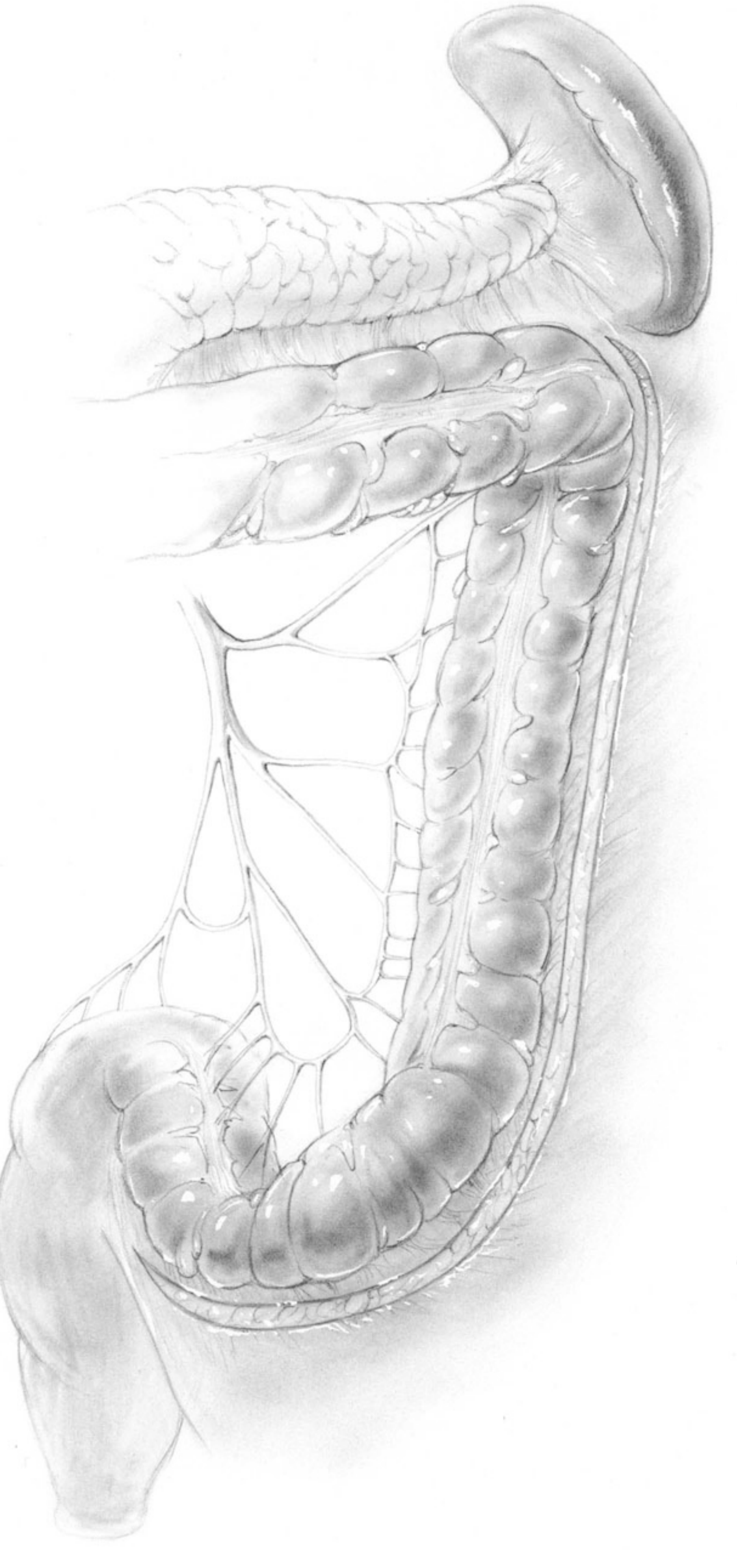


Fig. 41–4

Dissection of Left Colon

Remain at the patient's right side and make an incision in the peritoneum of the left paracolic gutter in the line of Toldt, beginning at the sigmoid. With the aid of the left hand elevate the avascular peritoneum and divide it in a cephalad direction with a Metzenbaum scissors. Carry this incision up to and around the splenic flexure (**Fig. 41–4**).

After the peritoneal attachments of the splenic flexure have been divided, divide the renocolic ligament (**Fig. 41–5**), which stretches between Gerota's fascia and the undersurface of the mesocolon. Divide in a cephalad direction until the avascular ligament between the tail of the pancreas and

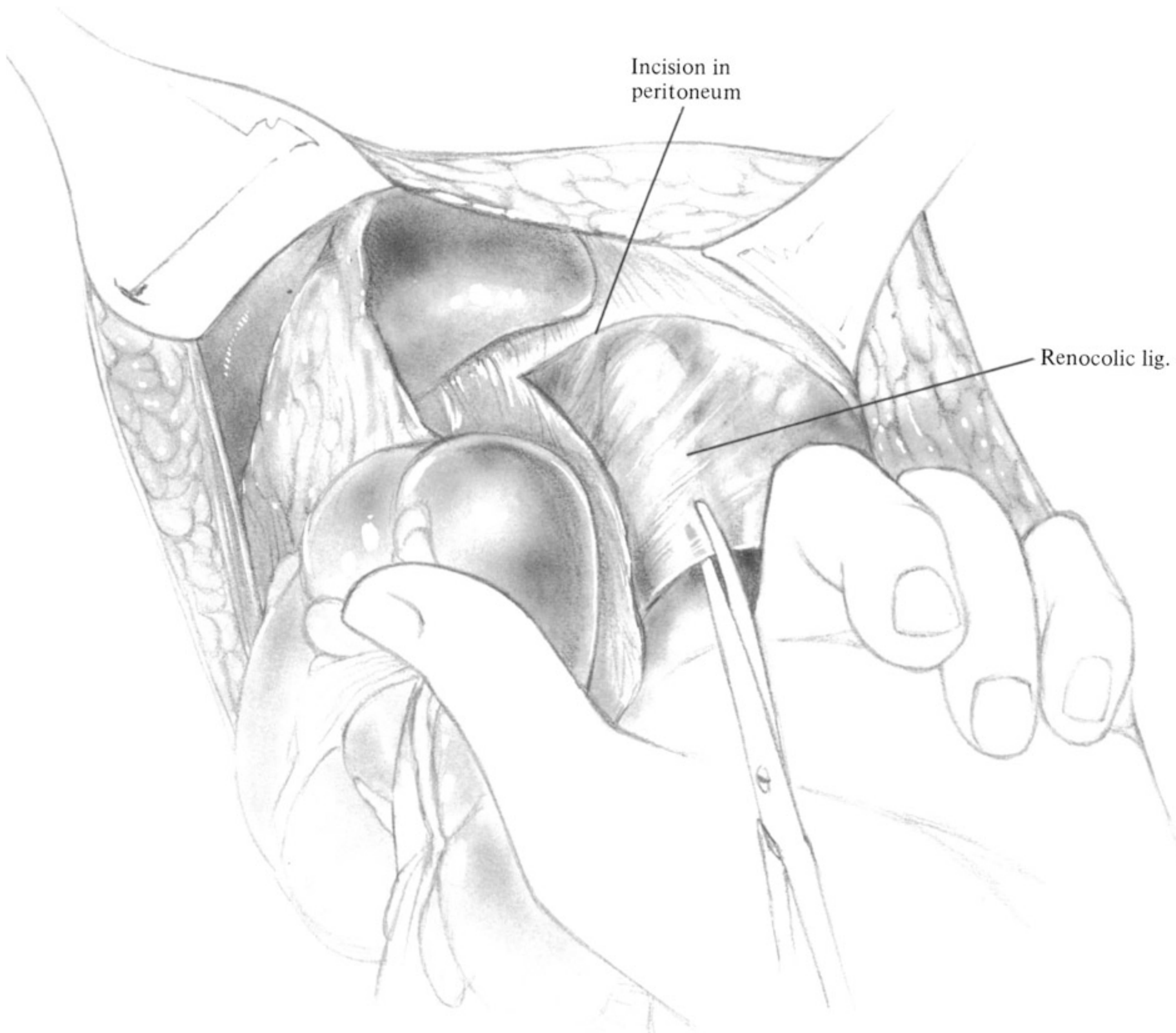


Fig. 41–5

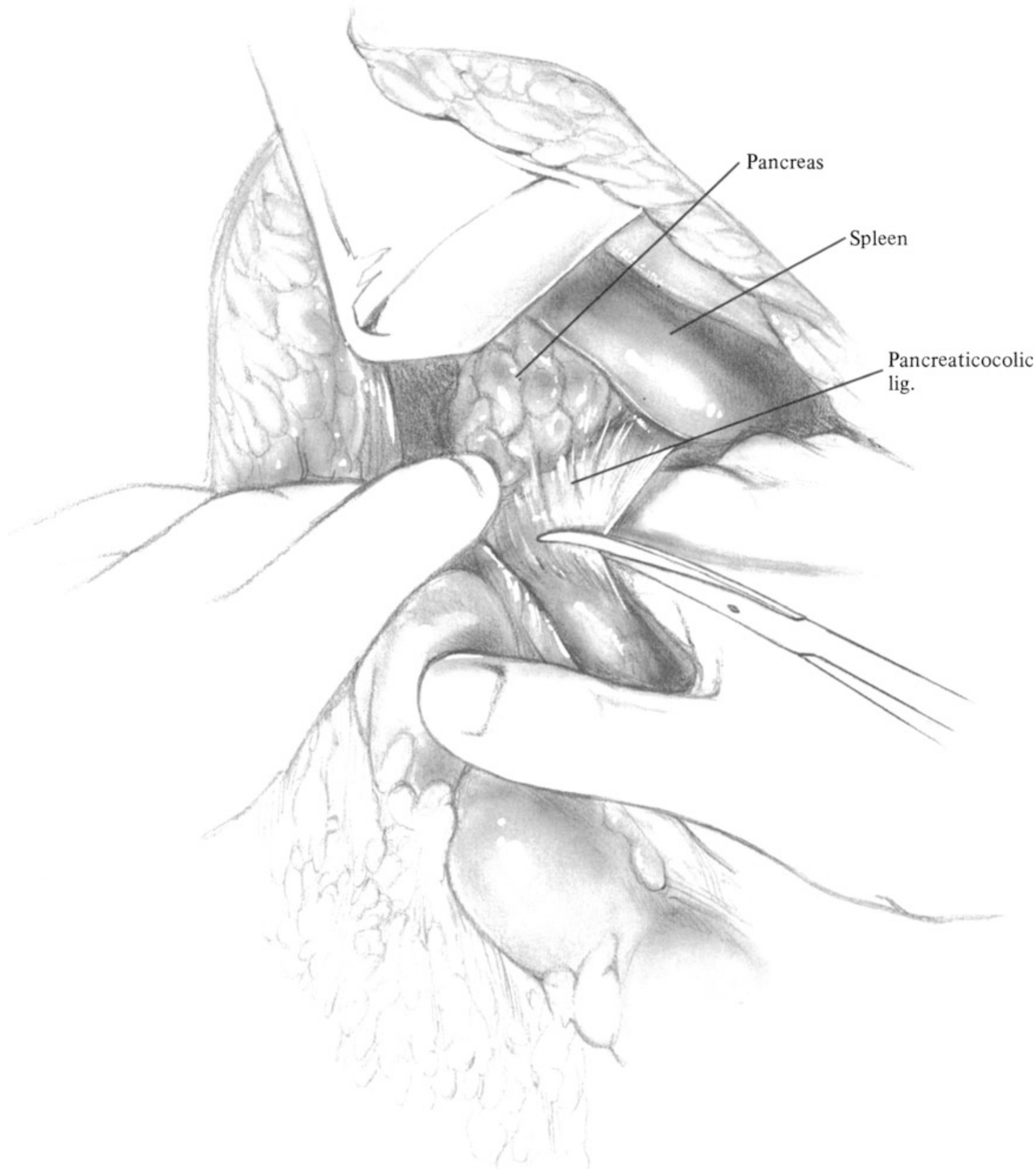


Fig. 41–6

the left transverse colon is encountered (**Fig. 41–6**). Transect this pancreaticocolic ligament, leaving the mesocolon as the only attachment the colon has to the patient. In patients who suffer from toxic megacolon, this dissection should be done with extreme caution, so as not to perforate the colon.

Division of Mesocolon

Turn now to the ileocecal region. If the terminal ileum is not involved in the disease process, its blood supply should be preserved and the point of transection should be close to the ileocecal valve. Divide the mesocolon along a line indicated in **Fig. 41–7**. Since most patients who require this operation are thin, each vessel can be visualized, doubly clamped, and divided accurately. Ligate each vessel with 2–0 PG or silk ligatures and divide the intervening avascular mesentery with a Metzenbaum scissors. In the same way, divide and ligate sequentially the ileocolic branches, the right colic, the middle colic, the two branches of the left colic, and each of the sigmoidal arteries.

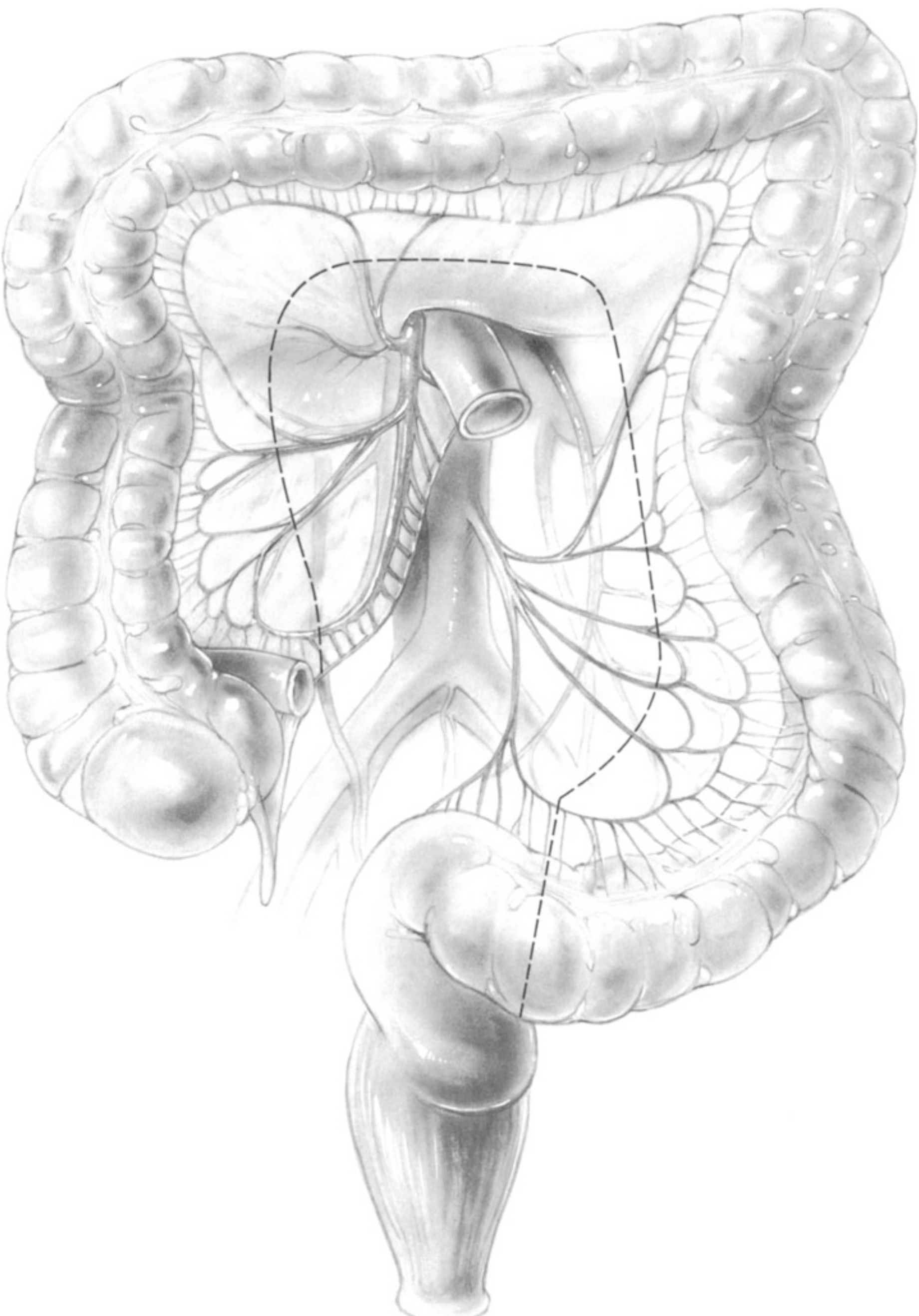


Fig. 41–7

Ileostomy and Sigmoid Mucous Fistula

The technique of fashioning a permanent ileostomy, including suturing the cut edge of the ileal mesentery to the right abdominal wall, is depicted in Figs. 44–1 through 44–9.

After the sigmoid mesentery has been divided up to a suitable point on the wall of the distal sigmoid, apply DeMartel clamps. Divide the colon and remove the specimen. Remove the Wound Protector drape. Bring out the stump of the rectosigmoid, its orifice closed by the DeMartel clamp, through the

Fig. 41–8

lower pole of the incision (**Fig. 41–8**). Fix the rectosigmoid stump to the lower pole with a few 3–0 PG sutures, approximating the mesocolon and the appendices epiploicae to the anterior rectus fascia. Close the abdominal incision around the mucous fistula.

Ileoproctostomy

When an ileorectal anastomosis is elected, we prefer the side-to-end technique, which is the same as that described by Baker (see Figs. 39–10 through 39–21) for the colorectal anastomosis. After the mesentery has been cleared at the point selected for the transection of the ileum, apply transversely and fire a TA–55 stapler using 3.5-mm staples. Apply an Allen clamp to the specimen side of the ileum and with a scalpel transect the ileum flush with the stapler. Lightly electrocoagulate the everted mucosa and remove the stapling device. Inspect the staple line to assure that proper B formation of the staples has occurred.

Divide the mesentery of the rectosigmoid up to the point on the upper rectum that has been selected for transection. This is generally opposite the sacral promontory. Apply a right-angle kidney clamp to the colon to exclude colonic contents from the field. Dissect fat and mesentery off the serosa of the rectum at the site to be anastomosed. Make a linear scratch mark on the antimesenteric border of the ileum beginning at a point 1 cm proximal to the staple line and continuing in a cephalad direction for a distance equal to the diameter of the rectum, usually 4–5 cm.

The first layer should consist of interrupted 4–0 silk seromuscular Cushing sutures inserted by the technique of successive bisection. After the sutures are tied, cut all the tails except for the two end sutures, to which small hemostats should be attached. Then make an incision on the antimesenteric border of the ileum. Also incise the back wall of rectum (**Fig. 41–9**). Initiate the closure of the posterior mucosal layer by inserting a double-armed 5–0 PG suture in the middle point of the posterior layer and tying it. With one needle insert a continuous locked suture to approximate all the coats of the posterior layer, going from the midpoint to the right corner of the anastomosis. Use the other needle to perform the same maneuver going from the midpoint to the left (**Fig. 41–10**). Amputate the specimen. Then use a continuous Cushing, Connell, or seromucosal suture to approximate the anterior mucosal layer, terminating the suture line at the midpoint of the anterior layer. Close the final anterior seromuscular layer with interrupted 4-0 silk

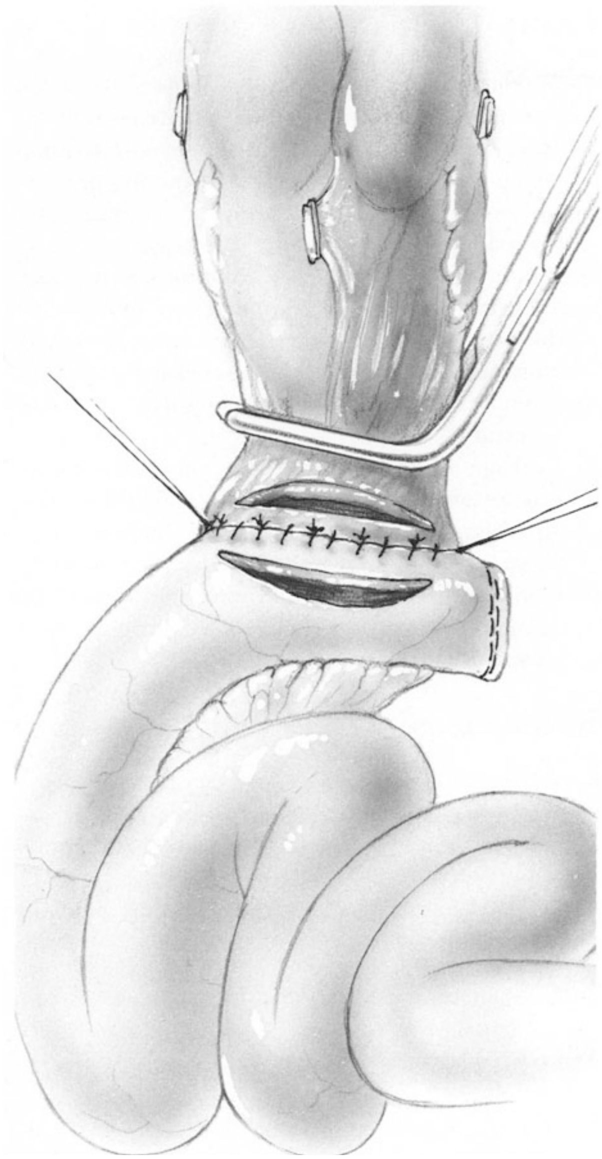


Fig. 41–9

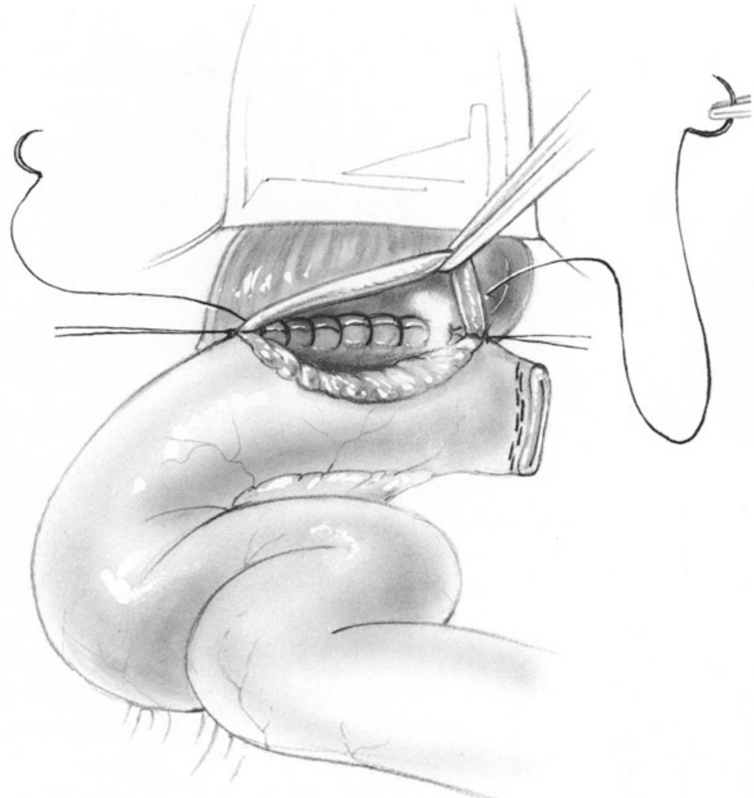


Fig. 41–10

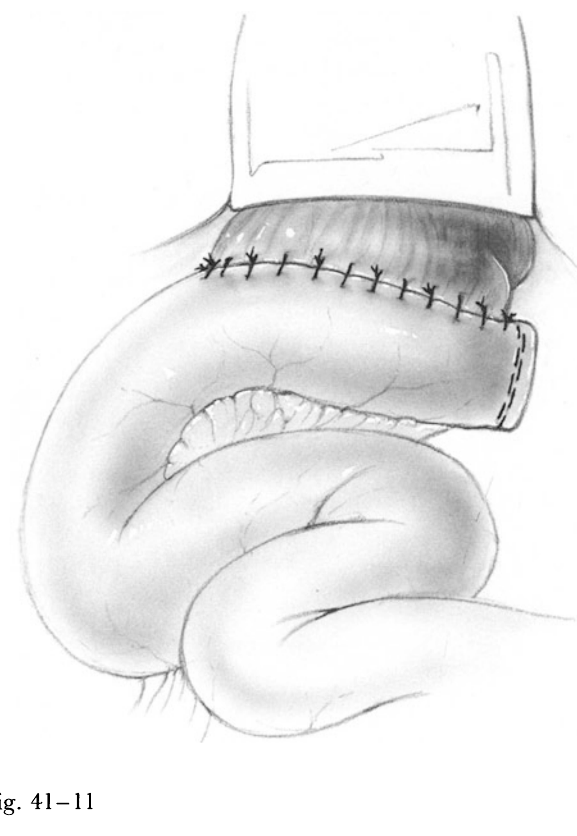


Fig. 41–11

Cushing sutures (**Fig. 41–11**). If possible, cover the anastomosis with omentum.

Approximate the cut edge of the ileal mesentery to the cut edge of the right lateral paracolic peritoneum with a continuous 2–0 atraumatic PG suture. Do not close the left paracolic gutter. Irrigate the abdominal cavity with an antibiotic solution. Remove the Wound Protector ring drape.

Subtotal Colectomy Combined with Immediate Total Proctectomy

When a proctectomy is performed at the same stage as a subtotal colectomy, occlude the rectosigmoid by a layer of TA–55 staples. Apply an Allen clamp to the specimen side of the colon, which should be transected with the removal of the specimen. Construct the ileostomy as depicted in Figs. 44–1 through 44–9. Then accomplish the abdominoperineal proctectomy by the technique described under "Abdominoperineal Proctectomy for Benign Disease" in Chap. 46.

Needle-Catheter Jejunostomy

Perform a needle-catheter jejunostomy in any patient suffering from malnutrition to permit enteral feeding immediately following surgery.

Closure of the Abdominal Incision

Irrigate the abdominal cavity with a dilute antibiotic solution and close the abdominal wall in routine fashion (see Chap. 5).

Postoperative Care

Continue nasogastric suction (when indicated) and intravenous fluids until there is good ileostomy function.

If there is no operative contamination, discontinue the perioperative antibiotics within 6 hours. Otherwise, order them when they are indicated by the operative findings and the postoperative course.

In the operating room apply a Stomahesive disc to the ileostomy after cutting a properly sized opening. Over the disc place a temporary ileostomy bag. Instruct the patient in the details of ileostomy management and encourage him or her to join one of the organizations of ileostomates, where considerable emotional support can be derived by meeting patients who have been successfully rehabilitated.

Complications

1) *Intra-abdominal abscess* is more common after colon resection for inflammatory bowel disease than for other conditions. When signs of intra-abdominal infection appear, prompt laparotomy or percutaneous CT-guided catheter drainage for evacuation of the abscess is indicated.
2) *Intestinal obstruction* due to adhesions is not rare following this group of operations, because of the extensive dissection. If treatment by a long intestinal suction tube does not bring a prompt response, laparotomy for enterolysis will be necessary.
3) Leakage of the anastomosis may follow ileoproctostomy. In case of a major leak, immediate laparotomy for a diverting loop ileostomy (see Chap. 45), followed by pelvic drainage, is mandatory. Alternatively, the anastomosis may be dismantled and the ileum brought out as a terminal ileostomy.

References

Kock N et al. Ileostomy. Curr Probl Surg 1977;14:1.

Martin LW et al. Total colectomy and mucosal proctectomy with preservation of continence in ulcerative colitis. Ann Surg 1977;186:477.

Ravitch MM, Sabiston DC. Anal ileostomy with preservation of the sphincter: a proposed operation in patients requiring total colectomy for benign lesions. Surg Gynecol Obstet 1947;84:1095.

Sher ME, Bauer JJ, Gorphine S et al. Low Hartmann's procedure for severe anorectal Crohn's disease. Dis Colon Rectum 1992;35:975–980.

Turnbull R, Weakley FL. Surgical treatment of toxic megacolon: ileostomy and colostomy to prepare patients for colectomy. Am J Surg 1971;122:325.

42 Ileoanal Anastomosis with Ileal Reservoir Following Total Colectomy and Mucosal Proctectomy

Concept: Currently Available Operations for Ulcerative Colitis and Familial Polyposis

Total Colectomy with Abdominoperineal Proctosigmoidectomy and Permanent Ileostomy

This combination of operations will certainly accomplish complete removal of the diseased colonic mucosa. The threat that carcinoma may develop postoperatively in the colon is eliminated at the cost of removing all of the colon and rectum. The patient must live henceforth with a permanent ileostomy. Although many patients may make a good adjustment to life with a permanent ileostomy, the ileostomy does engender late surgical and psychosocial complications.

Kock Continent Ileostomy

While the Kock operation, with its various modifications, may eliminate the need for the patient constantly to wear an appliance, the operation is accompanied by many complications, and in several large series of such procedures as many as 30% of the patients have required reoperation for one cause or another. Even when the Kock ileostomy functions perfectly, it requires the patient to insert a catheter of some type into the ileostomy four times a day in order to empty the pouch.

This operation may be indicated in patients who are resolutely opposed to wearing a stoma appliance and who have previously undergone total proctectomy or a failed ileoanal procedure.

Subtotal Colectomy with Ileoproctostomy

Although anastomosing the terminal ileum to the rectum following subtotal colectomy for ulcerative colitis has never achieved any popularity in the United States, it is an operation performed in the United Kingdom, especially by Aylett. It is suitable in less than half the patients undergoing colectomy for ulcerative colitis. The recurrence of colitis is often severe enough to require dismantling the ileoproctostomy. Also, the remnant of rectum is subject to the development of carcinoma over a period of years. For this reason the operation is not a satisfactory solution to the problem of treating ulcerative colitis by surgical means.

Total Colectomy and Mucosal Proctectomy with End-to-End Ileoanal Anastomosis

In 1947 Ravitch and Sabiston (also Ravitch 1948) postulated that removing all of the rectal mucosa but preserving the wall of the rectum, followed by an ileoanal anastomosis, might preserve fecal continence subsequent to total colectomy. Although Ravitch and Handelsman subsequently reported nine successful results in patients with ulcerative colitis and familial polyposis, the operation did not achieve acceptance because of its complexity and because it was followed by many complications. However, because of their familiarity with the Soave operation, pediatric surgeons like Martin and LeCoultre and like Telander and Perrault have reported satisfactory results with this operation in children and young adults. Telander's group initiated a program of balloon catheter dilatations of the distal ileum 2 weeks following operation. They felt that the dilatations accelerated the adaptation of the ileum into a successful reservoir more rapidly than was ordinarily the case. Nevertheless, 4 of Telander's 14 patients, who were followed for more than 1 year, continued to have fecal staining nightly. Also the average daily number of stools exceeded six, and 2 patients of the 14 were converted to permanent ileostomies. For this reason considerable interest was directed to the addition of an ileal reservoir to the operation under discussion.

Total Colectomy, Mucosal Proctectomy, Ileal Reservoir, and Ileoanal Anastomosis

Martin and LeCoultre performed 19 operations without a reservoir, and Martin and Fischer reported 18 patients who underwent the same operation with the addition of an "S" reservoir similar to the one reported by Parks, Nicholls, and Belliveau. Martin and Fischer found that the patients who were given a reservoir have had significantly fewer bowel movements. Their patients sustained no complications related to the reservoir except for mild temporary stasis in two cases. They emphasized that the reservoir should be brought down to within 1 cm of the end-to-end ileoanal anastomosis, unlike Parks's reservoir, which remains about 5 cm above the anastomosis. Parks and associates noted that in a large number of their early cases, catheterization of the reservoir was required in the early postoperative period to assure complete emptying.

Utsunomiya, Iwama, Imajo, and associates introduced the concept of a "J" shaped ileal reservoir, the elbow of which was anastomosed to the anus. This brings the pouch itself inside the cuff of rectal muscularis. These authors found that patients with the "J" pouch achieved satisfactory bowel function sooner than did those undergoing different types of sphincter-saving colectomies. Pemberton, Heppel, Beart, Dozois, and associates, after reviewing the literature together with their own experiences, came to the conclusion that it was advisable to construct

> an ileal reservoir in order to achieve increased capacity of the ileum more rapidly and reliably and, therefore, reduce or eliminate overflow incontinence, nocturnal soiling and perineal excoriation. If a patient is to be continent after undergoing ileoanal anastomosis and not merely possess an anal ileostomy, reservoir capacity as well as sphincteric preservation must be provided.

These authors prefer the "J" pouch. It should be noted that even in the absence of an ileal reservoir, Heppel, Kelley, Phillips, and colleagues found that the resting pressures and squeeze pressures of the anal sphincter subsequent to mucosal proctectomy and ileoanostomy were similar to those in healthy control patients. These authors concluded that, although the sphincter function seemed to be good, the maximum capacity of the ileum was far less than that of normal rectum. Taylor, Beart, Dozois, and associates compared 50 patients following straight ileoanal anastomoses with 74 patients subjected to "J" pouch-anal anastomoses. The patients with pouches experienced less diarrhea, better continence, and an improved quality of life in this study.

Our operation of choice at this time is mucosal proctectomy combined with a "J" shaped ileal reservoir and anastomosis between the elbow of the reservoir and the anus.

One-, Two-, or Three-Stage Operation

In well-nourished patients who do not have much disease in the distal rectum, a total colectomy, mucosal proctectomy, and ileoanostomy may be performed at one sitting, provided the possibility of Crohn's disease has been eliminated. Martin and Fischer advocate a 4- to 6-week period of total parenteral alimentation, systemic steroids, steroid enemas, and systemic antibiotics. Meanwhile, nothing is given by mouth. Of the 27 patients treated by this regimen, 26 healed almost all the inflammation and ulcerations in their rectums. Then, a total colectomy, mucosal proctectomy, and ileoanostomy were performed. Rothenberger, Vermeulen, Christenson, and associates as well as other surgeons prefer to pursue a different strategy in acutely ill or malnourished patients. They treat these patients by means of a three-stage procedure, the first stage of which is an ileostomy, subtotal colectomy with mucous fistula or a Hartmann pouch. Then, nutritional rehabilitation is combined with steroid enemas, systemic steroids, or antibiotics as necessary prior to the second-stage operation, which consists of mucosal proctectomy, reservoir construction, ileoanostomy, and a diverting temporary loop ileostomy. The third stage, generally performed 3 months later, consists of closing the loop ileostomy.

In general, we prefer the three-stage sequence of procedures for the malnourished patient. At the present stage of development, we still prefer with respect to these operations to routinely perform a temporary diverting loop ileostomy because it is extremely important to avoid infection in the area of the ileoanostomy. So much depends on the proprioceptive nerves in the puborectalis and levator ani muscles that permitting an anastomotic leak to develop into a cuff abscess may produce sufficient fibrosis to eliminate the function of these nerve endings. Consequently, until we learn more about these procedures, it is wise to take precautions that will minimize the incidence of cuff or pelvic abscesses.

On the other hand, Cohen, McLeod and associates and Sugerman et al. reported that they omitted the diverting ileostomy in good-risk patients with satisfactory results in patients whose pouch was attached to the rectum just above the dentate line by a double stapling technique. No mucosal proctectomy was performed.

Indications

Colectomy, mucosal proctectomy, and ileostomy are indicated in ulcerative colitis when the complications or intractability of the disease or the threat of cancer requires surgery.

Familial polyposis

Contraindications

Crohn's disease

Perianal fistulas

The rectal muscular cuff should not be strictured and fibrotic but soft and compliant.

Preoperative Care

Inflammation and ulcerations of the lower rectum must be treated preoperatively. If the patient has had a subtotal colectomy and ileostomy, steroid enemas (Proctocort)—and sometimes systemic steroids and antibiotics or 5-ASA (Rowasa) enemas or suppositories—may be helpful.

Nutritional rehabilitation when necessary

Perioperative antibiotics

Nasogastric tube (optional)

Foley catheter in bladder

Endoscopy of ileum via the ileostomy when Crohn's disease is suspected after subtotal colectomy

If one-stage colectomy and ileoanostomy is anticipated, appropriate mechanical and antibiotic bowel preparation is indicated.

Pitfalls and Danger Points

Performing an inadequate mucosectomy, which may produce a cuff abscess and possibly lead later to carcinoma

Establishing inadequate pelvic, reservoir, or anastomotic hemostasis, which may result in postoperative hemorrhage or hematoma

Injuring the nervi erigentes or the hypogastric nerves so that either sexual impotence or retrograde ejaculation results

Failing to properly diagnose Crohn's disease with development of Crohn's ileitis in the reservoir

Using improper technique in closing temporary loop ileostomy which in turn leads to postoperative leakage or obstruction

Operative Strategy

Mucosectomy

Both Rothenberger and associates and Sullivan and Garnjobst recommend starting the operation by placing the patient in the prone jacknife position in order to excise the distal 5–6 cm of rectal mucosa transanally. This dissection is expedited by injecting a solution of epinephrine (1:200,000) into the submucosal plane. If the rectum is so badly diseased that mucosectomy cannot be reasonably accomplished, the remainder of the operation is contraindicated.

Some of the earlier authors reporting on muscosal proctectomy felt that it was necessary to dissect the mucosa away from the rectal muscularis for a distance of perhaps 8–10 cm above the dentate line. This is not necessary. Good fecal continence can be maintained if the mucosa is dissected away from the rectum up to a point no more than 1–2 cm above the puborectalis, the upper end of the anal canal. This amount of dissection can generally be accomplished transanally with less difficulty in the adult patient than from the abdominal approach. Complete hemostasis in the region of the retained rectum must be attained. Generally, careful electrocoagulation will accomplish this end.

Some surgeons advocate the use of a CUSA ultrasonic dissector to facilitate the mucosal proctectomy.

Frozen-section histological examination of the excised mucosa may be helpful in ruling out Crohn's disease.

Abdominal Dissection

Division of Ileum

In performing the colectomy, transect the ileum just proximal to its junction with the ileocecal valve in order to preserve the reabsorptive functions of the distal ileum. If a previous ileostomy is being taken down, again preserve as much terminal ileum as possible.

Rectal Dissection

In dissecting the rectum away from the sacrum, keep the dissection immediately adjacent to the rectal wall. Divide the mesenteric vessels near the point where they enter the rectum and leave the major portion of the "mesentery" behind. In this way the hypogastric nerves will be preserved.

Similarly, when the lateral ligaments are divided, make the point of division as close to the rectum as possible in order to avoid dividing the parasympathetic nerves essential for normal male sexual function. Anteriorly, the dissection proceeds close to the rectal wall posterior to the seminal vesicles and Denonvilliers' fascia down to the distal end of the prostate.

Division of Waldeyer's Fascia

In the adult patient it will not be possible to expose the levator diaphragm unless the fascia of Waldeyer is divided by sharp dissection. This layer of dense fascia is attached to the anterior surface of the sacrum and coccyx and attaches to the posterior wall of the rectum. Unless it is divided just anterior to the tip of the coccyx, it will not be possible to expose the lower rectum down to the level of the puborectalis muscle.

Temporary Loop Ileostomy

Described by Turnbull and Weakley (see Chap. 45), the loop ileostomy will completely divert the fecal stream, yet it is a simple ileostomy to close without generally requiring the resection and anastomosis of the ileum. Since several authors have reported complications, such as stricture and leakage, following closure of the temporary ileostomy in addition to a high incidence of small bowel obstruction related to the ileostomy, it behooves the surgeon to perform this operation carefully. If the tissues are not unduly traumatized in freeing the ileostomy from the abdominal wall, closure of this ileal stoma should have a low complication rate. Otherwise, resect the ileostomy and reanastomose the ileum.

Ileoanostomy

In order to facilitate anastomosing the ileum or the ileal reservoir to the anus, it is helpful to flex the thighs on the abdomen to a greater extent than is usually the case when the patient is placed in the lithotomy position for a two-team abdominoperineal operation. Be certain that the rectal mucosa has been divided close to the dentate line. Otherwise, it will be necessary to insert sutures high up in the anal canal where transanal manipulation of the needle will be extremely difficult. Also, it is important to remove all of the diseased mucosa in this operation to eliminate the possibility of the patient developing a rectal carcinoma at a later date.

One method of achieving exposure with this anastomosis is to insert the bivalve Parks retractor with the large blades into the rectum. Then draw the ileum down, between the open blades of the retractor, to the dentate line. Insert two sutures between the ileum and the anterior wall of the anus. Insert two more sutures between the ileum and the posterior portion of the dentate line. Now, remove the Parks retractor. Remove the large blades from the retractor and replace them with the small blades. Then carefully insert the blades of the Parks retractor into the lumen of the ileum and open the retractor slowly.

With the Parks retractor blades in place, continue to approximate the ileum to the dentate line with 12–15 interrupted sutures of 4-0 Vicryl. This will require that the retractor be loosened and rotated from time to time to provide exposure of the entire circumference of the anastomosis. Be certain to include the underlying internal sphincter muscle together with the epithelial layer of the anal canal when inserting these sutures.

An alternative and more effective method of exposing the anastomosis is to use a Gelpi retractor with one arm inserted into the tissues immediately distal to the dentate line at about 2 o'clock while the second arm of this retractor is placed at 8 o'clock. A second Gelpi retractor is inserted into the anus with one arm at 5 o'clock and the second at 11 o'clock. If the patient is properly relaxed, these two retractors should assure visibility of the whole circumference of the cut end of the anorectal mucosa at the dentate line. Then draw the ileum down into the anal canal and complete the anastomosis.

Constructing the Ileal Reservoir

We prefer a J-loop ileal reservoir that is constructed by making a side-to-side anastomosis in the distal segment of the ileum. We do not include the elbow of the J-loop in the staple line so that there is no possibility of impairing the blood supply to the ileoanal anastomosis. The terminal end of the ileum is occluded with staples.

Although it is possible to establish an ileoanal anastomosis by using an EEA stapler, we prefer to suture this anastomosis because we like to be sure that no rectal mucosa has been left behind.

Operative Technique—Mucosal Proctectomy, Ileal Reservoir, and Endorectal Ileoanal Anastomosis

Mucosal Proctectomy Combined with Total Colectomy

When the mucosa of the distal rectum is devoid of visible ulcerations and significant inflammation, mucosal proctectomy may be performed at the same time as total colectomy. In these cases perform the colectomy as described in Chap. 41. Be certain to divide the mesentery of the rectosigmoid close to the bowel wall in order to avoid damaging the hypogastric and the parasympathetic nerves. Also, divide the branches of the ileocolic vessels close to the cecum to preserve the blood supply of the terminal ileum. It is important to transect the ileum within 1–2 cm of the ileocecal valve. Preserving as much ileum as possible will salvage some of the important absorptive functions of this organ.

In transecting the terminal ileum, use a GIA stapler and lightly electrocoagulate the everted mucosa. Mobilize the entire colon down to the peritoneal reflection, following the procedures illustrated in Figs. 41–1 to 41–7. Divide the specimen with a GIA stapler at the sigmoid level.

Before proceeding with the mucosal proctectomy, perform multiple frozen-section histological examinations of the colon specimen to rule out the possibility that the patient may be suffering from Crohn's disease. If there is a question that the patient may have Crohn's disease, one may perform an ileostomy and a mucous fistula and wait for permanent histological sections rather than proceed to immediate mucosal proctectomy.

Divide the rectosigmoid mesentery close to the bowel wall to avoid interrupting the hypogastric nerves (see Fig. 46–1). Divide the lateral ligaments close to the rectum and divide Denonvilliers' fascia proximal to the upper border of the prostate. If the dissection is kept *close to the anterior and lateral rectal walls* in men, the incidence of sexual impotence following surgery will be minimized. After dividing Waldeyer's fascia (see Fig. 39–8), expose the puborectalis portion of the levator diaphragm (see Fig. 39–23).

At this time, transect the anterior surface of the rectal layer of muscularis in a transverse direction down to the mucosa. Make this incision in the rectal wall about 2–4 cm above the puborectalis muscle. Now dissect the muscular layer away from the mucosa. Injecting a solution of 1:200,000 epinephrine between the muscosa and muscularis expedites this dissection. After the muscle has been separated from 1–2 cm of mucosa anteriorly, extend the incision in the muscularis layer circumferentially around the rectum. Use a Metzenbaum scissors and a peanut sponge dissector in this step. Achieve complete hemostasis by accurate electrocoagulation. Continue the mucosal dissection until the middle of the anal canal has been reached. Divide the mucosal cylinder at this point, remove the specimen, and leave an empty cuff of muscle about 2–4 cm in length above the puborectalis, which marks the proximal extent of the anal canal. If any mucosa has been left in the anal canal proximal to the dentate line, it will be removed transanally later in the operation.

Alternatively, one may perform the rectal mucosectomy prior to opening the abdomen. This method is described in the next section of this chapter.

Mucosal Proctectomy by the Perineal Approach

We agree with the suggestion of Sullivan and Garnjobst that the rectal mucosal dissection is best performed as the initial step in the operation, whether or not the procedure is combined with a simultaneous total colectomy. If it is not possible to dissect the mucosa away from the internal sphincter, then perform an ileostomy and abdominoperineal total proctectomy instead of an ileoanostomy.

Performing the mucosal proctectomy with the patient in the prone position affords better exposure than is available in the lithotomy position. After inducing endotracheal anesthesia, turn the patient face down and elevate the hips either by flexing the operating table or by placing a pillow under the hips. Also place a small pillow under the feet and spread the buttocks apart by applying adhesive tape to the skin and attaching the tape to the sides of the operating table. Gently dilate the anus until it admits three fingers. Obtain exposure by using either a large Hill-Ferguson, a narrow Deaver, or a bivalve Pratt (or Parks) retractor. Inject a solution of 1:200,000 epinephrine in saline in the plane just deep to the mucosa, immediately proximal to the dentate line around the circumference of the anal

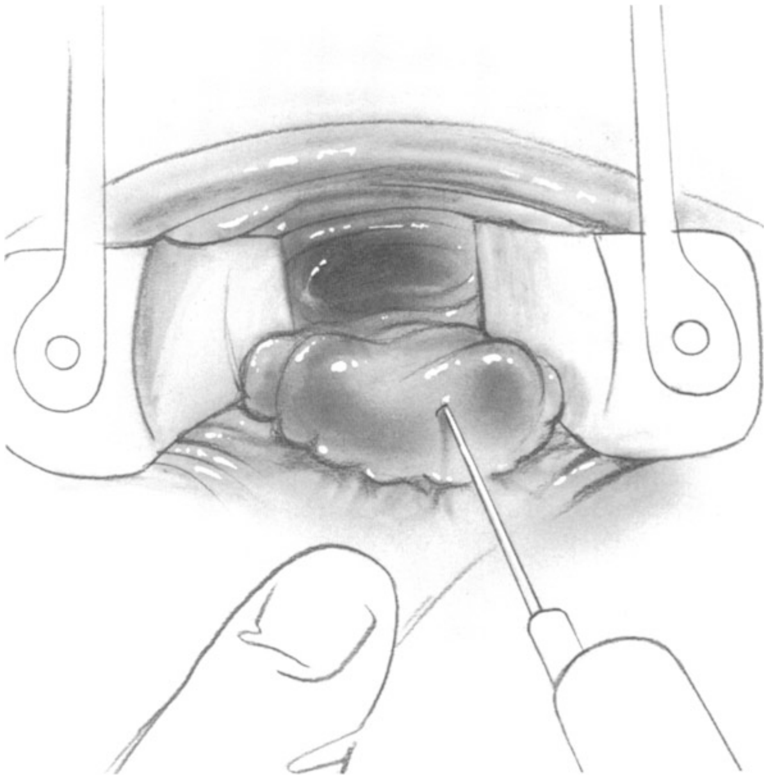


Fig. 42–1

canal (**Fig. 42–1**). Now make a circumferential incision in the transitional epithelium immediately cephalad to the dentate line. Using a Metzenbaum scissors, elevate the mucosa and submucosa for a distance of 1–2 cm circumferentially from the underlying circular fibers of the internal sphincter muscle (**Fig. 42–2**). Apply several Allis clamps to the cut end of the mucosa. Maintain hemostasis by accurate electrocoagulation using the needle tip attachment on the electrocautery. It is helpful to roll up two 10 × 20-cm moist gauze sponges soaked in a 1:200,000 epinephrine solution and to insert this roll into the rectum. This step facilitates the dissection between mucosa and muscle. Continue the dissection to a point 4–6 cm above the dentate line (**Fig. 42–3**). s the dissection continues cephalad, exposure is obtained by inserting two narrow Deaver retractors that the assistant holds in varying positions appropriate to the area being dissected.

After an adequate tube of mucosa 4–6 cm in length has been dissected, insert a purse string near the apex of the dissected mucosal tube and amputate the mucosa distal to the purse-string suture. Submit this specimen to the pathologist for frozen-section histological examination to identify any hitherto undiagnosed cases of Crohn's disease. Insert into the denuded rectum a loose gauze pack that has been moistened with an epinephrine solution. Reposition the patient on his back with the lower extremities elevated on Lloyd-Davies stirrups (see Figs. 40–1a and 40–1b).

Abdominal Incision and Exposure

In patients who have undergone a previous subtotal colectomy with a mucous fistula and an ileostomy, reopen the previous long vertical incision, free all of the adhesions between the small bowel and the peritoneum, and liberate the mucous fistula from the abdominal wall. Divide the mesentery between Kelly hemostats along a line close to the posterior wall of the sigmoid and rectosigmoid until the peritoneal reflection is reached. Incise the peritoneal

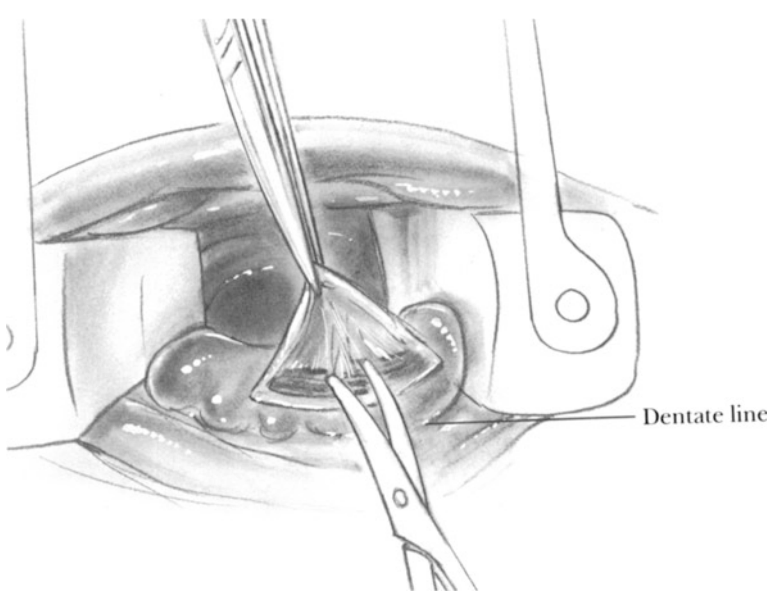


Fig. 42–2

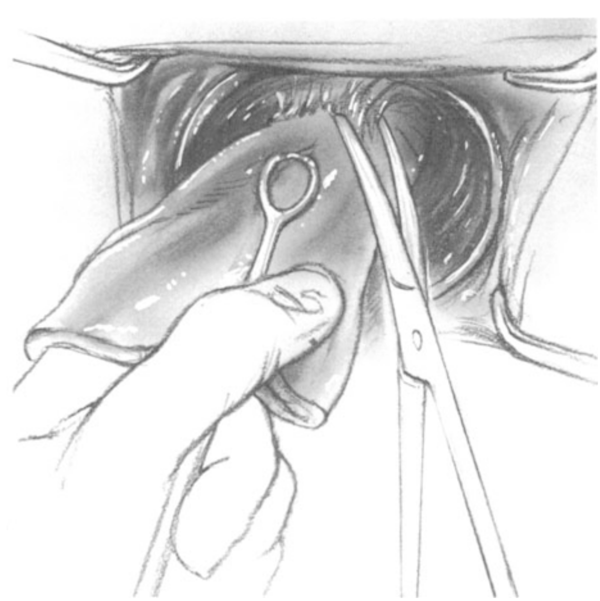


Fig. 42–3

reflection to the right and to the left of the rectum. Continue the dissection downward and free the vascular and areolar tissue from the wall of the rectum. Then elevate the rectum out of the presacral space and incise the peritoneum of the rectovesical or rectouterine pouch (see Fig. 40–7). Keep the dissection close to the rectal wall, especially in males, to avoid the nervi erigentes and the hypogastric nerves. Pay special attention to dividing the lateral ligaments close to the rectum; also avoid the parasympathetic plexus between the prostate and the rectum.

Now, with a long-handled scalpel incise Waldeyer's fascia (see Fig. 40–8) between the tip of the coccyx and the posterior wall of the rectum. Enlarge this incision with a long Metzenbaum scissors. In the male, incise Denonvilliers' fascia on (see Fig. 40–9) the anterior wall of the rectum proximal to the prostate and the seminal vesicles. Separate prostate from rectum. These last two maneuvers will permit exposure of the levator diaphragm. Palpating the rectum at this time should enable the surgeon to detect the level at which the purse-string suture was placed in the mucosa during the first phase of this operation. If this purse-string suture is not palpable, ask the assistant to place a finger in the rectum from the perineal approach to help identify the apex of the previous mucosal dissection. Now transect the rectum with the electrocoagulator and remove the specimen. Remove the gauze packing that was previously placed in the rectal stump and inspect the muscular cylinder, which is all that remains of the rectum. This consists of the circular muscle of the internal sphincter surrounded by the longitudinal muscle of the rectum. All of the mucosa has been removed down to the dentate line. Check for complete hemostasis.

Constructing the Ileal Reservoir

In patients who have had a previous ileostomy, carefully dissect the ileum away from the abdominal wall. Preserve as much ileum as possible. Apply a TA-55 stapler across a healthy portion of the terminal ileum. Fire the stapler and amputate the scarred portion of the ileostomy. Lightly electrocoagulate the everted mucosa and remove the stapling device. Now liberate the mesentery of the ileum from its attachment to the abdominal parietes. For patients who have not undergone a previous ileostomy, divide the terminal ileum with a GIA stapling device and divide the mesentery along the path indicated in **Fig. 42–4**. Freeing the small bowel mesentery from its posterior attachments (see Figs. 29–1 and 29–2) and all other adhesions may sufficiently elongate the mesentery so that the ileal reservoir will reach the anal canal *without tension.*

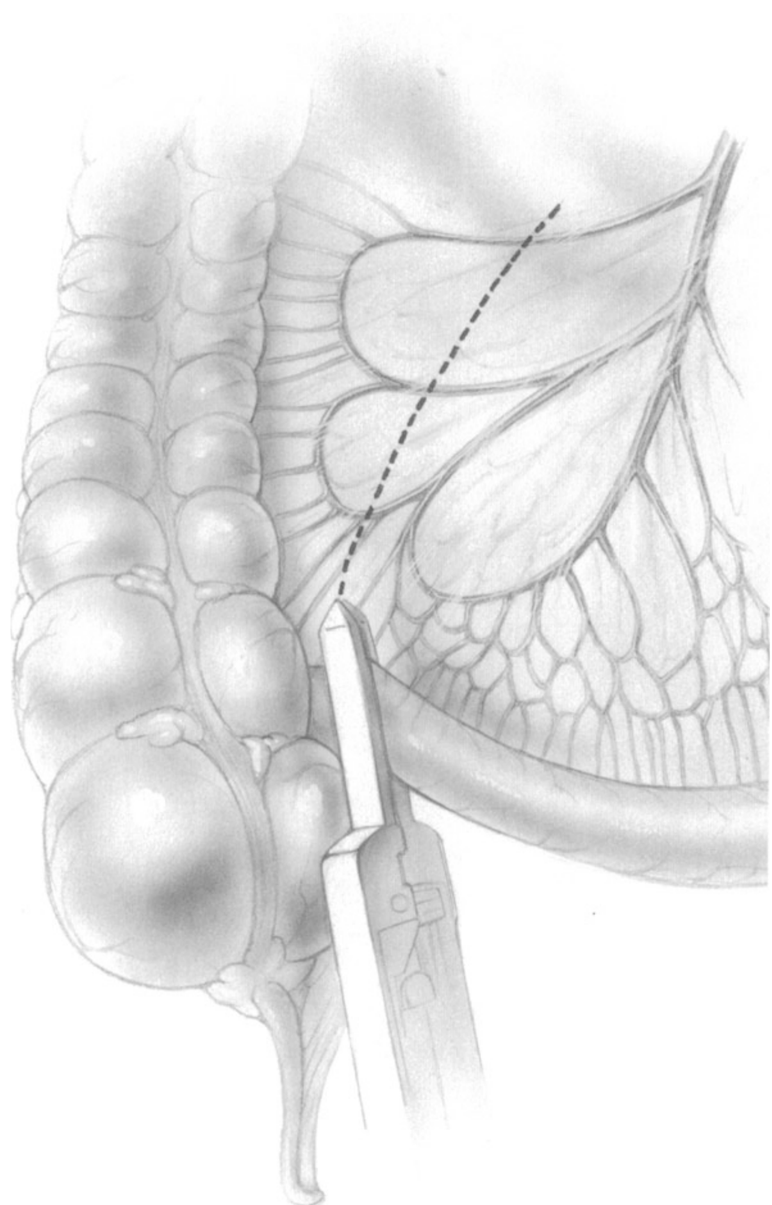


Fig. 42–4

Now select a point on the ileum about 20 cm from its distal margin which will serve as future site of the ileoanal anastomosis. If this point on the ileum can be brought 6 cm beyond the symphysis pubis, then one can rest assured that there will not be any tension on the anastomosis. Otherwise, further elongation of the mesentery can be accomplished by incising the peritoneum on the anterior and the posterior surfaces of the ileal mesentery. Burnstein and associates reported that these relaxing incisions each contributed 1 cm to the length of the ileal mesentery. Additional length may be obtained by applying traction to the anticipated elbow of the "J"

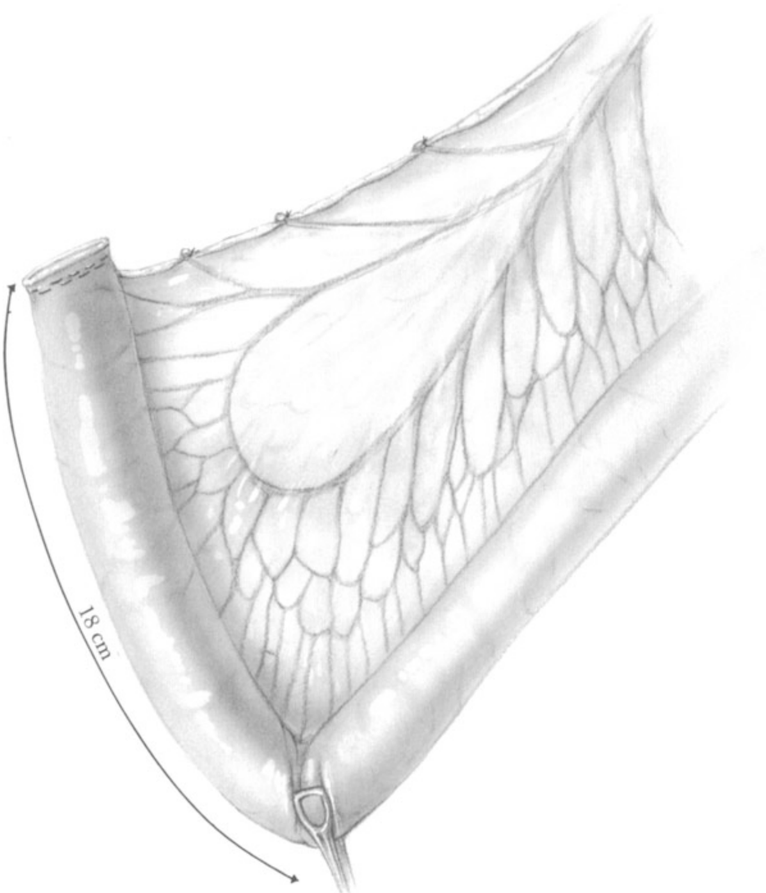


Fig. 42–5

pouch (**Fig. 42–5**), transilluminating the mesentery, and selectively dividing branches of the loop formed by the superior mesenteric and ileocolic arteries as shown in **Fig. 42–6** (Burnstein et al.).

Be certain that the blood supply to the terminal ileum will remain vigorous and that there will be no tension on the ileoanal anastomosis. Take great care to isolate and ligate each vessel in the ileal mesentery individually, especially if the mesentery is thickened from scar tissue or obesity. Several cases have been reported of postoperative hemorrhage from divided mesenteric vessels as well as of a large hematoma of the mesentery producing ileal ischemia.

Now align the distal ileum in the shape of a U, each limb of which measures about 18 cm. Create a side-to-side stapled anastomosis between the antimesenteric aspects of the ascending and descending limbs of this U. Make a transverse stab wound 9 cm proximal to the staple line of the terminal ileum. Make a second transverse stab wound in the descend ing limb of ileum just opposite the first stab wound (**Fig. 42–7**). Insert an 80-mm GIA stapler in a cephalad direction, one fork in the descending limb and one fork in the ascending limb of jejunum. Remember that this anastomosis is created on the *antimesenteric* borders of both limbs of jejunum. Fire the GIA stapler. This will create an 8-cm side-to-side anastomosis. Withdraw the stapling device and inspect the staple line for bleeding. Electrocoagulate bleeding points cautiously. Then reinsert the device into the same two stab wounds but direct the GIA in a caudal direction (**Fig. 42–8**). Lock the device and fire the staples. Remove the GIA and inspect for bleeding. Inspect the staple line via the stab wounds and electrocoagulate the bleeding points. The patient should now have a completed side-to-side stapled anastomosis about 16 cm in length. We prefer to leave an intact circular loop of ileum distal to the side-to-side anastomosis to assure that the bowel to be anastomosed has not been traumatized.

The ileal reservoir is now complete except for the remaining stab wound through which the GIA stapling device was previously inserted. Apply Allis clamps to approximate, in a transverse direction, the

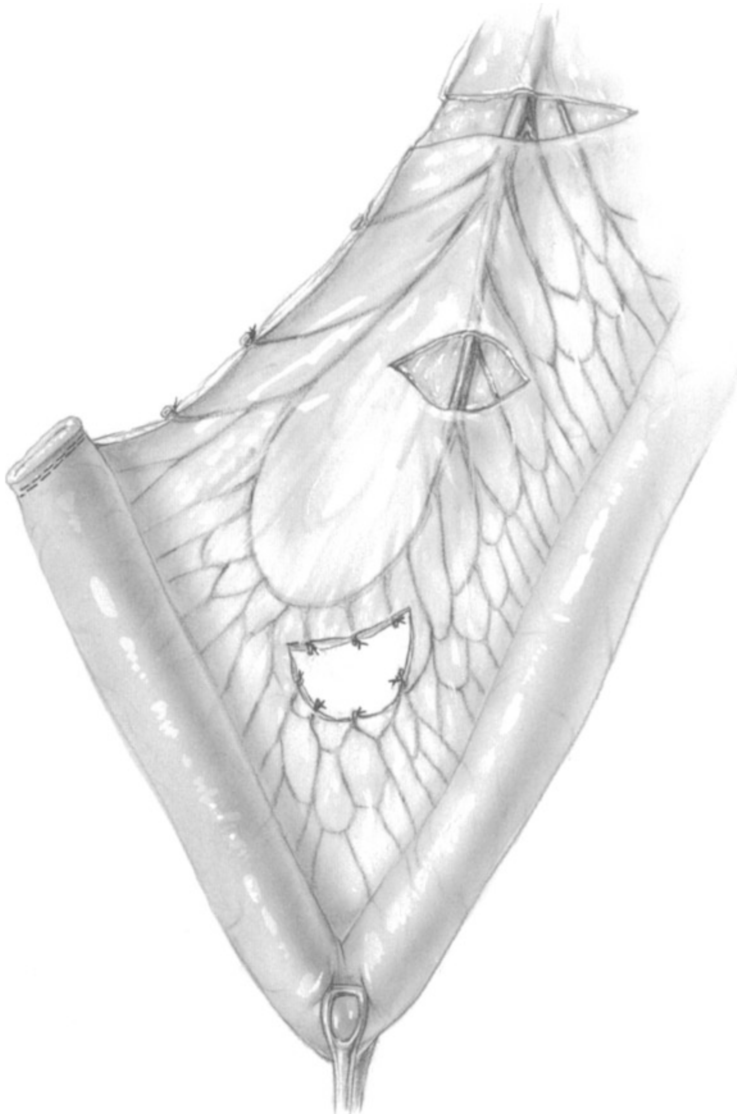


Fig. 42–6

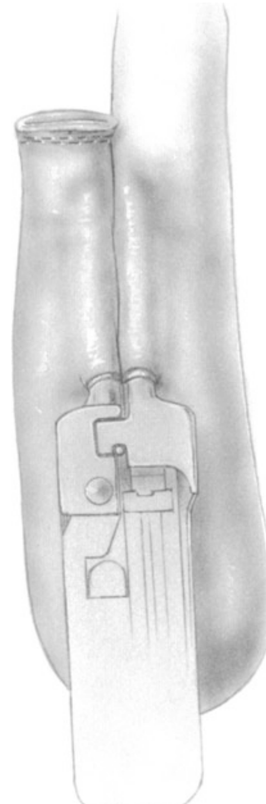


Fig. 42–7

walls of the ileum in preparation for the transverse application of a TA-55 stapling device that will accomplish an everted closure of the defect. Be certain that the superior and inferior terminations of the previous staple lines are included in the TA-55 device before firing the staples. Also, avoid the error of trying to fire the TA-55 when the two terminations of the previous staple lines are in exact apposition (see Figs. 36–18 to 36–20). After the TA-55 has been fired, lightly electrocoagulate the everted mucosa and carefully inspect the staple line to be sure of proper "B" formation (**Fig. 42–9**).

Alternatively, *sutures* may be used to construct the side-to-side anastomosis. Make longitudinal incisions along the antimesentric borders of both the ascending and descending limbs of the ileum. Achieve hemostasis with the electrocoagulator. In-

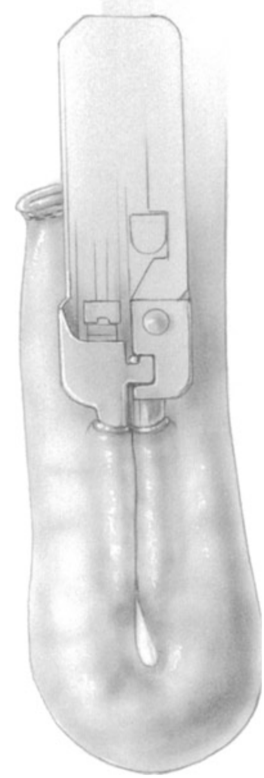


Fig. 42–8

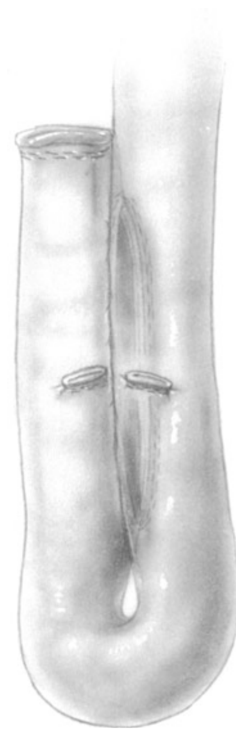


Fig. 42–9

sert interrupted sutures to approximate the bowel walls at the proximal and distal margins of the anastomosis with 3–0 Vicryl. Insert another suture at the midpoint between these two. Then use a straight atraumatic intestinal needle with 3–0 Vicryl starting at the apex of the posterior portion of the anastomosis and use a continuous locked suture encompassing all the layers of the bowel. Accomplish closure of the anterior layer of the anastomosis by means of a continuous seromucosal or Lembert (see Figs. B–16 and B–17) suture. Rothenberger and associates use a single layer of continuous suture to complete the entire anastomosis.

Carefully inspect all aspects of the side-to-side anastomosis, both front and back, to be certain that there are no defects or technical errors.

Ileoanal Anastomosis

Before passing the elbow of the ileal reservoir down through the anus, recheck the position of the pelvis and the buttocks on the operating table. The perineum should project beyond the edge of the table. The simplest method of exposing the dentate line for the anastomosis is to insert two Gelpi retractors, one at right angles to the other. The prongs of the retractors should be inserted fairly close to the dentate line so that the transected anorectal junction can be seen. Insert the first Gelpi retractor in the axis between 2 and 8 o'clock and the second between 5 and 11 o'clock. If exposure, for some reason, is not adequate, it may be helpful to readjust the stirrups so that the thighs are flexed upon the abdomen. This position makes more convenient the application of retractors to the anus.

After making certain that hemostasis in the pelvis is complete, insert two long Babcock clamps through the anus and grasp the dependent portion of the ileal reservoir. Bring this segment of ileum into the anal canal. Be certain that the bowel has not been twisted during this maneuver and that the mesentery lies flat and *that it will not exert significant tension* on the

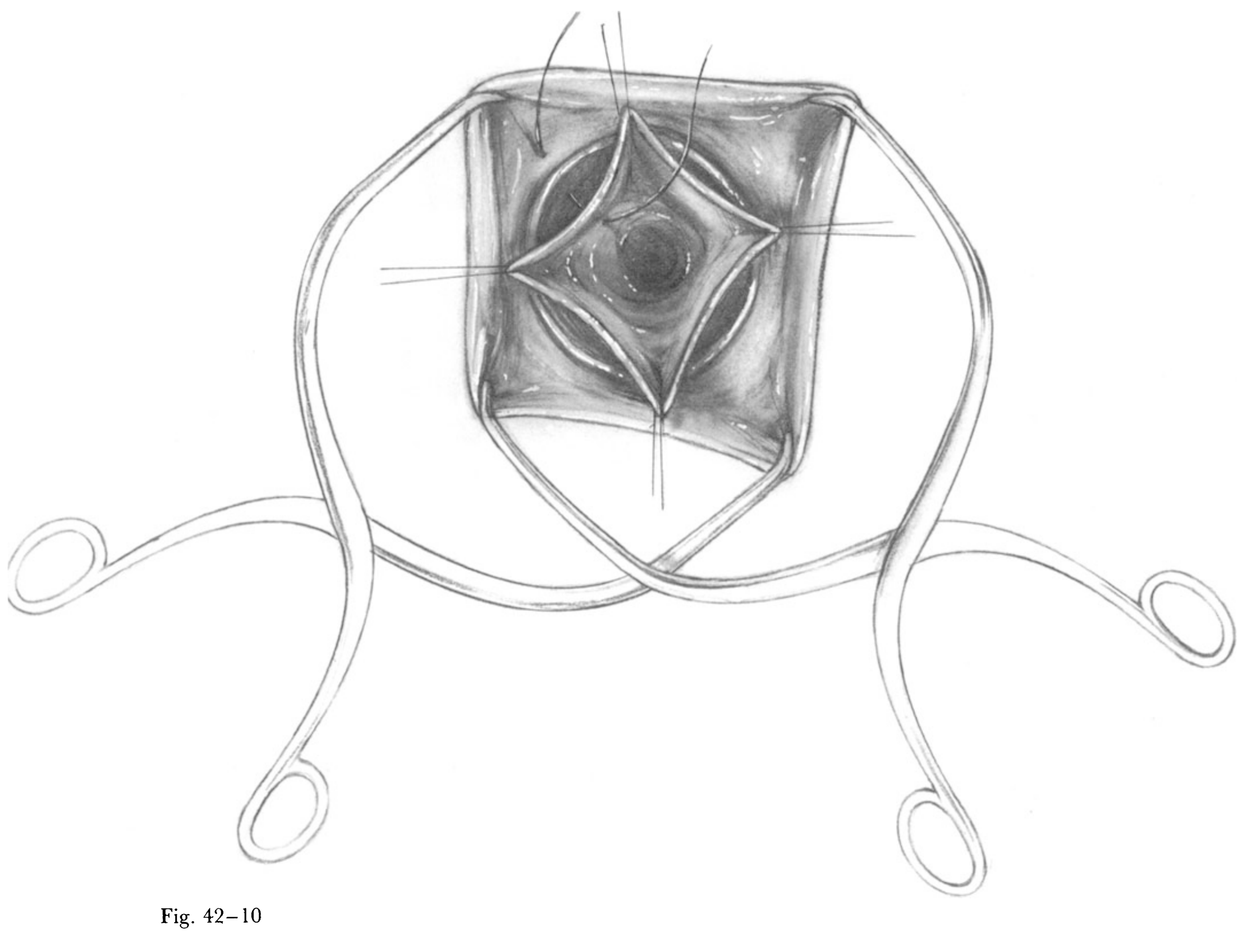


Fig. 42–10

anastomosis to be constructed. Make a longitudinal incision along the dependent border of the ileal reservoir. Electrocoagulate the bleeding points. Apply traction sutures to the incised ileum, one to each quadrant (**Fig. 42–10**). Construct a one-layer anastomosis between the ileum and the dentate line of the anus. Be sure to include in each stitch a 4-mm bite of underlying internal sphincter muscle as well as anal epithelium. Use atraumatic 4–0 Vicryl sutures (Fig. 42–11). If the anal canal is deep, using a double-curved Stratte needle-holder (see Fig. D–14) is helpful. Insert the first four sutures at 12, 6, 3, and 9 o'clock. Then continue to insert sutures by the method of successive bisection (see Figs. B–22 and B–23). The resulting ileoanal anastomosis should be widely patent (**Fig. 42–11**). If desired, the ileal reservoir may now be inflated with a methylene blue solution to check for possible defects in the reservoir staple or suture lines. **Fig. 42–12** illustrates the completed anastomosis.

Cohen, McLeod and associates reported the results in 71 patients of creating the anastomosis between the anus and the perineal pouch by means of a double stapling technique. No mucosal proctectomy was performed. The rectum was closed with a TA-30 stapler at a point 1–2 cm above the dentate line, leaving some transitional zone epithelium behind. The ileoanal anastomosis was accomplished by passing the CEEA stapler through the anus. Their results were satisfactory, even though they omitted the diverting ileostomy in good-risk patients, especially in those who underwent the subtotal colectomy at a previous stage. Sugerman et al. reported similar findings in 1991. It is unknown whether leaving a few millimeters of mucosa behind in patients with ulcerative colitis produces an increased risk of the future development of cancer. For this reason we have hesitated to adopt this modification of the pouch operation.

Loop Ileostomy

Until more evidence has accumulated to demonstrate that this step is not necessary, we believe that these patients should have a temporary diverting loop ileostomy similar to that described by Turnbull and Weakley (see Chap. 45). If the patient has a defect in the abdominal wall that remains from the dismantling of a previous ileostomy, it is generally possible to use the same site for the loop ileostomy. Insert a large Babcock clamp through the opening in the abdominal wall and grasp the antimesenteric aspect of a segment of ileum proximal to the ileal reservoir. Select a segment of ileum that will not exert any tension whatever on the ileal reservoir. Draw the loop of ileum through the opening in the

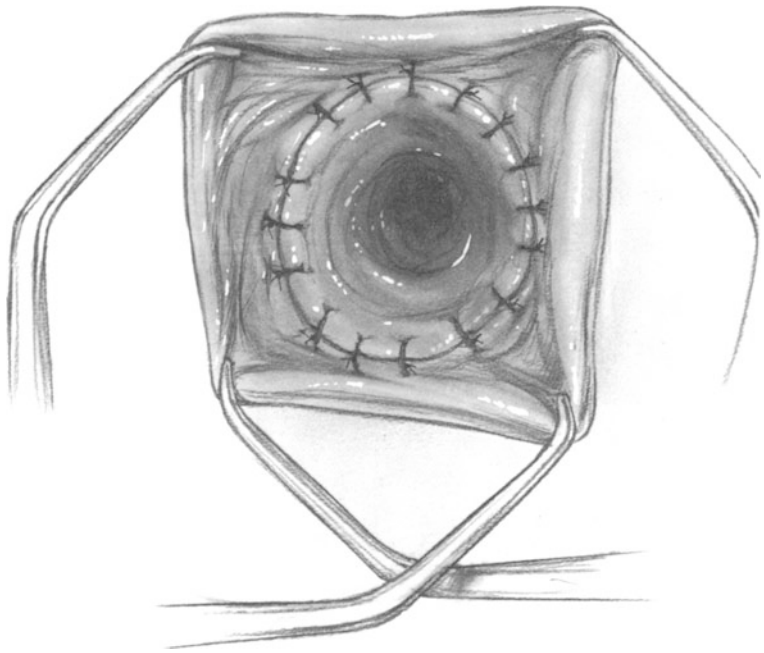


Fig. 42–11

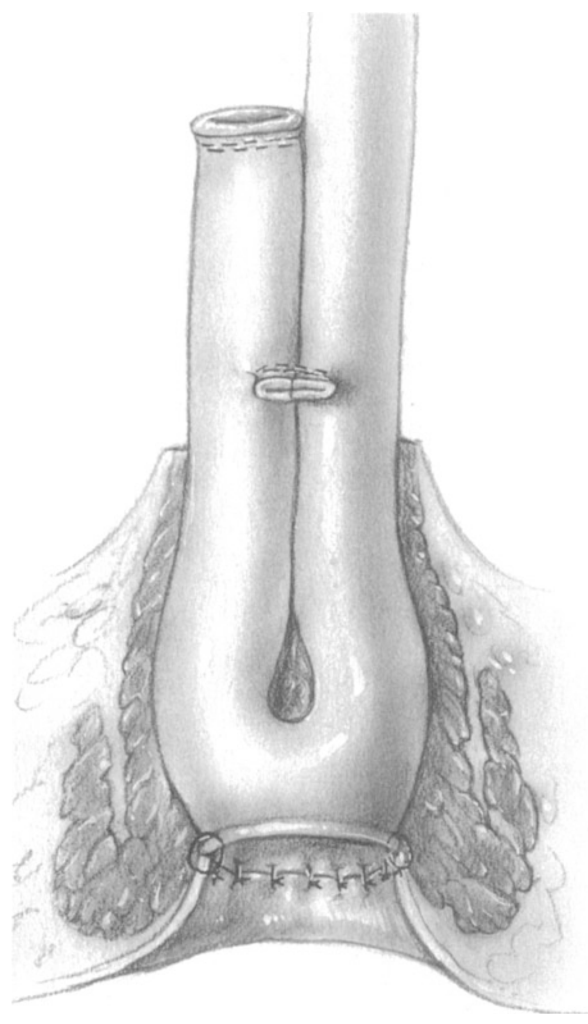


Fig. 42–12

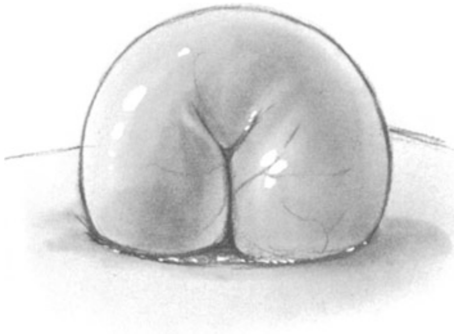


Fig. 42–13

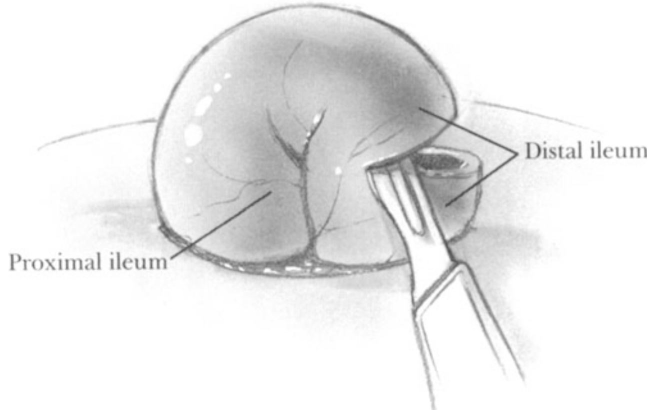


Fig. 42–14

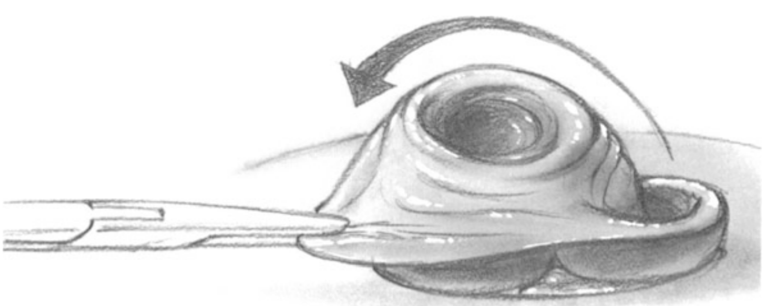


Fig. 42–15


Fig. 42–16

abdominal wall (**Fig. 42–13**). Position the ileum so that the afferent or proximal limb of ileum enters the stoma from its cephalad aspect and the distal ileum leaves the stoma at its inferior aspect. In order to insure that the proximal stoma will dominate the distal stoma and completely divert the fecal stream, transect the anterior half of the ileum at a point 2-cm distal to the apex of the loop (**Fig. 42–14**). Then evert the ileostomy (**Fig. 42–15**). Insert interrupted atraumatic sutures of 4–0 Vicryl to approximate the full thickness of the ileum to the subcuticular portion of the skin. The end result should demonstrate a dominant proximal stoma that compresses the distal stoma (**Fig. 42–16**). We do not suture the ileum to the peritoneum or fascia.

In order to minimze the contamination of the abdominal cavity, it is possible to deliver the loop of ileum through the abdominal wall, then pass a small catheter around the ileum and through the mesentery in order to maintain the position of the ileum. The actual division of the ileum and suturing of the ileostomy may be postponed until the abdominal incision has been completely closed. After suturing the ileum to the subcutis, remove the catheter.

Drainage and Closure

Intermittently throughout the construction of the ileal reservoir and the perineal anastomosis, we irrigate the operative field with a dilute antibiotic solution. This step is repeated during the closure of the abdominal wall.

With respect to draining the operative site, a number of authors insert a tube drain between the rectal cuff and the ileal reservoir because a hematoma or infection in this area may produce fibrosis and impair fecal continence. We do not believe that this step will compensate for imperfect hemostasis. Consequently, at this point in the operation, make every effort to achieve complete hemostasis in the rectal cuff and in the pelvis. Insert one or two Jackson-Pratt silicone closed-suction drains through puncture wounds in the abdominal wall down to the rectal cuff. Some authors believe it is important to place a layer of sutures between the proximal cut end of the rectal cuff and the ileal reservoir. Although we do not believe that these sutures will compensate for an inadequate ileoanal anastomosis, they may help prevent tension on anastomosis.

Close the abdominal wall with interrupted 1 PDS by the modified Smead-Jones technique described in Chap. 5. Close the skin with interrupted fine nylon or skin staples. Then mature the loop ileostomy as described above if this step has not already been done.

Postoperative Care

Continue perioperative antibiotics for 24 hours.

Continue nasogastric suction until the ileostomy begins to function.

Remove the closed-suction drains from the pelvis between the 4th and 6th postoperative day, depending on the volume of drainage. (Inject 25 mg kanamycin in 25 ml saline into the drainage catheters every 8 hours.)

Until the loop ileostomy is closed, perform weekly or biweekly digital examinations of the ileoanal anastomosis in order to prevent the development of a stricture.

About 8 weeks following operation, rule out anastomotic defects by direct inspection and palpation. If there has been uneventful healing without any evidence of hematoma or sepsis in the pelvis, perform a barium enema to visualize the ileal reservoir. If both these procedures are negative, close the loop ileostomy.

Following closure of the loop ileostomy, administer medications such as Lomotil, Imodium, codeine, or Metamucil, which will probably be required to help solidify the consistency of the bowel movements for a period of weeks.

Postoperative Complications

An abscess may occur in the rectal cuff or the pelvis. This complication has been reported in the early postoperative period but, remarkably enough, it has also been noted 2 and 6 months postoperatively in other cases. If the loop ileostomy is still in place, most cuff abscesses may be treated by drainage directly through the anastomosis. Pelvic abscesses may require laparotomy or CT-guided percutaneous catheter insertion for drainage. With proper precautions postoperative sepsis should be rare.

Hematoma in pelvis or in reservoir

Anastomotic dehiscence or stricture

Wound infection

Urinary tract infection

Excessive number of stools

Fecal incontinence

"Pouchitis" may occur following the "J" pouch, when stagnation and bacterial overgrowth produce an enteritis. This condition requires metronidazole medication by mouth.

Acute intestinal obstruction due to adhesions

References

Aylette SO. Three hundred cases of diffuse ulcerative colitis treated by total colectomy and ileorectal anastomosis. Br Med J 1966;1:1001.

Burnstein MJ, Schoetz DJ Jr, Collier JA et al. Technique of mesenteric lengthening in ileal reservoir-anal anastomosis. Dis Colon Rectum 1987;30:863–866.

Cohen Z, McLeod RS, Stephen W et al. Continuing evolution of the pelvic pouch procedure. Ann Surg 1992;216:506–512.

Heppel J, Kelley KA, Phillips SF et al. Physiologic aspects of continence after colectomy, mucosal proctectomy, and endorectal ileo-anal anastomosis. Ann Surg 1982; 195:435.

Martin LW, Fischer JF. Preservation of anorectal continence following total colectomy. Ann Surg 1982; 196:700.

Martin LW, LeCoultre C. Technical considerations in performing total colectomy and Soave endorectal anastomosis for ulcerative colitis. J Pediatr Surg 1978; 13:762.

Parks AG, Nicholls RJ, Belliveau P. Proctocolectomy with ileal reservoir and anal anastomosis. Br J Surg 1980; 67:533.

Pemberton JH, Heppel J, Beart RW Jr et al. Endorectal ileoanal anastomosis. Surg Gynecol Obstet 1982;155: 417.

Ravitch MM. Anal ileostomy with sphincter preservation in patients requiring total colectomy for benign conditions. Surgery 1948;24:170.

Ravitch MM, Handelsman JC. One stage resection of entire colon and rectum for ulcerative colitis and polypoid adenomatosis. Bull Johns Hopkins Hosp 1951;88:59.

Ravitch MM, Sabiston DC. Anal ileostomy with preservation of the sphincter. Surg Gynecol Obstet 1947; 84:1095.

Rothenberger DA, Vermeulen FD, Christenson CE et al. Restorative proctocolectomy with ileal reservoir and ileoanal anastomosis. Am J Surg 1983;145:82.

Soave F. A new technique for treatment of Hirschsprung's disease. Surgery 1964;56:1007.

Sugerman HJ, Newsome HH, DeCosta G et al. Stapled ileoanal anastomosis for ulcerative colitis and familial polyposis without a temporary diverting ileostomy. Ann Surg 1991;213:606–619.

Sullivan ES, Garnjobst WM. Advantage of initial transanal mucosal stripping in ileo-anal pull-through procedures. Dis Colon Rectum 1982;25:170.

Taylor BM, Beart RW Jr, Dozois RR et al. Straight ileoanal anastomosis v. ileal pouch-anal anastomosis after colectomy and mucosal proctectomy. Arch Surg 1983;118:696.

Telander RL, Perrault J. Colectomy with rectal mucosectomy and ileoanal anastomosis in young patients. Arch Surg 1981;116:623.

Utsunomiya J, Iwama T, Imajo M et al. Total colectomy, mucosal proctectomy, and ileoanal anastomosis. Dis Colon Rectum 1980;23:459.

43 Subtotal Colectomy for Massive Colonic Hemorrhage

Indications

Angiodysplasia
Diverticulosis
Inflammatory bowel disease

Concept

In many patients (especially the elderly) the etiology of colon hemorrhage is an *angiodysplasia*, usually located in the right colon. When this has been identified by arteriography, resection of the right colon, rather than subtotal colectomy, is indicated. While well tolerated by most patients, subtotal colectomy does produce disabling diarrhea in some. Ottinger reported that 16% of the patients studied were disabled by six or more bowel movements a day, after subtotal colectomy had been performed for noninflammatory conditions of the colon.

In the majority of cases, bleeding from *diverticulosis* does not exceed 1500 ml. Occasionally, especially in patients whose diverticulosis extends from the cecum to the rectosigmoid, major life-threatening hemorrhage of the colon does take place. In these cases the source of bleeding is more commonly located in the right colon than the left. Sometimes, there is more than one bleeding point. For these reasons, Drapanas et al. have recommended emergency subtotal colectomy for these patients. On the other hand, Boley et al. found that if the location of a bleeding diverticulum has been identified by arteriography, *partial* colectomy is followed by recurrent bleeding in less than 20% of the cases. When a bleeding point has been demonstrated angiographically, we generally do a segmental rather than subtotal colectomy, especially in elderly patients.

Occasionally, the bleeding can be stopped by an intra-arterial infusion of vasopressin, and an emergency operation will be unnecessary.

Preoperative Preparation

In cases of massive life-threatening hemorrhage, an operation is performed as an emergency procedure and the routine bowel preparation cannot be carried out. After blood loss has been replaced, insert a nasogastric tube and Foley catheter, initiate perioperative systemic antibiotics, and schedule an operation immediately.

Operative Strategy

The colon is rarely inflamed in cases of major hemorrhage, which makes the operation technically simple. The major blood supply to the colon may be transected just proximal to the marginal artery, where the right colic, the middle colic, and left colic branches are ligated easily. In the lower left colon, the sigmoidal vessels are ligated rather than the inferior mesenteric. A side-to-end anastomosis is constructed between the ileum and the rectosigmoid. No dissection is necessary in the presacral space in most cases.

It is hoped that the severity of postoperative diarrhea may be reduced if the terminal ileum is preserved. This is accomplished by avoiding ligation of the ileocolic trunk. Rather, the blood supply to the terminal ileum is preserved and the ileum divided close to the ileocecal valve in order to preserve, as much as possible, its water-absorbing capability.

In agreement with Drapanas et al. we perform a side-to-end (Baker) anastomosis because it is technically simpler and safer than is an end-to-end ileocolonic suture line, which would require an extensive Cheatle slit of the ileum. The incision on the antimesenteric border of the ileum for this anastomosis should begin no more than one centimeter from the end of the ileum, which we generally close with staples.

Operative Technique

(See Chap. 41.)

References

Boley SJ et al. Lower intestinal bleeding in the elderly. Am J Surg 1979;137:57.

Drapanas T et al. Emergency subtotal colectomy: preferred approach to management of massively bleeding diverticular disease. Ann Surg 1973;177:519.

Ottinger LW. Frequency of bowel movements after colectomy with ileorectal anastomosis. Arch Surg 1978; 113:1048.

44 Ileostomy, End

Indications

An end ileostomy is generally done in conjunction with a subtotal or total colectomy for inflammatory bowel disease. Occasionally a temporary end ileostomy and mucous fistula of the distal end of the bowel is constructed after the resection of a gangrenous segment of intestine or a perforated cecal lesion, when primary anastomosis is contraindicated.

Pitfalls and Danger Points

Devascularization of an excessive amount of terminal ileum, with resultant necrosis and stricture formation

Ileocutaneous fistula resulting from too deep a stitch in the seromuscular layer of the ileum when fashioning the ileostomy

Operative Strategy

Immediate maturation of the ileostomy by mucocutaneous suture, which prevents the occurrence of the serositis that is uniformly present when the serosa is exposed outside the body, has virtually eliminated a host of ileostomy complications, such as prolapse, obstruction, and excessive secretion.

The prevention of peristomal skin excoriation, which results from the escape of small bowel contents underneath the face plate of the ileostomy appliance, requires the formation of a permanently protruding ileostomy. Properly performed, the ileostomy should resemble the cervix of the uterus. A permanent protrusion of 2.0 cm is desirable. This allows for the likelihood that an underweight patient will accumulate a subcutaneous layer of fat following successful surgery for colitis.

To prevent herniation of small bowel, the gap between the cut edge of the ileum and the lateral abdominal wall should be closed in the formation of a permanent ileostomy.

Fig. 44–1

Operative Technique

Preoperative Selection of Ileostomy Site

Apply the face plate of an ileostomy appliance tentatively to various positions in the right lower quadrant of the patient to make sure it does not come into contact with the costal margin or the anterior superior spine when the patient is in a sitting position. The face plate should not extend beyond the midrectus line or the umbilicus.

In emergency operations, when an ileostomy has not been contemplated, the site for the ileostomy may be placed approximately 5 cm to the right of the midline and about 4 cm below the umbilicus.

Incision

Since ileostomy generally is not the main part of the contemplated operation, a midline incision will have already been made. Now make a circular incision in the previously selected site in the right lower quadrant and excise a circle of skin the diameter of a nickel (2 cm) (**Fig. 44–1**). The incision will then spontaneously stretch to the proper diameter. It is not necessary to excise a core of subcutaneous fat. Make a linear incision down to the anterior rectus fascia and insert retractors to expose the fascia.

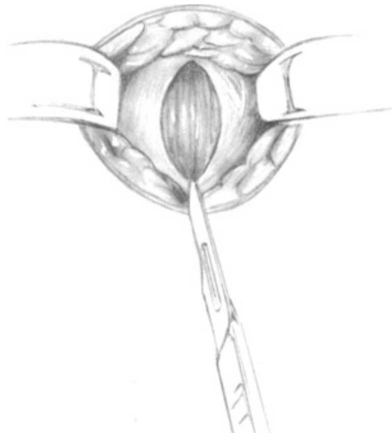


Fig. 44–2

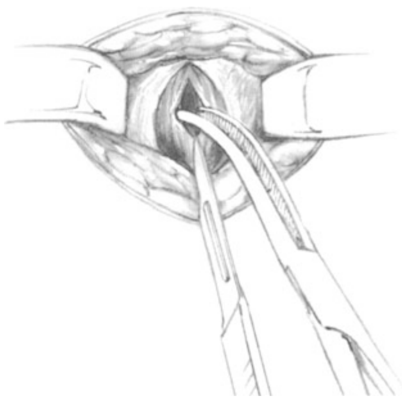


Fig. 44–3

Fig. 44–4

Make a longitudinal 2-cm incision in the fascia, exposing the rectus muscle (**Fig. 44–2**). Separate the muscle fibers with a Kelly hemostat (**Fig. 44–3**), and make a longitudinal incision in the peritoneum. Then dilate the opening in the abdominal wall by inserting two fingers (**Fig. 44–4**).

Fashioning the Ileal Mesentery

A 6–7 cm length of ileum is required beyond the point at which the ileum meets the peritoneum if a proper ileostomy of the protruding type is to be made. If the entire mesentery is removed from this length of ileum, necrosis of the distal ileal mucosa will take place in many patients. Consequently, the portion of the ileum that passes through the abdominal wall must retain a sufficient width of mesentery to assure vascularity. The "marginal" artery can be visualized in the mesentery within 2 cm of the ileal wall. Preserve this segment of vasculature while carefully dividing the mesentery. Complete removal of the mesentery is well tolerated by the distal 2–3 cm of the ileum.

Closure of Mesenteric Gap

Insert a Babcock clamp into the abdominal cavity through the opening made for the ileostomy. Grasp the terminal ileum with the clamp and gently bring it through this opening, with the mesentery placed in a cephalad direction (**Fig. 44–5**). Place no sutures between the ileum and the peritoneum or the rectus fascia (**Fig. 44–6**).

Using a continuous 2–0 PG suture, suture the cut edge of the ileal mesentery to the cut edge of the paracolic peritoneum. This will completely obliterate the mesenteric defect (**Fig. 44–7**).

Mucocutaneous Fixation of Ileostomy

Construct a "cervix" by inserting interrupted 4–0 PG sutures through the full thickness of the terminal ileum and then, using the same needle, take a shallow seromuscular bite of the lateral wall of the ileum which is situated opposite the level of the skin.

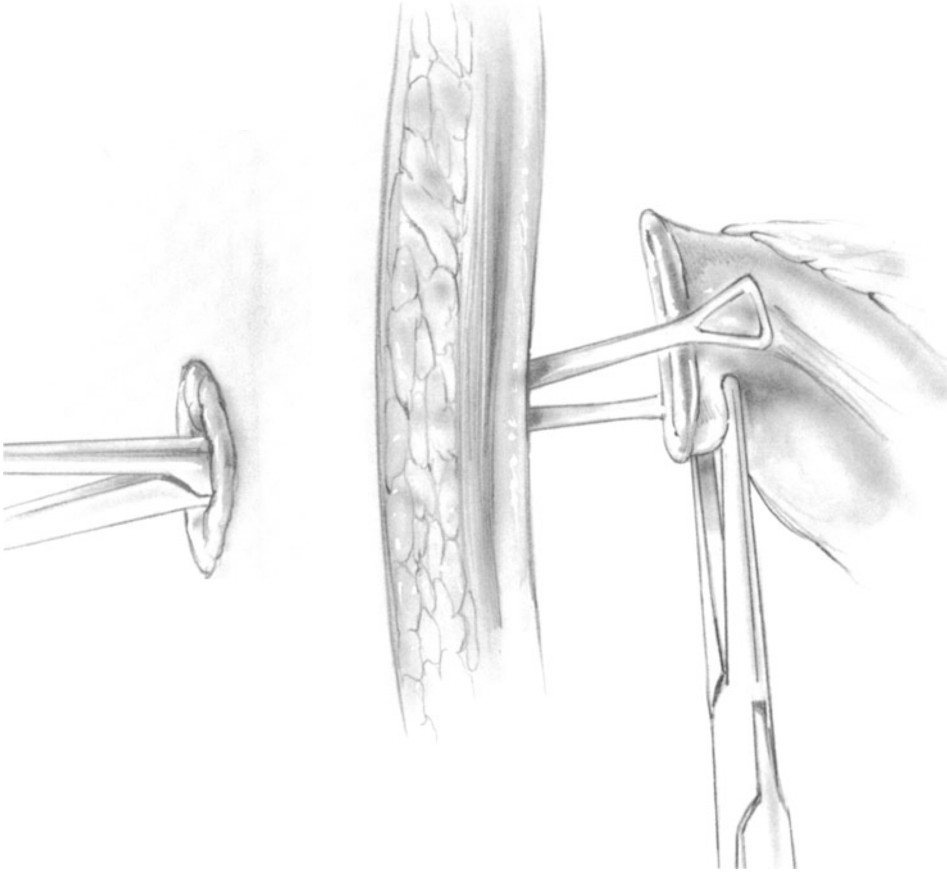


Fig. 44–5

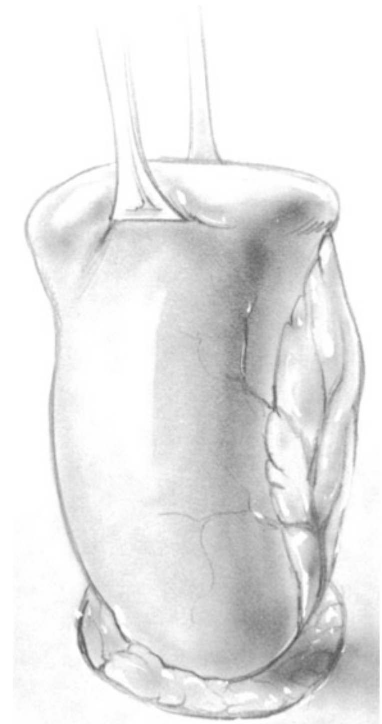


Fig. 44–6

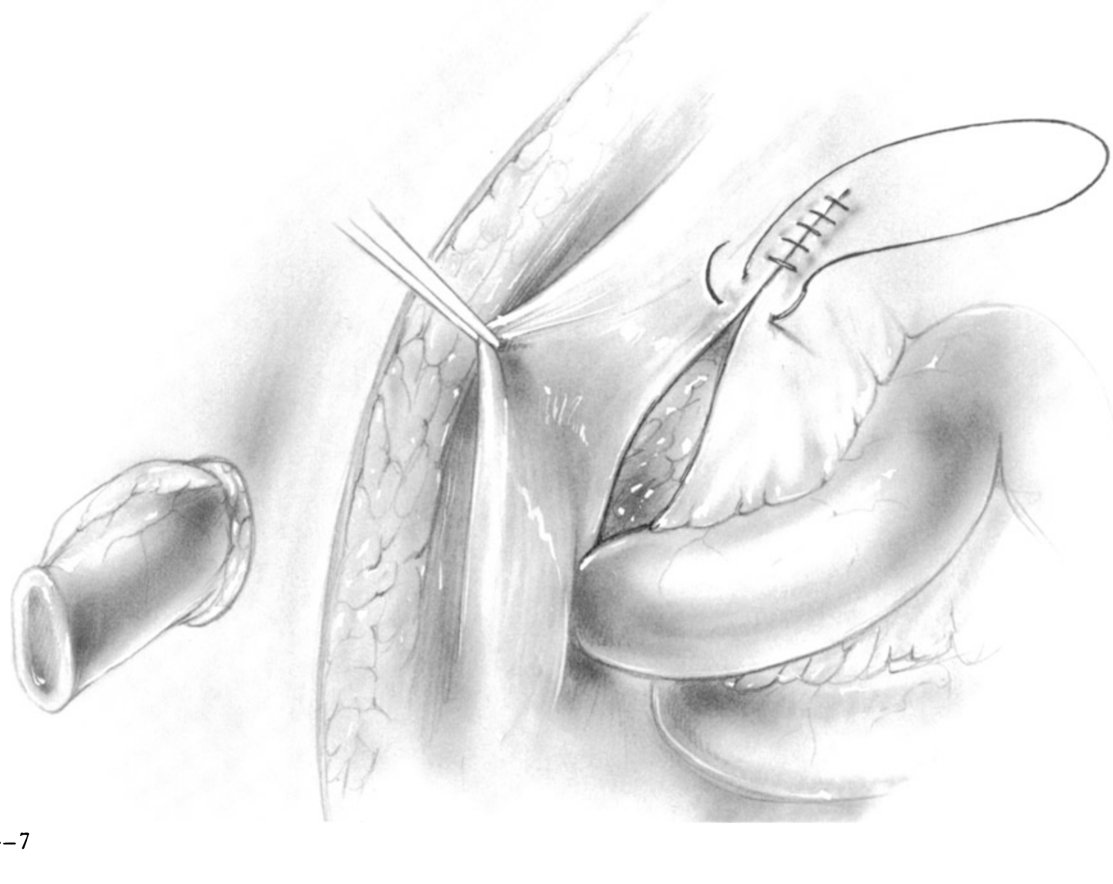


Fig. 44–7

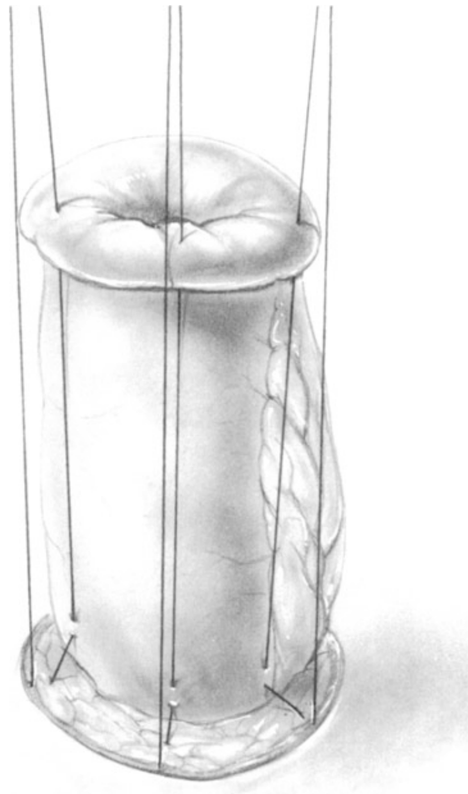


Fig. 44–8

Complete the suture by taking a bite of the subcuticular layer of skin (**Fig. 44–8**).

Temporarily hold the stitch in a hemostat and place identical stitches in each of the other quadrants of the ileostomy. After all the sutures have been inserted, gently tightening them will evert the ileum (**Fig. 44–9**). Then tie the sutures. Place one additional suture of the same type between each of the four quadrant sutures, completing the mucocutaneous fixation.

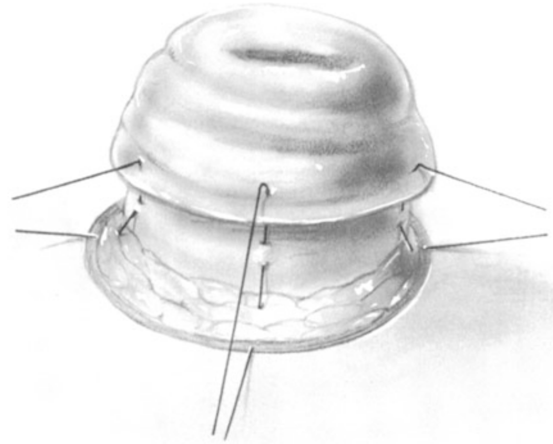


Fig. 44–9

Postoperative Care

Nasogastric suction usually not needed

Perioperative antibiotics

Apply Stomahesive disc to the ileostomy in the operating room; place an ileostomy bag over disc

Instruct patient in ileostomy care

Complications

Early

Although rare when good technique is used, occasional cases of slough of distal ileum have been observed

Peristomal infection or fistula

Late

Prolapse of ileostomy

Stricture of ileostomy

Obstruction of ileostomy due to food fiber

Peristomal skin ulceration

45 Ileostomy, Loop

Indications

Temporary ileostomy is used on rare occasions as the first stage of a subtotal colectomy for inflammatory bowel disease.

It is a temporary method of diverting the fecal stream in patients who undergo ileoproctostomy following subtotal colectomy.

The loop ileostomy serves to divert the fecal stream from the ileoanal pouch following total colectomy with mucosal proctectomy.

This temporary diverting ileostomy can also be employed to divert the fecal stream in patients with colon obstruction, especially those who have an incompetent ileocecal valve.

Pitfalls and Danger Points

If the ileum is not transected at the proper point, so as to make the proximal stoma the dominant one, total fecal diversion will not be accomplished.

Operative Strategy

Properly performed, this technique is a good method of achieving, temporarily, the total diversion of the intestinal contents.

Operative Technique

If a loop ileostomy is being performed as a primary procedure, a midline incision beginning at the umbilicus and going caudal for 8–10 cm is adequate. Identify the distal ileum and identify the segment selected for ileostomy by applying a single marking suture to that segment of the ileum that will form the *proximal* limb of the loop ileostomy.

Select the proper site in the right lower quadrant (see Chap. 44) and excise a nickel-size circle of skin. Expose the anterior rectus fascia and make a 2-cm longitudinal incision in it (see Fig. 44–1). Separate the rectus fibers with a large hemostat and make a similar vertical incision in the peritoneum (see Figs. 44–2 and 44–3). Then stretch the ileostomy orifice by inserting two fingers (see Fig. 44–4).

After this has been accomplished, insert a Babcock clamp through the aperture into the abdominal cavity. Arrange the ileum so that the proximal segment will emerge on the cephalad side of the ileostomy. Then have the Babcock clamp grasp the ileum. With the aid of digital manipulation from inside the abdomen, deliver the loop of ileum into the aperture made in the right lower quadrant. The proximal limb should be on the cephalad surface of the ileostomy.

Select a segment of ileum that will not exert any tension whatever on the ileal reservoir (**Fig. 45–1**). Position the ileum so that the afferent or proximal limb of ileum enters the stoma from its cephalad aspect and the distal ileum leaves the stoma at its inferior aspect. In order to insure that the proximal stoma will dominate the distal stoma and completely divert the fecal stream, transect the anterior half of the ileum at a point 2 cm distal to the apex of the

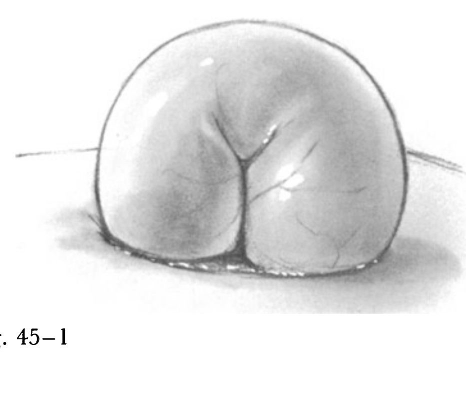


Fig. 45–1

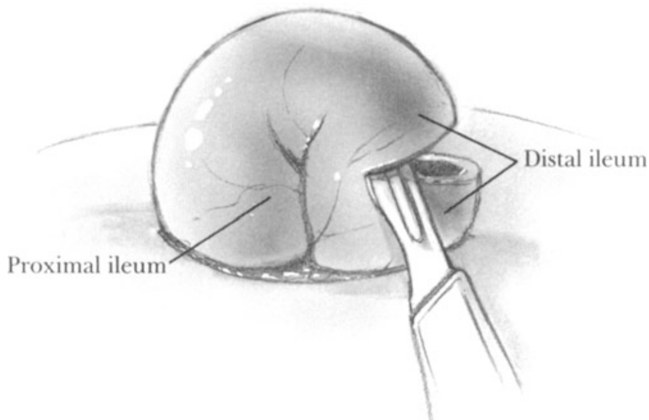


Fig. 45–2

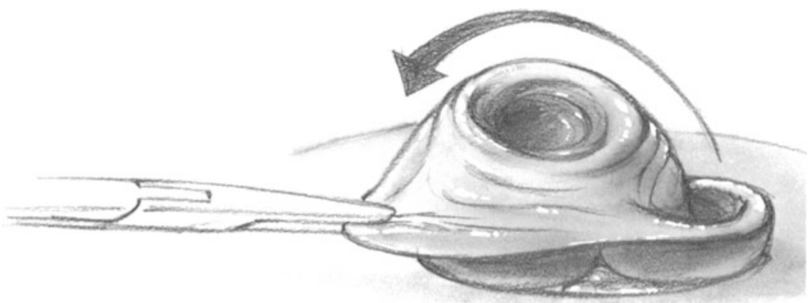


Fig. 45–3.

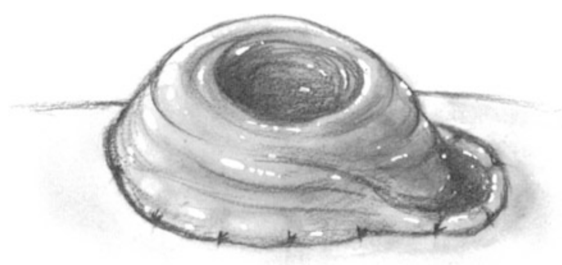


Fig. 45–4.

loop (**Fig. 45–2**). Then evert the ileostomy (**Fig. 45–3**). Insert interrupted atraumatic sutures of 4-0 Vicryl to approximate the full thickness of the ileum to the subcuticular portion of the skin. The end result should demonstrate a dominant proximal stoma that compresses the distal stoma (**Fig. 45–4**). We do not suture the ileum to the peritoneum or fascia.

In order to minimize the contamination of the abdominal cavity, it is possible to deliver the loop of ileum through the abdominal wall, then pass a small catheter around the ileum and through the mesentery in order to maintain the position of the ileum. The actual division of the ileum and suturing of the ileostomy may be postponed until the abdominal incision has been completely closed. After suturing the ileum to the subcutis, remove the catheter.

Close the abdominal wall with interrupted 1 PDS sutures by the modified Smead-Jones technique described in Chap. 5. Close the skin with interrupted fine nylon or skin staples. Then mature the loop ileostomy as described above if this step has not already been done.

Postoperative Care

(See Chap. 44.)

Complications

(See Chap. 44.)

Reference

Turnbull R, Weakley FL. Surgical treatment of toxic megacolon: ileostomy and colostomy to prepare patients for colectomy. Am J Surg 1971;122:325.

46 Abdominoperineal Proctectomy for Benign Disease

Indications

Inflammatory bowel disease, including ulcerative colitis and Crohn's colitis with intractable rectal involvement

Familial polyposis (a controversial indication)

Preoperative Preparation

(See Chap. 40.)

Pitfalls and Danger Points

Operative damage to or interruption of pelvic autonomic nerves in male patients, leading to sexual impotency or failure of ejaculation

Pelvic sepsis, especially in patients who have perineal fistulas

Inadequate management of perineal wound, resulting in chronic perineal draining sinus

Operative Strategy

The failure of normal ejaculation is caused by the transection of the hypogastric sympathetic nerve trunks that cross over the anterior aorta. Beyond the aortic bifurcation these nerves diverge into two bundles going toward the region of the right and left hypogastric arteries, where they join the inferior hypogastric plexus on each side. According to Lee et al. the *parasympathetic* sacral autonomic outflow will be interrupted if the lateral ligaments are divided too far lateral to the rectum or if the nerve plexus between the rectum and prostate is damaged. Parasympathetic nerve damage results in the failure of erection. Proper strategy requires that the mesentery in the region of the rectosigmoid be divided along a line just adjacent to the colon, leaving considerable fat and mesentery in the presacral space to protect the hypogastric nerves. The remainder of the pelvic dissection should be carried out as close to the rectum as possible, *especially in the region of the lateral ligaments and prostate.*

As long as there are not multiple perineal fistulas, it is generally possible to achieve primary healing of the perineum *if dead space between the closed levators and the peritoneal pelvic floor is eliminated.* Because there is no need for radical excision of the pelvic peritoneum, as much of this as possible should be preserved. Additional pelvic peritoneum should be mobilized from the lateral walls of the pelvis and the bladder. If there is sufficient peritoneum to permit the pelvic peritoneal suture line to come down easily into contact with the reconstructed levator diaphragm, then the pelvic peritoneum should be closed. Otherwise it is much better to leave the pelvic peritoneum entirely unsutured to permit the small bowel to fill this space. To aid in preventing perineal sinus formation due to chronic low-grade sepsis, insert closed-suction catheters into the presacral space and instill an antibiotic solution postoperatively.

In operations done for inflammatory bowel disease, Lyttle and Parks advocate the *preservation of the external sphincter muscles* in proctectomy. They begin the perineal dissection with an incision near the dentate line of the anal canal and continue the dissection in the intersphincteric space between the internal and external sphincters of the anal canal. Thus the rectum is cored out of the anal canal, leaving the entire levator diaphragm and external sphincters intact. This, say Lyttle and Parks, results in less operative trauma and further minimizes dead space. We have used this technique. It promises to reduce the incidence of damage to the prerectal nerve plexus.

Operative Technique: Abdominal

Incision and Position

With the patient positioned on Lloyd-Davies leg rests, thighs abducted and slightly flexed, make a midline incision from the midepigastrium to the pubis (see Fig. 40–1a). If the patient has previously undergone subtotal colectomy with ileostomy and mucous fistula, free the mucous fistula from its attachments to the abdominal wall. Ligate the lumen with umbilical tape and cover it with a sterile rubber glove.

Mesenteric Dissection

Divide the mesentery between sequentially applied Kelly clamps along a line *close to the posterior wall* of

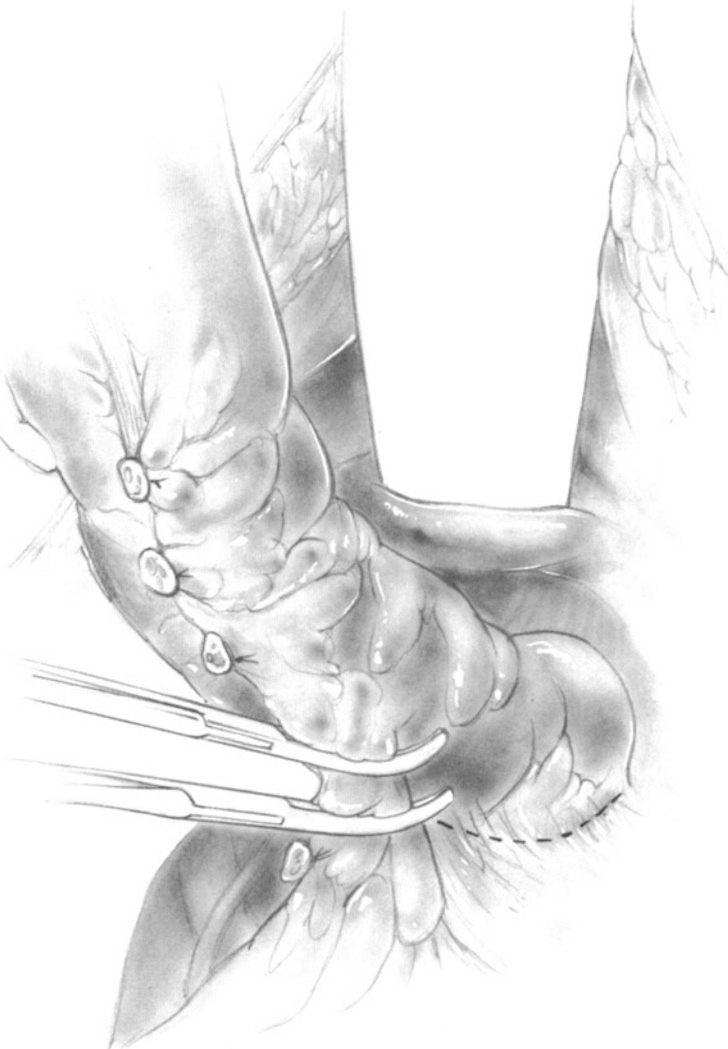


Fig. 46-1

the rectosigmoid. Continue the line of dissection well into the presacral space. This leaves a considerable amount of fat and mesentery behind to cover the bifurcation of the aorta and sacrum (**Fig. 46-1**). The fat and mesentery prevent injury to the hypogastric nerve bundles, which travel from the preaortic area down the promontory of the sacrum toward the hypogastric vessels on each side to join the hypogastric plexuses on each side (see Figs. 40-2 and 40-4).

Rectal Dissection

Incise the pelvic peritoneum along the line where the peritoneum joins the rectum, preserving as much peritoneum as possible. Accomplish this first on the right and then on the left side (see Fig. 40-3). Note the location of each ureter (see Fig. 40-4). Divide the posterior mesentery to the midsacral level. The posterior wall of rectum can now be seen, for at this point the blood supply of the rectum comes from the lateral wall of the pelvis. Elevate the rectum from the distal sacrum by blunt dissection, and with a Metzenbaum scissors incise Waldeyer's fascia close to the rectum. Draw the rectum in a cephalad direction, and place the peritoneum of the rectovesical or rectouterine pouch on stretch. This peritoneum can now be divided easily with a Metzenbaum scissors. Division of the lateral ligament can also be accomplished with good hemostasis by inserting a right-angle clamp beneath the ligament and dividing the overlying tissue with the electrocoagulator (see Fig. 40-7).

With cephalad traction on the rectum and a Lloyd-Davies retractor holding the bladder forward, divide Denonvilliers' fascia at the level of the proximal portion of the prostate (see Fig. 40-9b). Keep the dissection *close to the anterior rectal wall*, which should be bluntly separated from the body of the prostate. (In females, the dissection would separate the rectum from the vagina.) When the dissection has continued beyond the tip of the coccyx posteriorly and the prostate anteriorly, initiate the perineal dissection.

Operative Technique: Perineal

Incision

Close the skin of the anal canal with a heavy purse-string suture (**Fig. 46-2**). Then make an incision circumferentially in the skin just outside the sphincter muscles of the anus. Carry down the dissection *close* to the outer margins of the external sphincter to the levator muscles (**Fig. 46-3**). The inferior hemorrhoidal vessels will be encountered running toward the rectum overlying the levator muscles. Occlude these vessels by electrocoagulation. After the incision has been deepened to the levators on both sides, expose the tip of the coccyx. Transect the anococcygeal ligament by electrocautery and enter the presacral space posteriorly. The fascia of Waldeyer, which attaches to the anterior surfaces of the lower sacrum and coccyx and to the posterior rectum, forms a barrier blocking entrance into the presacral space from below even after the anococcygeal ligament has been divided. If this fascia is elevated from the sacral periosteum by forceful blunt dissection in the perineum, venous bleeding and damage to the sacral neural components of the nervi erigentes may occur. Consequently, the fascia of Waldeyer should be divided with a long scissors or scalpel, taking the abdominal approach (see Fig. 40-8), or by *sharp* dissection from below, before an attempt is made to enter the presacral space from below.

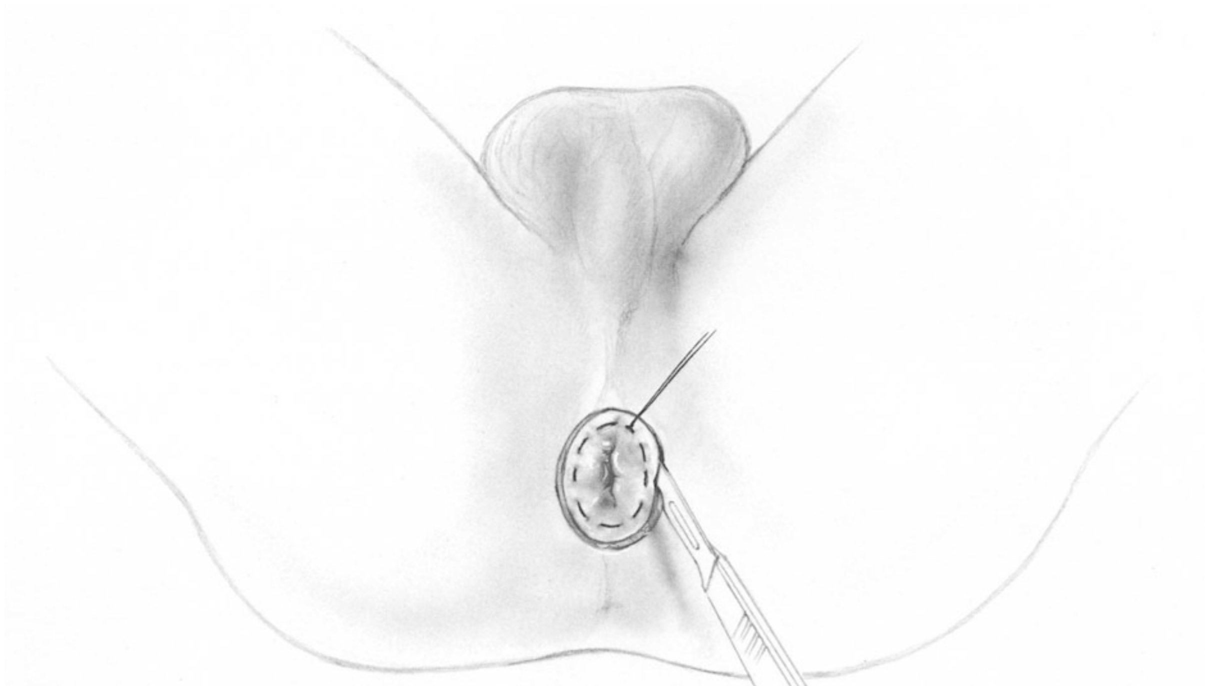


Fig. 46–2

Division of Levator Diaphragm

From the perineal approach, insert the left index finger into the opening into the presacral space and place it in the groove between the rectum and the levator muscles. Use the electrocoagulator to divide the levators close to the rectum on either side. Then deliver the specimen from the presacral space down through the posterior perineum, so that the anal canal is attached only anteriorly. Visualize the prostate gland. Using the electrocautery, transect the puborectalis and rectourethralis muscles close to the anterior rectal wall. Carry down this dissection to the level of the prostate and remove the specimen.

Closure of Pelvic Floor

Insert one or two large (6-mm) plastic catheters through the skin of the perineum and the levator muscles into the presacral space for closed-suction drainage. Alternatively, the one or two Jackson-Pratt closed suction drainage catheters can be brought from the presacral space up into the pelvis and out through puncture wounds of the abdominal wall.

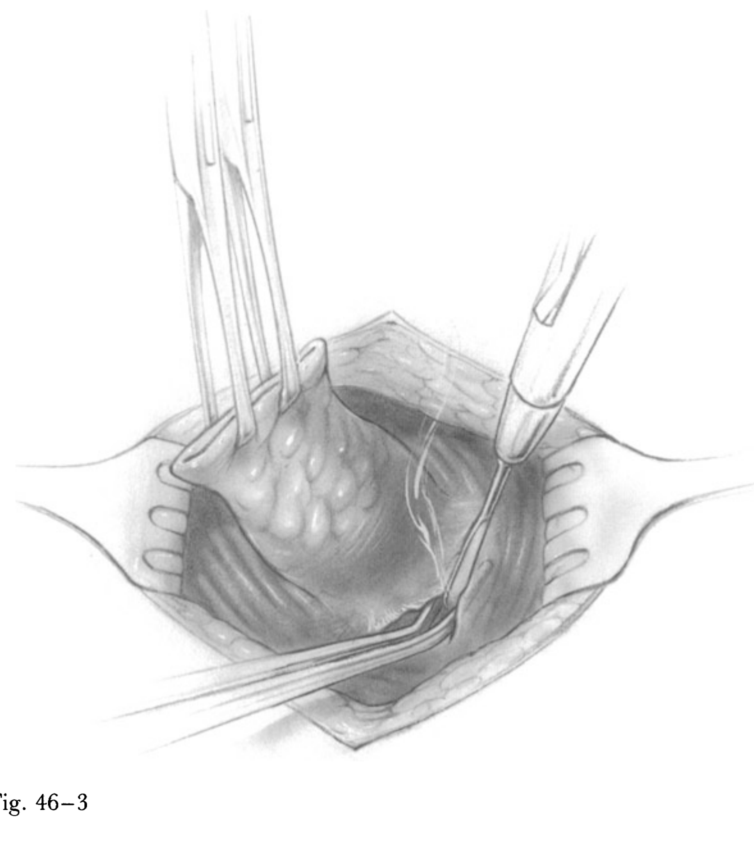


Fig. 46–3

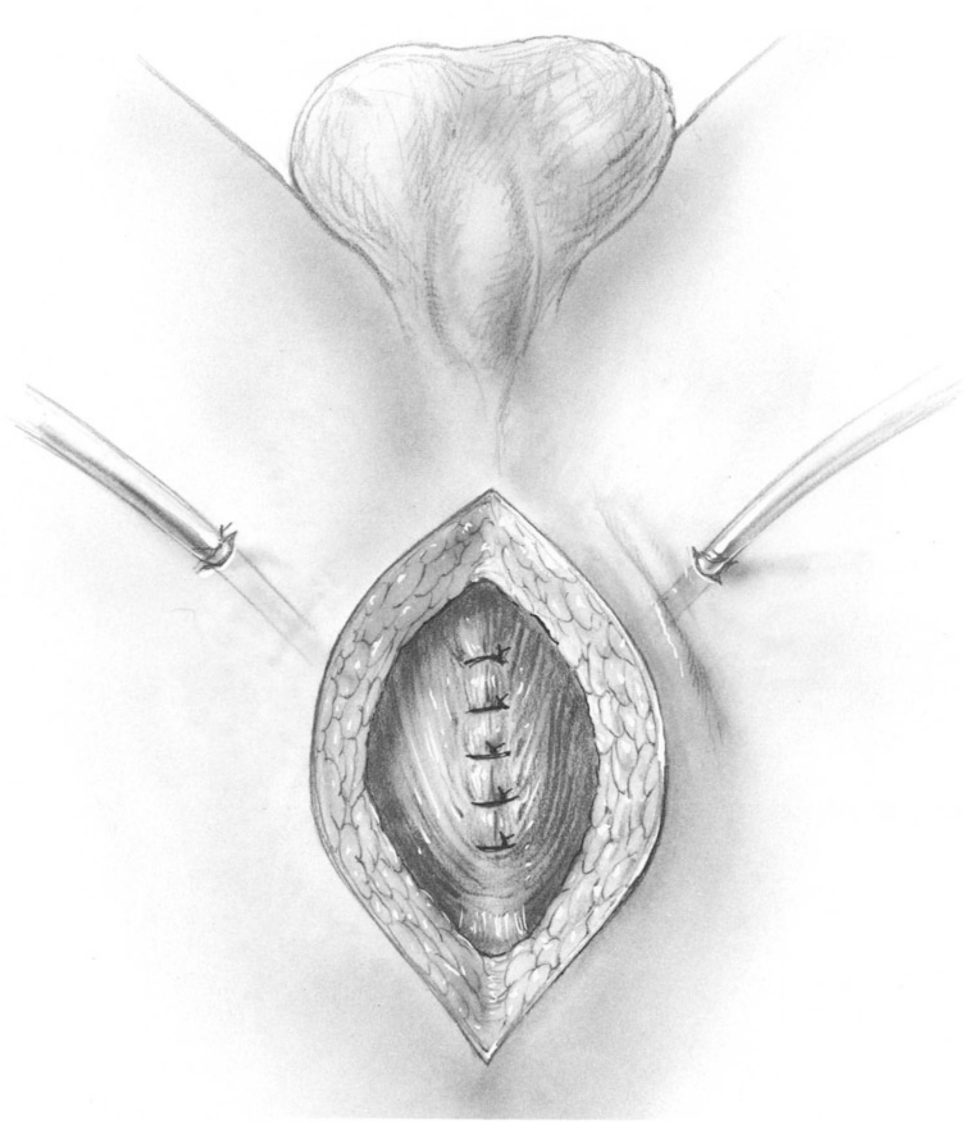


Fig. 46–4

Close the defect in the levator diaphragm, using interrupted sutures of 2–0 PG, after thoroughly irrigating the pelvis with an antibiotic solution and achieving perfect hemostasis (**Fig. 46–4**). Close the skin with subcuticular sutures of 4–0 PG. Attach the catheters to suction for the remainder of the procedure while an assistant closes the peritoneum of the pelvic floor with continuous 2–0 PG using the abdominal approach.

Abdominal Closure

After checking the integrity of the peritoneal pelvic suture line and making certain that it is contiguous with the pelvic floor, irrigate the abdominal cavity and pelvis with antibiotic solution. Approximate the abdominal wall with interrupted sutures using the modified Smead-Jones technique.

Postoperative Care

(See Chap. 40.)

Complications

(See Chap. 40.)

References

Lee JF et al. Anatomic relations of pelvic autonomic nerves to pelvic operations. Arch Surg 1973;107:324.

Lyttle JA, Parks AG. Intersphincteric excision of the rectum. Br J Surg 1977;64:413.

47 Operations for Colon Obstruction

Concept: Operations for Complete Colon Obstruction Due to Carcinoma of Right or Proximal Transverse Colon

Conventional wisdom indicates that, provided that there is no peritonitis, a reasonably good-risk patient who has been properly resuscitated can safely undergo an emergency right colectomy and ileocolic anastomosis. In this case one might expect, perhaps, a 3% rate of anastomotic leakage. However, there are very few published reports of large series of patients undergoing emergency surgery for complete right colon obstruction. Following curative resection of obstructed right colon cancer, Serpell and associates reported a postoperative mortality rate of 3.7%, compared with 14.3% for resections of obstructed left colon tumors. In their experience, resecting an *obstructed* right colon lesion was no more dangerous than resecting an *unobstructed* right colon cancer.

If a primary resection and anastomosis for an obstructed right colon is performed, even in the absence of peritonitis, there will indeed be some increased risk of leakage, in our experience, but the risk of death can be minimized by paying close attention to the abdomen in the postoperative period. If the patient demonstrates abdominal pain, distention, or any other sign of acute sepsis, promptly perform an aqueous-medium colon enema X ray and a CT scan of the abdomen. Perform an immediate laparotomy if there is any indication of anastomotic leak. If an anastomotic leak is found, take apart the anastomosis and perform an end ileostomy and mucous fistula of the colon. If this is done early, most patients suffering from anastomotic leaks can be salvaged.

For patients who are suffering from perforation of a carcinoma of the right colon, with or without obstruction, if the tumor is anatomically resectable, these cases will require a resection of the perforated tumor to arrest the septic process, but performing an anastomosis in the presence of peritonitis is followed by a high leak rate. Consequently, we would create an end ileostomy and bring the colon out as a mucous fistula.

Concept: Operations for Complete Colon Obstruction Due to Carcinoma of Mid-Descending Colon

Although there are many publications advancing the concept that the three-stage (1, colostomy; 2, tumor resection; 3, colostomy closure) sequence of operations for left-sided colon obstruction is a much more dangerous treatment than primary resection, the numbers of patients cited in these reports are invariably too small to be convincing. Remember that the medical status of these elderly patients is highly variable and that the sickest patients will always be treated by the staged sequence, while only the fit patients will be offered a primary resection. The only randomized prospective study (Kronberg) detected no difference in mortality between primary resection and staged operations for left-sided colon obstruction. Even employing on-table saline lavage of the colon has not eliminated the increase in mortality of primary resection-anastomosis in the obstructed left colon.

For a poor-risk patient, perform a proximal colostomy. If it is feasible, a left-sided colostomy above the lesion is convenient because at the next stage (7 to 10 days later) the colostomy can be resected in continuity with the tumor. This permits the definitive surgical therapy to be completed in two stages. If creating a left colon colostomy will require liberating the splenic flexure, then do not attempt it. Rather, perform a right upper quadrant transverse colostomy (see Chap. 49). At the second stage of the surgery, if the left colectomy goes well, then close the colostomy as well at this stage. Otherwise, close the colostomy 7 to 10 days later. Remember that even if three stages may be necessary in some patients, each of the three stages is a relatively simple procedure. Our mortality for staged resection has always been acceptably low.

In the young (under age 50), good-risk patient with a middle left colon obstruction, it is reasonable to perform a subtotal colectomy with an ileosigmoid primary anastomosis. An ileocolic anastomosis above the pelvis in a young patient does not engender severe diarrhea. Also, the extensive colon resection will probably encompass the 3 to 5% synchronous nonsymptomatic carcinomas that this patient might be expected to have. The colon distal to the obstruction can be cleansed preoperatively with enemas.

Perforated carcinoma of the left colon should be treated by resection, colostomy, and mucous fistula if possible, or else a Hartmann operation. In either case, the ileocolic anastomosis is performed at a second stage.

If the patient has a nonresectable obstructing carcinoma of the left colon, then perform a proximal colostomy wherever it is most feasible, or a side-to-side colocolonic bypass anastomosis if possible.

Concept: Operations for Complete Colon Obstruction Due to Carcinoma of the Rectosigmoid Colon

In a young (under age 50), good-risk patient, perform a subtotal colectomy and ileoproctostomy if the anastomosis can be constructed above the promontory of the sacrum. Otherwise, create a transverse right upper quadrant colostomy at the first stage. Then 7 to 10 days later perform an anterior resection of the rectosigmoid. If the patient is then in excellent condition, close the colostomy at the second stage. Otherwise, do so at a third stage.

For other than young patients, perform a transverse colostomy at the first stage and an anterior resection at the next stage, as above.

Concept: Cecostomy or Colostomy?

While considerable heated debate has in the past attended discussions of the relative merits of cecostomy and colostomy for obstructions of the left colon, a rational analysis reveals clear indications for each procedure. Patients who have marked distention of the cecum may develop patches of ischemic necrosis. Performance of a transverse colostomy in such cases will not prevent perforation in this necrotic area. Consequently, when the preoperative X ray of the abdomen discloses a cecal diameter in excess of 10–12 cm, or if there is right lower quadrant tenderness, a cecostomy is the proper decompressive operation. This permits direct inspection of the cecum. A surgeon who wishes to perform a transverse colostomy in a patient whose cecum is markedly distended is obligated, at the very least, to make a laparotomy incision of sufficient length to permit careful exploration of the cecum in order to check for impending perforation or gangrene.

In the past two decades, cecostomy has deservedly lost popularity as a definitive treatment for the usual case of left colon obstruction. This is because the traditional *tube* cecostomy provides inadequate decompression. Even when catheters of large caliber are used, removal of fecal matter from an obstructed colon requires hourly irrigation of the catheter for many days. Since nursing personnel to accomplish this successfully is often lacking, the results of the tube cecostomy leave much to be desired. Its only attractive feature is the ease, after the cecostomy is no longer needed, of withdrawing the tube and permitting the cecal fistula to close spontaneously.

A skin-sutured cecostomy, as described below (see Chap. 48), can on the other hand prove quite effective in decompressing and cleansing the obstructed colon. When there is no indication for exposing the cecum, a transverse colostomy is more efficient in accomplishing decompression and cleansing.

Some surgeons have suggested that a colostomy situated in the left colon, proximal to a colon obstruction, would permit more effective cleansing. It also would have the advantage of eliminating the colostomy at the time of colon resection. Unfortunately, the anatomy of the colon is such that performing a colostomy in the *descending* colon is often not possible without liberating the splenic flexure, for there is no redundancy of colon in this location. Using the sigmoid colon might place the colostomy too close to the tumor unless the lesion were situated in the distal portion of the left colon.

References

Kronberg O. The missing randomized trial of two surgical treatments for acute obstruction due to carcinoma of the left colon and rectum. Int J Colorect Dis 1986;1:162–166.

Runkel NS, Schlag P, Schwarz V et al. Outcome after emergency surgery for cancer of the large intestine. Br J Surg 1991;78:183–188.

Serpell JW, McDermott FT, Katrivessis H, Hughes ESR. Obstructing carcinomas of the colon. Br J Surg 1989; 76:965–969.

48 Cecostomy

Indications

A cecostomy is indicated when there is impending perforation of the cecum secondary to a colon obstruction or colonic ileus.

Concept

In left colon obstruction, when the diameter of the cecum is over 10 cm, as measured on abdominal X rays, an impending rupture of the cecum must be suspected. If the X-ray finding is accompanied by tenderness in the right lower quadrant, it is mandatory to explore the area of the cecum, as patches of pressure-caused necrosis may be present. If a transverse colostomy is done in this situation, the necrotic patch may nevertheless perforate, producing fatal peritonitis. Sometimes, in left colon obstruction, serosal tears can be noted. Whether the findings are large diameter and tenderness or serosal tears, it is safer to perform a skin-sutured cecostomy than a transverse colostomy, as the former permits inspection of the cecum, excision of possible necrotic patches, and immediate decompression.

If free perforation of the cecum has already occurred, an immediate resection of the perforated, segment with ileostomy and mucous fistula is often safer than cecostomy.

The skin-sutured cecostomy is a satisfactory method of decompressing obstructions of the left colon, but the use of a tube cecostomy for this purpose is not effective, as the tube will frequently become obstructed with particles of stool.

Tube cecostomy is, however, effective in cases of colonic ileus or a pseudo-obstruction of the type seen following Caesarian section. In these cases the problem is not one of removing stool, but simply of preventing the accumulated gas from perforating the cecum. The same can often be accomplished also by a skilled colonoscopist. It is a self-limiting condition; spontaneous remission occurs after 4–7 days. The tube cecostomy heals following the removal of the tube; the major disadvantage of the skin-sutured cecostomy is that a formal operation for closure is necessary later.

Preoperative Preparation

Perioperative antibiotics
Nasogastric suction
Fluid resuscitation

Pitfalls and Danger Points

A cecostomy introduces the danger that fecal matter may spill into the peritoneal cavity.

Operative Strategy

In the attempt to avoid fecal contamination of the abdominal cavity during this operation, the cecum may be sutured to the external oblique aponeurosis before being incised.

Operative Technique

Skin-Sutured Cecostomy

Incision

Make a transverse incision about 4–5 cm long over McBurney's point and carry it in the same line through the skin, external oblique aponeurosis, internal oblique, and transversus muscles, as well as through the peritoneum. Do not attempt to split the muscles along the line of their fibers.

Exploration of Cecum

Rule out patches of necrosis in areas beyond the line of incision by carefully exploring the cecum. To accomplish this without the danger of rupturing the cecum, insert a 16-gauge needle attached to an empty 50-cc syringe, which will release some of the pressure. After this has been accomplished, close the puncture wound with a fine suture. Elevate the abdominal wall with a retractor to expose the anterior and lateral walls of the cecum. If the exposure is inadequate, make a larger incision. If a necrotic patch of cecum can be identified, this is the area that should be selected for the cecostomy, for it enables the surgeon to excise the necrotic patch during the procedure.

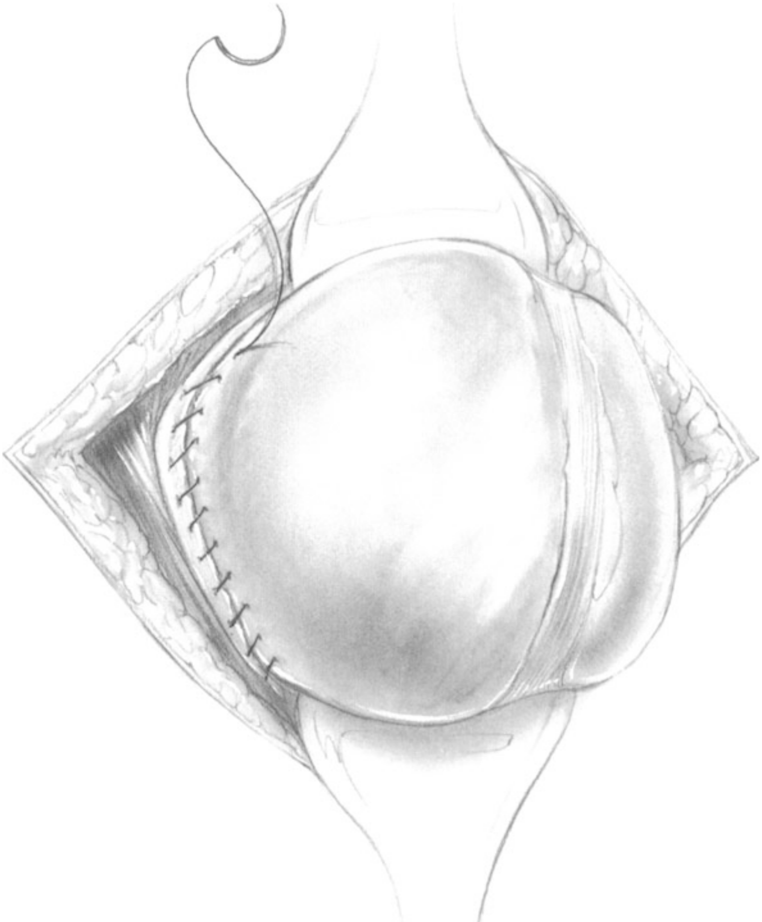


Fig. 48–1.

Cecal Fixation

Suture the wall of the cecum to the external oblique aponeurosis with a continuous 4–0 PG suture on a fine needle, so as to prevent any fecal spillage from reaching the peritoneal cavity (**Fig. 48–1**).

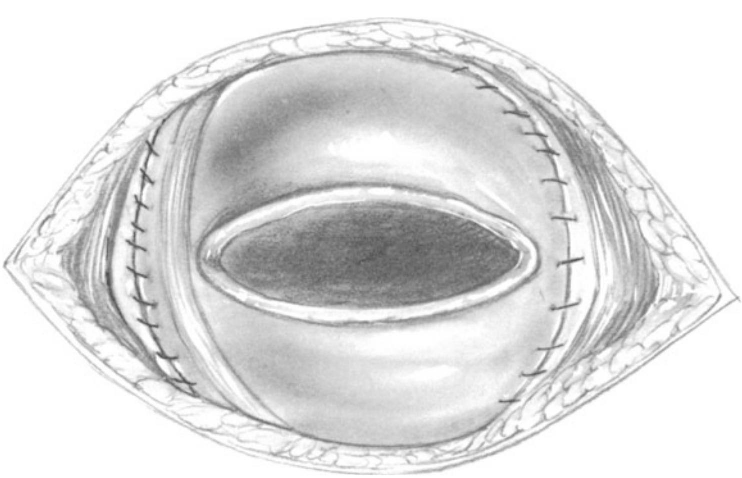


Fig. 48–2.

If the incision in the external oblique aponeurosis is longer than 4–5 cm, narrow it with several PG sutures. Narrow the skin incision also to the same length with several fine PG subcuticular sutures.

Mucocutaneous Suture

Make a transverse incision in the anterior wall of the cecum 4 cm long (**Fig. 48–2**) and aspirate liquid stool and gas. Then suture the full thickness of the cecal wall to the subcuticular layer of the skin with a continuous or interrupted suture of 4–0 PG on an atraumatic needle (**Fig. 48–3**). Place a properly fitted ileostomy bag over the cecostomy at the conclusion of the operation.

Tube Cecostomy

The abdominal incision and the exploration of the cecum for a tube cecostomy are identical to those done for a skin-sutured cecostomy. Insert a purse-string suture in a circular fashion on the anterior wall of the cecum, using 3–0 atraumatic PG. The diameter of the circle should be 1.5 cm. Insert a second purse-string outside the first, using the same suture material. Then make a stab wound in the middle of the purse-string; insert a 36F soft-rubber tube into the purse-string and for about 5 or 6 cm into the ascending colon. Tie the first purse-string around the rubber tube; then tie the second purse-string so as to invert the first. It is helpful if several large side holes have been cut first in the distal 3–4 cm of the rubber tube.

Select a site about 3 cm above the incision for a stab wound. Bring out the rubber tube through this stab wound and suture the cecum to the peritoneum around the stab wound. Use four interrupted 3–0 PG atraumatic sutures to keep the peritoneal cavity free of any fecal matter that may leak around the tube.

Close the abdominal incision in a single layer by the modified Smead-Jones technique, using interrupted 1–0 PDS sutures. Do not close the skin wound; insert several 4–0 nylon interrupted skin sutures, which will be tied 3–5 days after operation.

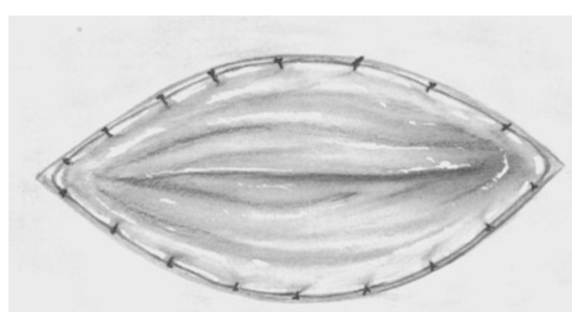


Fig. 48–3.

Postoperative Care

Manage the skin-sutured cecostomy in the operating room by applying an adhesive-backed ileostomy-type disposable plastic appliance to it.

The tube cecostomy requires repeated irrigation with saline to prevent it from being plugged by fecal particles. It may be removed after the tenth postoperative day if it is no longer needed.

Complications

The major postoperative complication of this procedure is peristomal sepsis, for the possibility of bacterial contamination of the abdominal incision cannot be completely eliminated. Nevertheless, peristomal sepsis is much less common than one would anticipate in an operation of this type.

49 Transverse Colostomy

Indications

Relief of obstruction due to lesions of left colon
Diversion of fecal stream
Complementary to left colon anastomosis

Preoperative Preparation

Before performing a colostomy for colon obstruction, do a barium colon enema X ray to confirm the diagnosis and rule out such causes of obstruction as fecal impaction: use preoperative flat X ray of abdomen to identify position of transverse colon relative to a fixed point, such as a coin placed over the umbilicus
Fluid restitution
Nasogastric tube
Perioperative antibiotics

Pitfalls and Danger Points

Performing colostomy in error for diagnoses such as fecal impaction or pseudo-obstruction
Be certain the "ostomy" is, in fact, being constructed in transverse colon (we are aware of cases in which procedure was performed erroneously in sigmoid colon and, in one instance, in gastric antrum!)
In advanced colon obstruction, be aware of possibility of impending rupture of cecum, for which transverse colostomy is an inadequate operation unless the cecum is seen to be viable

Operative Strategy

Impending Rupture of Cecum

In routine cases of left colon obstruction, with the diagnosis confirmed by barium enema X ray, the colon may be approached through a small transverse incision in the right rectus muscle. This incision should be made for the colostomy alone: the rest of the abdominal cavity does not have to be explored. Exceptions to this policy should be made for patients who suffer a sigmoid volvulus, who are suspected of having ischemic colitis or perforation, and in whom an advanced obstruction threatens an impending rupture of the cecum. Impending rupture should be suspected when the diameter of the cecum, measured on the flat abdominal X ray, is in the 10–12 cm range, and especially when the patient demonstrates right lower quadrant tenderness. In such cases, direct inspection of the cecum is mandatory. This may be accomplished with a midline laparotomy incision or a transverse right lower quadrant incision made over the cecum. If tears of the serosa can be seen, cecostomy should be performed. If there is an area of impending necrosis, this should be excised and the defect in the cecum converted to a skin-sutured cutaneous cecostomy (see Chap. 48). This provides satisfactory decompression of the obstructed colon while it eliminates the possibility of cecal rupture.

Importance of Immediate Maturation of Colostomy

With the discovery in 1951–52 by Patey and Brooke that fixing the bowel mucosa in apposition to the dermal epithelium eliminates serositis, the traditional loop colostomy over a glass rod became an obsolete operation. It became obsolete for a number of reasons:

1) *Exteriorization* of the posterior wall of the transverse colon over a glass rod requires more dissection as well as a longer incision than does a matured colostomy.
2) *Exposure* of the outer surface of the bowel outside the body results in marked serositis, manifested by much edema and inflammation.
3) *Closure* of the colostomy has to be delayed for at least 4–6 weeks to permit the serositis and edema to subside. When the colostomy is eventually closed, the fibrosis, which follows the serositis, often mandates a formal resection of the colostomy, followed by an anastomosis. A colostomy that has been immediately matured by skin sutures, however, may be closed at any time. The need for resection and anastomosis following the latter technique is rare.
4) The *bulky nature* of the loop colostomy over a glass rod makes it difficult to manage. Application of a colostomy bag is often followed by leakage. On

the other hand, the matured colostomy is fitted with an appliance in the operating room, making postoperative management far simpler.

Though it would appear that contamination of the subcutaneous tissues by fecal spillage during the act of suturing the mucosa to the skin would invariably lead to subcutaneous abscess, this has rarely occurred. Since 1961 we have been quite satisfied using the mucocutaneous suture technique for all colostomies.

Diversion of Fecal Stream

Contrary to widespread medical opinion, it is not necessary to construct a double-barreled colostomy, including complete transection of the colon, in order to divert the stool from entering the left colon. We agree with Turnbull and Weakley that if a 5-cm longitudinal incision is made on the antimesenteric wall of the transverse colon and is followed by immediate maturation, fecal diversion is accomplished even in the absence of a supporting glass rod. Fecal diversion is accomplished with this operation because the long incision in the colon permits the posterior wall to prolapse. This in effect results functionally in separate distal and proximal stomas.

It should be remembered, however, that in the presence of spreading peritonitis from perforated sigmoid diverticulitis, no type of transverse colostomy can prevent the column of stool situated between the colostomy and the sigmoid perforation from passing through the point of leakage and perpetuating sepsis. In cases such as these, *immediate resection with end colostomy and mucous fistula* is the only operation that will prevent further fecal leakage.

Operative Technique

Incision

Make a transverse incision over the middle and lateral thirds of the upper right rectus muscle (**Fig. 49–1**). The length of the skin incision, ideally, would equal the length of the longitudinal incision to be made in the colon (5–6 cm). To accomplish this, it is necessary to identify the level at which the transverse colon crosses the path of the right rectus muscle. This may be done by a preoperative flat X ray of the abdomen, followed by confirmation by percussion of the upper abdomen in the operating room. Make the transverse incision sufficiently long to accomplish accurate identification of the transverse colon. The incision should be partially closed subsequently, leaving a 5-cm gap to accommodate the colostomy.

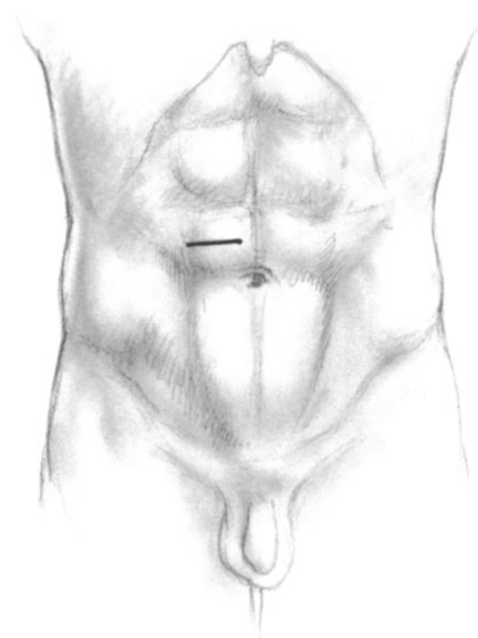


Fig. 49–1

When the transverse colostomy is to precede a subsequent laparotomy for the removal of colon pathology, begin the transverse incision 2 cm to the right of the midline and extend it laterally. If this is done, the colostomy will not prevent the surgeon from using a long midline incision for the second stage of the operation.

After the skin incision is made, incise the anterior rectus fascia with a scalpel. Insert a Kelly hemostat between the muscle belly and the posterior rectus sheath. Incise the rectus muscle transversely over the hemostat with the coagulating electrocautery for a distance of 6 cm. Then enter the abdomen in the usual manner by incising the posterior rectus sheath and peritoneum.

Identification of Transverse Colon

Even though the transverse colon is covered by omentum, in the average patient the omentum is thin enough so that the colon can be seen through it. Positive identification can be made by observing the taenia. The omentum should be divided for 6–7 cm over the colon. If colon is not clearly visible, extend the length of the incision.

Exteriorize the omentum and draw it in a cephalad direction; its undersurface will lead to its junction with the transverse colon. At this point make a window in the overlying omentum so that the transverse colon may protrude through the incision. Then replace the omentum into the abdomen.

Fig. 49–2

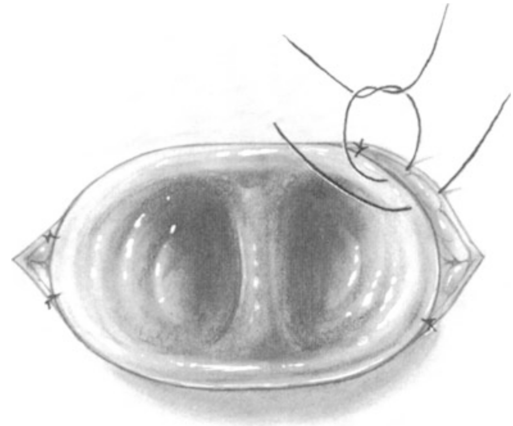


Fig. 49–4

Immediate Maturation of Colostomy

In patients who undergo operations for colon obstruction, the transverse colon is often so tensely distended that it is difficult to extract the anterior wall of the colon from the abdominal cavity without causing damage. To solve this problem, apply two Babcock clamps 2 cm apart to the anterior wall of the transverse colon. Insert a No. 16 needle, attached to a low-pressure suction line, into the colon between the Babcock clamps (**Fig. 49–2**). After the gas has been allowed to escape through the needle, the colon can be exteriorized easily.

At this point, Turnbull and Weakley insert a layer of chromic catgut sutures between the serosa of the colon and either the anterior rectus sheath or the deep subcutaneous fascia. We have omitted this step and have not discerned any ill effect from the omission.

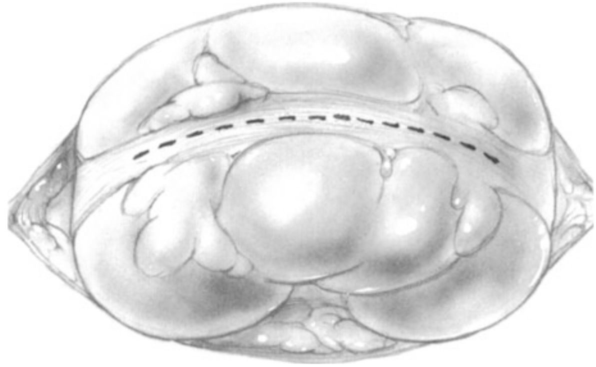


Fig. 49–3

The incision in the abdominal wall should be about 6 cm long. If it is longer than 6 cm, then close the lateral portion with interrupted No. 1 PDS sutures of the Smead-Jones type. Use interrupted 4–0 nylon skin sutures to shorten the skin incision appropriately.

Immediate maturation can be accomplished by making an incision, 5–6 cm long, longitudinally along the anterior wall of the colon, preferably in the taenia (**Fig. 49–3**). Aspirate the bowel gas. Irrigate the operative field with 0.1% kanamycin solution. Then suture the full thickness of the colon wall to the *subcuticular* layer of the skin with 4–0 PG sutures, either interrupted or continuous (**Fig. 49–4**). Attach a disposable ileostomy or colostomy bag to the colostomy.

Modification of Technique Using Glass Rod

We prefer not to interrupt the suture line between the colon and skin by the use of a glass rod. In markedly obese patients who have a short mesentery, a modified glass rod technique may be used to prevent retraction while it keeps the colocutaneous suture line intact. This may be accomplished by the technique of Turnbull and Weakley. Make a stab wound through the skin at a point about 4 cm caudal to the midpoint of the proposed colostomy. By blunt dissection pass a glass or plastic rod between the subcutaneous fat and the anterior rectus fascia, going in a cephalad direction. Pass the rod deep to the colon and have it emerge from a second stab wound 4 cm cephalad to the colostomy (**Fig. 49–5**). This technique permits the subcutaneous fat to be protected from postoperative contamination by stool. It also simplifies the application of the colostomy bag.

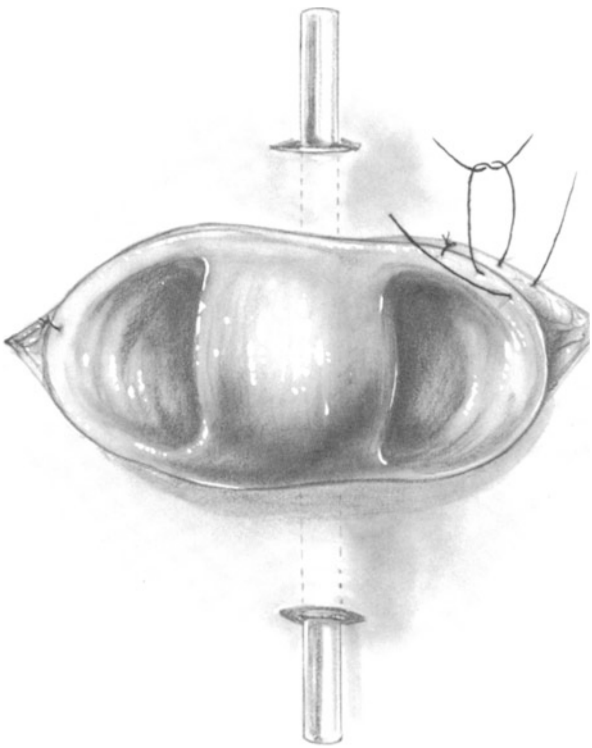


Fig. 49–5

One alternative to the solid rod is a Silastic tube, 6 mm in diameter. We prefer this because it produces minimal inflammatory tissue response. However, since the Silastic tube is soft, it has to be fixed to the skin of the two stab wounds with nylon sutures.

Postoperative Care

In the operating room apply a plastic disposable adhesive-type colostomy bag, with a karaya gum facing or Stomahesive disc to the colostomy

Nasogastric suction until colostomy functions

Complications

Peristomal sepsis is surprisingly uncommon. Treatment requires local incision and drainage. Massive sepsis would require moving the colostomy to another site.

References

Brooke BN. The management of ileostomy including its complications. Lancet 1951;2:102.

Patey DH. Primary epithelial apposition in colostomy. Proc R Soc Med 1951;44:423.

Turnbull RB Jr, Weakley FL. Atlas of intestinal stomas. St Louis: Mosby; 1967.

50 Closure of Temporary Colostomy

Concept: When to Close a Colostomy

There are reports in the surgical literature—Wheeler and Barker, Knox et al., and Yaiko et al. among them—describing many complications and even mortality following operations for closure of a colostomy. In many instances it is emphasized that the complications are more numerous when a colostomy is closed before 30–90 days have passed after the formation of the colostomy. On the other hand, we have had excellent results even when colostomies were closed 2–3 weeks after the initial operation. The discrepancy exists because all of our colostomies were immediately matured by mucocutaneous suture. Most of the authors who report complications from colostomy closure and who require the passage of 30–90 days to make closure safer do a loop colostomy over a glass rod. If immediate mucocutaneous suture is not done, several weeks must elapse before granulation and contraction results in spontaneous maturation of the colostomy. Because this type of colostomy often is accompanied by considerable fibrosis and inflammation, the surgeon should indeed wait 60–90 days before attempting closure. Turnbull and Weakley agree that when the colostomy has been matured by mucocutaneous suture at the initial operation, the colostomy closure may take place whenever indicated by the patient's condition. Also, in our experience the matured colostomy can generally be closed without the need to resect and anastomose a segment of colon.

The absence of distal obstruction in the colon is another requirement for safe closure of a colostomy. This should be confirmed by a barium colon enema X ray or colonoscopy before colostomy closure.

Preoperative Preparation

Barium colon enema X ray to demonstrate patency of distal colon

Nasogastric tube

Routine mechanical and antibiotic bowel preparation (see Chap. 34); in addition, carry out saline irrigations of inactivated left colon segment

Perioperative systemic antibiotics

Pitfalls and Danger Points

Suture-line leak

Intra-abdominal abscess

Wound abscess

Operative Strategy

Suture-line leakage can follow when traumatized or devascularized colon tissue is used in the closure. Another common cause of leakage is tension on the suture line due to inadequate lysis of the adhesions between the transverse colon and surrounding structures. To avoid these complications a sufficient segment of transverse colon must be freed of all surrounding adhesions. If necessary, the incision in the abdominal wall should be enlarged to provide exposure. If the tissue in the vicinity of the colostomy has been devascularized by operative trauma, do not hesitate to resect a segment of bowel and perform an end-to-end anastomosis instead of a local reconstruction. Proper suturing or stapling of healthy colon tissue—minimizing fecal contamination—combined with local antibiotic irrigation helps prevent formation of abscesses.

Infection of the operative incision is rather common following colostomy closure. This is in part the result of failure to minimize the bacterial inoculum into the wound. Another phenomenon that contributes to wound infection is the retraction of subcutaneous fat that occurs around the colostomy. This can produce a gap between the fascia and the epidermis when the skin is sutured closed. If the fat has retracted, the skin should be left open at the conclusion of the operation.

Operative Technique

Incision

Occlude the colostomy by inserting a small gauze packing moistened with povidone-iodine solution. Make an incision in the skin around the colostomy 3–4 mm from the mucocutaneous junction (**Fig. 50–1**). Continue this incision parallel to the mucocutaneous junction until the entire colostomy has been encircled. Applying three Allis clamps to the lips of the defect in the colon expedites this dissection and helps prevent contamination. Deepen the incision by scalpel dissection until the seromuscular coat of colon can be identified. Then separate the serosa and surrounding subcutaneous fat by Metzenbaum-scissors dissection (**Fig. 50–2**). This dissection should be carried out with meticulous care in order to avoid trauma to the colon wall. Carry down the dissection to the point where the colon meets the anterior rectus fascia.

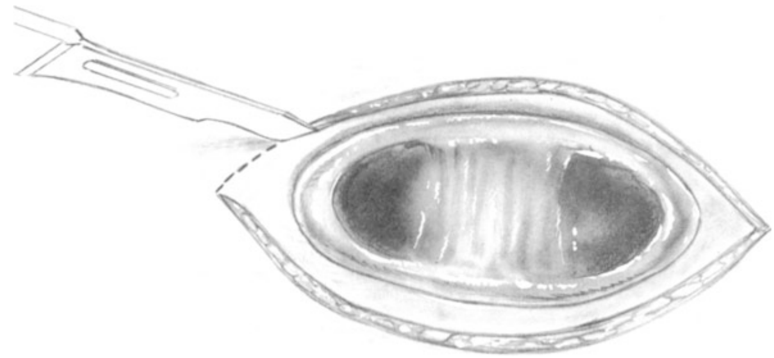


Fig. 50–1

Fascial Dissection

Identify the fascial ring and use a scalpel to dissect the subcutaneous fat off the anterior wall of the fascia for a width of 1–2 cm, until a clean rim of fascia is visible all around the colostomy. Then disect the colon away from the fascial ring until the peritoneal cavity is entered.

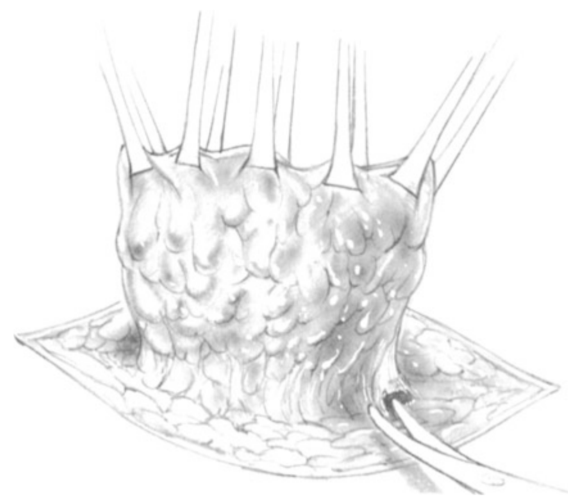


Fig. 50–2

Peritoneal Dissection

Once the peritoneal cavity has been identified, it is often possible to insert the index finger and gently dissect the transverse colon away from the adjoining peritoneal attachments. Under the guidance of the index finger, separate the remainder of the colon from its attachments to the anterior abdominal wall. This can often be accomplished without appreciably enlarging the defect in the abdominal wall. However, if any difficulty whatever is encountered in freeing the adhesions between the colon and peritoneum, extend the incision laterally by dividing the remainder of the rectus muscle with the electrocautery for a distance adequate to accomplish the dissection safely.

Closure of Colon Defect by Suture

After the colostomy has been freed from all attachments for a distance of 5–6 cm (**Fig. 50–3**), detach the rim of skin from the colon. Carefully inspect the wall of the colon for injury. A few small superficial patches of serosal damage are of no significance as long as they are not accompanied by devascularization. In most cases, merely freshening the edge of the colostomy by excising a rim of 3–4 mm of scarred colon will reveal healthy tissue.

The colon wall should now be of relatively normal thickness. In these cases, the colostomy defect, which resulted from a longitudinal incision in the transverse colon at the initial operation, should be closed in a transverse direction. Initiate an inverting stitch of 4–0 PG on an atraumatic curved needle at the caudal margin of the colonic defect and pursue it as a continuous Connell or continuous Cushing suture

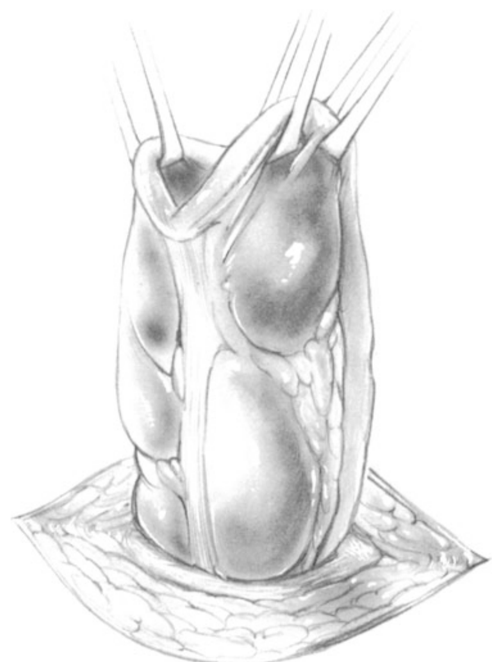


Fig. 50–3

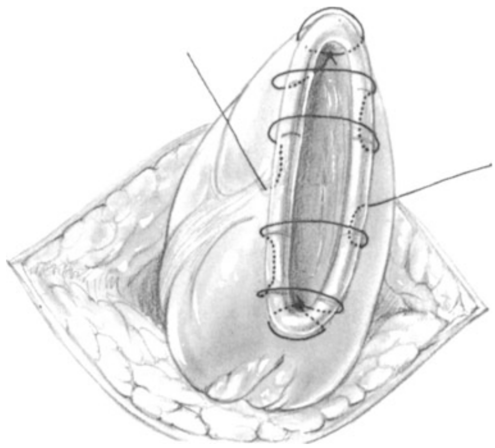


Fig. 50–4

to the midpoint of the defect (**Fig. 50–4**). Then initiate a second suture of the same material on the cephalad margin of the defect and continue it also to the midpoint. Terminate the suture line here (Fig. 50–4). Then invert this layer with another layer of interrupted 4–0 silk atraumatic seromuscular Lembert sutures (**Fig. 50–5**). Because of the transverse direction of the suture line, the lumen of the colon is quite commodious at the conclusion of the closure. There should be no tension whatever on this suture line. Finally, irrigate with a dilute antibiotic solution and reduce the colon into the abdominal cavity.

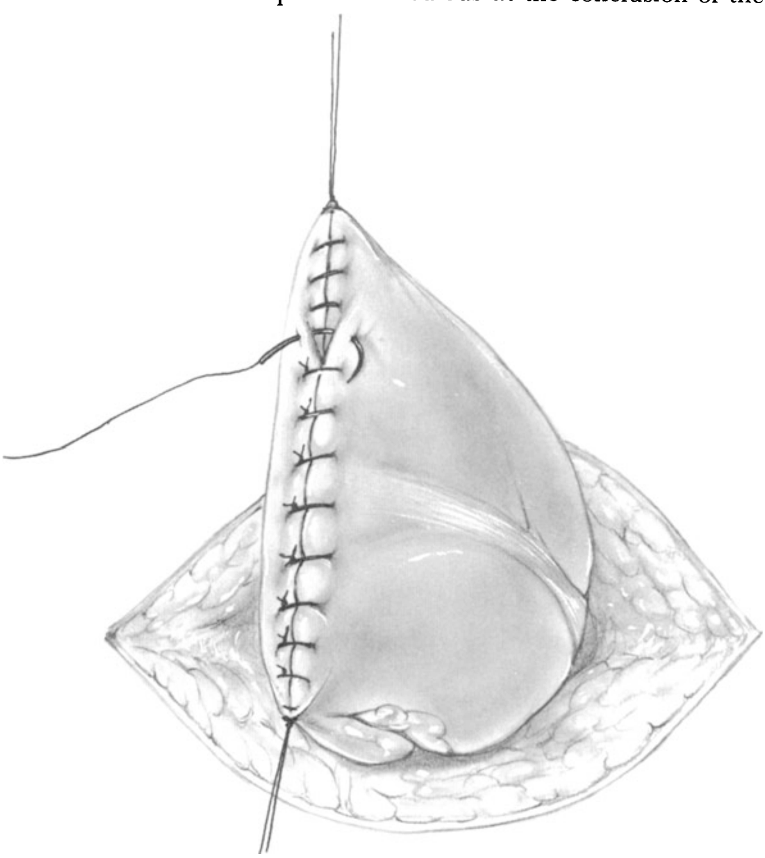


Fig. 50–5

Closure of Colonic Defect by Staples

If the colon wall is not so thick that compressing it to 2 mm will produce necrosis, stapling is an excellent method of closing the colon defect. Align the defect so that the closure can take place in a transverse direction. Place a single guy suture to mark the midpoint of the transverse closure (**Fig. 50–6**) and apply Allis clamps to approximate the colon staple line with the bowel wall in eversion.

Carry out stapling by triangulation with two applications of the TA-55 device. First, in the TA-55 device grasp the everted mucosa supported by the Allis clamps on the caudal aspect of the defect and the guy suture. Fire the staples and use a Mayo scissors to excise the redundant everted mucosa flush with the stapler. Leave the guy suture at the midpoint of the closure intact.

Make the final application of the TA-55 as the device is positioned deep to the Allis clamps on the cephalad portion of the defect (**Fig. 50–7**). It is important to position the guy suture so as to include the previous staple line in this second line of staples, assuring that no gap will exist between the two staple lines. Then fire the staples. Remove any redundant mucosa by excising it with Mayo scissors flush with the stapler. Lightly electrocoagulate the everted mucosa. Carefully inspect the integrity of the staple line to insure that proper B formation has taken place. It is important, especially with stapling, to ascertain that no tension is exerted on the closure.

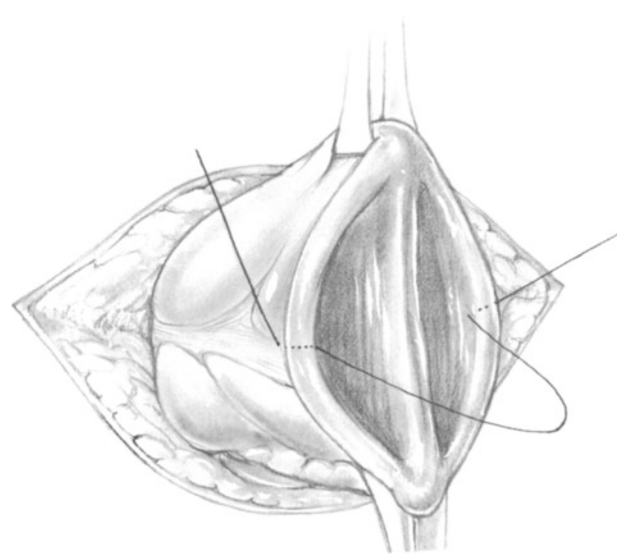


Fig. 50–6

Resection and Anastomosis of Colostomy

Whenever the tissue is of inadequate quality for closing, the incision in the abdominal wall must be enlarged and resection of a segment of colon carried out. A sufficient section of the right transverse colon must also be mobilized. Occasionally, the hepatic flexure will have to be freed from the abdominal wall too. Dissect the omentum off the transverse colon both proximal and distal to the defect. After the proximal and distal segments of the colon have been sufficiently mobilized and the traumatized tissue excised, end-to-end anastomosis can be constructed by the usual two-layer technique (see Figs. 37–16 through 37–24). Alternatively, a functional end-to-end colocolonic anastomosis may be constructed by the stapling technique (see Figs. 37–33 through 37–36).

Closure of Abdominal Wall

Irrigate the area with a dilute antibiotic solution and apply an Allis clamp to the midpoint of the abdominal wall on the caudal and cephalad aspects of the wound. Then close the incision by the modified Smead-Jones technique (see Chap. 5).

Management of Skin Wound

Frequently the colostomy can be closed without enlarging the skin incision, which was no longer than 5–6 cm. In such cases we simply insert a loose packing of gauze into the subcutaneous space, which we allow to heal by granulation and contraction. If desired, several interrupted vertical mattress sutures of nylon may be inserted; but do not tie them until the eighth or tenth postoperative day. The subcutaneous tissue should be kept separated with moist gauze packing. There is a high incidence of wound infection following primary closure of the skin. To avoid it, the surgeon must eliminate bacterial contamination or leave the skin open.

Postoperative Care

Nasogastric suction if necessary

Systemic antibiotics are not continued beyond the perioperative period unless there was a serious degree of wound contamination during surgery

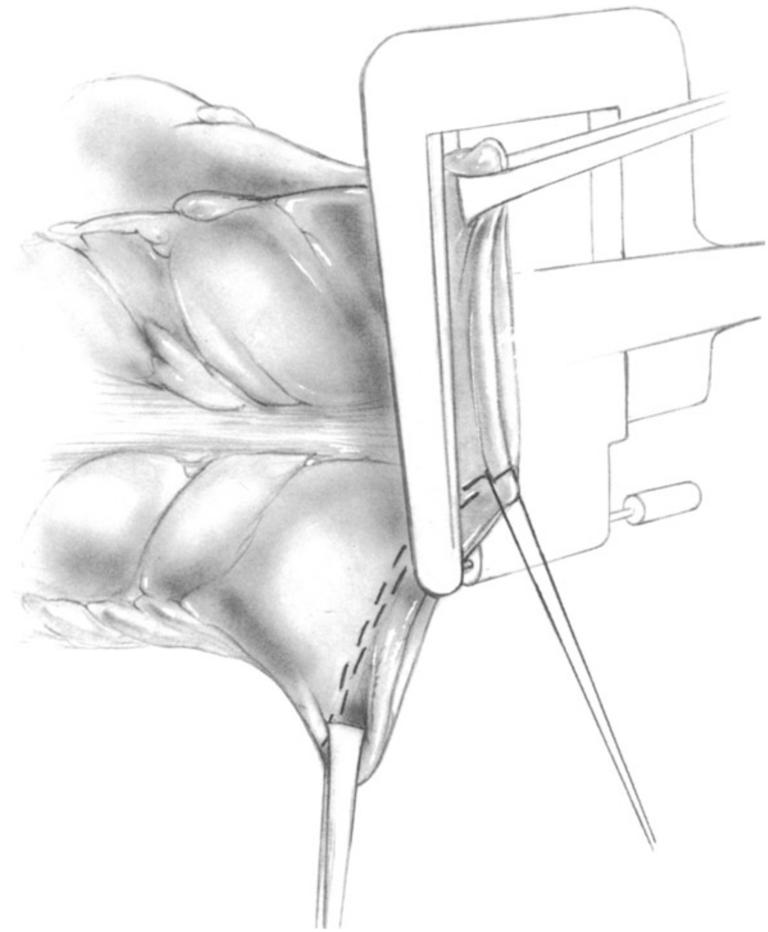


Fig. 50–7

Complications

Wound infection

Abdominal abscess

Colocutaneous fistula

References

Knox AJS et al. Closure of colostomy. Br J Surg 1971; 58:669.

Turnbull RB Jr, Weakley FL. Atlas of intestinal stomas. St. Louis: Mosby; 1967.

Wheeler MH, Barker J. Closure of colostomy—a safe procedure. Dis Colon Rectum 1977;20:29.

Yaiko RD et al. Morbidity of colostomy closure. Am J Surg 1976;132:304.

51 Operations for Colonic Diverticulitis

Indications

Elective

Recurrent diverticulitis

Colovesical fistula

Urgent

Diverticular abscess or phlegmon, unresponsive to medical management

Complete colon obstruction

Suspicion of coexistent carcinoma

Emergent

Spreading or generalized peritonitis

Massive colonic hemorrhage

Concept: Selection of Operation

Management of Typical Acute Diverticulitis

The typical case of acute sigmoid diverticulitis appears with fever, leukocytosis, and pain and tenderness in the left lower quadrant. The patient may or may not have a palpable mass in the lower abdomen or in the pelvis. The best imaging technique for diagnosing a diverticulitis phlegmon is computed tomography. Initial therapy depends upon intravenous antibiotics and nasogastric suction. After 2–3 days the patient is much improved. Tenderness and fever will diminish. By the end of a week the pelvic or abdominal mass may no longer be palpable. After three weeks a barium colon enema radiographic study may be performed. If this is the patient's first attack, surgery is not generally indicated unless the X ray shows an extravasation of contrast material outside the lumen of the colon.

On the other hand, if the patient's toxicity and physical findings advance despite 2–3 days of intensive therapy, perform an immediate CT scan. If this scan demonstrates a localized abscess that can safely be drained by inserting a percutaneous CT-guided catheter, emergency surgery may be avoided in favor of a one-stage resection 4–7 days later.

It should be emphasized that in the vast majority of cases acute diverticulitis is caused by intramural and pericolonic cellulitis (phlegmon) rather than a collection of pus (abscess). For this reason many cases of severe acute diverticulitis respond to conservative therapy. In many patients, not only does conservative therapy often avoid the need for surgery, it enables the surgeon to perform a *one-stage* resection at a time of election instead of the traditional two-three-stage procedure.

In those patients for whom conservative therapy has failed, performance of a proximal colostomy and local drainage will prove inadequate for the control of *spreading sepsis*, according to Alexander-Williams and Eng et al. Because of the column of stool in the left colon situated between the colostomy and the perforation, the progression of sepsis is likely if there is a continuing leak. Also, the surgeon may fail to identify a retro or intermesenteric abscess. In these patients the preferred operation is either a Hartmann or a sigmoid resection with exteriorization of the proximal segment as an end colostomy and the distal segment as a mucous fistula.

Obviously, when acute diverticulitis presents initially with signs of extensive or generalized peritonitis, an operation should be performed on an emergency basis immediately following the administration of antibiotics and fluids.

Elective Left Colon Resection with Anastomosis, One Stage

Patients who have recovered from an attack of acute diverticulitis may undergo primary resection as early as 1–3 weeks following the attack, provided all the signs of local inflammation have receded rapidly. Many surgeons prefer to delay the operation for 3 months. Delay for a period of time longer than 3 months appears to be of no incremental value, as the operation does not become technically easier with the passage of additional time.

If a reading of the X rays raises the suspicion of carcinoma, either operate within 3 weeks following the attack or rule out carcinoma by colonoscopy.

Transverse Colostomy for Complete Colon Obstruction

A few patients who have diverticulitis present with signs of a complete obstruction. In the absence of localized tenderness, fever, and leukocytosis, these patients can be treated the same way as those having an obstrction due to carcinoma: a simple transverse colostomy can be performed on them as the first stage of a three-stage operation. If on physical examination there are also local findings of acute inflammation, a midline incision should be made and the sigmoid colon explored and evaluated.

If preoperative abdominal X rays disclose evidence of complete small bowel obstruction, laparotomy should be performed to mobilize the segment of the small bowel adherent to the diverticular mass.

Emergent Operation for Massive Colonic Hemorrhage

Massive colonic hemorrhage is an uncommon complication of diverticulosis. Many cases of colonic hemorrhage, previously attributed to diverticulosis, have proved on arteriography to be due to angiodysplasia in the cecum. Arteriography may also identify the point of bleeding in cases of diffuse diverticulosis. In such cases the intra-arterial administration of vasopressin often controls bleeding and avoids the need for emergency surgery.

For uncontrolled colonic hemorrhage immediate subtotal colectomy is indicated, with a side-to-end anastomosis between the terminal ileum and rectosigmoid (see Chap. 43).

Colovesical Fistula

When a colovesical fistula develops as the result of sigmoid diverticulitis having eroded into the bladder, if proper preoperative preparation is carried out it is generally possible to perform a primary resection of the diseased sigmoid, including immediate anastomosis. The fibrotic area in the bladder is generally small in diameter and may be excised and repaired by a primary closure of the bladder accompanied by constant bladder drainage with a large Foley catheter.

Summary

At present there is no indication for a diverting transverse colostomy and simple drainage of acute diverticulitis. Many of the patients who in previous years underwent the three-stage operation are now treated conservatively. This permits a primary resection and anastomosis 1–3 weeks later.

Patients who have generalized or advancing peritonitis are best treated by an emergency resection of the diseased sigmoid, which eliminates the feeding focus of the sepsis. This should be accompanied by a colostomy and a mucous fistula or a Hartmann pouch. This operation often is indicated also for those patients who have failed to respond to conservative management. In these patients, routinely thrusting a drain in the left lower quadrant and making a diverting colostomy will fail to arrest the sepsis in many of such cases.

Preoperative Preparation

(See Chap. 34.)

Primary Resection and Anastomosis

Operative Strategy

The operative technique for the resection of the left colon and for the anastomosis is similar to that described for left colectomy for carcinoma—but with a number of important exceptions.

Because there is no need to perform a high lymphovascular dissection in the absence of cancer, the mesentery may be divided at a point much closer to the bowel, unless the mesentery is so inflamed and edematous that it cannot hold ligatures.

In most cases it is not necessary to elevate the rectum from the presacral space, as this area is rarely the site of diverticula. The anastomosis can be done at the promontory of the sacrum.

Though it is important to remove the greatest concentration of diverticula, in an elderly patient it is not necessary to do an extensive colectomy just because there are some innocent diverticula in the ascending or transverse colon. At the site selected for anastomosis, however, there should be no diverticula or any gross muscle hypertrophy.

Primary anastomosis should be performed only if the proximal and distal bowel segments selected for anastomosis are free of cellulitis and of marked muscle hypertrophy. Also, if an abscess has been encountered in the pelvis, so that the anastomosis will lie on the wall of an evacuated abscess cavity, it is wiser to delay the anastomosis for a second-stage operation.

Operative Technique

Incision

Make a midline incision from the upper epigastrium to the pubis.

Liberation of Sigmoid and Left Colon

Initiate the dissection in the region of the upper descending colon by incising the peritoneum in the paracolic gutter. Then insert the left hand behind the colon (**Fig. 51–1**), in an area above the diverticulitis, to elevate the mesocolon. Continue the incision in the paracolic peritoneum down to the descending colon and sigmoid to the brim of the pelvis.

At this point, to safeguard the left ureter from damage, it is essential to locate it in the upper portion of the dissection, where the absence of inflammation simplifies its identification. Then trace the ureter down into the pelvis. It may have to be dissected off an area of fibrosis in the sigmoid. When this dissection has been completed, the sigmoid is free down to the promontory of the sacrum.

Division of Mesocolon

In the elective case the mesentery generally may be divided serially between Kelly hemostats at a point no more than 4–6 cm from the bowel wall (Fig. 51–1). Initiate the line of division at a point on the left colon that is free of pathology. This sometimes requires the liberation of the splenic flexure and distal transverse colon. Continue the dissection to the rectosigmoid. Remove the specimen after applying Allen clamps.

Anastomosis

Perform an open type of anastomosis, either in one layer or two layers, or by stapling as described in Chap. 37 (Figs. 37–10 through 37–36). In a rare case it may be necessary to make the anastomosis at a lower level, where the ampulla of the rectum is significantly larger in diameter than the proximal

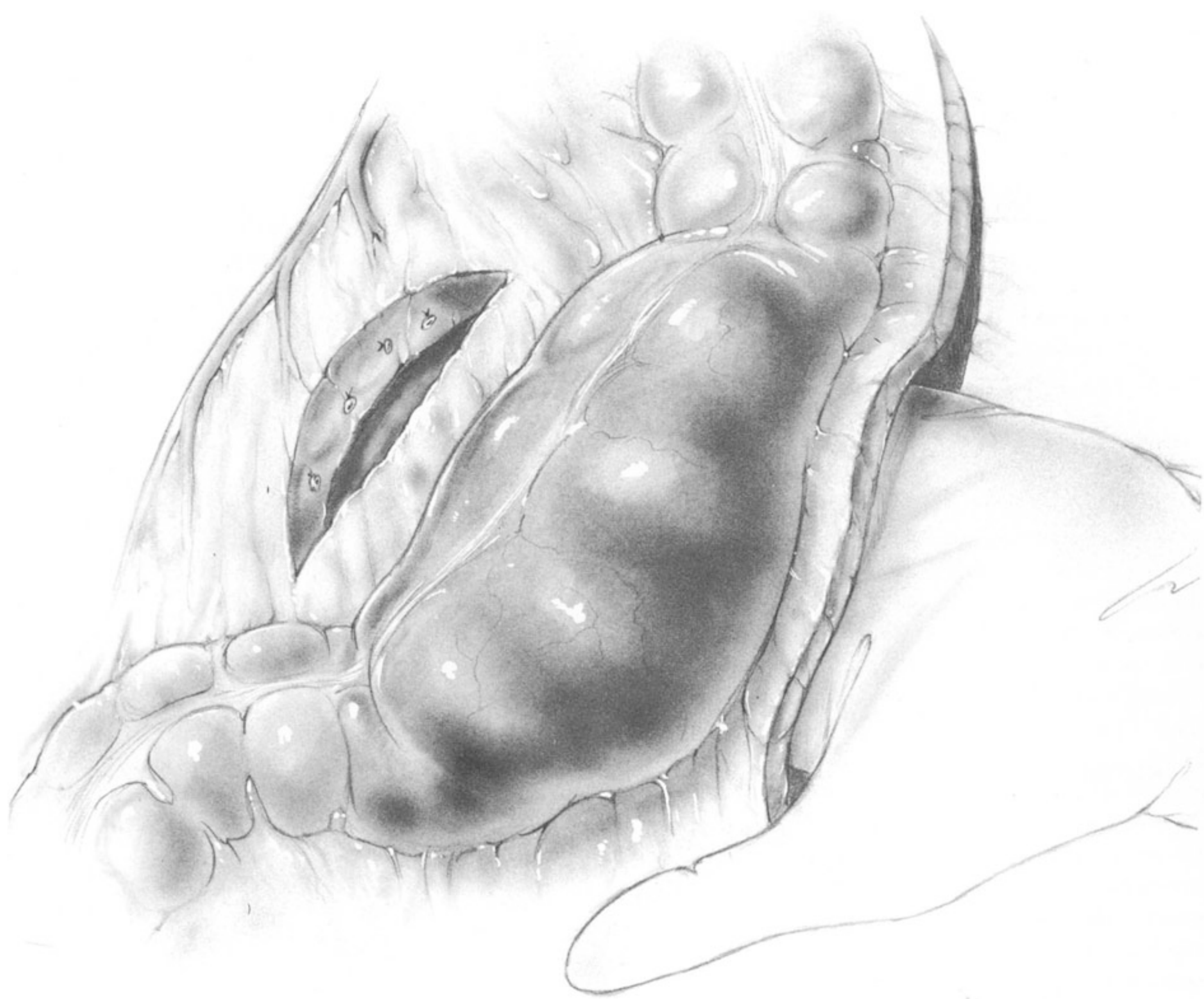


Fig. 51–1

colon. In that case a side-to-end Baker anastomosis is preferable, as described in Chap. 39 (see Figs. 39–10 through 39–20).

At frequent intervals during the above dissection and during the anastomosis, irrigate the abdominal and pelvic cavities with an antibiotic solution.

Abdominal Closure

In the absence of any intra-abdominal or pelvic abscesses, close the abdomen in the usual fashion (see Chap. 5), using no intraperitoneal drains.

Primary Resection, End Colostomy with Mucous Fistula

Operative Strategy and Technique

After the sigmoid colon has been liberated, but before complete division of the mesentery, it is important to decide whether or not to perform an immediate anastomosis. If a residual abscess has been encountered in the pelvis, where the anastomosis is to be made, then anastomosis should be delayed until a second-stage operation is performed. A small collection of pus behind the colon is not a contraindication to primary anastomosis, provided that the proximal and distal bowel are normal and that the anastomosis will not be situated adjacent to the wall of a pelvic abscess. The vicinity of the anastomosis should be essentially clean.

If it is decided to delay the anastomosis for a second stage, then it is not necessary to excise every bit of inflamed bowel, as this frequently requires a Hartmann pouch at the site of the rectosigmoid transection and makes the second stage more difficult than if a mucous fistula can be constructed. In almost every case, proper planning of the operation will permit the exteriorization of the distal sigmoid as a mucous fistula, which can be brought out through the lower margin of the midline incision after a De Martel or other clamp is applied (**Fig. 51–2**). Divide the mesocolon so as to preserve the vascularity of the mucous fistula. Then bring out an uninflamed area of the descending colon as an end colostomy through a separate incision in the lateral portion of the left rectus muscle and excise the intervening diseased colon. The second stage of this operation, with removal of the colostomy and mucous fistula and anastomosis of the descending colon to the rectosigmoid, may be carried out after a delay of several weeks.

Emergency Sigmoid Colectomy with End Colostomy and Hartmann's Pouch

Indications

For patients suffering generalized or spreading peritonitis secondary to perforated sigmoid diverticulitis, a conservative approach, with diverting transverse colostomy and local drainage, carries a mortality of more than 50%. Immediate excision of the perforated bowel is necessary to remove the focus of sepsis. Following this excision the preferred procedure is a mucous fistula and end colostomy. However, if excising the perforated portion of the

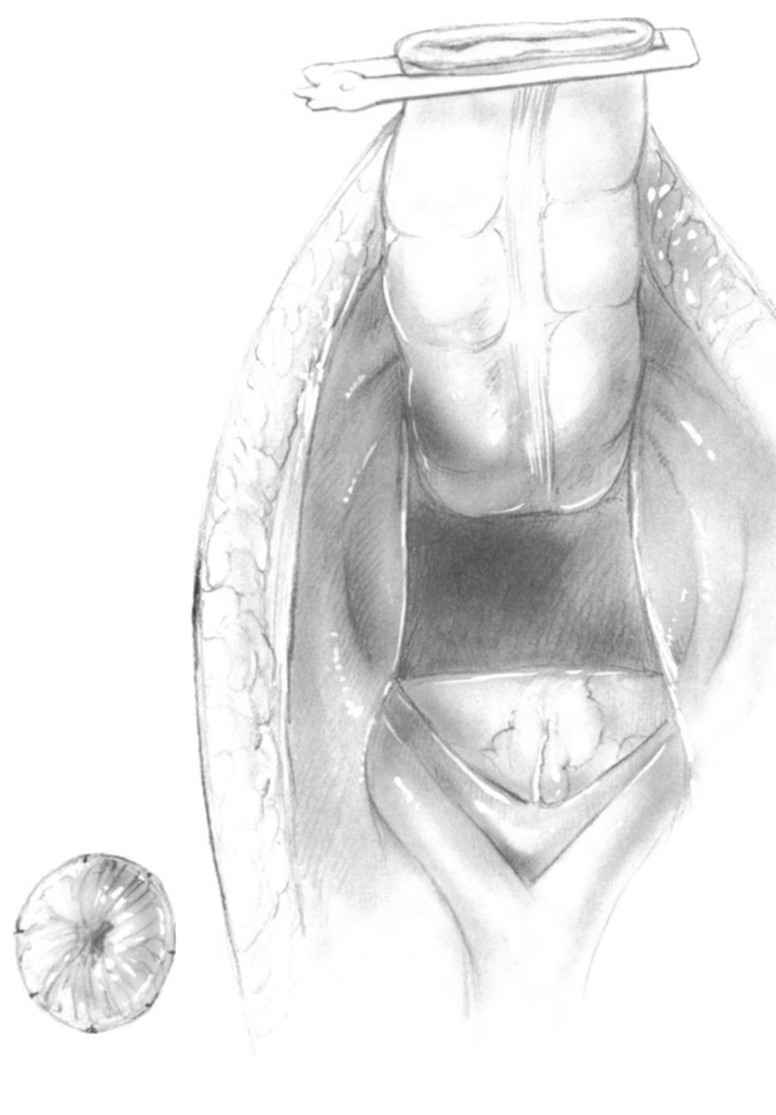


Fig. 51–2

sigmoid leaves an insufficient amount of distal bowel with which to form a mucous fistula, then Hartmann's operation is indicated. It is not wise to attempt to make a mucous fistula by extensive presacral dissection, in the hope of lengthening the distal segment, as this only opens new planes to potential sepsis.

Preoperative Preparation

Preoperative preparation primarily involves rapid resuscitative measures using intravenous fluids, blood, and antibiotics, as some patients are admitted to the hospital in septic shock. Complete colon preparation may not be possible but many patients may be given a modified dose of Golytely for colon cleansing. Nasogastric suction and bladder drainage with a Foley catheter should be instituted.

Operative Technique

Incision and Liberation of Left Colon

The steps for the incision and the liberation of the left colon are identical to those described above. It is essential to find the proper retromesenteric plane by initiating the dissection above the area of maximal inflammation. Once this has been achieved, with the left hand elevate the sigmoid colon and the diseased mesocolon—which is generally the site of a phlegmon—so that the left paracolic peritoneum may be incised safely (see Fig. 51–1). Again, it is essential to identify the left ureter in the upper abdomen in order to safeguard it from damage. There sometimes is a considerable amount of blood oozing from the retroperitoneal dissection, but this can often be controlled by moist gauze packs while the dissection continues. After the left colon has been liberated, divide the mesentery serially between hemostats, as above.

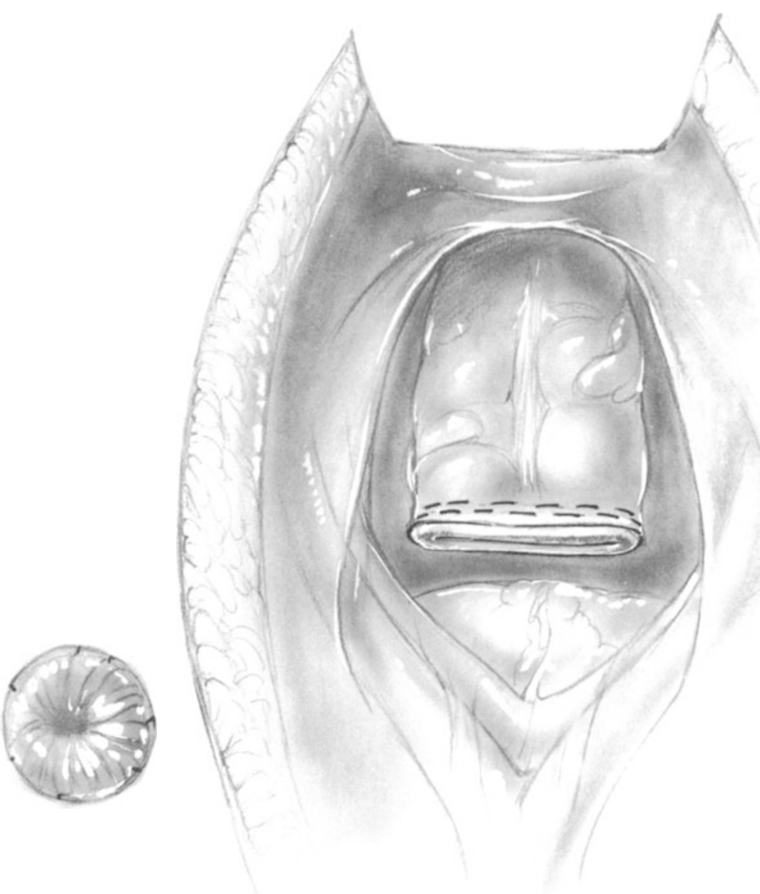


Fig. 51–3

Hartmann's Pouch

Often in acute diverticulitis the rectosigmoid is not involved to a great extent in the inflammatory process. Mesenteric dissection should be terminated at this point. If the thickness of the rectosigmoid is not excessive, occlude it by an application of the TA-55 stapler. In the presence of mild or moderate thickening, use the 4.8-mm staples. Place an Allen clamp on the specimen side of the sigmoid and divide the bowel flush with the stapler. After the stapling device is removed there should be slight oozing of blood through the staples, which is evidence that excessively thickened tissue has not been necrotized by using the stapling technique on it (**Fig. 51–3**).

If the tissue is so thick that compression to 2 mm by the stapling device will result in necrosis, then the technique is contraindicated and the rectal stump should be closed by a continuous layer of locked sutures of 3–0 PG. Invert this layer with a second layer of continuous 3–0 PG Lembert sutures. Suture the apex of the Hartmann pouch to the pelvic fascia near, or if possible, higher than the promontory of the sacrum, in order to prevent retraction low into the pelvis which would make a secondary anastomosis more difficult.

End Colostomy

Use an uninflamed area of the left colon as an end colostomy. In a patient who is desperately ill, the colostomy may be brought out through the upper portion of the midline incision if this will save time. Otherwise, bring it out through a transverse incision over the lateral portion of left rectus muscle. The incision should admit two fingers. Bring out the cut end of the colon and immediately suture it with 4–0 PG, either interrupted or continuous, to the subcuticular layer of the skin incision.

Wound Closure

Any rigid abscess cavities that cannot be excised should be managed by the insertion of sump drains for antibiotic irrigation and suction. If no rigid abscess walls have been left behind, then the abdomen, which has been irrigated with antibiotic solution at intervals during the operation, should be closed in the usual fashion without drainage. The skin can be managed by delayed primary closure.

References

Alexander-Williams J. Management of acute complications of diverticular disease—the dangers of colostomy. Dis Colon Rectum 1976;19:289.

Eng K et al. Resection of the perforated segment—a significant advance in the treatment of diverticulitis with free perforation of abscess. Am J Surg 1977;133:67.

52 Operation for Rectal Prolapse (Ripstein)

Indications

This operation is indicated for the management of a complete prolapse of the rectum.

Preoperative Preparation

Routine bowel preparation (see Chap. 34)
Sigmoidoscopy
Barium colon enema
Foley catheter in bladder
Perioperative antibiotics

Concept: Selection of Operation

For many years it was believed that massive rectal prolapse resulted from the weakness of the levator diaphragm anterior to the rectum. This hypothesis explained prolapse as a sliding hernia of the rectum through the defect in the anterior part of this diaphragm. Ripstein in 1965 emphasized that the normal rectum curves posteriorly and follows the contour of the sacrum, to which it is closely attached. Only when the rectum reaches the puborectalis sling does it change sharply to an inferior direction at the anal canal. In the normal individual, straining tends to force the rectum in a posterior direction against the hollow of the sacrum. Radiological observation of barium in the rectum of patients who have rectal prolapse demonstrates that when they increase their intra-abdominal pressure, the rectum assumes more of a straight-line position from the sacral region to the anal canal. This permits intussusception of the rectal wall through the anal musculature. It is likely that the weakness of the levator diaphragm is secondary to many years of constipation and prolapse, rather than the cause of prolapse. This explains how prolapse can occur in young patients who have strong levator musculature.

The concept underlying the operation is the application of a permanent polypropylene mesh that fixes the rectum to the presacral fascia. This restores the normal posterior curve of the rectum and eliminates intussusception and prolapse. Although an abdominal approach is used, Gordon and Hoexter have found the mortality in over 1000 cases to be less than 0.5%, and the recurrence rate 2%–3%.

This operation is indicated only in patients who are not also suffering from significant constipation. Constipated patients will do better with resection of the redundant sigmoid colon and colorectal anastomosis with sutures attaching the lateral ligaments of the rectum to the sacral fascia.

For really poor-risk patients with rectal prolapse, a Thiersch operation may be performed, as discussed in Chapter 92.

Performing a low anterior resection for massive rectal prolapse is effective because the postoperative scarring in the area of the anastomosis fixes the anastomosis to the presacral space. In addition, insert several 3–0 Tevdek sutures to attach the divided lateral ligaments of the rectum to the presacral fascia to enhance the fixation of the lower rectum to the sacrum. Removing the long redundant sigmoid also contributes to the efficacy of this opera-

Fig. 52–1

tion. In expert hands, the mortality should be low, as reported by the group from the University of Minnesota (Watts et al. and Frykman et al.). We feel this is the procedure of choice in the medically fit patient with rectal prolapse and associated serious constipation.

Another procedure advocated for this condition is amputation of the prolapsed segment, with colorectal anastomosis performed outside the anal canal. The Altemeier procedure, perhaps in combination with levatorplasty, as described by Prasad and associates, is a good option in the elderly patient with associated anorectal incontinence.

Pitfalls and Danger Points

Excessive constriction of rectum by the mesh, which may result in partial obstruction or, on rare occasions, erosion of mesh into lumen of rectum

Disruption of suture line between mesh and presacral space

Presacral hemorrhage

Operative Strategy

To prevent undue constriction of the rectum when the mesh is placed around it, *there should be sufficient room left for the surgeon to pass two fingers behind the rectum* after the mesh has been fixed in place.

The success of the Ripstein operation is *not predicated upon any degree of constriction* of the rectum. It will suffice if the mesh simply prevents the rectum from advancing in an anterior direction away from the hollow of the sacrum.

The site on the rectum selected for the placement of the mesh is important. The upper level of the mesh should be 5 cm below the promontory of the sacrum. This requires opening the rectovesical or rectouterine peritoneum. In most cases the lateral ligaments of the rectum need not be divided.

Damage to the hypogastric nerves in the presacral area should be avoided, especially in males, in whom nerve transection produces retrograde ejaculation.

Operative Technique

Incision

A midline incision between the umbilicus and pubis provides excellent exposure in most patients. In young women, the operation is accompanied by improved cosmetic results if it is performed through a Pfannenstiel incision. Place the Pfannenstiel incision just inside the pubic hairline, in the crease that goes from one anterior superior iliac spine to the other (**Fig. 52–1**). It should be 12–15 cm long. With the scalpel, divide the subcutaneous fat down

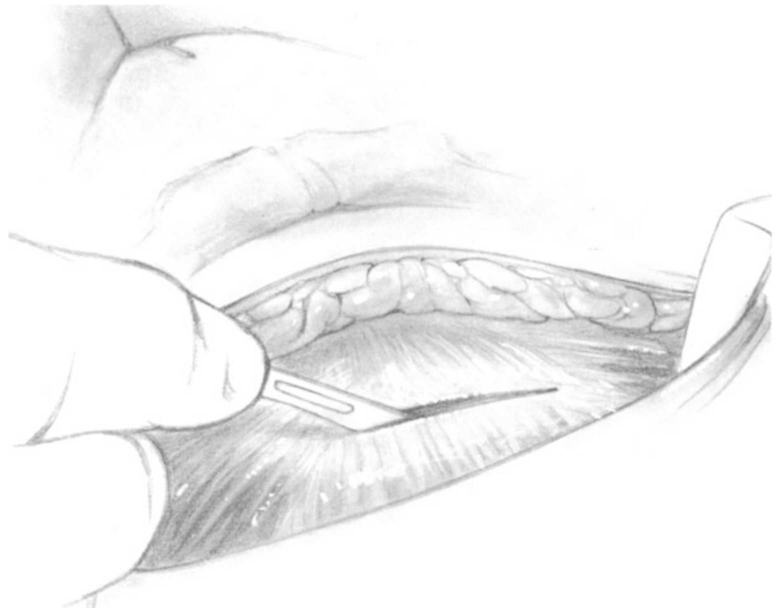


Fig. 52–2

to the anterior rectus sheath and the external oblique aponeurosis. Divide the anterior rectus sheath in the line of the incision about 2 cm above the pubis (**Fig. 52–2**). Extend the incision in the rectus sheath laterally in both directions into the external oblique aponeurosis. Apply Allis clamps to the cephalad portion of this fascial layer and bluntly dissect it off the underlying rectus muscles almost to the level of the umbilicus (**Fig. 52–3**). Separate the rectus

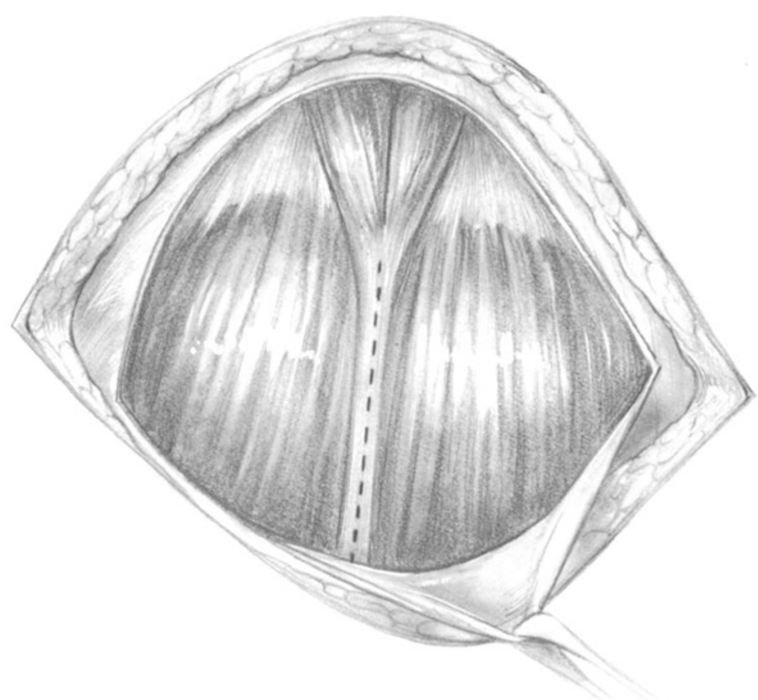


Fig. 52–3

muscles in the midline, exposing the preperitoneal fat and peritoneum. Grasp these in an area sufficiently cephalad to the bladder so as not to endanger that organ. Incise the peritoneum, open the abdominal cavity, and explore it for coincidental pathology. A moderate Trendelenburg position is helpful.

Incision of Pelvic Peritoneum

Retract the small intestine in a cephalad direction. Make an incision in the pelvic peritoneum beginning at the promontory of the sacrum and go along the left side of the mesorectum down as far as the cul de sac. Identify the left ureter.

Make a second incision in the peritoneum on the right side of the mesorectum, where the mesorectum meets the pelvic peritoneum. Extend this incision down to the cul de sac too and identify and preserve the right ureter. Join these two incisions by dividing the peritoneum at the depth of the rectovesical or rectouterine pouch, using a Metzenbaum scissors (see Figs. 40–2 through 40–4). Frequently, the cul de sac is quite deep in patients with rectal prolapse. Further dissection between the rectum and the prostate or the vagina is generally not necessary.

Presacral Dissection

In cases of rectal prolapse the rectum can be elevated with ease from the hollow of the sacrum. Enter the presacral space via a Metzenbaum dissection, a method similar to that described for anterior resection (see Chap. 39). Take the usual precautions to avoid damage to the presacral veins. Inspect the presacral area for hemostasis, which should be perfect before the procedure is continued.

Application of Mesh

Fit a section of Prolene mesh measuring 5 cm × 10 cm or 5 cm × 12 cm into place overlying the lower rectum. The upper margin of the mesh should lie over the rectum at a point 4–5 cm below the sacral promontory. Using a small Mayo needle, insert three interrupted sutures of 2–0 Prolene or Tevdek into the right margin of the mesh and attach the mesh to the sacral periosteum along a line about 1–2 cm to the right of the midsacral line. Use the same technique to insert three interrupted sutures in the left lateral margin of the mesh and through the sacral fascia and periosteum (**Fig. 52–4a**). Tie none of these sutures yet, but apply a hemostat to each of them temporarily. After all six sutures have been inserted have the assistants draw them taut. Then insert two fingers between the rectum and sacrum in order to check the tension of the mesh, so as to ensure against constriction of the rectum (**Fig. 52–4b**). Now tie all six sutures. Use additional sutures of 4–0 atraumatic Prolene or Tevdek to attach both the proximal and distal margins of the mesh to the underlying rectum so that there will be no possibility of the rectum sliding forward beneath the mesh.

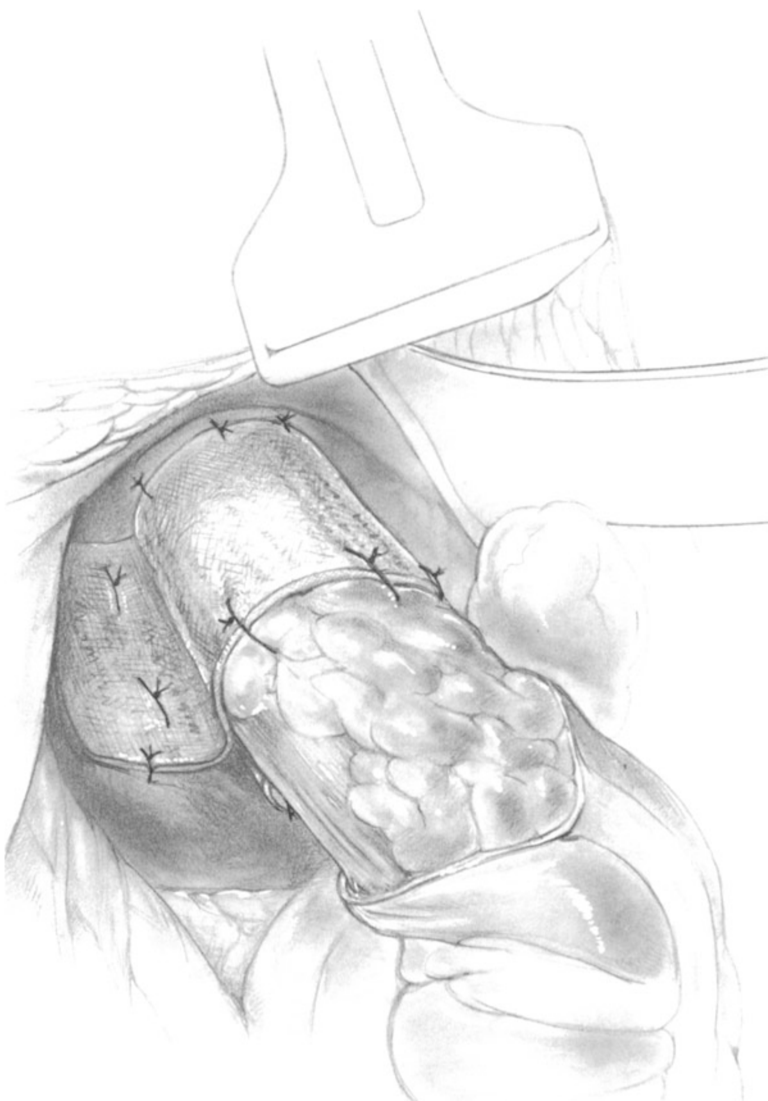


Fig. 52–4a

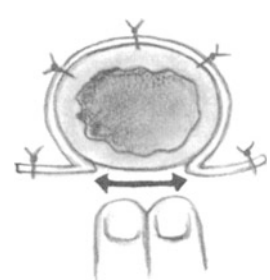


Fig. 52–4b

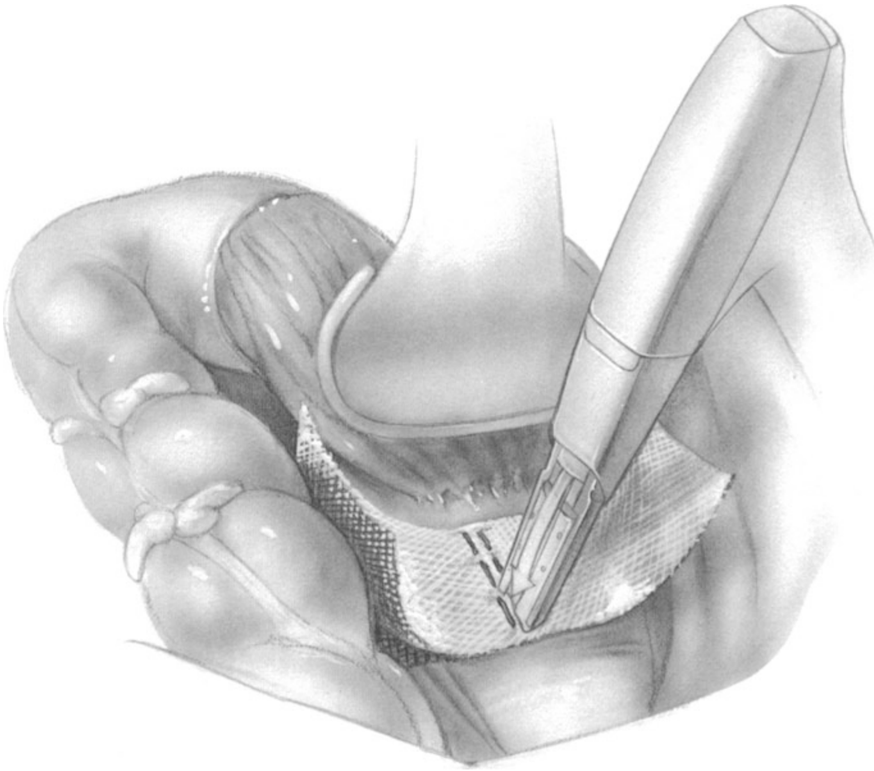


Fig. 52–5

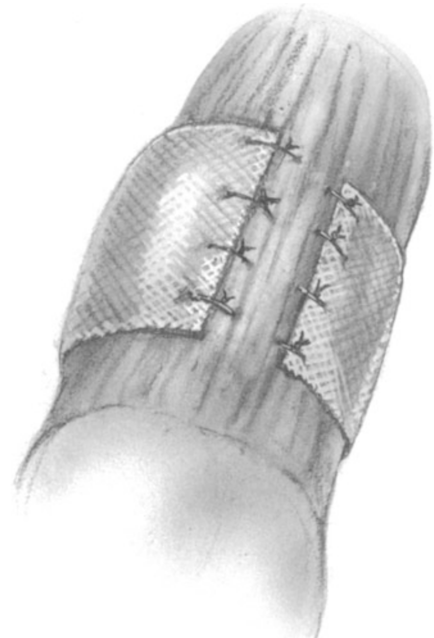


Fig. 52–6

Since there is a significant incidence of severe constipation and narrowing of the lumen by the mesh, Nicosia and Bass have described fixation of the mesh to the presacral fascia using either sutures or a fascial stapler. The mesh is then *partially* wrapped around and sutured to the rectum leaving the anterior third of the rectal circumference free to dilate as necessary (**Figs. 52–5 and 52–6**).

Closure of Pelvic Peritoneum

Irrigate the pelvic cavity with an antibiotic solution. Close the incision in the pelvic peritoneum with a continuous suture of 2–0 atraumatic PG (**Fig. 52–7**).

Wound Closure

For closure of the Pfannenstiel incision, grasp the peritoneum with hemostats and approximate it with a continuous 2–0 atraumatic PG suture. Use several sutures of the same material loosely to approximate the rectus muscle in the midline.

Close the transverse incision in the rectus sheath and external oblique aponeurosis with interrupted sutures of atraumatic 2–0 PG. Close the skin with a continuous 4–0 PG subcuticular suture.

Generally, no pelvic drains are necessary. If hemostasis is not perfect, bring a 6-mm Silastic

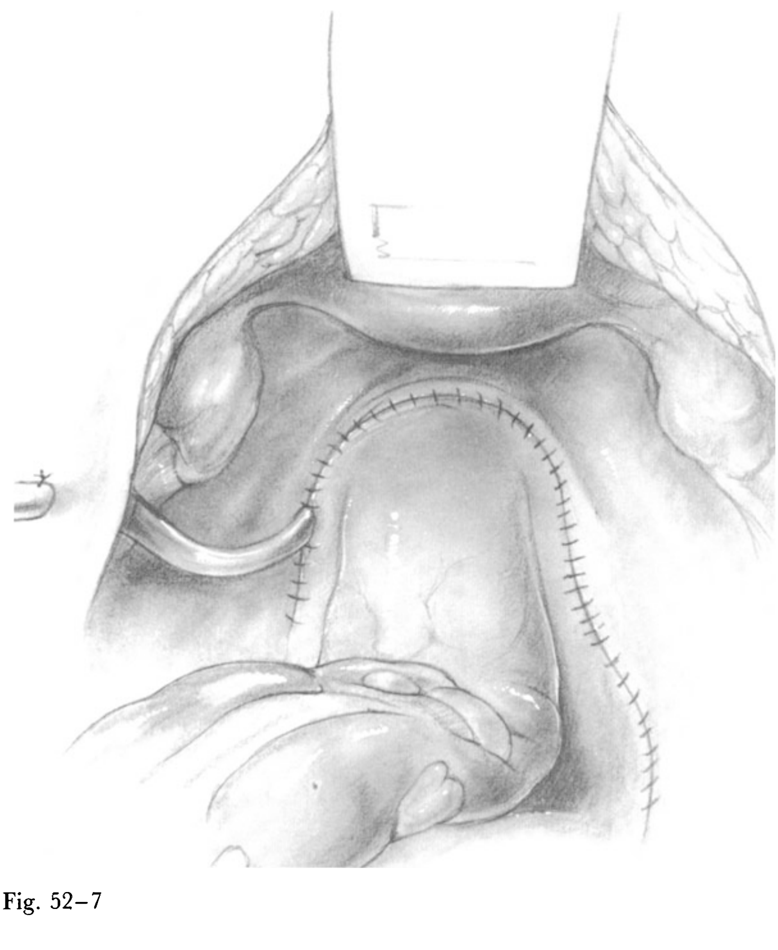


Fig. 52–7

catheter out from the presacral space through a puncture wound in the lower abdomen and attach it to a closed-suction device (Fig. 52–5).

Postoperative Care and Complications

Nasogastric suction is not necessary.

Most patients who have a complete prolapse have suffered from years of constipation. The colon may require continued use of laxative medications for this condition, although in some cases there is a definite improvement in the patient's bowel function following the operation.

Fecal incontinence, as a result of many years of dilatation of the anal sphincters by repeated prolapse, is also common among these patients. Correction of the prolapse will not automatically eliminate incontinence. This condition improves over time in more than 50% of patients who are placed on a regimen of high fiber and muscle-strengthening exercises, occasionally supplemented with biofeedback.

References

Frykman HM, Goldberg SM. The surgical treatment of rectal procidentia. Surg Gynecol Obstet 1969;129:1225–1230.

Gordon PH, Hoexter B. Complications of the Ripstein procedure. Dis Colon Rectum 1978;21:277.

Nicosia JF, Bass NM. Use of the fascial stapler in proctopexy for rectal prolapse. Dis Colon Rectum 1987;30:900–901.

Prasad ML, Pearl RK, Abcarian H et al. Perineal proctectomy, posterior rectopexy, and postanal levator repair for the treatment of rectal prolapse. Dis Colon Rectum 1986;29:547–552.

Ripstein CB. Surgical care of massive rectal prolapse. Dis Colon Rectum 1965;8:34.

Watts JD, Rothenberger DA, Buls JG et al. The management of procidentia, 30 years experience. Dis Colon Rectum 1985;28:96–102.

Breast

53 Operations for Benign Breast Diseases

Fibroadenoma

Concept: Management of Fibroadenoma

Most fibroadenomas are small, round, freely movable, well-encapsulated nodules that are easily diagnosed on physical examination and occur most often in women aged 15 to 30. Operation is indicated because some of these tumors will continue to grow, especially during pregnancy. Occassionally, carcinoma may masquerade as a fibroadenoma.

Operative Strategy

Although most fibroadenomas are completely surrounded by a smooth fibrous capsule, occasionally a fibroadenoma of the pericanalicular type may at some point be fixed to surrounding breast tissue. Whenever this is the case, include a narrow rim of normal adjacent breast in the specimen that is being excised. Otherwise, a local recurrence of the tumor is possible.

Among the errors encountered in surgery for a fibroadenoma is the failure to locate the lesion. This can occur when a deep-seated tumor is being excised under local anesthesia. Unless the tumor is easily palpable and is superficial, it may not be easy to localize, especially when the operation is being performed through a cosmetic type of circumareolar incision at a distance from the lesion.

A more important consideration, especially in cases of fibroadenomas that are large in size, is the possibility of overlooking the diagnosis of cystosarcoma phyllodes. This latter tumor, which may be malignant, often resembles a large fibroadenoma on physical examination. The most important characteristic of the cystosarcoma is a strong predilection for local recurrence. Therefore, whenever a fibroadenoma exceeds 4–5 cm in diameter, suspect the existence of a cystosarcoma and include a 1-cm shell of normal breast tissue in the specimen around its entire circumference.

Another pitfall to be avoided is postoperative bleeding. Following any breast excision, *do not depend on the presence of a small latex drain to compensate for inadequate hemostasis.* A large hematoma may develop despite the use of a drain. It is essential that hemostasis be complete. This is generally a simple matter with careful dissection and electrocoagulation.

Operative Technique

Incision

Superior cosmetic results follow the use of a circumareolar incision or an incision made in the inframammary fold. However, it is not advisable to dissect through a large distance of breast when trying to extract a fibroadenoma via one of these incisions. For tumors more than 2–3 cm away from the areola, make an incision in the line of Langer directly over the tumor. These lines are essentially circular in nature in the skin overlying the breast, each circle being concentric with the areola.

Dissection

After opening the skin, use a scalpel to carry the incision through the subcutaneous fat down to breast tissue. Then incise the breast tissue down to the lesion. Electrocoagulate each bleeding point so that the field remains bloodless.

When the capsule of the fibroadenoma appears, incise it with a scalpel. If the fibroadenoma then shells out with no further attachment, the capsule may be left behind. If there are any attachments between the fibroadenoma and the surrounding tissue, excise the capsule and a small rim of breast tissue with it.

Repair

If the dissection has created a deep defect in the breast, use PG sutures on cutting-edged needles to repair only the deepest portion of the defect. Otherwise, make no attempt to resuture the defect in the breast, as these sutures will often create a mass at the site of the repair. In the months and years following surgery, evaluation of the patient's breast on physical examination can be made extremely difficult by the presence of a firm mass at the site of the previous excision. For this reason, we generally leave most defects unsutured.

Close the skin with interrupted sutures of 5–0 nylon. If hemostasis has been complete, no drain is necessary. This will help prevent venous bleeding.

Postoperative Care

In order to apply even pressure on the operative site, request that the patient wear a supportive bra over a bulky gauze dressing continuously for the first postoperative week.

Postoperative Complications

Hematoma
Infection

Fibrocystic Disease

Concept: Operation versus Aspiration

Solitary Mass

A solitary cyst of the breast differs from a fibroadenoma in that it is not as freely movable with respect to the surrounding breast tissue, although the overlying skin does move freely. Also, cystic disease occurs at a later age than does fibroadenoma, the age incidence extending from 30 to the menopause. Some breast cysts give a sense of fluctuation when palpated, confirming the diagnosis. A breast mass suspected of containing a cyst should be aspirated using a syringe and needle. While a gauge No. 22 needle is adequate in most cases, using a larger needle, such as a No. 18, has been reported to be followed by fewer cyst recurrences. If the mass disappears *completely* after the cyst has been emptied, no biopsy is necessary. However, if the cyst should refill within 3–4 weeks after aspiration, a biopsy is indicated. If the cyst recurs at a later date, repeat aspiration is acceptable treatment. Another positive indication for biopsy is the presence of old blood in the aspirate. Occasionally, a bloody tap will yield bright red blood together with the clear yellow fluid in the cyst. This event may be followed by a small ecchymosis in the region of the needle puncture. Further observation is indicated in this situation.

If the patient has several isolated cysts, aspirate each of them and follow the same guidelines as above. Rarely will surgery be indicated if a cystic mass disappears after aspiration.

Studying the cyst aspirate for cell cytology has not proved to be fruitful in finding cases of breast cancer; we do not perform this test in the usual case of cyst aspiration.

When the presence of a cyst is suspected on a mammogram, a sonogram can confirm this diagnosis. If the cyst is not palpable, and the diagnosis is confirmed by classical sonogram features, surgery is not necessary.

Multiple Areas of Induration

More commonly, patients with fibrocystic disease present with multiple areas of induration, often in the upper outer quadrant. These are often bilateral, but one breast may demonstrate much more induration than the other. Deciding which of these patients needs a biopsy can be a vexing problem to the surgeon. Generally, patients in this category require aspiration cytology and repeated physical examinations at 3–6 month intervals. Whenever a "dominant lump" appears, one that has not been noted on previous examinations, prompt biopsy is indicated. Otherwise, make a sketch of the findings on each physical examination so that new areas of suspicion will be identified early. While the accuracy of mammography is impaired by the dense breast of women in their early thirties, this X-ray study can be quite helpful in identifying malignant areas in a dysplastic breast of an older woman.

Nonoperative Treatment

Although the prime consideration in following patients with fibrocystic disease is to avoid overlooking an early carcinoma, other manifestations of the disease also merit attention. Patients may complain of pain in the breasts especially around the time of their menstrual periods. Frequently, the anxiety related to this complaint is the result of the patient's conviction that she is suffering from cancer. Strong reassurance that there is no evidence of malignancy is often the only treatment required. Otherwise, supporting the breast with a good bra and treatment with a mild analgesic may be necessary.

Hormonal therapy with danazol, aimed at reducing estrogen levels, has been suggested (Humphrey and Estes) for the relief of these symptoms. Insufficient experience has been gathered to determine whether there are significant risks associated with altering the patient's hormonal balance with this medication. We do not find the need to prescribe danazol.

Prophylactic Bilateral Subcutaneous Mastectomy with Prosthetic Implant

In patients who have a strong family history of breast cancer as well as multiple areas of induration in the breast some surgeons advocate bilateral mastectomy with preservation of the nipples and the areolas followed by prosthetic implants in the hope of preventing the occurrence of breast cancer. Unfortunately, this operation does not remove all of the breast tissue and we are aware of at least one patient in whom cancer occurred in a 1-cm area of residual breast following prophylatic mastectomy. For patients who are conscientious about returning to an experienced physician for regular follow-up examinations and for annual mammography (after age 40), prophylactic mastectomy is rarely indicated for fibrocystic disease.

Indications

In patients with fibrocystic disease, the only indication for surgery is the suspicion of cancer.

Preoperative Care

Preoperative mammography is advisable to determine whether there are any additional suspicious areas identifiable by roentgenography that the surgeon was unable to identify. Once the decision is made that an area in the breast is suspicious for carcinoma on physical examination, a negative finding on mammography does not constitute a reason to cancel the operation.

Breast sonography can contribute information in determining the presence or absence of fluid-filled cysts.

Operative Strategy

Local Excision versus Segmental Resection

In a thin-breasted woman a well-localized mass is easily removed by local excision. On the other hand, in many cases a suspicious thickening of the breast may be due to a scirrhus tumor. Except for the patient with thin breasts, the core of a scirrhus carcinoma may be 3 cm or more deep to the area of thickening. It is these tumors that the unsophisticated surgeon may fail to reach during his attempt at local excision. Removing the overlying breast may result in a negative biopsy when, in fact, the carcinoma remains behind. For this reason, when the suspicious area is not clearly defined and well localized, it is preferable to excise a segment of breast extending from the subcutaneous fat down to the pectoral fascia in order to be sure that in performing an excision the cancer has not been missed.

If the area of suspicion is in the upper outer quadrant of the breast, the most common site of fibrocystic disease, the segmental excision will include the axillary tail of Spence together with the area of suspicion, as described below.

After excising a segment of breast, we prefer to omit closing the defect by suturing so that a new mass will not be created by the sutures. Postoperatively, palpating a gap in the continuity of the breast tissue is easier to interpret than palpating a mass.

Operative Technique—Upper Quadrant Tylectomy (Lumpectomy)

Incision

Make the incision along the skin lines of Langer (**Fig. 53–1**) directly over the lesion with consideration of the anticipated location of the skin incision that will be made in case a mastectomy becomes necessary. Make the incision long enough to provide adequate exposure for the procedure.

Dissection

Carry the scalpel incision through the subcutaneous fat down to the surface of the breast. Then dissect the subcutaneous fat off the breast over the entire

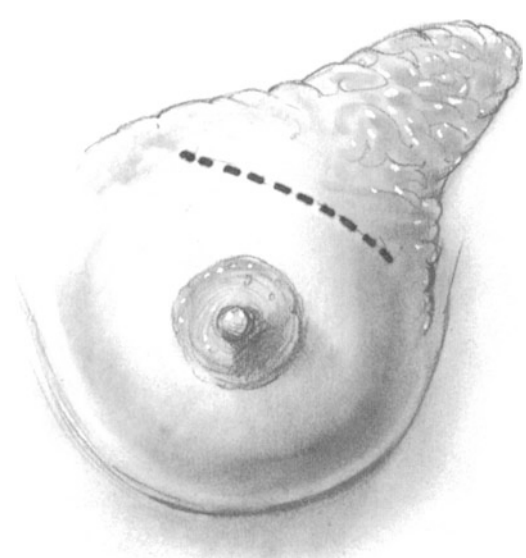


Fig. 53–1

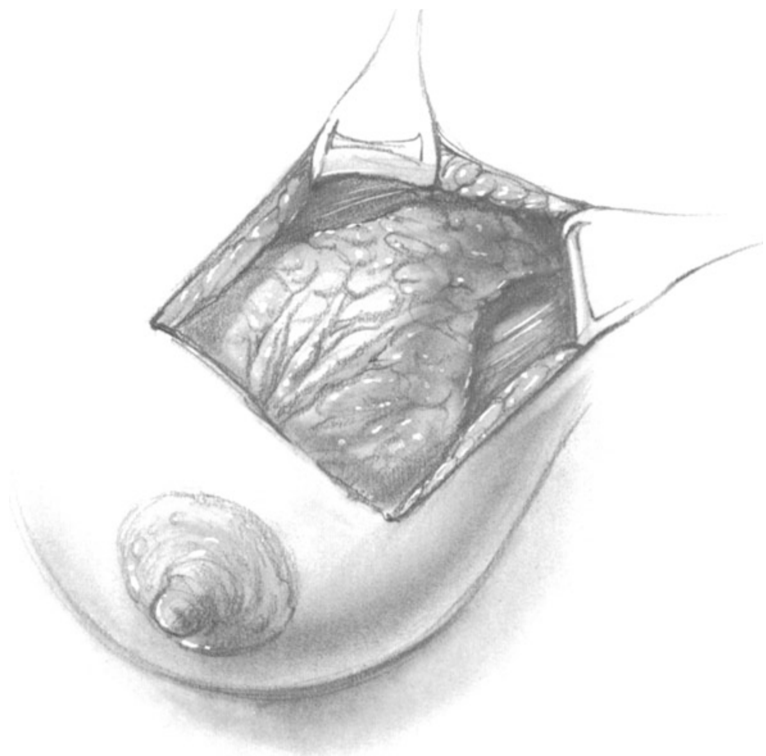


Fig. 53–2

area to be excised (**Fig. 53–2**). Expose the axillary tail of Spence.

Whenever a blood vessel is encountered use the coagulating current to achieve complete hemostasis. When the entire area of induration in the upper outer quadrant has been identified, insert the left index finger between the pectoral fascia and the overlying breast to be excised. Now, with the finger as a guide, complete the incision through the full thickness of the breast (**Fig. 53–3**) and remove the specimen.

Achieving complete hemostasis is much more efficient if each bleeding point is electrocoagulated as soon as it is encountered rather than leaving it until the specimen has been removed. Close the overlying skin with interrupted 5–0 nylon sutures. A drain is not necessary if hemostasis is complete.

Postoperative Care

If a drain has been used, remove it in 1–2 days.

Instruct the patient to wear a supportive bra over a large gauze dressing around the clock for the first 7 days.

Fig. 53–3

Postoperative Complications

Hematoma
Infection

Excision of Mammary Ducts

Concept: Management of Nipple Discharge

Presence or Absence of Mass

When a patient has a nipple discharge, the presence of a mass is a positive indication for the excision and biopsy of this lesion. The combination of a mass with a bloody nipple discharge indicates a high incidence of carcinoma.

In the *absence of a palpable mass*, nipple discharge was accompanied by a 12% incidence of carcinoma in the study of Urban and Egeli while Seltzer, Perloff, Kelley, and Fitts noted that 8% of their patients who underwent surgery for nipple discharge without a palpable mass had breast cancer. Nipple discharge that is physiological does not require biopsy. This type of discharge is almost always bilateral and can be seen to arise from multiple ducts in the nipples. This is common during pregnancy but may also be initiated by the administration of estrogens, chlorpromazine, and other drugs. Birth control pills may occasionally produce a clear serous or milky discharge from a single duct, although it more commonly produces secretion from multiple ducts. According to Urban and Egeli, "true pathologic nipple discharge is spontaneous, persistent, intermittent and usually secondary to pathologic lesions of the intraductal epithelium. It typically arises from a single duct opening in the nipple, and is most often unilateral, but occasionally bilateral." It should be remembered that each of the dozen mammary ducts has its individual orifice in the nipple so that secretion from a single diseased duct will always exude from the same nipple orifice. Persistent, spontaneous discharge from a single nipple duct is an indication for surgery.

Nature of Discharge

Bloody

On rare occasions a bloody discharge may appear from a single nipple duct during pregnancy owing to vascular engorgement of the breast. However, in 16% of cases bloody nipple discharge is due to malignant disease of the ducts; in most of the remaining cases, bloody nipple discharge is caused by benign intraductal papilloma, either single or multiple.

Serous

Although a clear serous discharge from the nipple is almost always caused by a benign process, 2% of Urban's cases had cancer, and Haagensen noted an even higher incidence of malignancy. Serous discharge from multiple nipple ducts, especially if bilateral, may be treated expectantly if there is no mass and if mammography is negative. Persistent, single-duct serous discharge requires duct excision.

Cloudy, Purulent, Multicolored

Most patients with turbid nipple discharge suffer from duct ectasia and stasis, although 3.8% of Urban's series of 435 lesions had cancer. For this reason, this type of discharge also requires duct excision.

Cytology

Surprisingly, attempts to detect cancer by studying the cytology of the nipple discharge have not been successful (Urban and Egeli).

Indications

Nipple discharge with palpable mass. The combination of a single-duct discharge, especially if bloody in nature, with a palpable mass indicates a high incidence of breast cancer and requires prompt operation.

Single-duct discharge without a palpable mass, if persistent and spontaneous, is accompanied by 11.8% incidence of cancer. It is an indication for surgery.

Multiple-duct discharge, especially if bilateral, is not, by itself, an indication for operation.

Preoperative Care

Localize the diseased duct. If the surgeon anticipates the excision of a single diseased duct, it is important to localize this duct preoperatively. This may be accomplished by applying finger pressure at varying points along the outer margin of the areola in order to determine which segment of the breast contains the offending duct, as the finger pressure will induce discharge from this duct. If this is not accomplished at a single examination, apply collodion to the surface of the nipple in order temporarily to occlude all of the ducts and prevent any discharge. At a subsequent examination a week later, remove the collodion and repeat the attempt to localize the offending duct. Also, collodion may be applied to the surface of the nipple one week prior to operation in order to cause distention of the diseased duct.

Perform mammography prior to operation on the ductal system.

Obtain radiological ductograms by inserting a tiny catheter into the duct orifice and injecting a small amount of aqueous radiopaque medium. This is a difficult procedure and many radiologists have no experience with it. If the entire ductal system of the breast is to be excised, a ductogram will be of no value and need not be done.

Operative Strategy

Single-Duct Excision versus Total Duct Excision

When the indication for surgery is a bloody nipple discharge, the diagnosis is generally carcinoma or intraductal papilloma. In the latter case, the lesions are often multiple, and excision of a single duct may overlook an intraductal carcinoma. For this reason, we agree with Urban (1963) that total excision of the mammary ducts is preferable to a single-duct excision. With other types of discharge, where the incidence of carcinoma is much lower, excision of a single duct is satisfactory, once the offending duct has been accurately localized by repeated preoperative examination.

Prevention of Skin Necrosis

Total excision of the mammary ducts requires elevation of the entire areola. This may impair the vascularity of the distal tip of the skin flap unless careful dissection is performed. Do not make the circumareolar incision greater than 40%–50% of the circumference of the areola. Also, be sure that the breast defect beneath the areola is reconstructed so that the resutured skin flap may have an opportunity to derive a blood supply from underlying soft tissue.

Operative Technique—Single-Duct Excision

Incision

A single duct may be excised either through a radial incision or an incision around the circumference of the areola. Use a sharp scalpel and obtain hemostasis with accurate electrocoagulation.

Identification and Excision

If collodion has been used to occlude the surface of the nipple for a week prior to surgery, the diseased duct will by now be distended. If it contains blood, its surface will display a purplish hue. In this case, gently dissect the duct from surrounding tissue. Divide it between hemostats at its junction with the nipple and dissect it out to a point about 1–2 cm beyond the circumareolar incision. Submit it for frozen section histological examination.

If the duct cannot be clearly identified, it will be necessary to excise an area of the ductal system beginning at the nipple and proceeding in a peripheral direction. Then have the pathologist examine the specimen to ascertain that the pathology has indeed been excised.

Closure

In many cases it is necessary only to close the skin incision with interrupted 5–0 nylon sutures. In some cases a few PG sutures may be placed if there is a significant defect in the underlying breast. If hemostasis is good, drainage is not necessary.

Operative Technique—Total Duct Excision

Incision

Make an incision along the circumference of the areola at the exact margin between the areola and skin (**Fig. 53–4**). The length of the incision should encompass 50% of the areola's circumference. Insert sutures in the edge of the incised areola temporarily and apply a hemostat to each suture. These will be used to apply traction while the areola is being dissected off the breast (**Figs. 53–5a and 53–5b**). Use scalpel or scissors dissection to elevate the areola with a thin layer of fat. This dissection must be continued beyond the nipple so that the entire skin of the areola has been elevated. Do not detach the nipple from its ducts at this stage of the operation.

Excising the Ductal System

After the skin has been elevated, it will be noted that the 12 or so ducts constitute the only attachment between the nipple and the underlying breast. Apply a ligature to these ducts and make an incision that

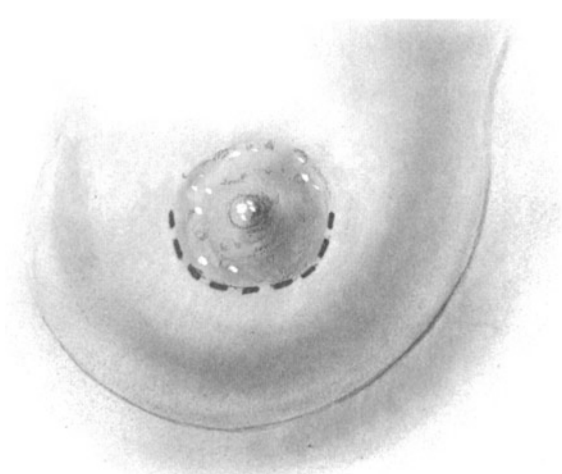


Fig. 53–4

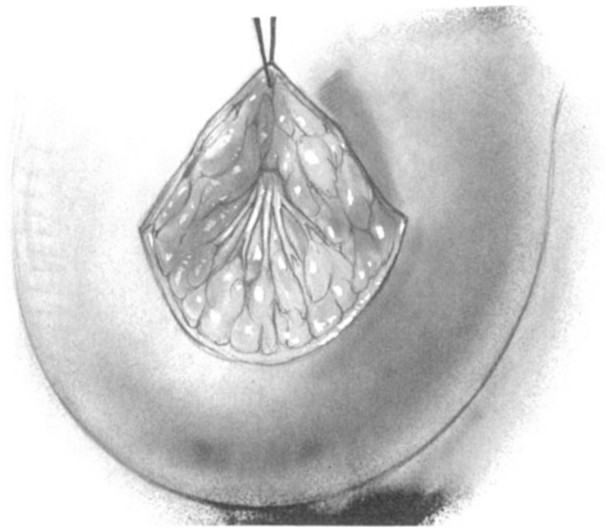


Fig. 53–5a

Fig. 53–5b

will detach them flush with the nipple (**Figs. 53–6a and 53–6b**).

Now, dissect the ducts for a distance of 3–5 cm. Using the electrocoagulator, excise the circle of ducts and breast tissue (**Figs. 53–7a and 53–7b**). The

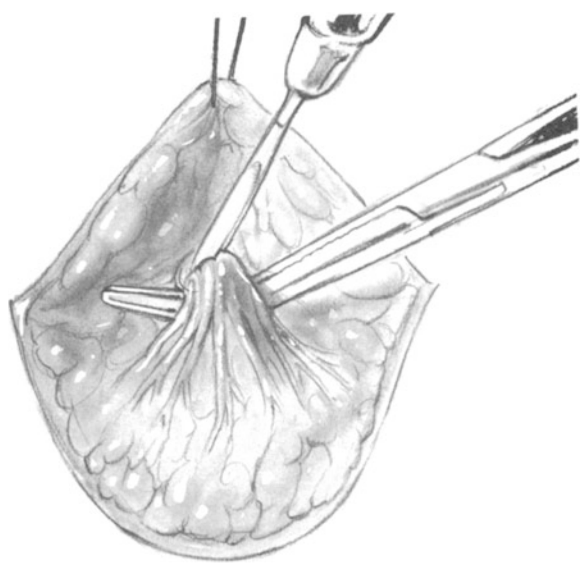


Fig. 53–6a

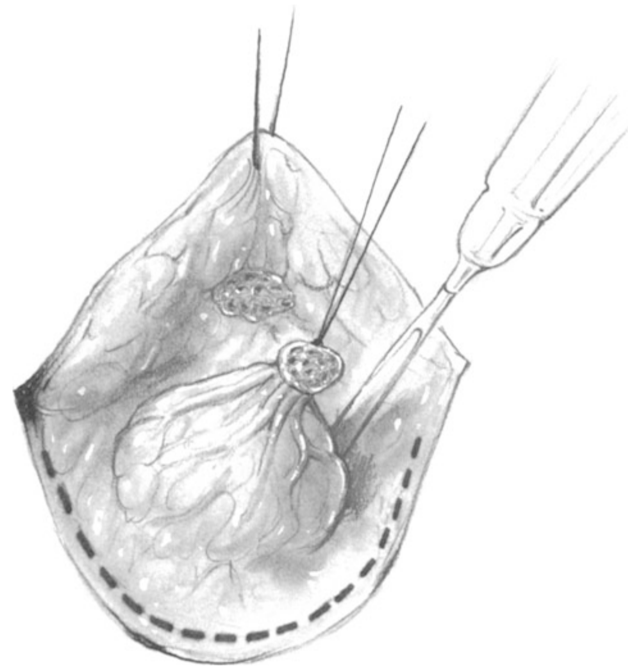


Fig. 53–7a

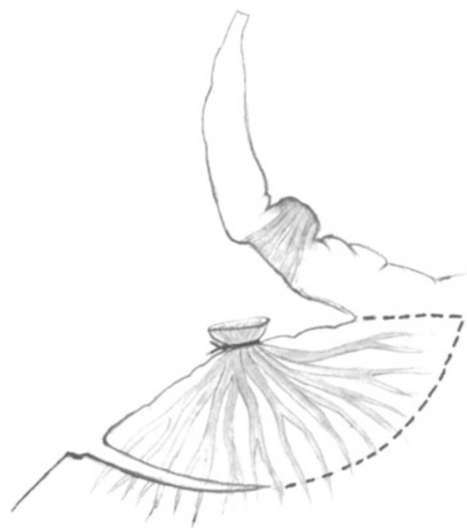


Fig. 53–7b

Fig. 53–6b

circular mass of tissue will have a radius of 3–5 cm and a thickness of 1–2 cm. If any of the diseased ducts is dilated and extends beyond 5 cm, follow this duct and remove a further section until it disappears into the breast tissue. Occasionally a diseased duct involves a section of the nipple, which may be inverted. In this case a tiny segment of nipple may be removed. Obtain complete hemostasis with the electrocoagulator.

Reconstruction

In the patient with a large breast, the resulting defect may be relatively shallow so that the reconstructed areola will rest on a solid base of breast tissue. In this case no further reconstruction is necessary. In many cases, however, there will be a significant defect beneath the areola. Since the blood supply of the areola is somewhat tenuous, it requires a firm base of breast tissue for optimal healing. In this case, close the defect in the breast in layers with interrupted small sutures of PG material.

If detaching the areola results in a tendency for the nipple to invert, corrective measures must be taken. Before closing the skin incision, insert a 5–0 PG purse-string suture in the subcuticular tissues at the base of the nipple in order to maintain it in the erect position (**Fig. 53–8**). Then close the skin incision with interruped 5–0 nylon sutures (**Fig. 53–9**).

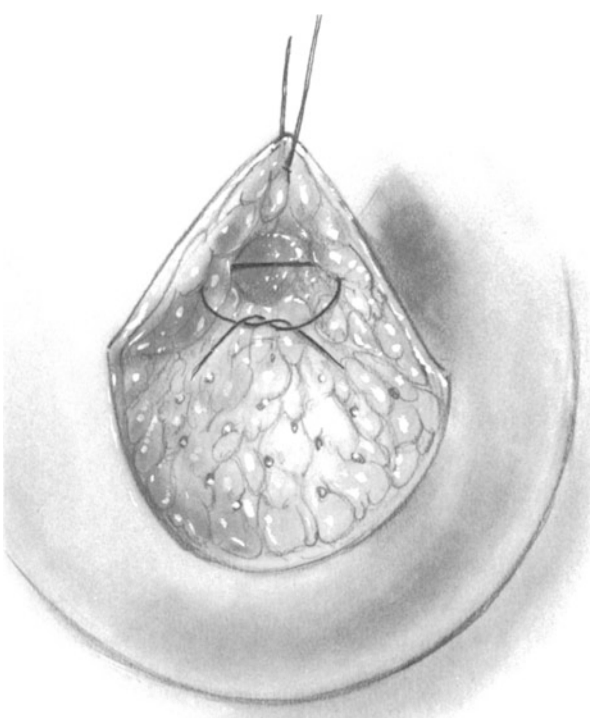


Fig. 53–8

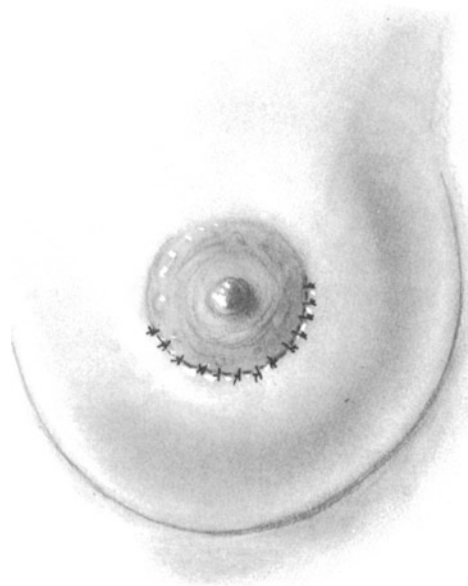


Fig. 53–9

Postoperative Care

If a latex drain has been used, remove it after 1–2 days.

Instruct the patient to wear a supportive bra over a moderately bulky dressing to apply even pressure for the first 7 days and nights after surgery.

Postoperative Complications

Hematoma

Occasionally following a total duct excision, elevation of the entire areola in a plane too close to the subcutis results in an area of *skin necrosis.*

Breast Abscess

Breast abscess is most often seen in a nursing mother. It is generally the result of the introduction of bacteria by a break in the skin of the nipple. In a lactating woman, treatment requires incision along a radial direction in order to produce as little damage as possible to the breast ducts. The pus is evacuated and a gauze packing is loosely inserted until the cavity heals.

In the nonlactacting woman, an abscess may appear without very much surrounding inflammation and induration. In some of these cases, an attempt may be made to aspirate the pus with a large needle under local anesthesia. This, together with antibiotic treatment, may avoid the necessity for operation in occasional cases.

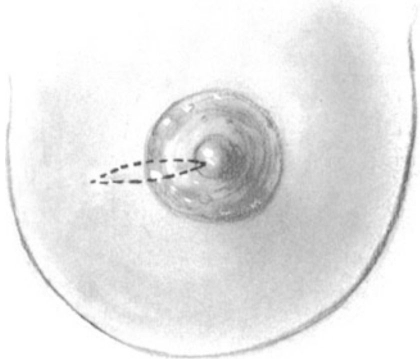


Fig. 53–10

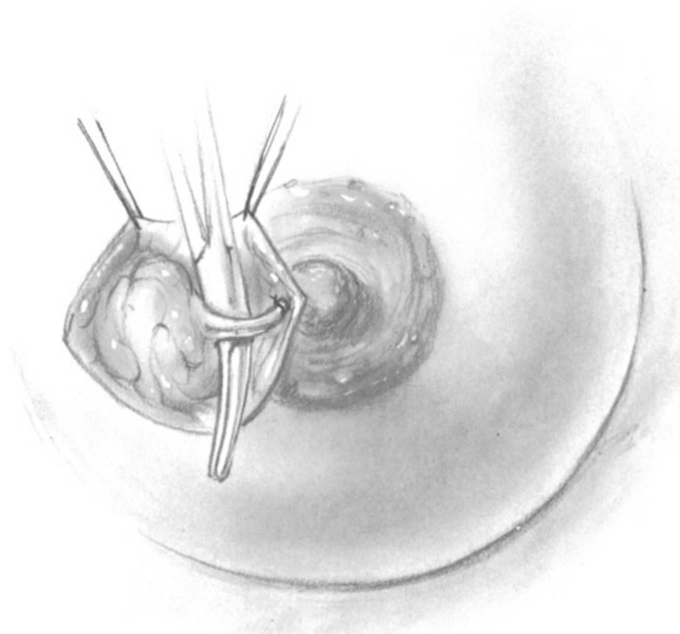


Fig. 53–11

Para-Areolar Abscess or Fistula

An abscess in the region of the areola or just adjacent to the areola often originates in an obstructed mammary duct, termed duct ectasia. This may result either in a recurring abscess at the same location or in a chronic draining fistula. In either case, proper treatment requires a radial elliptical incision (**Fig. 53–10**) overlying the duct, which can usually be palpated as a thickened cord running from the nipple towards the periphery of the breast. A small ellipse of skin and surrounding breast tissue are removed. Identify the duct (**Fig. 53–11**) and excise it together with the diseased tissue (**Fig. 53–12**). If the incision has not been greatly contaminated, close the skin loosely around a latex drain. If the area is grossly contaminated, it may be wiser to insert the skin sutures for delayed primary closure 4–6 days later.

If the diseased duct is not removed, the abscess or fistula will recur.

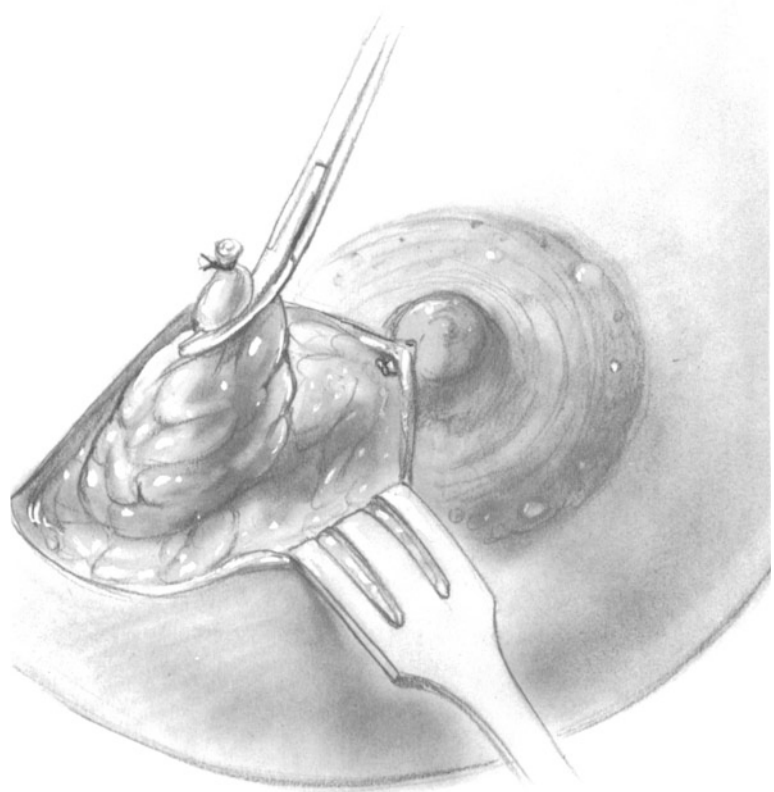


Fig. 53–12

References

Dixon JM, Thompson AM. Effective surgical treatment for mammary duct fistula. Br J Surg 1991;78:1185–1186.

Haagensen DD. Diseases of the breast. Philadelphia: Saunders; 1971.

Humphrey LJ, Estes NC. Aspects of fibrocystic disease of the breast; treatment with danazol. Postgrad Med J 1979;55:48.

Seltzer MH, Perloff LJ, Kelley RL, Fitts WT Jr. The significance of age in patients with nipple discharge. Surg Gynecol Obstet 1970;131:519.

Urban JA. Excision of the major duct system of the breast. Cancer 1963:16:516.

Urban JA, Egeli RA. Non-lactational nipple discharge. CA 1978;28:130.

54 Concept: Which Operation for Breast Cancer?

Mastectomy or Lumpectomy—Axillary Dissection?

The past decade or two has witnessed the adoption of a large number of new therapies for breast cancer ranging from biopsy-plus-radiotherapy all the way to superradical mastectomy. It is important to distinguish fact from fancy in addressing this problem.

Rosen, Fracchia, Urban et al. have shown that local excision of breast cancer, including removal of an entire quadrant of breast, leaves residual microscopic malignancy in the remaining three quadrants or in the axillary nodes in 56% of patients who have small primary lesions and in 69% of those who have tumors greater than 2 cm in diameter. Fisher et al. (1989) reported that among women who underwent lumpectomy for breast cancer without postoperative irradiation, 28% developed local recurrences after 5 years, and 39% after 8 years. It is clear that *local excision alone is poor therapy for breast cancer.*

Since the first edition of this book was written, randomized prospective studies have clearly demonstrated that the combination of lumpectomy, axillary lymphadenectomy, and high-dose radiation therapy to the breast constitutes a therapy that is equal in efficacy to radical mastectomy after an 8- to 12-year follow-up (Veronesi, Saccozzi et al.; Fisher et al. (1989); Veronesi, Salvadori et al.).

Veronesi's study was restricted to patients whose primary cancer was no more than 2 cm in diameter. Also, the lumpectomy was accomplished by removing a full quadrant of the breast, while the study of Fisher et al. (1989) required only that the specimen's margin was histologically free of tumor. Also, the latter group accepted patients whose primary tumor measured up to 4 cm in diameter. In the publication of Veronesi, Salvadori et al., a local recurrence within 3 cm of the primary tumor occurred in only 2.8%, while new primary ipsilateral tumors occurred in 1.6% of their patients. The patients with recurrent tumor were treated by total mastectomy or wide resection of the recurrent tumor. Only 10% of these reoperated patients died of metastatic breast cancer, while the others remain alive and well.

At this point in time, it appears that a woman who has a primary tumor measuring up to 4–5 cm in diameter that is classified as Stage I or II can be offered the choice between lumpectomy-axillary lymphadenectomy-radiation and modified radical mastectomy, with the expectation that her survival and her rate of local recurrence will be statistically the same for either method of treatment.

Axillary Sampling or Total Axillary Lymphadenectomy?

Whereas axillary lymphadenectomy requires an anatomical dissection with scientific precision involving the removal of all of the axillary nodes up to the point where the axillary vein passes underneath the subclavius muscle and clavicle, the term "axillary sampling" implies an inexact biopsy of fat and hopefully lymph nodes in the general vicinity of the axillary vein. Performance of the latter operation varies from excision of a few pieces of fat to what may be a large dissection. Cady and Sears accumulated data indicating that if at least 10 axillary lymph nodes are excised, and if there is no microscopic evidence of tumor metastasis in these 10 nodes, then only rarely will the apical nodes contain malignancy. This generally requires the excision of nodes at Levels I and II.

Knowledge of the number of metastatic axillary nodes, as well as the extent of tumor invasion, if any, is of vital importance in estimating the prognosis of the patient. This information will also largely determine the nature of any adjuvant therapy to be prescribed.

Should all patients with breast cancer undergo axillary lymphadenectomy? In the absence of palpable axillary lymph nodes, is it reasonable for the surgeon to omit axillary dissection in a patient whose primary carcinoma is less than 1.0 cm in size? The patients presenting with these small tumors are estimated to have only a 10%–12% rate of tumor recurrence over a 10-year period. In studying the incidence of axillary metastasis in patients with nonpalpable tumors, Margolis and associates found axillary metastases in 20% of 84 patients. Carter, Allen, and Henson found a 21% incidence of nodal involvement in 339 patients who had carcinoma of the breast less than 5 mm in size. In studying 137 patients with carcinoma of the breast measuring 1 mm in size reported to the Connecticut Tumor Registry, Margolis et al. noted that in 16% of these patients axillary nodal metastases were found. One can conclude from these data that invasive carcinoma of the breast of whatever size requires axillary lymphadenectomy unless the patient suffers from extensive systemic disease such that she will not tolerate surgery.

In addition to providing valuable information required to stage the cancer, axillary lymphadenectomy has another important advantage in the treatment of breast cancer. After axillary lymphadenectomy, it is rare to find a patient who develops recurrent tumor in the dissected axilla unless the dissection was limited. Consequently these patients do not require any radiation to the axilla. Even if, as reported by Fisher and associates (1985), omission of axillary dissection in the treatment of breast cancer does not demonstrate any negative effect on the 10-year survival rate, experienced surgeons and oncologists are well aware of patients who develop extensive axillary metastases following omitted or inadequate axillary dissection. Metastatic disease in the axilla often involves the brachial plexus and the axillary vein, producing both intractable pain and severe arm edema. This is a highly distressing condition that generally does not respond to either chemotherapy or radiation. The only possible surgical treatment is a forequarter amputation. Not only does axillary dissection provide valuable information for staging the disease, but it also has distinct therapeutic value in preventing the late development of axillary metastases.

In patients with Stage I or Stage II disease who have no palpable disease in the axilla at the time of operation, we perform complete axillary dissections at Levels I and II. In patients who have unfavorable prognostic features such as poor nuclear grade, vascular invasion, tumor size over 2 cm, or evident axillary metastases at Levels I and II, we recommend that the nodes at Level III also be included for a total axillary lymphadenectomy.

Preinvasive Cancer

Lobular carcinoma in situ is a slow-growing lesion that serves as a marker that predicts the development of an invasive cancer in 20%–30% of patients. Rosen, Braun, and Kinne believed that these patients should undergo total mastectomy, but Haagensen, Bodian, and Haagensen feel that lifelong, careful, periodic examinations will detect the malignancy in sufficient time to achieve a long-term cure. We agree. A complicating feature of this disease is its high incidence of bilaterality. The cancer may occur in the *opposite* breast in half the cases and is usually of the duct-cell type.

Intraductal carcinoma is a misnomer. A more precise term for this premalignant condition is duct-cell carcinoma in situ (DCIS). Over a long period of time, perhaps 10–20 years, 25%–60% of patients suffering from DCIS will develop invasive duct-cell carcinoma of the ipsilateral breast.

Until the development of sophisticated mammographic technology, DCIS was a rarely detected disease. In the past 5 or 10 years, roughly 20% of all cancers have consisted of DCIS, most of which were nonpalpable lesions that were detected because mammographic microcalcification led to a radiographically localized breast biopsy. Until the past decade, the standard treatment for DCIS consisted of total mastectomy, sometimes with lymph node sampling. If DCIS was a preinvasive stage of cancer, total mastectomy was a logical choice, since removing the entire organ resulted in 100% prevention of cancer in the excised breast. For patients who wish to have the greatest possible insurance against developing breast cancer, total mastectomy remains an excellent choice. Recently, several authors have studied the efficacy of local excision with and without postoperative radiation therapy in the treatment of DCIS.

Lagios advocates wide local excision of DCIS when this condition has been detected because of microcalcification on the mammogram. The maximum diameter of lesions suitable for conservative therapy is no more than 25 mm as measured by both mammographic and histological study. The margins of the excised tissue should be histologically negative. Lagios reported treating 79 patients by local excision. After a follow-up period of 68 months, 12.7% demonstrated local recurrences. Half of the local recurrences consisted of recurrent DCIS, and the other half of invasive carcinoma. Many of these local recurrences were detected by noting the presence of recurrent microcalcification in the follow-up mammograms. All the local recurrences were treated either by reexcision or by total mastectomy.

Lagios notes that DCIS of the comedo type produces a local recurrence rate of 25% when treated by wide local excision. For this reason we consider that in patients who suffer from the comedo type of DCIS, local excision is contraindicated and mastectomy should be performed.

Whether the addition of postoperative breast irradiation will reduce the number of local recurrences after wide local excision of DCIS is still unknown. Solin and associates reported on 10-year results of breast-conserving surgery and irradiation for DCIS in 259 women collected from nine institutions in Europe and the United States. All had complete gross excision of the primary DCIS lesion and had postoperative irradiation of 6000 cGy. The actuarial rate of local failure was 16%. Half of the local recurrences consisted of invasive ductal carcinoma. Two percent of all of the patients treated developed distant metastases during the period of observation. As yet, there are no randomized prospective studies evaluating the efficacy of adding irradiation to local excision in patients with DCIS.

Table 54–1. Staging System for Cancer of the Breast[a]

Symbol	Meaning
TNM system	
TX	Primary tumor cannot be assessed
T0	No evidence of primary tumor
Tis	Carcinoma in situ: intraductal carcinoma, lobular carcinoma in situ, or Paget's disease of the nipple with no tumor
T1	Tumor ≤2 cm
a	Tumor ≤0.5 cm
b	Tumor >0.5 cm, but not >1 cm
c	Tumor >1 cm, but not >2 cm
T2	Tumor >2 cm, but not >5 cm
T3	Tumor >5 cm
T4	Tumor of any size with direct extension to chest wall[b] or skin[c]
a	Extension to chest wall
b	Edema (including peau d'orange), ulceration of the skin of the breast, or satellite skin nodules confined to the same breast
c	Both of the above
d	Inflammatory carcinoma
NX	Regional lymph nodes cannot be assessed (e.g., previously removed)
N0	No regional lymph-node metastases
N1	Metastasis to movable ipsilateral axillary nodes
N2	Metastases to ipsilateral axillary nodes fixed to one another or to other structures
N3	Metastases to ipsilateral internal mammary lymph nodes
M0	No evidence of distant metastasis
M1	Distant metastases (including metastases to ipsilateral supra-clavicular lymph nodes)
Clinical stage	
I	T1,N0,M0
IIA	T0,N1,M0
	T1,N1,M0
	T2,N0,M0
IIB	T2,N1,M0
	T3,N0,M0
IIIA	T0 or T1,N2,M0
	T2,N2,M0
	T3,N1 or N2,M0
IIIB	T4,any N,M0
	Any T,N3,M0
IV	Any T,any N,M1

[a] According to the Union Internationale Contre le Cancer and American Joint Commission on Cancer Staging and End-Results Reporting. As reported in Staging for carcinoma of the breast. In: Beahrs O, Henson D, Hutter R, Myers M, eds. Manual for staging of cancer. 3rd ed. Philadelphia: J. B. Lippincott;1988:145–50.
[b] The chest wall includes the ribs, intercostal muscles, and serratus anterior muscle, but not the pectoral muscle.
[c] Dimpling of the skin, nipple retraction, or any other skin changes except those listed for T4b may occur in T1, T2, or T3 without affecting the classification.
Note: Reprinted with permission from Beahrs O, Henson D, Hutter R, and Meyers M, eds. Manual for Staging of Cancer. 4th ed. Philadelphia: J. B. Lippincott; 1988:145–50.

Stage I and Stage II

Currently accepted worldwide is the TNM (see Table 54–1) staging classification of breast cancer developed by the Union Internationale Contre le Cancer (UICC) for cancer staging and end-results reporting. This classification is given in Tables 54–1 and 54–2.

For the Stage I, II, or III categories of breast cancer when the lesion is 4 cm or less in diameter, both modified radical mastectomy and lumpectomy-axillary lymphadenectomy-radiation are satisfactory therapies.

Stage III

It is important not to adopt a defeatist attitude in the surgery of Stage III breast cancer. Fracchia, Evans, and Eisenberg have demonstrated that T3 patients

Table 54–2. Histopathology of Breast Cancer[a]

Noninfiltrating Carcinoma (CA)
Paget's disease with intraductal CA
In situ ductal (intraductal) CA
In situ lobular CA
Infiltrating Carcinoma (CA)
Paget's disease with infiltrating CA
Ductal CA
Infiltrating but not otherwise specified CA
Adenoid cystic CA
Comedo CA
Medullary CA
Mucinous (colloid) CA
Papillary CA
Lobular CA
Other Neoplasms
Cystosarcoma phyllodes, malignant
Sarcoma

[a] Inflammatory carcinoma of the breast is a *clinicopathologic entity* characterized by diffuse brawny induration of the skin of the breast with erysipeloid edge, usually without an underlying palpable mass. *Histologically*, inflammatory carcinoma consists of infiltrating mammary carcinoma that diffusely permeates dermal lymphatics. Inflamed cancers that are clinically similar to the above due to inflammation, infection, or necrosis but lack microscopic dermal lymphatic permeation are not classified as inflammatory carcinoma.

with negative axillary nodes (12% of their 430 cases) had an 82% 5-year and a 75% 10-year survival following radical mastectomy! In fact, even the presence of skin edema or malignant skin infiltration did not adversely affect 10-year survival in T3 patients whose lymph nodes were negative. Fracchia and associates reported that their 5-year survival for all the Stage III cases was 41% and the 10-year rate, 21%. Fifty percent of patients having less than four involved axillary nodes lived 5 years. Finding nodes that were matted or fixed (N2) did not influence either survival or recurrence rates. Invasion of the pectoral muscle did not affect survival rates in patients with positive lymph nodes undergoing radical mastectomy. Postoperative radiotherapy (4000–5500 rads), as administered to these patients, did not improve either their survival or the incidence of local recurrence. Because this study was not randomized, it is possible that the most advanced cases received radiotherapy. Nevertheless, it seems clear that modified or radical mastectomy is the basic treatment for Stage III breast cancer. Surgery should be followed by adjuvant chemotherapy.

T2 or T3 N2

In patients with some degree of fixation of their axillary nodes (N2), perform a radical mastectomy unless the degree of fixation seems so advanced as to rule out adequate surgical resection. In cases of advanced matting, one should precede surgery by a course of chemotherapy (Perloff and Lesnick; Aisner, Morris, Elias, and Wiernik) in the hope that this treatment will shrink these lymph nodes so that they become resectable.

Stage IV

In the absence of distant metastases, the problem in the T4-N1 patient is to eradicate the disease from the chest wall. In some cases, preoperative chemotherapy may help reduce the size of the primary tumor and make surgery feasible. In order cases, radical mastectomy with resection of a small portion of the chest wall may be necessary for the complete removal of a tumor that invades the thoracic cage. We do not believe that rediotherapy alone is the method of choice for the management of large T4 lesions.

Any T N3 M0

In the N3 situation surgery cannot eradicate the metastatic lymph nodes completely. Therefore perform a total mastectomy. Whether the metastatic lymph nodes should be treated by radiotherapy or chemotherapy or some combination of the two, is a question regarding which there is no data. We would follow the mastectomy by intensive chemotherapy. If this modality did not control the metastatic lymph nodes, radiotherapy would be added.

T3 or T4 Any N M1

In patients with distant metastases, treatment of the primary lesion is palliative. If the distant metastases are not advanced and the primary tumor is large but resectable, a palliative debulking partial mastectomy may be indicated. Otherwise the brunt of treatment falls in the realm of chemotherapy.

Management of Recurrent Carcinoma

Local Recurrence

A small solitary recurrence may appear at the site of operation 5–10 years following mastectomy. In this situation, local excision of the recurrence may be adequate therapy because the patient obviously has had an excellent immune response to the tumor. On the other hand, most local recurrences appear relatively soon after mastectomy and are often indicative of widespread malignant disease. In such cases, biopsy or excise the local lesion and initiate chemotherapy. Sometimes local radiotherapy is also helpful in controlling disease in the chest wall.

Bone Metastases

If a bone metastasis appears to be symptomatic and solitary, local radiotherapy is indicated. Otherwise, systemic therapy (chemotherapy or hormonal alteration) is preferred.

Visceral Metastases

With advanced hepatic or pulmonary metastases, intensive chemotherapy offers the best means of palliation.

Estrogen Receptor Status

If a tumor is rich in estrogen receptors (estrogen receptor-positive), altering the patient's hormonal status by administering an anti-estrogen drug like tamoxifen is likely to produce palliation in 60%–70% of cases. A favorable response to hormonal therapy requires a number of weeks or months before reaching its maximal effectiveness.

Frozen-Section or Two-Stage Procedure?

A patient suspected of breast cancer should have her biopsy performed at one stage and then should discuss the results of the biopsy with her surgeon prior to deciding on the ultimate therapy. If there is the slightest doubt about the competence of the pathologist who will be interpreting the frozen-section biopsy, then it is certainly wise to delay a decision until further consultation may be obtained concerning the histological diagnosis. This is also true when a competent pathologist has any doubt about the presence of cancer.

However, when an experienced pathologist is competent to make a positive diagnosis of cancer on a frozen-section examination, the patient who has an obvious breast cancer and who has elected mastectomy can undergo frozen-section biopsy and avoid a second anesthesia and a second operation. Of course, this will require that the surgeon and the patient have a detailed discussion in advance of the biopsy regarding the available options.

Most breast tumors can be biopsied under local anesthesia as an outpatient procedure. In most cases the two-stage sequence is preferred.

Positive Mammography in the Absence of Palpable Tumor

When the signs of a localized carcinoma are seen on the mammogram and the patient has no palpable lesion, localizing the area for biopsy may be difficult.

One method that has proven successful is for the mammographer, an hour or two prior to biopsy, to insert a needle into the breast under X-ray control until the tip of the needle lies in the area of suspicion. Through the needle, he inserts a hooked wire (available as a "Kopans Breast Locator" from Cook Inc., P.O. Box 489, Bloomington, Indiana, 47402, U.S.A.). This wire is inserted into the lesion under X-ray control. The wire acts as a harpoon and will stay in place if covered with a sterile dressing until surgery is begun. The surgeon proceeds to excise the area of breast that is located near the tip of the wire. The operation should be done soon after the needle has been inserted. When the specimen has been removed, tissue mammography should confirm that it contains the area of suspicion.

References

Aisner J, Morris D, Elias EG et al. Mastectomy as an adjuvant to chemotherapy for locally advanced or metastatic breast cancer. Arch Surg 1982;117:882.

Cady B, Sears HF. Usefulness and technique of axillary dissection in primary breast cancer. J Clin Oncol 1986; 4:623–624.

Carter CL, Allen C, Henson DE. Relation of tumor size, lymph node status, and survival in 24,740 breast cancer cases. Cancer 1989;63:181–186.

Fisher B, Redmond C, Fisher E et al. Ten-year results of a randomized clinical trial comparing radical mastectomy and total mastectomy with or without radiation. N Engl J Med 1985;312:674–681.

Fisher B, Redmond C, Poisson R et al. Eight-year results of a randomized clinical trial comparing total mastectomy and lumpectomy with or without irradiation in the treatment of breast cancer. N Engl J Med 1989;320: 822–828.

Fracchia AA, Evans JF, Eisenberg BL. Stage III carcinoma of the breast, a detailed analysis. Ann Surg 1980;192:705.

Haagensen CD, Bodian C, Haagensen D. Breast carcinoma, risk and detection. Philadelphia: Saunders; 1981.

Handley RS. The conservative radical mastectomy of Patey: 10-year results in 425 patients. Breast 1976;2:16.

Lagios MD. Duct carcinoma in situ; pathology and treatment. Surg Clin North Am 1990;70:853–871.

Margolis DS, McMillen MA, Hashmi H et al. Aggressive axillary evaluation and adjuvant therapy for nonpalpable carcinoma of the breast. Surg Gynecol Obstet 1992;109:113.

Perloff M, Lesnick GJ. Chemotherapy before and after mastectomy in stage III breast cancer. Arch Surg 1982;117:879.

Pollak EW, Getzen LC. Inflammatory carcinoma of the breast, a therapeutic approach followed by improved survival. Am J Surg 1978;136:722.

Rosen PP, Braun DW, Kinne DE. The clinical significance of pre-invasive breast carcinoma. Cancer 1980; 46:919–925.

Rosen PP, Fracchia AA, Urban JA et al. Residual mammary carcinoma following simulated partial mastectomy. Cancer 1975;35:735.

Solin LJ, Recht A, Fourquet A et al. Ten-year results of breast-conserving surgery and definitive irradiation for intraductal carcinoma (ductal carcinoma in situ) of the breast. Cancer 1991;68:2337–2344.

Veronesi U, Saccozzi R, Del Vecchio M et al. Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast. N Engl J Med 1981;305:6–11.

Veronesi U, Salvadori B, Luini A et al. Conservative treatment of early breast cancer; long-term results of 1232 cases treated with quadrantectomy, axillary dissection, and radiotherapy. Ann Surg 1990;211: 250–259.

55 Biopsy of Breast—Lumpectomy

Indications

Palpation of a suspicious breast mass or "dominant lump" even if mammogram is normal

Detection of a suspicious shadow on mammography even if not palpable

Pitfalls and Danger Points

Failure to include the pathological tissue in the biopsy specimen

Operative Strategy

Biopsy—Lumpectomy of Palpable Mass. In patients who have a palpable mass that has a high likelihood of being malignant, it is a great advantage to perform a complete excision of the tumor surrounded by 1 cm of normal breast tissue at the initial biopsy. In this case, it will not be necessary to perform a lumpectomy at a later date. After a mass has undergone local excision, if the specimen does not contain the entire tumor, a secondary lumpectomy requires the excision of a considerable amount of breast tissue in order to be sure that the remnant of the tumor has been excised. In most cases the tumor remnant will not be palpable or visible to the naked eye. Consequently, an ideal cosmetic result would be accomplished if the first biopsy excision contained all of the tumor. If the tumor is small, this presents no problem to the surgeon. If the tumor measures 3 cm or more in size, especially in a woman with small breasts, a wide excision would be unwise if the mass proved histologically to be benign. Consequently, in patients with small breasts and relatively large lesions, it would be wise during the initial office visit to perform a core needle biopsy (Tru-Cut, Travenol Co.) or aspiration cytology or both. If either of these two biopsies is positive, the surgical biopsy should encompass the entire lesion with a 1-cm margin of normal breast surrounding it. If both types of needle biopsy turn out to be negative for cancer, remove a deep wedge of tissue from the center of the large mass at the surgical biopsy. If this proves to be positive for cancer, a formal lumpectomy may be performed at the next stage together with the axillary lymphadenectomy.

In women with large breasts, even a 4–5 cm mass may be excised together with a 1-cm margin of normal tissue at the initial biopsy without causing a significant cosmetic defect.

Biopsy of Nonpalpable Breast Lesions. When mammography has detected a suspicious stellate mass or a suspicious cluster of microcalcifications in a breast where no mass is palpable, some type of localization procedure must be performed with the help of mammographic technology. Most breast surgeons agree that the most efficacious method involves the insertion under mammographic control of a Kopans hooked guidewire inside a needle. The tip of the wire is left in or close to the radiographically suspicious lesion. The surgeon's task is then to locate and excise a mass of breast tissue around the tip of the wire. Since most of these nonpalpable lesions are relatively small in size, we endeavor to perform a complete excision of the lesion together with normal breast tissue whenever possible. If no palpable lesion is encountered, we excise a liberal portion of breast from the area indicated by the needle. This is feasible because many of the patients with nonpalpable lesions have reasonably large breasts. It is frequently difficult to perform an accurate lumpectomy at a second stage following a guidewire-directed biopsy of this type.

Local or General Anesthesia? Although there are some reports purporting to demonstrate that surgeons who utilize local anesthesia fail to locate the pathology in as high a percentage of patients as those who perform the operation under general anesthesia, we have not found this to be true, either for the biopsy of palpable masses or biopsy utilizing the Kopans hooked wire technique. Over 80% of the author's biopsies have been done with local anesthesia. If the patient expresses any apprehension concerning the use of local anesthesia, or has some cardiorespiratory or other chronic illness that requires close monitoring, the biopsy is performed with an anesthesiologist present who administers either general anesthesia or intravenous sedation while at the same time paying close attention to monitoring the patient's physiological parameters.

All of these biopsies have been done in the hospital's Ambulatory Surgical Unit during the past 5 to 6 years without any significant intraoperative complications.

The occasional patient who elects a mastectomy after a positive core needle biopsy is admitted to the hospital for frozen section biopsy confirmation of the diagnosis followed by modified radical mastectomy under a single general anesthesia.

Operative Technique—Palpable Mass—Lumpectomy

Incision

In performing a biopsy for a palpable mass, the incision should be made directly over the mass. Make the incision in the lines of Langer, which represent the natural skin creases and can be seen to run in a circular fashion, roughly parallel to the perimeter of the areola. For lesions located at the medial aspect of the breast, a horizontal incision along the 9 o'clock axis of the breast is acceptable. Elsewhere in the breast, curve the incision in a direction parallel to the areola. One should also consider that a mastectomy may be indicated subsequent to the biopsy. The biopsy site should preferably be in a location that can be easily encompassed by the mastectomy incision.

The incision should be long enough to facilitate the removal of the entire mass with a 1-cm shell of normal surrounding breast tissue without requiring excessive retraction of skin flaps.

After marking the line of the skin incision local anesthesia is introduced using 1% lidocaine with 1:200,000 epinephrine. This is introduced along the line of the skin incision and the surrounding skin overlying the area of the palpable mass. If the mass is relatively small, inject the anesthetic agent in the tissue planes surrounding the mass on all sides and into the deep tissues. For larger masses, injection of the anesthetic agent into the deeper levels is delayed until the dissection has entered into the deeper layers. Wait 5–10 minutes for the anesthetic agent to take effect. We generally inject the anesthetic agent prior to scrubbing for the operation.

Make an incision along the previous ink mark down into the subcutaneous layer using a scalpel. Elevate the skin flaps as necessary in the subcutaneous plane.

Then, with the left index finger palpating the mass, carry the incision along one side of the tumor deep enough to palpate the deep aspect of the tumor. If the anesthesia is adequate, a cutting current electrocautery may be used for this dissection. Do not apply a tenaculum clamp to the tumor mass. This will only make it more difficult to ascertain the outer margins of the tumor by tensing the tissues. Sometimes an accurately placed figure-of-eight suture in the tumor mass for retraction is of some benefit.

Then initiate the dissection on the opposite side of the mass and carry the dissection down to a level of the breast deep to the mass, leaving a margin of normal breast tissue on the deep layer. Sometimes it is simpler to go down to the fascia of the pectoral muscle where there is a natural plane between the breast and the fascia. Under the guidance of the left index finger, excise the tumor. Obtain meticulous hemostasis utilizing the coagulating current of the electrocautery. While the patient may not complain of pain during the scalpel dissection, the electrocautery often requires injection of additional anesthetic agent prior to obtaining complete hemostasis. Since there will remain a tissue defect in the breast, even minor bleeding will produce a large postoperative hematoma. Therefore hemostasis must be complete.

Closure

Attempting to reapproximate the layers of the breast by means of suturing will result in creating a palpable mass in the breast that may be permanent. This results in considerable confusion in later evaluations of the breast. If no attempt is made to close the defect and if hemostasis is complete, simply closing the skin will achieve a good cosmetic result even though one may palpate a round defect in the breast tissue following operation. This defect is far simpler to evaluate for recurrent tumor than the firm mass that frequently develops after the breast tissue is resutured.

The skin may be closed by a continuous subcuticular suture of 4–0 PDS or vertical mattress sutures of 5–0 nylon, which must not be tied with excessive tension.

Operative Technique—Nonpalpable Lesion

Incision

In these cases the patient is transferred from the radiographic suite to the operating room with a Kopans hooked wire and needle already inserted into the breast close to the suspicious X-ray shadow. If the area at the tip of the needle can be palpated or otherwise identified, make a curved incision in the skin crease overlying the tip of the needle and excise the breast tissue in that vicinity. Unless the patient has a small breast, do not hesitate to excise a liberal quantity of tissue around the tip of the wire, perhaps

5 × 3 × 2 cm. Then submit the tissue with the wire in place to the X-ray department where a specimen mammogram will be performed. Do not close the wound until confirmation that the suspicious shadow is indeed located in the specimen mammogram. In the rare situation where the X-ray shadow was not included in the specimen, carefully palpate the entire area of dissection for any suspicious lesions. Excise such additional tissue and submit it for another specimen mammogram. If again no pathology can be detected, terminate the operation and subject the patient to a repeat mammogram in 2 or 3 months. If a suspicious lesion remains in the breast, perform another biopsy using the Kopans localization procedure.

In cases where the tip of the Kopans device cannot be accurately localized, one can make the incision at the point where the needle enters the skin of the breast, and by measuring the wire external to the skin, one can calculate the length of wire that remains in the breast tissue. Dissect along the shaft of the wire. Remove a cylinder of breast tissue about 2 cm in diameter at the level of the incision and increase the diameter of the cylinder to 3–4 cm as one approaches the tip of the wire. Periodically palpate the tissue to ascertain that the wire has not been exposed during the dissection. When the proper depth has been reached, transect the cylinder of tissue and remove it together with the wire.

Again, achieve complete hemostasis with electrocautery.

Close the skin with either a subcuticular or a vertical mattress suture, as described above. Several fine Vicryl absorbable sutures may be placed in the subcutaneous layer if necessary.

Postoperative Care

Apply a bulky gauze dressing over the area of dissection. Instruct the patient to wear her bra day and night for 7–10 days following surgery. The gauze dressing should be large enough so that continuous pressure will be applied to the defect created by the biopsy excision. This will inhibit venous bleeding and also control the volume of serum that is accumulated in this tissue defect.

Postoperative Complications

Failure to identify and excise pathological tissue in patients who have a breast cancer

Hematoma

Infection (should be no more than 1%–2%)

Lumpectomy Following Previous Biopsy

The term "lumpectomy" refers to excision of a primary carcinoma of the breast with histological confirmation that the entire malignancy has been enclosed in an envelope of normal breast tissue on all sides. In patients who have had the diagnosis of cancer confirmed by a needle biopsy, a lumpectomy is essentially the same procedure as that described above for the excision of a palpable mass.

In patients whose initial biopsy resulted in histological confirmation of the diagnosis of cancer, but in whom no attempt was made at a complete excision of the carcinoma, a second operation for lumpectomy is indicated. In these cases, make an elliptical incision around the previous biopsy scar, with a 1-cm margin of normal skin on both sides. Thereafter, use the scalpel to incise the breast tissue so that the entire previous cavity left by the biopsy procedure will be excised en bloc. If the deep margin of the biopsy cavity is close to the pectoral fascia, excise the pectoral fascia in this location together with the specimen. If the excision of the amount of breast tissue required for lumpectomy will produce a poor cosmetic result, the lumpectomy is contraindicated and modified radical mastectomy followed by reconstruction of the breast is a preferable choice. Achieve complete hemostasis with electrocoagulation and ligatures as necessary. After hemostasis is complete, close the incision without drainage, utilizing 4–0 Vicryl sutures to the subcutaneous fat and a subcuticular stitch of 4–0 PDS, and apply a gauze pressure dressing.

56 Axillary Lymphadenectomy

Concept: When to Perform Axillary Lymphadenectomy for Breast Cancer

(See discussion in Chap. 54.)

Concept: When to Perform Lymphadenectomy for Melanoma

Radical axillary lymphadenectomy requires the removal of all the axillary lymph nodes. In this respect it is identical with the lymphadenectomy of a radical mastectomy. The medial boundary of the dissection is the point at which the axillary vein meets the clavicle and the lateral boundary is the anterior border of the latissimus dorsi muscle.

Lymph flows to the axilla from the skin overlying the shoulders, the upper extremity, the anterior portion of the trunk from the clavicle to the umbilicus anteriorly, and the posterior trunk down to the level of approximately L2–3. Lesions within the 2–3 cm of the midline, anteriorly or posteriorly, may drain into the opposite axilla. Although some squamous cell carcinomas of the skin metastasize to the regional lymph nodes, most regional node dissections are performed for metastases from malignant melanoma of the skin. In patients who do not have distant metastases a regional node dissection is clearly indicated in the therapy of malignant melanoma when clinical examination of the axilla discloses a metastatic node. If the melanoma is in an area contiguous to the axilla, a wide and deep resection of the primary lesion is performed in continuity with the regional node dissection. If the primary lesion is some distance from the axilla, excise the lesion, close the defect by suturing or with a skin graft, and perform the axillary dissection through a separate incision.

Although there is general agreement that a therapeutic regional node dissection is indicated when the diagnosis of a lymph node metastasis is made in the patient with melanoma, considerable controversy still surrounds the concept of a prophylactic node dissection when there is no clinical suspicion of a lymph node metastasis. Balch, Murad, Soong, and others have demonstrated that the thickness of the melanoma, as measured by Breslow's technique, is a direct indication of the incidence of regional lymph nodes metastasis in malignant melanoma patients. In patients whose tumor was less than 0.76 mm in thickness, no lymph node metastases occurred during a 3-year period of observation. For tumors 0.76 to 1.50 mm in thickness, 25% developed metastases; for 1.50 to 3.99 mm lesions, the corresponding figure was 51%; and for lesions greater than 4.0 mm in thickness, 62%. Roses, Harris, Hidalgo, and others did not encounter any lymph node metastases in patients with a melanoma less than 1 mm thick. One randomized prospective study by Veronesi, Adamus, Bandiera, and others did not find any significant increase in survival when they compared immediate with delayed node dissection in patients suffering from melanoma of the extremities who had clinically negative regional nodes. On the other hand, Balch and associates, in a retrospective study, noted that the actuarial 5-year survival rate increased from 37% following wide local excision alone to 83% when wide excision was combined with a prophylactic regional node dissection in patients who suffered from melanomas that were 1.50 to 3.99 mm in thickness. A number of other retrospective studies have also concluded that elective regional node dissections were indicated in the higher risk melanoma patient (Breslow; Cohen, Ketcham, Felix et al.; Das Gupta; Holmes, Moseley, Morton et al.; and Wanebo, Fortner, Woodruff et al.). Although increasing thickness of the primary lesion and the number of metastases to the regional nodes are the two most significant factors in worsening the prognosis of a malignant melanoma, other factors contribute to an adverse prognosis: the presence of ulceration in the melanoma, the location of the primary lesion on the trunk as opposed to the extremities; its location in the lower extremity as opposed to the upper; and the sex of the patient (male rather than female).

Some patients present to the physician with a metastatic lymph node when no primary lesion can be detected. It is believed that in these cases the primary melanoma has undergone complete regression. Therapy in such cases consists of performing a regional node dissection, and the prognosis is not worse than the more common situation following wide excision of the primary lesion together with the therapeutic node dissection.

Indications

If lumpectomy for breast cancer is performed, axillary lymphadenectomy is indicated for purposes of both therapy and staging.

Palpable lymph node metastases from primary malignancies involving the skin of the upper extremity and shoulder, the skin of the breast and upper trunk

Malignant melanoma involving the skin in the regions listed above, if the depth of invasion is 1.5–3.99 mm or more, when lymph nodes are clinically negative

Preoperative Care

Obtain a positive biopsy for malignancy.

Pitfalls and Danger Points

Nerve injury (lateral pectoral, long thoracic, or thoracodorsal nerve, brachial plexus)

Injury to axillary vein

Operative Strategy

Fundamentally, this operation employs the same strategy as that used for the modified radical mastectomy. Adipose and lymphatic tissues inferior to the axillary vein are excised en bloc from the clavicle to the anterior border of the latissimus muscle. Adequate exposure requires that the arm be flexed on the trunk to relax the major pectoral muscle during the medial part of the dissection; and the minor pectoral muscle must be divided in most cases if Level III lymph nodes are to be removed. We generally excise some of the minor pectoral muscle if the muscle has lost its blood supply during the dissection. The long thoracic and thoracodorsal nerves may be preserved if they are not involved with tumor.

Operative Technique

(Also see Chap. 57)

Incision

The skin incision, in a general way, follows the course of the axillary vein. Start the incision at the lateral border of the pectoralis major and continue laterally across the axilla to the level of the latissimus muscle. The area of skin to be dissected is outlined by the dotted line in **Fig. 56–1**. Elevate both the superior and inferior skin flaps leaving no more than 8 mm of fat on the skin. The superior dissection will expose the anterior surface of the major pectoral muscle in its medial aspect, the fat overlying the axillary vein and brachial plexus in the middle, and the coracobrachialis and latissimus muscles laterally (**Fig. 56–2**). Dissect the lower flap for a distance of 8 cm.

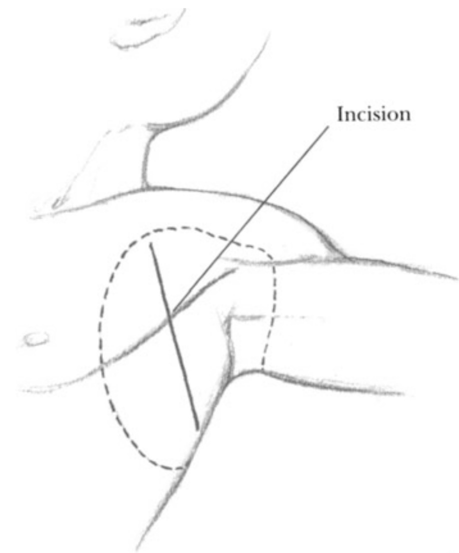


Fig. 56–1

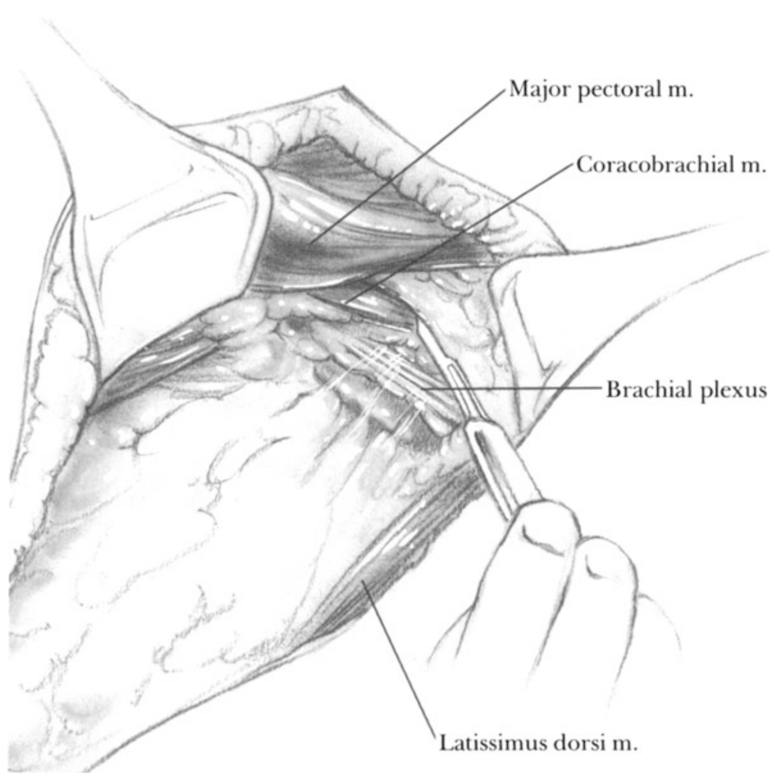


Fig. 56–2

Exposing the Axillary Contents

Incise the fascia overlying the lateral border of the major pectoral muscle. Dissect this fascia away from the undersurface of the muscle. Insert a Richardson retractor beneath the pectoral muscle and expose the coracobrachial muscle. Dissect fat and fascia off the inferior surface of the coracobrachial muscle and continue this dissection toward the coracoid process where the coracobrachial meets the minor pectoral muscle. Encircle the minor pectoral muscle with the index finger and divide it near its insertion using the electrocoagulator (**Fig. 56–3**) if Level III lymph nodes are to be excised. Branches of the medial pectoral nerve will be seen entering the minor pectoral muscle near its *lateral* border. Divide these nerves, but take care to *protect the pectoral nerve that emerges along the medial margin of the minor pectoral muscle* because this nerve will largely constitute the innervation of the major pectoral muscle. Freeing the pectoralis minor from the chest wall will improve exposure for the axillary dissection.

Incise the fat along the anterior border of the latissimus muscle to identify the lateral boundary of the lymphadenectomy.

Incise the thin layer of costocoracoid ligament at a level calculated to be just cephalad to the course of the axillary vein. Do not skeletonize the nerves of the brachial plexus as this may produce a permanent painful neuritis. After dividing this ligament, sweeping the loose fat in a caudal direction will generally expose the axillary vein.

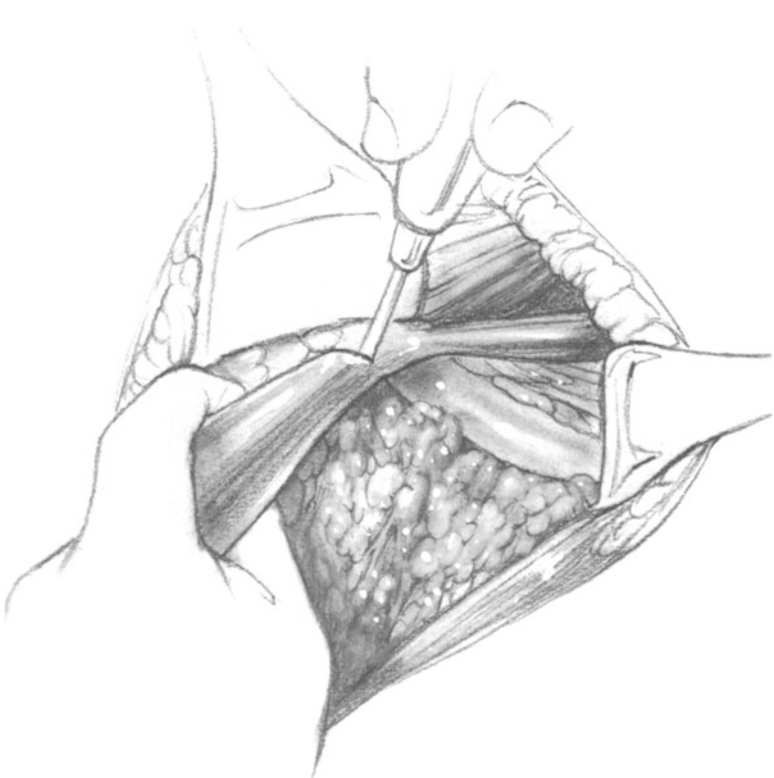


Fig. 56–3

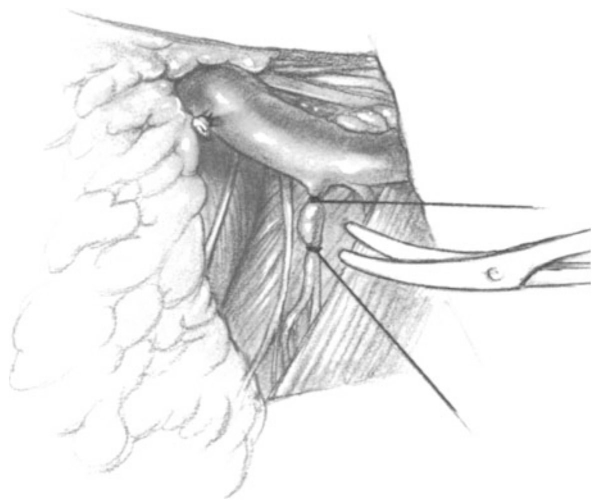


Fig. 56–4

Clearing the Axillary Vein

Identify the axillary vein in the lateral portion of the axilla. Elevate its adventitia with a Brown-Adson or DeBakey forceps and incise it with a Metzenbaum scissors. Continue this division of the adventitia in a medial direction until the clavicle is reached. Several branches of the lateral anterior thoracic and thoracoacromial nerves and blood vessels will be encountered crossing over the axillary vein. Divide each of these between Hemoclips.

Dissect the adventitia in a caudal direction exposing the various branches of the axillary vein coming from below. Divide and ligate or clip each of the branches that enters the axillary vein on its inferior surface (**Fig. 56–4**). Preserve the subscapular vein, which enters the posterior wall of the axillary vein.

Dissecting the Chest Wall

Incise the clavipectoral fascia on a line parallel to and just caudal to the axillary vein beginning at the level of the clavicle and continuing to the subscapular space. Suture a label to the lymph nodes at the apex of the dissection (near the clavicle). Make a vertical incision in the fascia from the apex of the dissection downward for 4–6 cm parallel to the sternum. Now sweep the lymphatic and adipose tissue in a lateral direction exposing the ribs and intercostal musculature. Bleeding points may be controlled with electrocoagulation. Use the cautery also to excise part of the minor pectoral muscle leaving its proximal half attached to the thorax. Divide the intercostobrachial nerve that emerges from the second intercostal space and enters the specimen.

At this point in the dissection, the anterior and inferior portion of the axillary vein will have been cleared, as well as the upper 6–10 cm of the anterior chest wall.

Subscapular Space

In the subscapular space, use a gauze pad to bluntly dissect the loose fat and areolar tissue from above downward to clear the space between the scapula and the lateral chest wall. This will expose the long thoracic nerve which tends to hug the thoracic cage. Identify the thoracodorsal nerve, which crosses the subscapular vein and moves laterally together with the vessels supplying the latissimus muscle (**Fig. 56–5**).

If the anterior border of latissimus muscle was not dissected free during the first step in this operation, liberate this muscle at this time, preserving the thoracodorsal nerve. Now dissect the specimen free of the chest wall after dissecting out and preserving the long thoracic nerve.

Label the lateral margin of the lymph node dissection to orient the pathologist.

Drainage and Closure

Make a puncture wound in the anterior axillary line about 10 cm below the armpit and pass a plastic multiperforated Jackson-Pratt closed suction catheter through the puncture wound into the apex of the axillary dissection near the point where the axillary vein goes under the clavicle. It may be necessary to suture the catheter in place with fine catgut or PG.

Close the skin incision with interrupted 4–0 nylon sutures or skin staples. Attach the catheter to a closed-suction drainage device (**Fig. 56–6**).

Postoperative Care

Maintain suction on the catheter till the drainage is less than 30 ml per day. Then remove the catheter.

Limit abduction of the arm during the first postoperative week. Thereafter encourage the patient to exercise the shoulder joint through its entire range of motion.

Encourage the patient to achieve full ambulation on the day following operation.

Later in the postoperative course, a seroma may develop under the skin flap. Aspirate the fluid once or twice weekly as necessary.

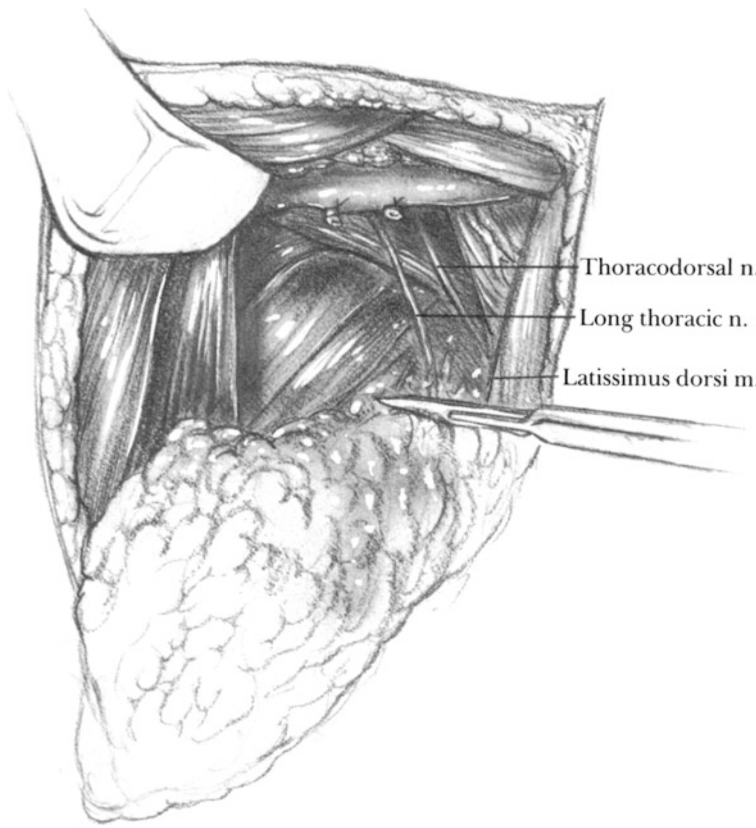


Fig. 56–5

Postoperative Complications

Hematoma or seroma

Wound infection

Fig. 56–6

References

Balch C, Murad T, Soong SJ et al. Tumor thickness as a guide to surgical management of clinical Stage I melanoma patients. Cancer 1979;43:883.

Breslow A. Tumor thickness, level of invasion and node dissection in Stage I cutaneous melanoma. Ann Surg 1975;182:72.

Cohen MH, Ketcham AS, Felix EL et al. Prognostic factors in patients undergoing lymphadenectomy for malignant melanoma. Ann Surg 1977;186:635.

Das Gupta TK. Results of treatment of 169 patients with primary cutaneous melanoma: a five-year prospective study. Ann Surg 1977;186:201.

Holmes EC, Moseley S, Morton D et al. A rational approach to the surgical management of melanoma. Ann Surg 1977;186:481.

Reintgen DS, McCarty KS, Woodard B et al. Metastatic malignant melanoma with an unknown primary. Surg Gynecol Obstet 1983;156:335.

Roses D, Harris M, Hidalgo D et al. Primary melanoma thickness correlated with regional lymph node metastases. Arch Surg 1982;117:921.

Veronesi V, Adamus J, Bandiera CC et al. Inefficacy of immediate node dissection in Stage I melanoma of the limbs. N Engl J Med 1977;297:627.

Wanebo HJ, Fortner JG, Woodruff J et al. Selection of the optimum surgical treatment of Stage I melanoma by depth of microstage technique (Clark-Breslow). Ann Surg 1975;182:302.

57 Modified Radical Mastectomy

Concept: Defining the Modified Radical Mastectomy of Patey

The term modified radical mastectomy has come to mean removal of the breast together with a variable number of axillary lymph nodes. Some surgeons take a few outer lymph nodes, some do a complete excision of the lateral third of the axillary nodes using the pectoralis minor muscle as the upper boundary for their dissection, some elevate the pectoralis minor and take a few lymph nodes deep to this muscle, while others do a complete axillary lymph node dissection to the level of the clavicle. Patey described an operation removing all of the breast tissue together with the underlying fascia of the pectoralis major in continuity with a total axillary lymphadenectomy. The pectoralis minor muscle also was excised.

Without removing or dividing the pectoralis minor muscle, it is often not possible to achieve a complete lymphadenectomy. Furthermore, Durkin and Haagensen demonstrated that after chemically treating the axillary specimen to dissolve the fat, but preserving all the lymph nodes, they could identify as many as 12 Rotter's nodes in the area between the minor and major pectoral muscles. In the treatment of infiltrating breast cancer, complete axillary lymphadenectomy is indicated because 25% of patients with clinically negative lymph nodes harbor microscopic metastases in the axillary nodes.

Indications

The modified radical mastectomy is the operation of choice for patients with an infiltrating carcinoma of the breast who are not eligible for breast conservation.

Preoperative Care

Perform mammography not only to study the area already under suspicion but to identify any possible additional sites of malignancy away from the primary area of suspicion.

Only in Stage III and suspected Stage IV breast cancer is it necessary to perform a bone scan and a chemical profile for liver dysfunction. For Stage I and II breast cancer, scanning the bones or the liver is counterproductive because the incidence of false positive results will outweigh the few cases of proven metastases that these studies will detect.

Pitfalls and Danger Points

Performing an inadequate biopsy that fails to detect the cancer
Ischemia of skin flaps
Injury to axillary vein or artery
Injury to brachial plexus
Injury to chest wall resulting in pneumothorax
Injury to lateral pectoral nerve resulting in atrophy of the pectoralis major muscle

Operative Strategy

Biopsy (See Chap. 55)

Incision

Before making the *biopsy* incision, be sure to plan the direction of the incision that will be made for the *mastectomy* in case the biopsy is malignant. If the biopsy incision is made in a vertical direction and then it is decided to perform the mastectomy through a transverse incision, it will be difficult to excise the entire field of the biopsy procedure. If a transverse mastectomy incision is anticipated, make a transverse biopsy incision.

Incisional Wedge Biopsy, Total Excision of the Tumor, or Segmental Mastectomy?

When the primary tumor is larger than 3–4 cm in diameter, perform the biopsy simply by excising a wedge of the tumor, but leave the bulk of the tumor behind. Otherwise, such a large defect is made in the breast that it is difficult to avoid entering the field of the biopsy procedure when doing the mastectomy. When the tumor is smaller than 3–4 cm, excise the entire lesion for the biopsy and the estrogen receptor determination. This has the advantage that manipulating the breast during the mastectomy will not dislodge additional tumor emboli into the lymphatic and blood streams. When the breast is large, a larger primary cancer can be excised for the biopsy without difficulty as compared with patients who have a small breast.

In many situations the surgeon will undertake to biopsy an area of breast that is the site of suspicious thickening as, for instance, in early scirrhus carcinoma. In these cases there may be no discrete tumor mass. It is important, therefore, that a sufficient sample of breast tissue be excised for the pathologist. Given an inadequate sample, the pathologist will not identify the malignancy. In such cases the aim of the biopsy should be to excise a *segment* of the breast, rather than to try to localize a mass. This often requires that the dissection be carried down to a plane just superficial to the pectoral fascia. Then insert the left index finger into this plane and excise a segment of overlying breast containing the entire area of suspicion.

Use of Electrocautery for the Biopsy

Rapid and effective in accomplishing hemostasis during breast surgery, the electrocautery device nevertheless has one disadvantage. If excessive heat is applied to the breast tumor during electrocoagulation, this may render the determination of estrogen receptors inaccurate. Consequently, use only the cutting current when incising the breast tissues surrounding the tumor. This does not result in excessive heat. When a bleeding point is encountered, use the electrocoagulating current only for the bleeding point. If the tumor is small, use the electrocoagulating current with great caution to avoid overheating the specimen.

Incision and Skin Flaps

Thickness of Skin Flap

While Halsted emphasized the importance of removing almost all of the skin of the breast and employing very thin skin flaps, subsequent experience has shown that these precepts were necessitated by the advanced stage of cancer encountered by Halsted. How thin to make the skin flap depends on how much subcutaneous fat exists between the skin and the breast. Obese patients may have 1–2 cm of subcutaneous fat, while thin patients may have only a few millimeters of fat in this location. The important strategy is to remove all of the breast tissue. Leaving behind a layer of subcutaneous fat on the skin flap does not increase the incidence of local tumor recurrence. On the other hand, it does help assure the viability of the skin flap and facilitates the reconstruction of the breast at a subsequent operation for those patients who desire this procedure.

Cooper's ligaments extend from the breast to the subcutis and form a discontinuous layer of thin white fibrous tissue, visible against the background of yellow fat. Incising this fibrous layer where it joins the subcutaneous fat is one good method of assuring complete removal of the breast tissue while at the same time preserving an even layer of subcutaneous fat. This technique is described below.

Alternative Incisions for Mastectomy

Placing the incision in a horizontal direction gives the best cosmetic result because the scar will not be visible when the patient wears a low-cut gown. While the horizontal incision is easy to apply to tumors in the 3 or 9 o'clock positions (**Figs. 57–1 and 57–2**), some modifications are necessary for

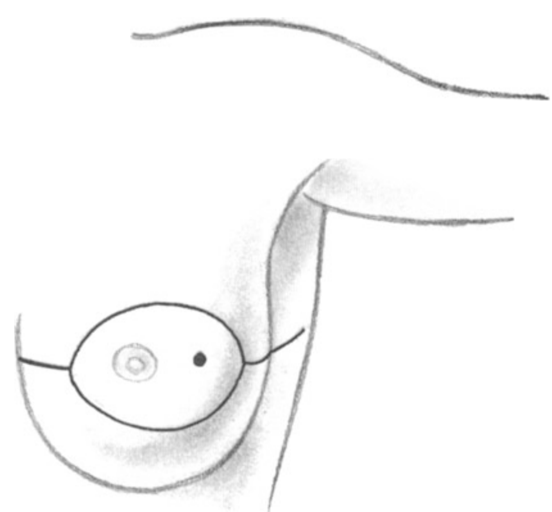


Fig. 57–1

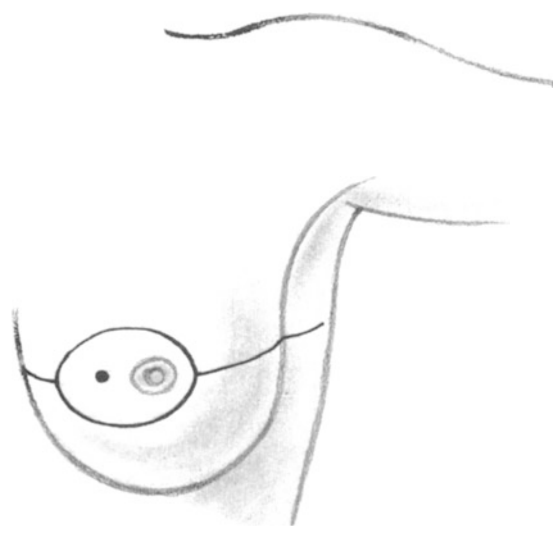


Fig. 57–2

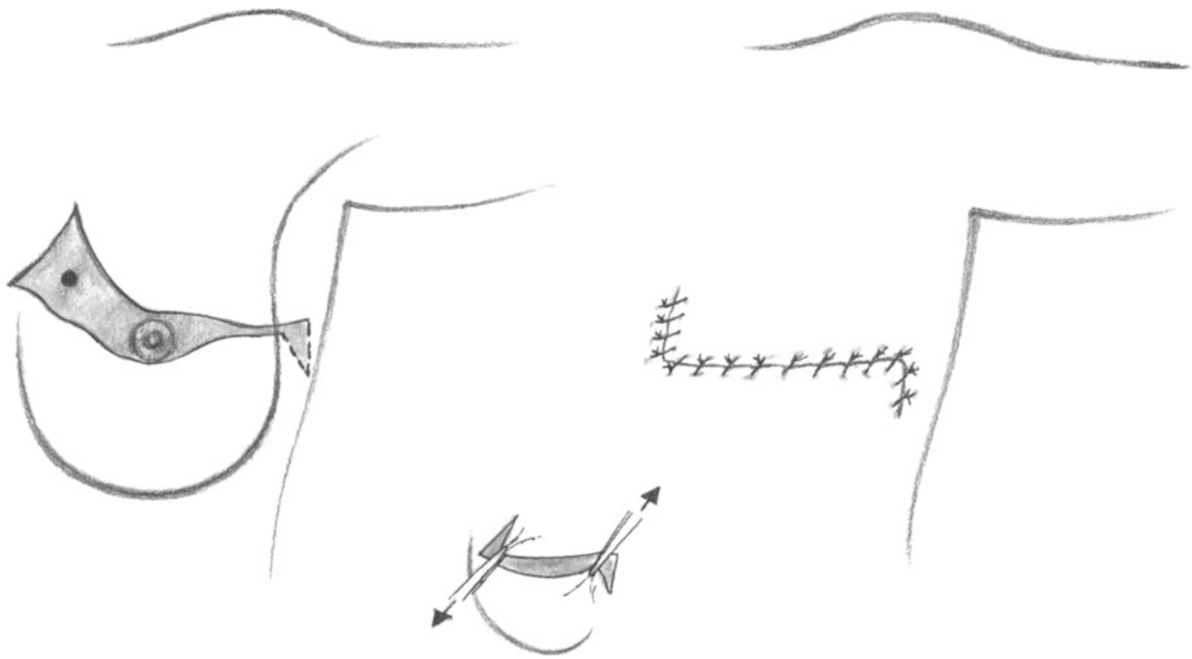


Fig. 57–3

tumors in the upper or lower portions of the breast. A good basic approach is to draw a circle around the tumor leaving a margin of 3 cm on all sides. Then plan the remainder of the incision so that the entire areola will be included in the specimen. If possible, accomplish this in a horizontal direction. After having drawn the circle around the tumor, preserve as much of the remaining skin as possible. This will avoid tension on the skin suture line. The redundant skin can be excised after the specimen has been removed. At that time an accurate judgment as to the proper tension can be formulated. Also, the redundant skin that has been excised at the end of the operation can be converted into a full-thickness skin graft by excising the underlying fat. By planning ahead in this fashion, it is almost never necessary to obtain a dermatome split-thickness skin graft from another part of the body. Not only does this technique save operating time, but it also avoids a graft donor site wound that is often painful. Furthermore, the full-thickness graft provides a superior cosmetic and functional result as compared with the split-thickness graft. Properly performed, one can expect a 100% "take" of the full-thickness graft.

If any defatted surplus skin remains, wrap it in gauze and store it in a small bottle of sterile saline solution in a refrigerator. At any time in the next 10–14 days, if the patient should require a skin graft, remove the skin from the refrigerator and use it.

There are a number of alternative incisions for tumors in various locations of the breast. **Fig. 57–3a** illustrates a difficult horizontal incision for a lesion at 10 o'clock. **Fig. 57–3b** illustrates the resultant scar after the redundant triangle of skin has been removed.

Cosmetic Considerations

Following the lead of the two originators of the radical mastectomy, William Stewart Halsted and Willy Meyer, surgeons have for many decades used incisions for the mastectomy that were made generally in a vertical direction. A significant portion of the scar extended above the clavicle or over the shoulder and was exposed when the patients wore any type of sleeveless gown. Also, complete removal of the major pectoral muscle left a marked hollow beneath the clavicle.

Without detracting from the efficacy of the mastectomy, modern techniques can avoid many of these cosmetic deficiences. During a radical mastectomy, it is advisable to leave the clavicular head of the major pectoral muscle. This improves the cosmetic appearance and does not interfere with performing a complete lymphadenectomy.

In performing either a radical or the Patey modification of the radical mastectomy, it is far preferable from the cosmetic viewpoint to make an incision that is horizontal rather than vertical. For tumors in the upper outer quadrant of the breast, it

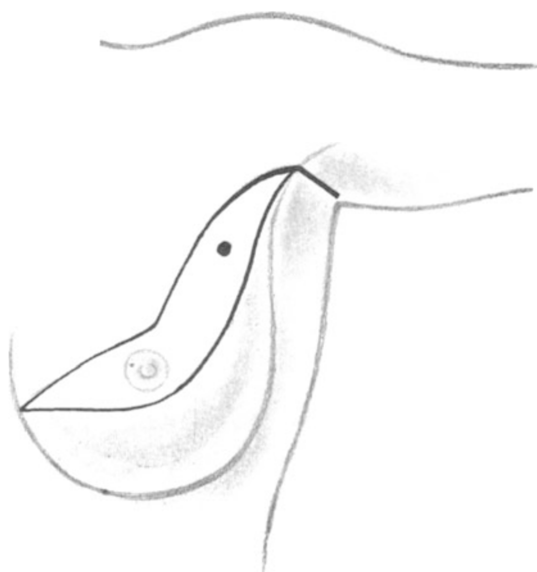


Fig. 57–4

may be necessary to make the incision in an oblique direction as shown in **Fig. 57–4**; it is never necessary to carry the incision over the shoulder. Complete exposure of the axilla can be obtained with an incision that crosses the upper axilla in a transverse direction rather than one that passes along the anterior aspect of the upper arm.

Tranverse incisions also have the advantage of enhancing the cosmetic appearance following the insertion of an implant at a later date in an effort to reconstruct the breast following mastectomy.

Another cosmetic defect that should be avoided is the "dog-ear" deformity that can result at either end of the incision following mastectomy. This bunching together of skin is interpreted by many women as a residual tumor and is a cause for great anxiety. It is easily prevented by excising an additional triangle of skin until the incision lies flat on the chest wall (**Figs. 57–5a and 57–5b**).

Skin Grafts

Although Halsted advocated excision of most of the skin of the breast followed by an extensive split-thickness skin graft, most of our patients in the modern era come for treatment with disease at a much earlier stage than did those in Halsted's time. Extensive excision of the skin is designed to minimize the incidence of local tumor recurrence on the chest wall. Skin recurrences in the parasternal region are usually the result of tumor in the internal mammary lymph nodes rather than residual tumor in the subcutaneous tissues. Parasternal recurrences will not be eliminated simply by removing more skin. In general, removing all of the skin over the tumor plus an additional 3 cm seems to allow for an adequate margin and a low recurrence rate.

Traditionally, surgeons have used the dermatome to obtain a split-thickness graft from the skin of the thigh to replace a deficit on the chest wall following mastectomy. A full-thickness graft is preferable both from the functional and the cosmetic point of view. In planning the skin incision for the mastectomy most surgeons outline an incision that is symmetrical and elliptical. In so doing, they do not leave any surplus skin on the chest wall, but rather they re-

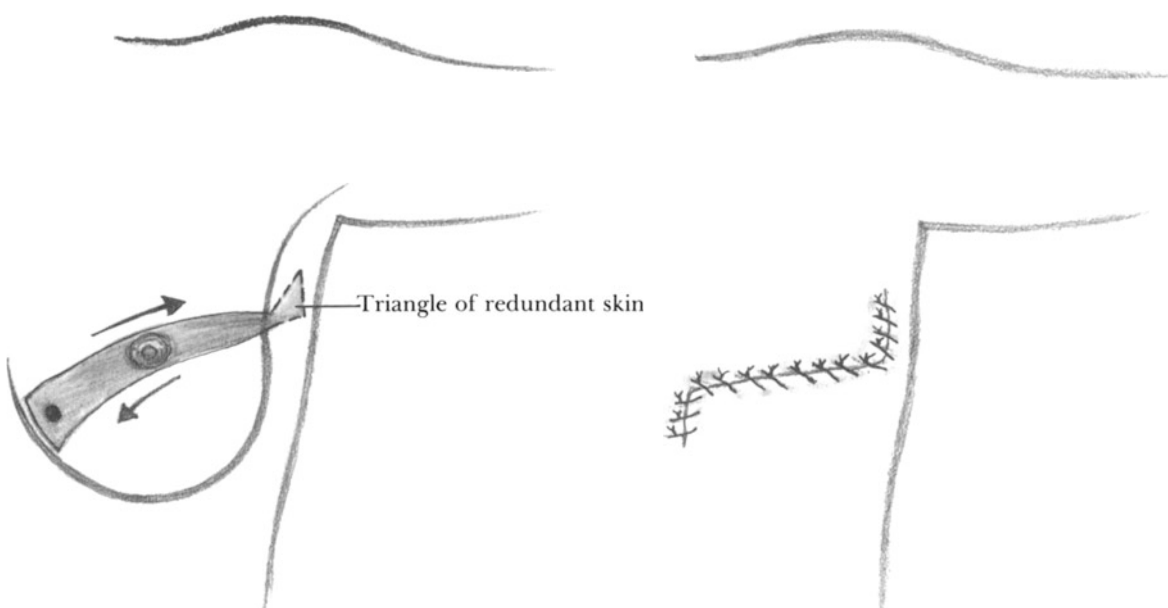


Fig. 57–5

move the surplus with the specimen. This can be avoided by drawing a circle with the skin marking pen and measuring 3 cm from the outer perimeter of the tumor. Only the skin of this circle plus that of the areola need be removed for the purpose of avoiding local recurrence. The remainder of the skin of the breast temporarily may be left behind on the chest wall. If this strategy is followed and a skin graft is necessary, then this graft may be obtained by trimming the skin from that portion of the chest wall where it is in surplus. This patch of skin is then defatted by pinning it to a sterile board and removing all of the subcutaneous fat. This will convert the patch of skin into a full-thickness skin graft. In our experience a properly defatted full-thickness skin graft has resulted in approximately as many 100% "takes" as can be expected following split-thickness grafts. By following this strategy over a period of many years we have rarely had to perform split-thickness grafts. Not only is the functional and cosmetic result superior following full-thickness grafts, but the painful second wound at the donor site is avoided.

Since most of our patients undergoing mastectomy in the current era have Stage T1 or T2 tumors, the necessity for skin grafts of any type is rare.

Pros and Cons of Electrocautery

For the past decade or two we have used an elecrocautery technique both for the sharp dissection involved in elevating the skin flap and for hemostasis. Although the use of the coagulating current for incising subcutaneous fat creates an intense amount of heat (and sometimes actually boils the fat), using the cutting current avoids producing much heat. In fact, dissecting with the cutting current does not seem to have an effect on the tissue very much different from that of the cold scalpel blade. In other words, there does not appear to be any significant heating of the local tissues; nor does there seem to be a considerable hemostatic effect. Why, then, do we dissect with a cutting current? In this portion of the operation, using the cutting current will not produce instant hemostasis. However, we use an electrocautery instrument that has a fingertip control that can very easily be switched from cutting to coagulating current. By making an incision with a cutting current, the switch can instantly be changed to the coagulating current when one encounters a bleeding point. Thus, the local vessel may be coagulated without interposing the step of grasping it with a hemostat and then ligating it or applying electrocoagulation to the hemostat. Once the technique is mastered, it encourages the development of rapid and efficient surgery with minimal blood loss.

Achieving hemostasis in a fatty layer requires considerably more skill than coagulating a bleeding point in muscle. Coagulating the fat in the general vicinity of a bleeding point creates tissue damage and little hemostasis. Try to see the actual blood vessel from which the bleeding is coming. Touch the blood vessel at a point proximal to its cut end using the flat part of the electrocoagulator's electrode.

After many years of using electrocoagulation for virtually all of the bleeding points in the modified radical mastectomy, except for the axillary artery and vein branches, we have not noticed any increase in wound complications, nor in the incidence and severity of serum accumulations under the skin flaps. The incidence of serum accumulation seems to be related more to the degree of obesity than to the method of obtaining hemostasis.

Operative Technique

Biopsy

Determine the direction that the mastectomy incision will take and make the biopsy incision directly over the tumor in the same direction as the anticipated mastectomy incision. If the tumor is 2–3 cm in diameter, make the biopsy incision 3–4 cm in length. Then carry this incision through the subcutaneous fat down to the level of breast tissue. Apply rake retractors to the subcutaneous fat. Use the cutting current of the electrocautery to dissect in the plane between the fat and the breast tissue until an area of breast about 3–4 cm in diameter has been exposed.

If the tumor is easily identified, use the cutting current to incise the breast tissue around the perimeter of the tumor until the lesion has been removed. Now use a coagulating current to achieve complete hemostasis in the wound, while the pathologist is performing a frozen-section examination of the specimen. Be sure that a portion of the specimen is submitted for the estrogen receptor determination.

It is generally not necessary to apply sutures in the attempt to close the defect left in the breast following the biopsy excision. Closing the defect in layers with sutures will produce an area of induration in the breast that may well resemble a tumor. If the lesion is benign, this area of induration may persist for months or years and cause great consternation to the patient and her personal physician. Leaving the defect unsutured makes postoperative evaluation of the breast on physical examination more accurate.

When the area to be biopsied consists of nondiscrete thickening, excise the entire area down to pectoral fascia (see Figs. 53–1 to 53–3).

If the lesion is benign, close the skin with a subcuticular continuous suture of 4–0 PDS or interrupted 5–0 nylon sutures. If the specimen is reported to be malignant, close the incision with continuous heavy silk. Change gowns, gloves, and instruments, and redrape the patient.

Incision and Elevation of Skin Flaps

Position the patient so that the arm is abducted 90° on an arm board and place a folded sheet, about 5 cm thick, underneath the patient's scapula and posterior hemithorax. Prepare the area of the breast, upper abdomen, shoulder, and upper arm with an iodophor solution. Enclose the entire arm in a double layer of sterile orthopedic stockinette to maintain sterility of the entire extremity because the arm must be flexed during the dissection of the upper axilla. We prefer to place a sterile Mayo instrument stand over the patient's head. This will be used for extra hemostats and gauze pads for the assistant as well as to support the arm during the period of the operation that requires it to be flexed.

Using a sterile marking pen, draw a circle 3 cm away from the perimeter of the primary tumor. Depending on the location of the tumor, mark the medial and lateral extensions of the incision as discussed above. In addition to the area of skin outlined by the circle drawn around the tumor, include the entire areola and nipple in the patch of skin left on the specimen (see **Fig. 57–1**). If there is little or no possibility of requiring a skin graft, then make an elliptical incision (**Fig. 57–6**). Then use a scalpel to make the incision through all the layers of the skin. Attain hemostasis by applying electrocoagulation to each bleeding point.

Now apply either Adair clamps or rake retractors, about 2–3 cm apart, to the cut edge of the skin on the lower flap. Have the assistant elevate the skin flap by drawing the Adair clamps in an anterior direction. Apply countertraction by depressing the breast posteriorly. Then use the electrocautery set on a medium cutting current to incise Cooper's ligaments, which attach the subcutaneous tissues to the surface of the breast (**Fig. 57–7**). Leave

Fig. 57–6

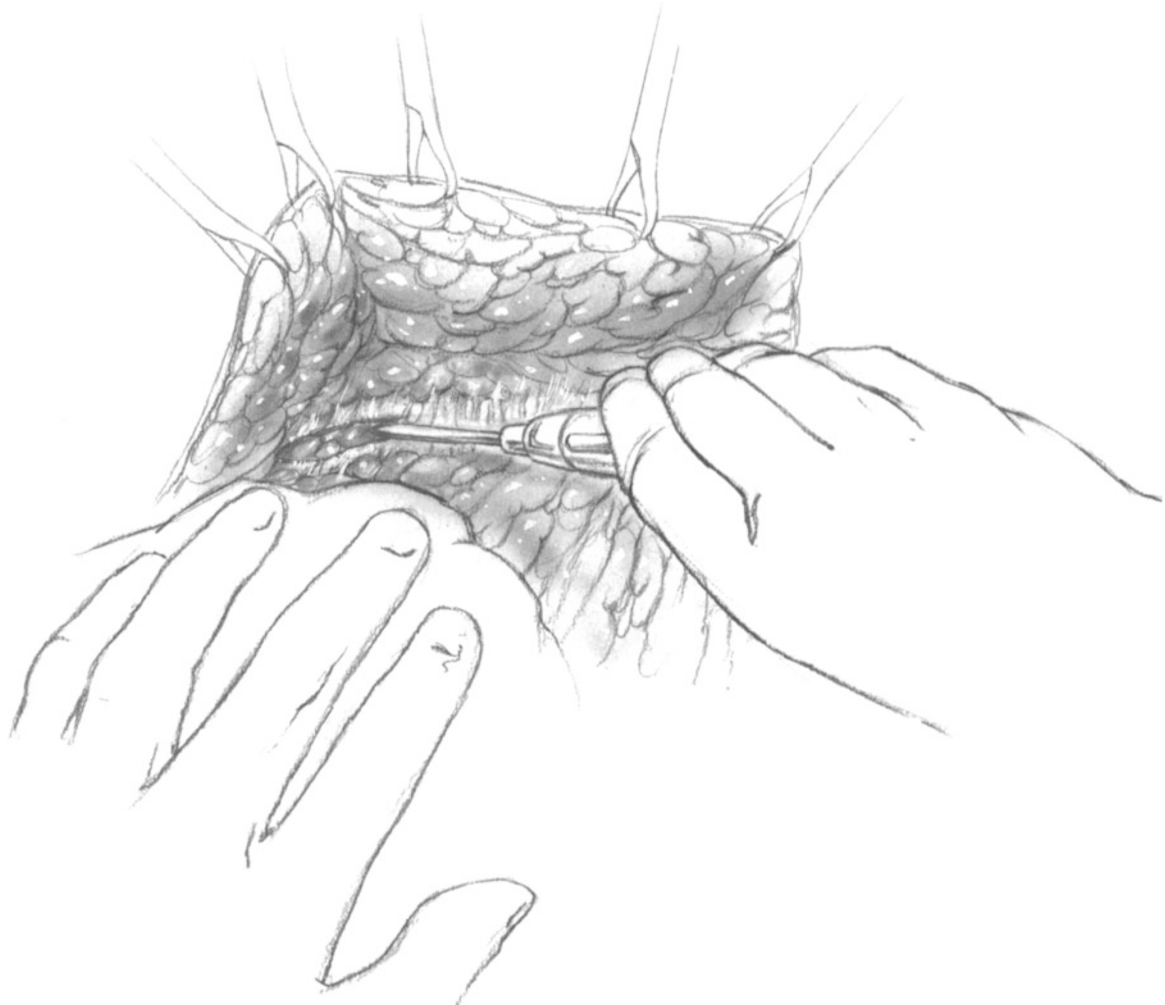


Fig. 57–7

no breast tissue on the skin flap. When any significant bleeding is encountered, change the switch on the handle of the electrocautery device from the "cutting" to the "coagulating" setting. By using the cutting current for dissecting the fat off the breast not much heat is generated nor is the tissue trauma significantly greater than that imposed by the cold steel scalpel. Whenever a blood vessel is encountered, the surgeon has in his hand the electrocoagulating device and need only move the switch from one setting to the other. This technique facilitates performing a mastectomy with minimal trauma and excellent hemostasis. Continue elevating the inferior skin flap until the dissection is beyond the breast. The medial margin for the dissection is the sternum. The lateral margin is the anterior border of the latissimus dorsi muscle, which is exposed for the first time during this phase of the operation. Apply a moist gauze pad to the operative site. Remove the Adair clamps from the lower skin flap and apply them now to the upper skin flap.

Use the same technique to elevate the upper skin flap to a point about 3 cm below the clavicle. Whichever skin incision has been selected, it should permit wide exposure of the axillary contents from the clavicle to the point where the axillary vein crosses over the latissimus muscle. The final step in achieving exposure consists of clearing the fat from the anterior border of the latissimus muscle with a scalpel so that the entire lateral margin of the dissection has been identified.

Clearing the Pectoral Fascia

After checking to ascertain that complete hemostasis has been achieved, use a scalpel to incise the fascia overlying the major pectoral muscle. Begin near the medial margin of this muscle and proceed with scalpel or electrocautery to dissect the fascia off

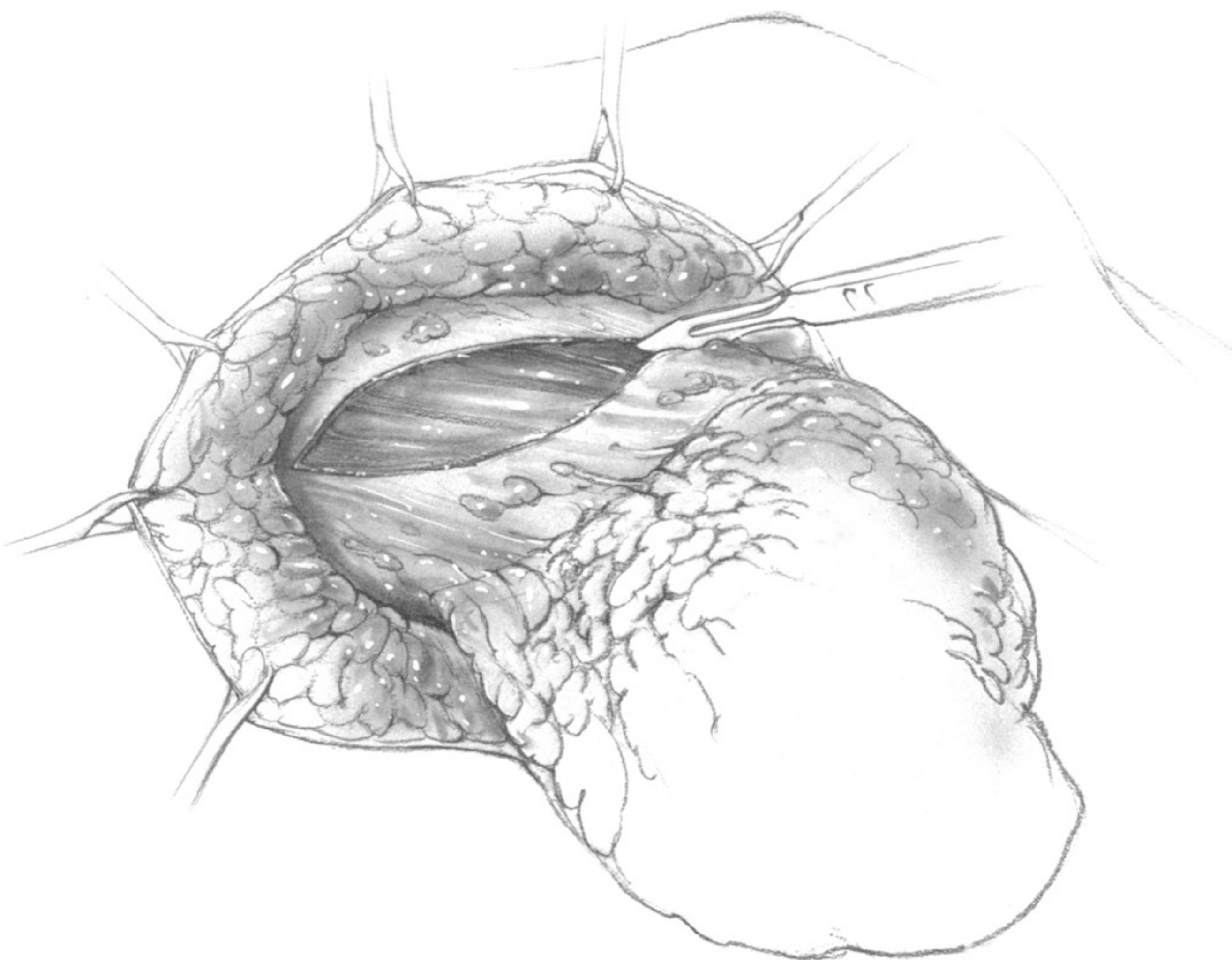


Fig. 57–8

the anterior surface of the major pectoral muscle from the sternum to the lateral margin (**Fig. 57–8**). Simultaneous hemostasis will be achieved if the first assistant will electrocoagulate each of the branches of the mammary vessels as they are exposed or divided by the dissection. Whether you use electrocautery or hemostats, exercise caution in pursuing a vessel that has retracted into the chest wall after being divided. We have on occasion, especially in thin patients, observed pneumothorax following this step. When the vessel is not easily controlled by electrocoagulation or a hemostat, simply apply a suture-ligature to control it.

When the lateral margin of the pectorals major has been reached, use a combination of blunt and sharp dissection to elevate the edge of the pectoral muscle from its investing fascia. This will maintain continuity between the breast, the pectoral fascia, and the lymph nodes of the axilla.

Unroofing the Axillary Vein

Use a Richardson retractor to elevate the major pectoral muscle. Identify the pectoralis minor muscle (**Fig. 57–9**). Branches of the medial pectoral nerve will be seen lateral to the origin of the pectoralis minor. These may be divided without serious consequence, but be sure to identify and preserve the major branch of the lateral pectoral nerve that emerges just *medial* to the origin of the pectoralis minor and travels along the undersurface of the major pectoral muscle. Division of this nerve may result in atrophy and contraction of the pectoralis major.

Dissect the fat and fascia off the anterior-inferior edge of the coracobrachialis muscle using the scalpel. Directly inferior to this muscle will be found the brachial plexus and the axillary vessels. Continuing the dissection of the inferior border of the coraco-

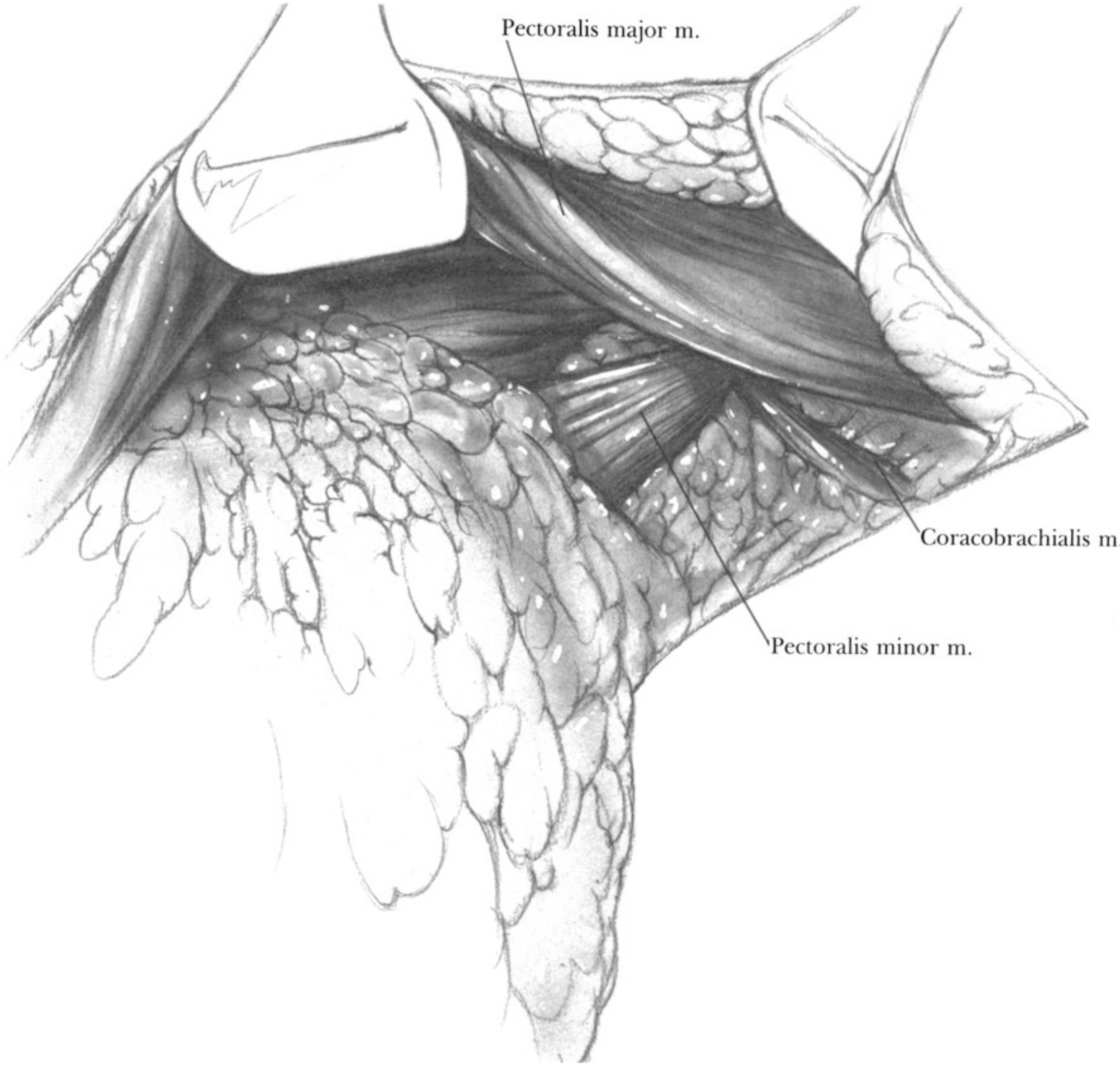


Fig. 57–9

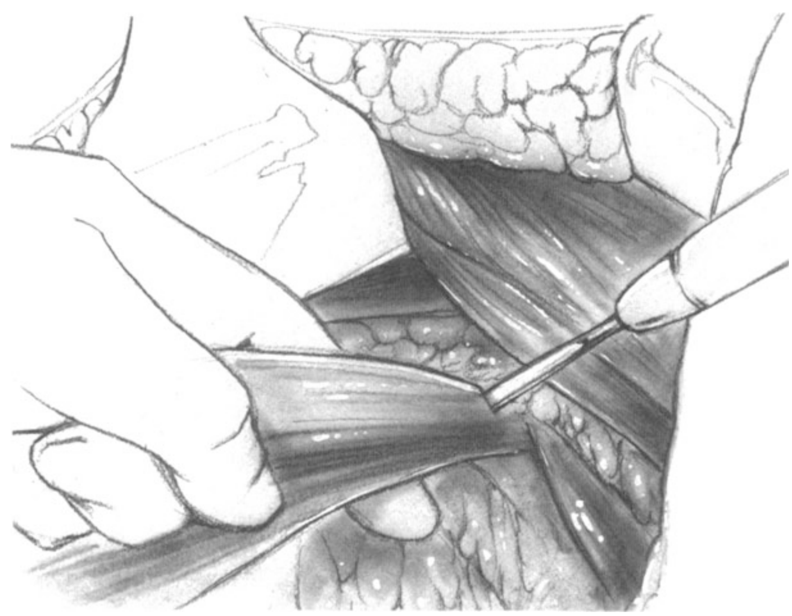


Fig. 57–10

brachialis in a medial direction will lead to the coracoid process upon which the pectoralis minor inserts. Divide the pectoralis minor muscle near its insertion using the electrocoagulator (**Fig. 57–10**). If you do not wish to excise Level 3 lymph nodes, it is not necessary to divide the minor pectoral muscle. Simply free its posterior attachments and elevate it with a Richardson retractor. Free up enough of the divided muscle to provide complete exposure of the axillary vein. Deep to the point where the pectoralis minor muscle was divided will be found a well-defined fat pad overlying the junction of the cephalic and axillary veins. Gentle blunt dissection will generally succeed in elevating this fat pad and drawing it in a caudal direction to expose the anterior surface of the axillary vein.

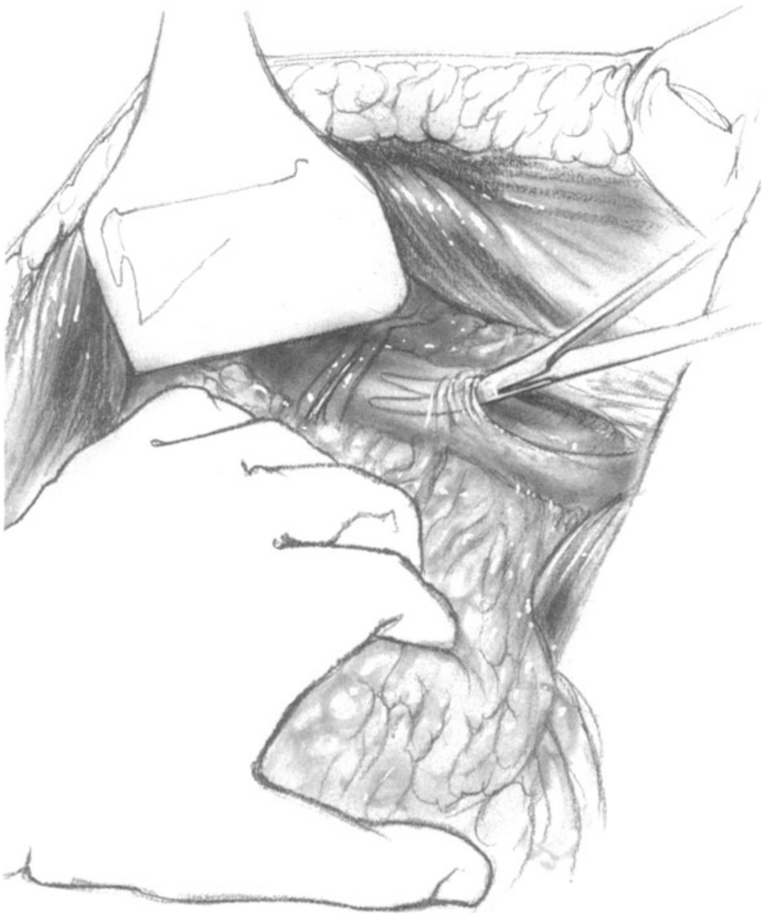


Fig. 57–11

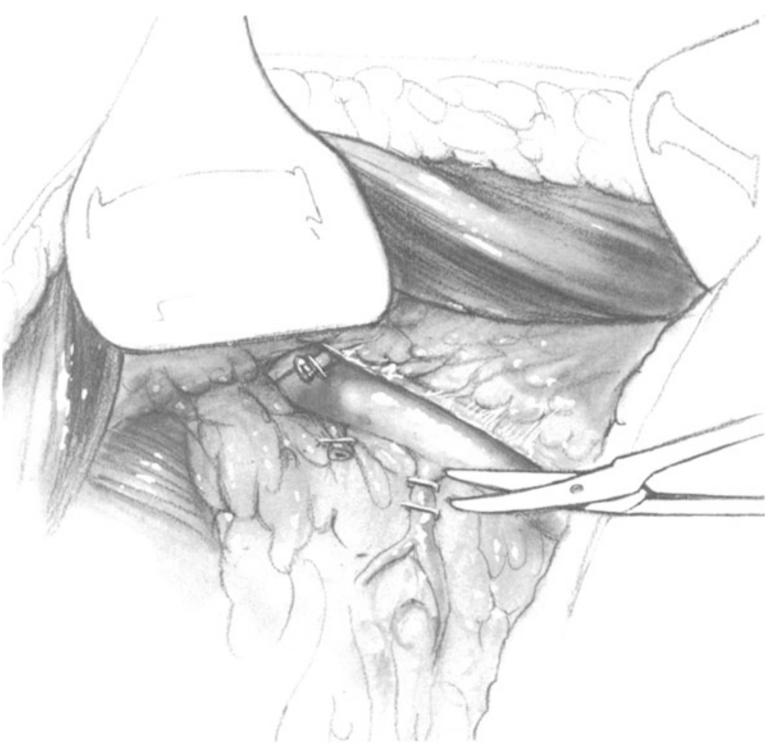


Fig. 57–12

Now incise the adventitial sheath of the axillary vein (**Fig. 57–11**). Although light dissection with the belly of the scapel can accomplish this, most surgeons prefer to use a Metzenbaum scissors. A few branches of the lateral anterior thoracic artery, vein, and nerve will cross over the anterior wall of the axillary vein. Divide these branches between Hemoclips. In order to complete the division of the sheath of the axillary vein from the region of the latissimus muscle to the clavcle, it will be necessary to flex the upper arm. This will relax the major pectoral muscle, which is then elevated with a Richardson retractor.

Axillary Vein Dissection

Axillary lymphadenectomy aims at removing all of the lymph glands inferior to the axillary vein. Only when these glands are replaced by metastases will tumor spread to the nodes cephalad to the axillary vein and to the neck. Not only is it unnecessary to strip all of the fat from the brachial plexus, but this maneuver may produce a lifelong painful neuritis in some patients.

Now identify all the branches entering the axillary vein from below. Clear each of the branches of adventitia, and divide each between Hemoclips (**Fig. 57–12**). The subscapular vein, which enters the axillary from behind, should not be divided.

At this point, it is essential to label the apex and the lateral margin of the axillary specimen. Many pathologists prefer that a third label be attached at the point where the pectoralis minor muscle crosses the axillary specimen. It is important that the pathologist be able to tell the surgeon which nodes are involved, as a metastasis to the apical node has a worse prognosis than one to the lateral node group.

The upper boundary of the axillary dissection is the crossing of the clavicle over the axillary vein. Detach the lymphatic and areolar tissue at this point with the electrocoagulator. Now make a scalpel incision in the clavipectoral fascia on a line parallel to and 1 cm below the axillary vein. Do not retract the axillary vein in a cephalad direction, as this may expose the underlying axillary artery to injury during this step.

Dissect the areolar and lymphatic tissues off the intercostal muscles and ribs going from medial to lateral. When the minor pectoral muscle is encountered, divide it 2–3 cm from its origin with the electrocoagulator (**Fig. 57–13**) and leave the excised muscle attached to the specimen. If this muscle was not divided earlier in the operation, it is not necessary to resect it. Now restore the arm to its previous position of 90° abduction. As the chest wall is cleared laterally, one or two intercostobrachial nerves will be seen emerging from the intercostal muscle on their way to innervate the skin of the upper inner arm. Since these nerves penetrate the specimen, divide them even though this will result in a sensory deficit in the upper inner arm (**Fig. 57–14**).

Then use a sterile gauze pad to wipe the loose fat out of the subscapular space going from above downward. This maneuver will expose the long thoracic nerve that runs along the rib cage in the anterior axillary line in a vertical direction from above downward to innervate the anterior serratus muscle. The thoracodorsal nerve can be identified as it leaves the area of the subscapular vein and runs both laterally and downward together with the thoracodorsal artery and vein to innervate the latissimus dorsi muscle. Since these two nerves run close to the peripheral boundary of the dissection, they should be preserved when no metastatic lymph nodes are seen in their vicinity.

Detach the lymphatic tissue inferior to that portion of the axillary vein that crosses over the latissimus muscle. Preserving the long thoracic nerve is complicated by the fact that a number of small veins cross over the nerve in its distal portion. Circumvent this difficulty by moving the partly detached breast in a medial direction so that it rests on the patient's chest after freeing the specimen from the anterior

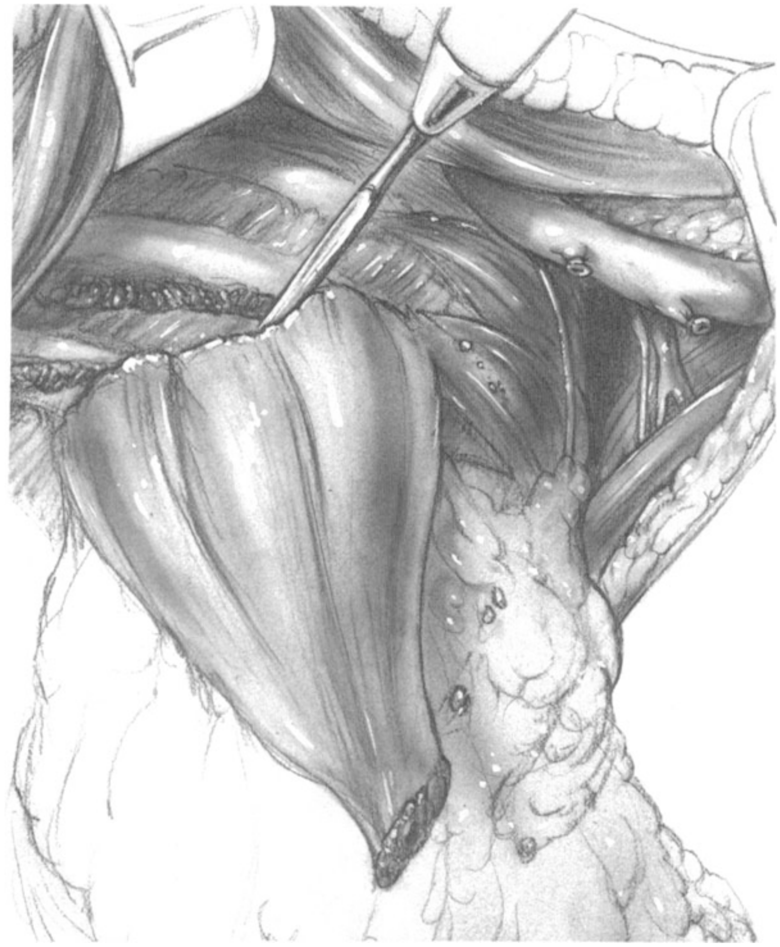


Fig. 57–13

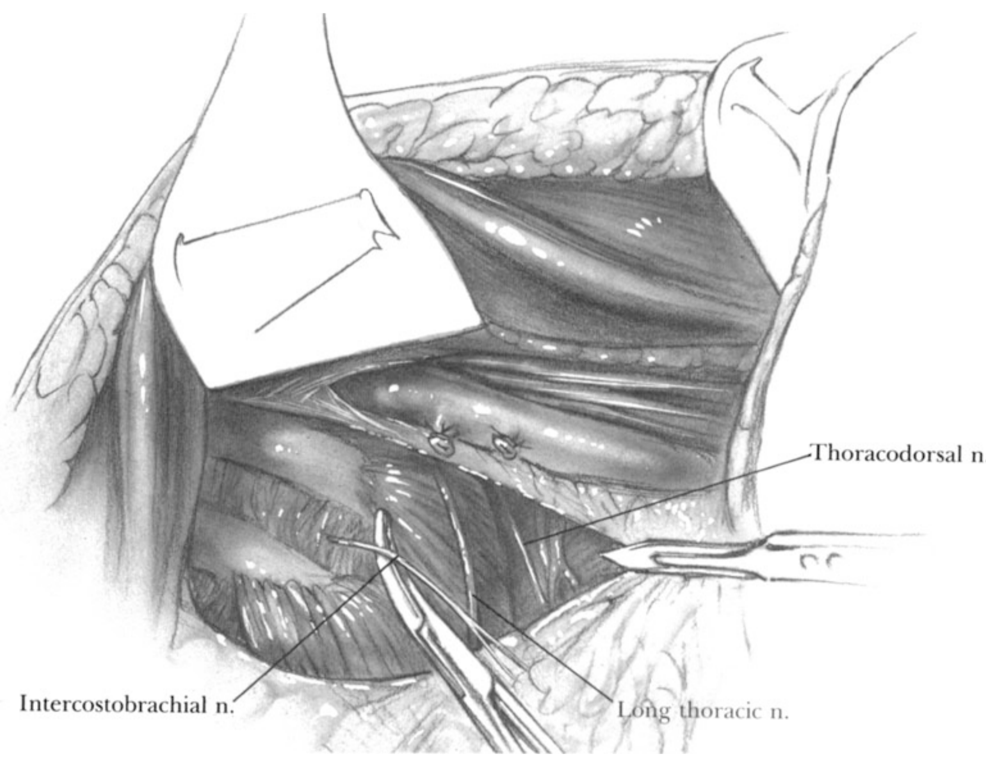


Fig. 57–14

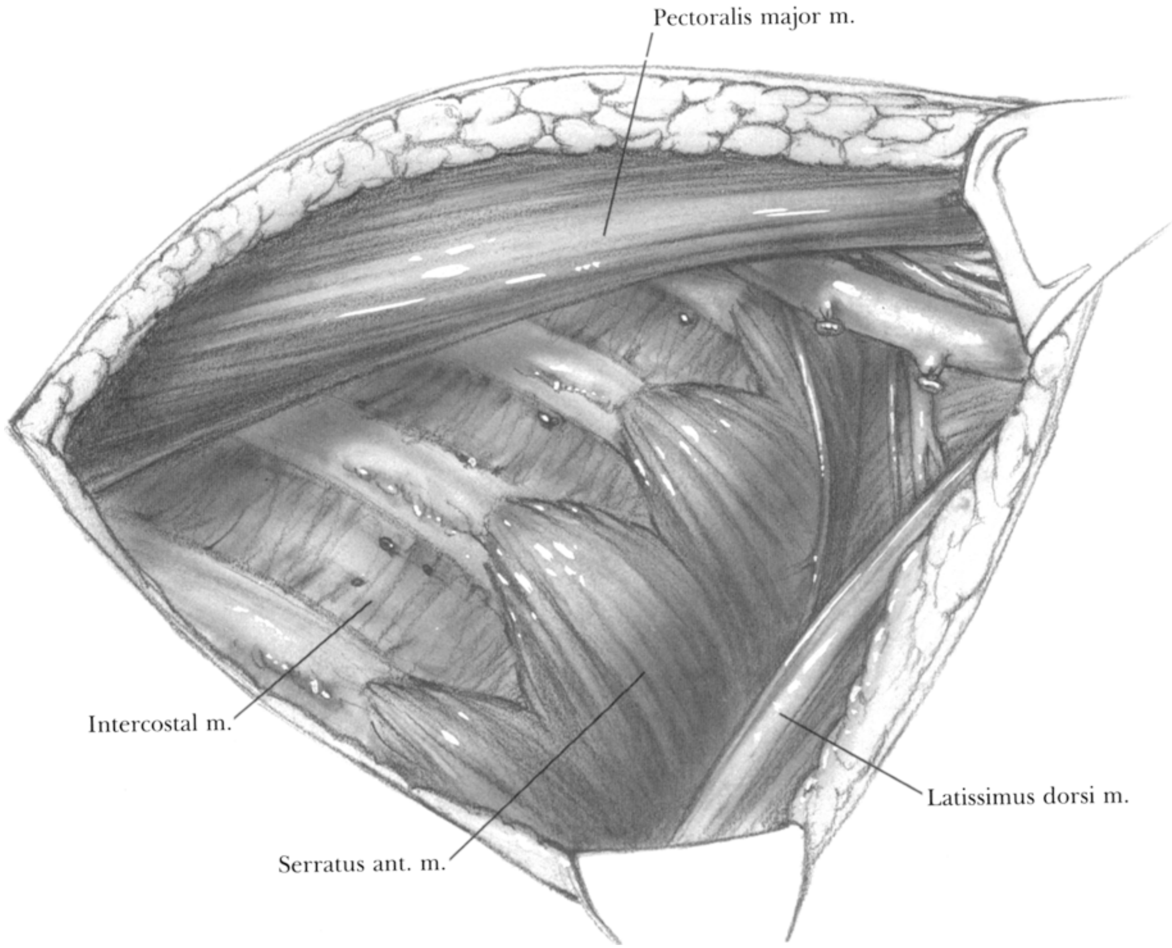


Fig. 57–15

border of the latissimus muscle. Then make an incision in the fascia of the serratus muscle 1 cm medial to the long thoracic nerve. Dissecting this fascia a few centimeters in a medial direction will detach the entire specimen from the chest wall (**Fig. 57–15**).

Irrigation and Closure

Thoroughly irrigate the operative field with sterile water, a solution that has cancercidal effect on loose tumor cells that may have been dispersed into the operative field. Check the entire field to be sure that *complete* hemostasis has been achieved.

Then insert two multiperforated catheters, each about 4 mm in diameter, through puncture wounds in the lower axilla. Bring one catheter deep to the axillary vein where it may be sutured with some fine catgut. Bring the other catheter across the thoracic wall from the puncture wound to the region of the sternum. Suture each catheter to the skin at the site of the puncture wounds and attach to closed-suction drainage (Hemovac) (**Fig. 57–16**).

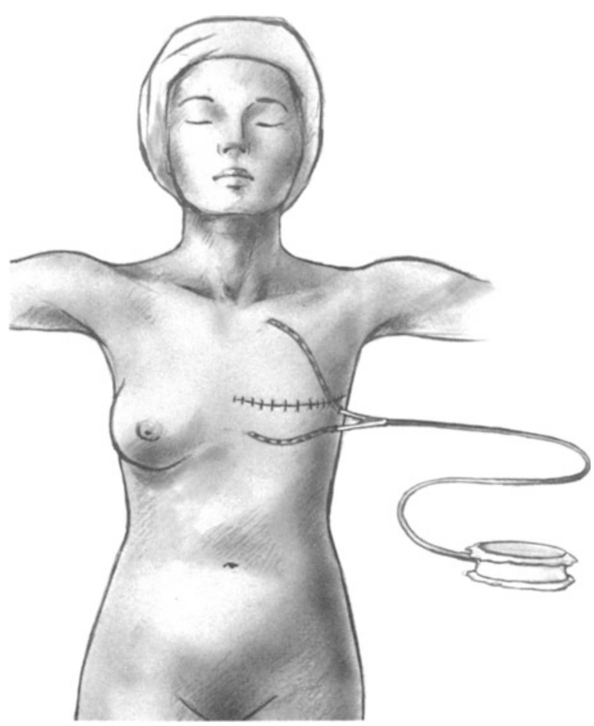


Fig. 57–16

Then close the skin with interrupted fine nylon sutures or skin staples. Be certain that there is no significant tension on the incision or else postoperative necrosis of the skin flap may be anticipated. Often shifting the skin flaps in a medial or lateral direction will relieve tension. Do not permit either of the skin flaps at the lateral margin of the incision to become bunched up in such a fashion that a "dog ear" will form. Many patients are convinced that this represents residual tumor. The "dog ear" deformity can be eliminated by excising a triangular wedge of skin as noted in Figs. 57–3 and 57–5.

When closed-suction drainage is used postoperatively, it is not necessary to apply a bulky pressure dressing.

Postoperative Care

Leave the two closed-suction drainage catheters in place until the daily drainage diminishes to 30–40 ml/day or about 7 days.

Encourage early ambulation but do not permit the patient to abduct the arm on the side of the operation for 5–7 days, as this activity prevents the skin flaps from adhering to the chest wall and encourages prolonged drainage of serum. Permit the patient to use this arm for ordinary activities not requiring abduction. Do not initiate active abduction exercises until the 8th–10th postoperative day. This delay will not interfere with the patient's ability to regain a complete range of motion of the arm, as demonstrated by the study of Lotze, Duncan, Gerber, and colleagues.

Take appropriate steps throughout postoperative treatment to assure the patient's emotional as well as her physical rehabilitation.

Do not remove the skin sutures for 2 weeks because the operation has separated the skin flaps from much of their blood supply. This slows down the rate of healing.

Aspirate any significant collections of serum beneath the skin flaps with a sterile syringe and needle as necessary.

Administer adjuvant treatment with chemotherapy as soon as the incision is healed in all premenopausal women with axillary lymph node metastases. Prescribe tamoxifen 10 mg twice daily to node-negative postmenopausal women whose tumors test positive for estrogen receptors. For a review of the validity of other indications for adjuvant therapy, see the report of Harris, Lippman, Veronesi et al.

Conduct follow-up examinations every 3 or 4 months for the first 5 years and then every 6 months for life. These examinations, combined with annual mammography, are an integral part of the treatment of breast cancer. Aside from the search for local recurrence and distant metastases, the opposite breast must be carefully followed because 10% of patients will develop a new primary tumor in the opposite breast following mastectomy for cancer.

Also, carefully inspect the arm for the development of lymphedema, which can become a disabling complication if not detected and treated early. Warn the patient to avoid trauma, including sunburn, to the arm and forearm of the operated side. If at any time the hand should be traumatized or any evidence of infection should appear in the hand or arm, prompt treatment with antibiotics (dicloxacillin) for a period of 7–10 days, followed by the application of a specially fitted elastic sleeve of the Jobst type, may prevent the development of permanent arm edema.

Postoperative Complications

Ischemia of Skin Flap

This complication is preventable by avoiding tension on the suture line as well as excessive devascularization of the skin flaps. It is a serious complication. When ischemia is permitted to develop into gangrene of the skin, a process that takes 2 or more weeks, some degree of cellulitis invariably follows. This process occludes many residual collateral lymphatic channels through which the lymph fluid from the arm manages to return to the general circulation. Blocking these channels increases the incidence and severity of permanent lymphedema of the arm. Consequently, skin necrosis should be anticipated when purple discoloration appears in the skin flap on the 5th or 6th day following mastectomy. If this purple discoloration cannot be blanched by finger pressure, it represents devitalization of the skin and is not cyanosis.

Once this skin change has been observed, the patient should promptly be returned to the operating room. With local anesthesia, excise the devitalized skin and replace it with a skin graft. At this early date infection will not yet have ensued, and primary healing of the skin graft may be anticipated. This prompt action will eliminate weeks of morbidity as well as damage to the collateral lymphatic channels. It is, of course, far preferable to prevent skin necrosis in the first place by utilizing a skin graft during the primary operation whenever excessive tension is observed during the skin closure.

Wound Infection

Wound infection is uncommon in the absence of skin necrosis.

Seromas

Seromas, collections of serum beneath the skin flap, occur in the first few weeks following mastectomy when there has been failure of the skin flap to become adherent to the chest wall. This appears to be more common in obese patients. Treatment consists of aspirating thc serum every 3–5 days. On rare occasions this process may continue for several months. In such a case, it is preferable to make an incision with local anesthesia and insert a latex drain. Repeated aspiration over a period of many weeks may result in infection of the seroma.

Lymphedema

Lymphedema of the arm is more common in obese patients, in those who have had radiotherapy to the axilla, and in those who have experienced skin necrosis, wound infection, or cellulitis of the arm. Treat cellulitis of the arm promptly with antibiotics. Lymphedema in the absence of any sign of infection is treated as soon as it is detected by the application of a Jobst elastic sleeve, which applies a pressure of 50 mm of mercury over the course of the forearm and arm. These sleeves should be changed whenever they lose their elasticity, generally after 6 weeks. This kind of treatment should be instituted whenever one detects an increase in circumference of the arm of 2 cm or more. Generally, elastic compression will keep the condition under control if it has not already been long neglected. Once the edema has been permitted to remain for many months, subcutaneous fibrosis replaces the edema and makes it irreversible. Intermittent pneumatic compression has been recommended, but few patients will tolerate the many hours a day of intermittent compression which are necessary before significant progress is demonstrated in long-standing edema. Prompt treatment of the hand or arm with antibiotics and early application of elastic compression is helpful in preventing and controlling edema.

References

Durkin K, Haagensen CD. An inproved technique for the study of lymph nodes in surgical specimens. Ann Surg 1980;191:419.

Handley RS. The conservative radical mastectomy of Patey: 10-year results in 425 patients. Breast 1976;2:16.

Harris JR, Lippman ME, Veronesi U et al. Breast cancer. N Engl J Med 1992;327:473–480.

Lotze MT, Duncan MA, Gerber LH et al. Early versus delayed shoulder motion following axillary dissection, a randomized prospective study. Ann Surg 1981;193:288.

58 Radical Mastectomy

Indications

Radical mastectomy is useful only in patients who have very large tumors that invade the pectoral muscles.

Preoperative Care

Same as for the modified radical mastectomy (see Chap. 57).

Pitfalls and Danger Points

Same as for the modified radical mastectomy operation (see Chap. 57).

Operative Strategy

After elevating the skin flaps by the usual technique, the radical mastectomy can be accomplished in one of two sequences. In the technique described below, the axillary lymphadenectomy precedes removal of the breast from the chest wall. It is also feasible to remove the breast and the major pectoral muscle from the chest wall prior to doing the axillary dissection, a sequence that is observed in the Patey operation. Proponents of the latter sequence feel that it reduces the incidence of tumor emboli caused by traction applied to the specimen. When the breast is removed going from medial to lateral, gravity provides sufficient retraction. Since there are no data available comparing these two sequences, each surgeon will base his choice on personal preference.

Operative Technique

Incision

The principles underlying the choice of an incision for radical mastectomy (**Fig. 58–1**) are the same as those for the Patey operation. Also, see Figs. 57–1 to 57–5.

Elevation of Skin Flaps

Same as for the Patey operation (see Chap. 57).

Exposing the Axilla

To perform a complete axillary lymphadenectomy, it is not necessary to remove that portion of the major pectoral muscle which arises from the clavicle. Also, preservation of the clavicular head of this muscle improves the cosmetic appearance of the upper chest wall. Consequently, develop a line of separation by blunt dissection between the sternal and clavicular heads of the pectoral muscle. Continue this separation to the point where the major pectoral muscle inserts upon the humerus. Place the left index finger underneath the sternal head of the muscle near its insertion and divide the muscle from its insertion with the electrocoagulating cur-

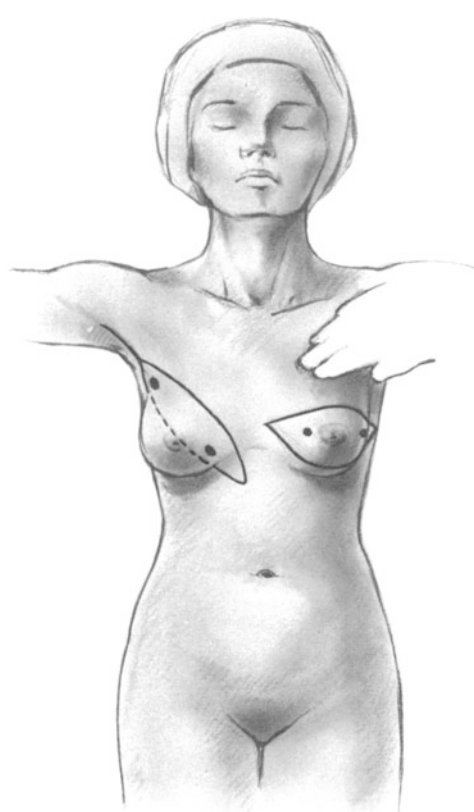


Fig. 58–1

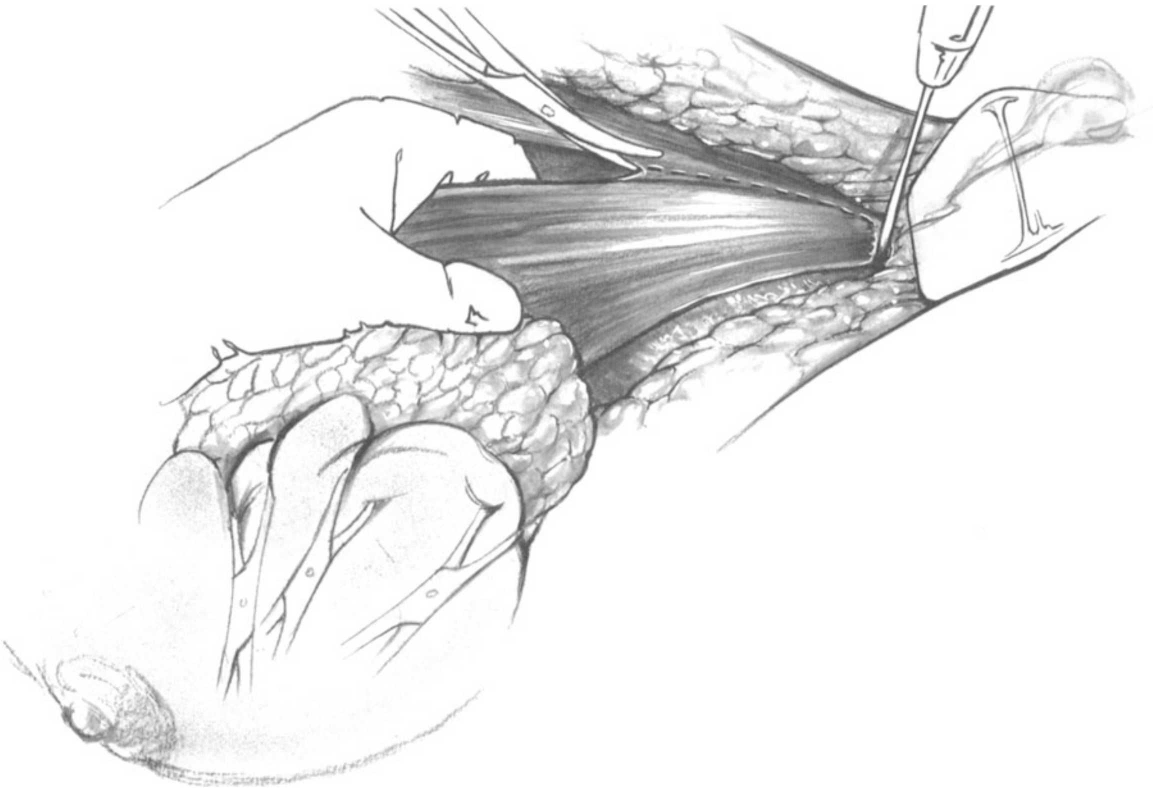


Fig. 58–2

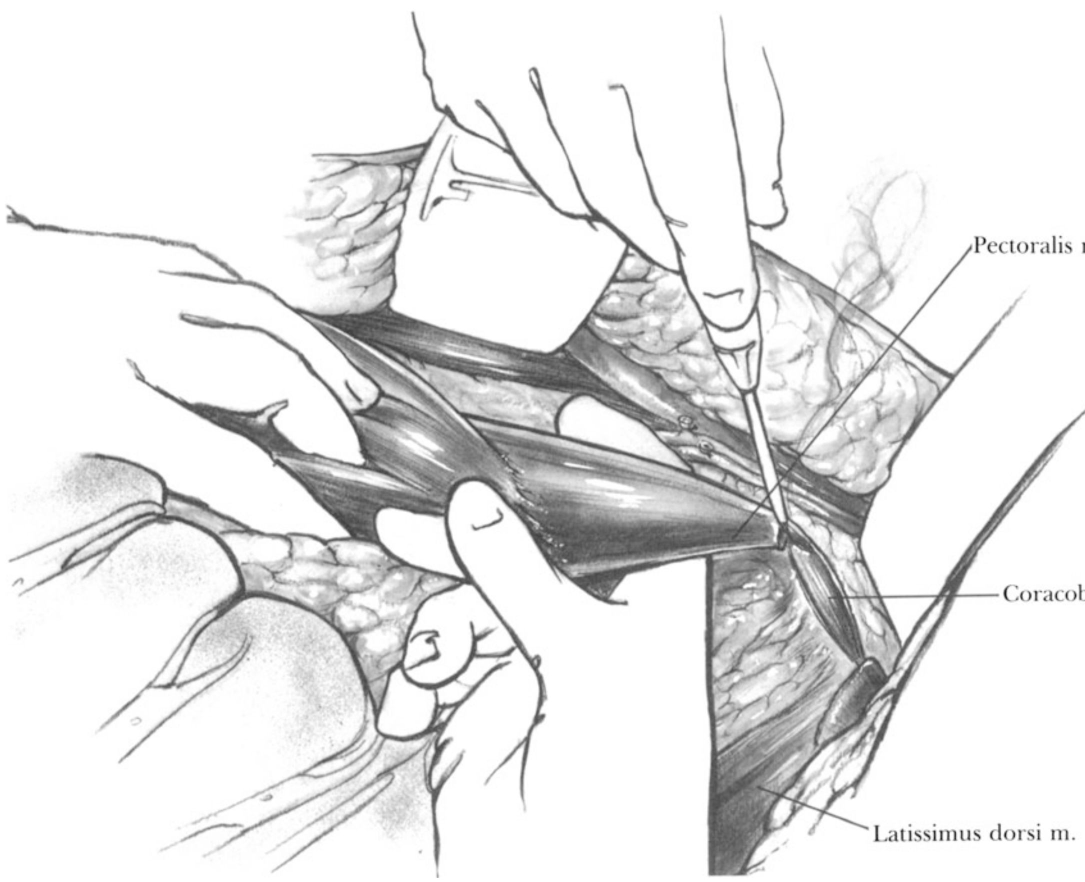


Fig. 58–3

rent (**Fig. 58–2**). Complete the line of division between the two heads of the muscle going in a medial direction until the sternum is reached. A number of lateral anterior thoracic arteries, veins, and nerves will be divided between Hemoclips during this dissection. Also detach the upper 2–3 cm of the major pectoral muscle from the upper sternum.

Incise the areolar tissue and fascia over the surface of the coracobrachial muscle and continue in a medial direction until the coracoid process is reached. This will expose where the junction is between the coracobrachial muscle and the insertion of the minor pectoral muscle (**Fig. 58–3**). Just caudal to the coracobrachial muscle are the structures contained in the axilla, namely, the brachial plexus and the axillary artery and vein. They are covered not only by fat and lymphatic tissue, but also by a thin layer of costocoracoid fascia. Clearing the fascia away from the inferior border of the coracobrachial muscle serves to unroof the axilla as well as to expose the insertion of the minor pectoral muscle. Detach this muscle from its insertion after isolating it by encircling it with the index finger; use the coagulating current to divide the muscle near the coracoid process (Fig. 58–3). A pad of fat overlying the axillary vein near the entrance of the cephalic branch can be swept downward by blunt dissection, exposing the axillary vein.

Dissecting the Axillary Vein

It is not necessary to clean the fat off the brachial plexus or to remove tissue cephalad to the axillary vein. Pick up the sheath of the axillary vein with a Brown-Adson or DeBakey forceps and use a Metzenbaum scissors to separate the adventitia from underlying vein (**Fig. 58–4**). Once the unopened scissors has been inserted underneath the adventitia to establish the plane, remove the scissors and then insert one blade of the scissors under this tissue. Close the scissors, dividing the adventitia. Continue this dissection along the anterior wall of the axillary vein from the region of the latissimus muscle to the clavicle. The only structures crossing anterior to the axillary vein will be some thoracoacromial, lateral anterior thoracic, and pectoral blood vessels and nerves. Divide these structures between ligatures or Hemoclips. At the conclusion of this step, the branches of the axillary vein will have been fairly

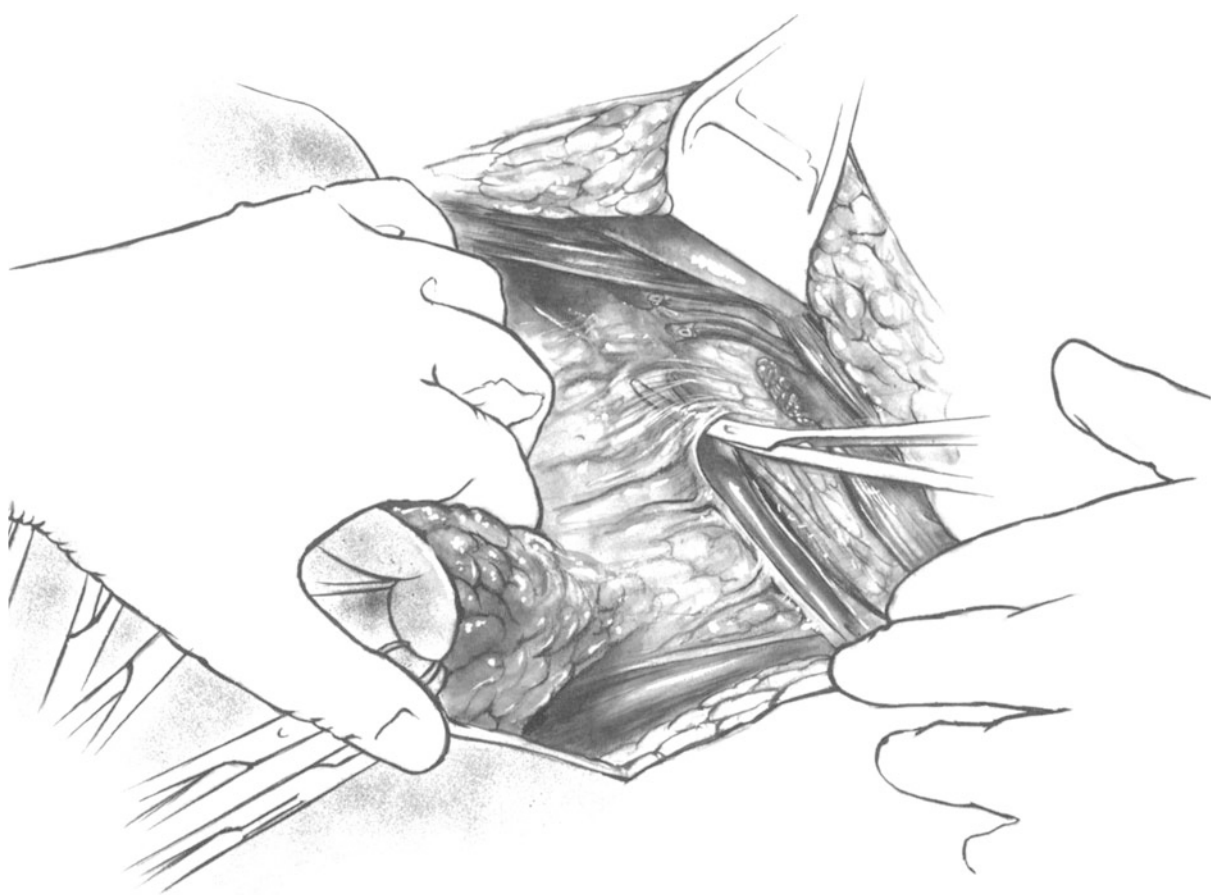


Fig. 58–4

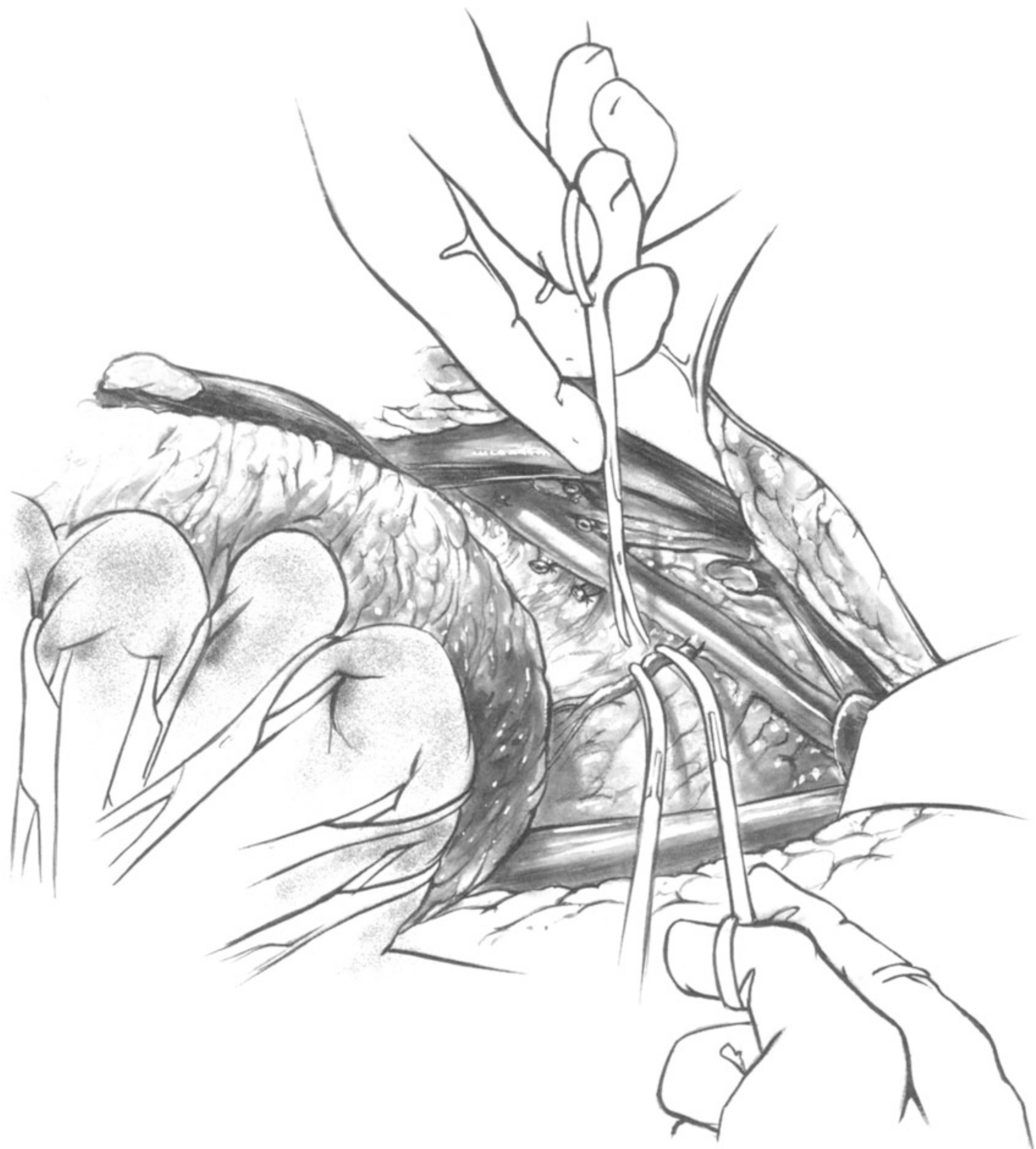


Fig. 58–5

well skeletonized. Now divide each of the branches of the axillary vein that comes from below, using Hemoclips or 3–0 PG ligatures (**Fig. 58–5**).

At this point use some silk sutures to apply labels to mark the apex and the lateral portion of the lymphadenectomy specimen.

Dissecting the Chest Wall

Make a scalpel incision through the clavipectoral fascia just inferior to the medial portion of the axillary vein (**Fig. 58–6**). This will clear fat and lymphatic tissue from the upper chest wall. Continue this dissection laterally until the subscapular space has been reached. Then clear the areolar tissue from the subscapular space by using a gauze pad, bluntly dissecting from above downward. This maneuver will reveal the location of the long thoracic nerve descending from the brachial plexus in apposition to the lateral aspect of the thoracic cage. Preserve this nerve. Identify the thoracodorsal nerve that crosses the subscapular vein and travels 2 or 3 cm laterally together with the artery and vein supplying the latissimus dorsi muscle (**Fig. 58–7**). In the absence of obvious lymph node metastases in this area, dissect out the thoracodorsal nerve down to its junction with the latissimus dorsi muscle.

If the anterior border of the latissimus muscle has not yet been thoroughly exposed, complete this maneuver now. The entire lymphadenectomy specimen should be freed from the axillary vein, the upper anterior chest wall, and the anterior border of the latissimus muscle.

Fig. 58–6

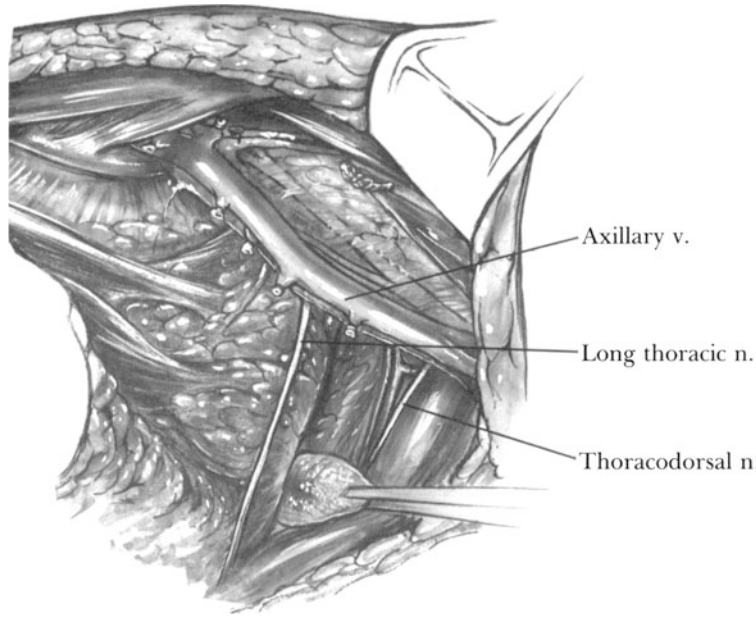


Fig. 58–7

Detaching the Specimen

Keeping the long thoracic nerve in view, make an incision in the fascia of the anterior serratus muscle on a line parallel to and 1 cm medial to this nerve. Elevate the fascia by dissecting in a medial direction exposing the underlying muscle until the interdigitations of the pectoral muscles are encountered (**Fig. 58–8**). Detach the pectoral muscles from their

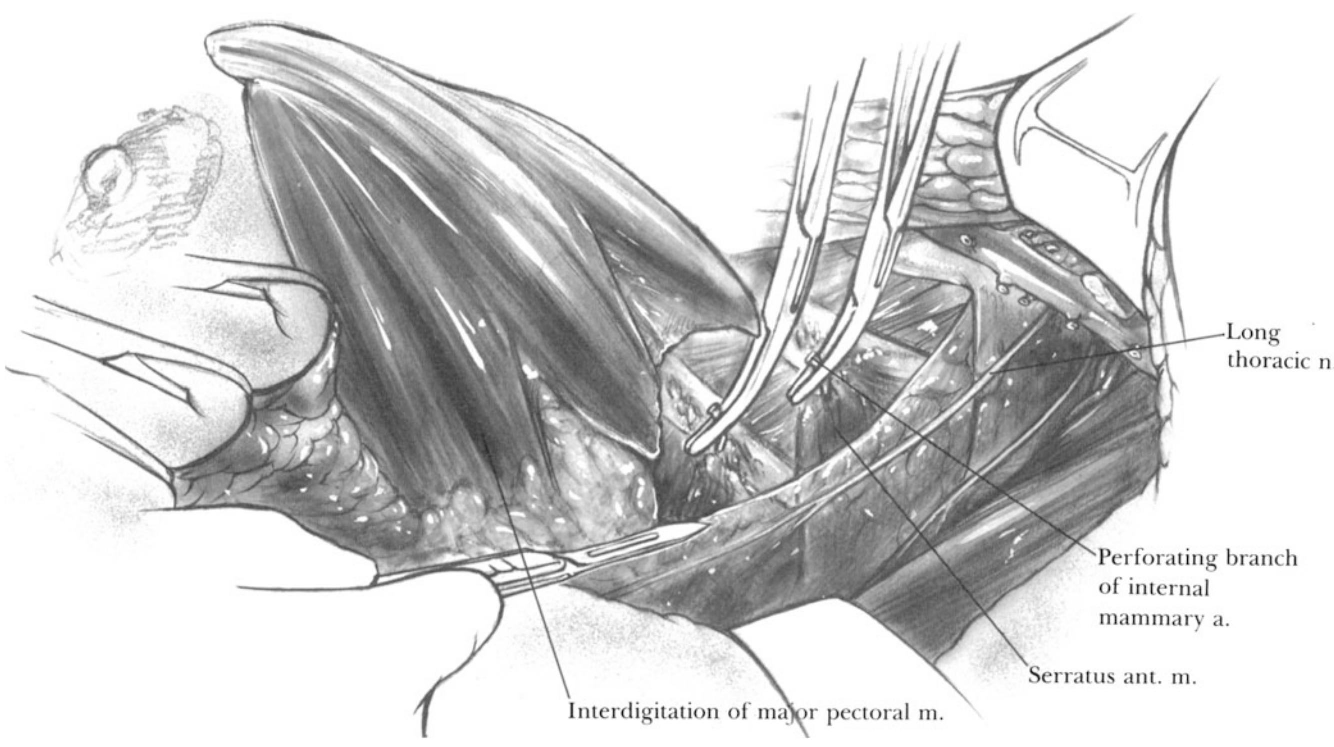


Fig. 58–8

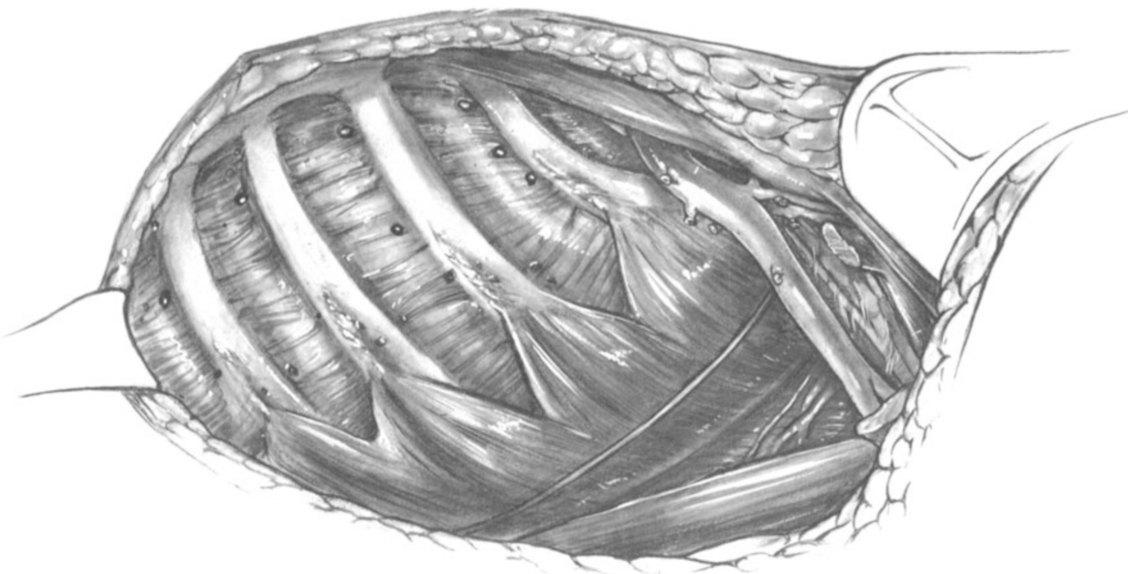


Fig. 58–9

points of origin with the electrocautery. Apply small hemostats to each bleeding vessel. Try to avoid including any extraneous tissue in the hemostat other than the blood vessel. If this is accomplished, each of the blood vessels on the chest wall may be occluded by applying the coagulating current to each hemostat at the conclusion of the dissection. As the pectoral muscles are divided, leave about 0.5 cm of muscle tissue on the rib cage, as this will facilitate applying the hemostats to the perforating branches of the internal mammary vessel. If these are divided flush with their point of emergence from the chest wall, they will often retract into the chest, which makes hemostasis difficult and increases the risk of pneumothorax. Continue the retraction in a medial direction of the pectoral muscles and the attached breast, proceeding until all of the internal mammary branches have been clamped and divided and the dissection has been completed at the border of the sternum. Then remove the specimen and electrocoagulate each of the hemostats. Ascertain that hemostasis is complete. Then irrigate the entire operative field with sterile water in the attempt to wash out detached tissue and malignant cells (**Fig. 58–9**).

Closure of Incision and Insertion of Drains

Same as for the Patey operation (**Fig. 58–10**).

Full-Thickness Skin Graft

Whenever an area of excessive tension is encountered during the closure of the skin wound by means of suturing, leave this portion of the incision unsutured. Measure the defect and determine if there is sufficient redundant skin in other areas of the skin flaps which may be excised, defatted, and transplanted into the defect. In order to expedite the defatting of skin to be grafted, it is helpful to pin one edge of the

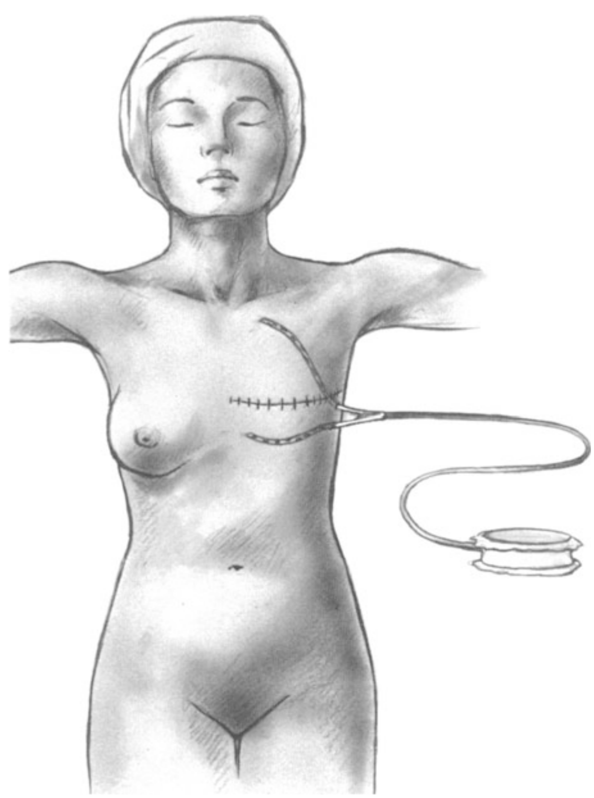


Fig. 58–10

skin patch down to a sterile board. Then grasp the fat with the forceps and use a large scalpel blade to dissect all of the fat off the skin. Sometimes a few remaining bits of fat may be excised with a curved Metzenbaum scissors. When a patch of skin has been sufficiently defatted to convert it into a full-thickness graft, the undersurface of the skin assumes a characteristic pitted appearance. Then place the full-thickness skin graft into the defect and tailor its dimensions so that there is mild tension on the graft after it is sutured into place.

First suture the edges of the skin down to the chest wall musculature with interrupted 3–0 silk. Use about six such sutures to fix the skin edges down to the chest wall to stabilize the perimeter of the defect. Then insert a continuous over-and-over suture of atraumatic 5–0 nylon to attach the skin graft to the edges of the skin defect using small bites. Skin staples are another good method of fixing the graft in place.

Make multiple puncture wounds in the skin graft with a No. 10 scalpel blade to permit seepage of serum from the wound through the graft. Over the skin graft apply a single layer of iodophor gauze. Over this, place a small mass of gauze fluffs. Then tie the long ends of the previously placed silk sutures over the gauze stent in order to fix the skin graft in position with some pressure.

This step may be accelerated by omitting sutures entirely and fixing the skin graft in place with either Steristrip adhesive tapes or skin staples. Then the gauze fluffs are taped into place over the graft.

Split-Thickness Skin Graft

When there is no surplus of skin on the chest wall to be harvested for a skin graft, use an electric dermatome to obtain a split-thickness graft from the anterolateral portion of the upper thigh. After this area has been cleansed with soap and an iodophor solution has been applied, dry the area and apply a sterile lubricating solution of mineral oil. Then have the assistants stretch the skin by applying traction in opposite directions with wooden tongue depressors. Set the electric dermatome so that the graft will be 0.015 inch in thickness. Apply the dermatome to the surface of the skin with firm pressure and start the motor. Apply even pressure and move the dermatome in a cephalad direction. It may be helpful for the scrub nurse to pick up the cut edge of the graft with two forceps while the surgeon continues to operate the dermatome until an adequate patch of skin has been obtained. Place the skin graft in a normal saline solution temporarily. Apply a single layer of coarse gauze anointed in iodophor ointment to the donor site over which apply a moist sterile gauze laparotomy pad.

Suture the skin graft into the defect as described above.

Postoperative Care

With reference to the skin graft, unless there are signs of infection, do not remove the gauze stent for 5–7 days. After this, the healing skin graft may be left exposed or covered with a loose dry dressing.

Remove the dressing from the donor site, with the exception of the single layer of iodophor gauze, on the day following operation. We prefer to leave this area exposed to the air. Use an electric hair dryer on the donor site intermittently to accelerate the formation of a solid crust over this area. As this crust begins to loosen around its periphery at the end of about 3 weeks, gradually trim that portion of the crust and the attached layer of gauze with a scissors.

See also the section on postoperative care following the Patey operation (Chap. 57).

Postoperative Complications

See discussion of postoperative complications following the Patey operation (Chap. 57).

With reference to the skin graft, complications include infection of the grafted area and occasionally of the donor site. Failure of a complete "take" is generally due to hematoma or serum collecting underneath the graft and separating it from its bed. This can be prevented by careful hemostasis at the time of surgery and also by making several perforations with a scalpel blade to permit the seepage of serum.

Hepatobiliary Tract

59 Concept: When to Remove the Gallbladder

Mortality Following Cholecystectomy

Despite the potential risk of surgical errors, which may produce complications of a horrendous nature, cholecystectomy in the hands of a skilled surgical team is followed by a remarkably low mortality rate. In a review of 1,100 cholecystectomies without common bile duct (CBD) exploration performed (1969–1980) for nonmalignant gallbladder disease, including acute cholecystitis, by the residents and staff of the Booth Memorial Medical Center in Flushing, New York, the hospital mortality was 0.25%. Martin and van Heerden reported a 0.3% rate for 586 cholecystectomies for chronic cholecystitis and 2.1% for acute cholecystitis. McSherry and Glenn found a 0.5% hospital mortality rate following cholecystectomy for chronic disease of the biliary tract; in patients under age 50 the mortality rate was 0.1%, while those over age 50 experienced a rate of 0.9%. In studying cholecystectomy for acute cholecystitis, the same authors found a mortality rate of 1.3% for the entire group of 1,643 cases: under age 50, 0.4% died while over age 50 the rate was 2.2%. These authors surveyed 11,808 patients who underwent surgery from 1932 to 1978. It is our experience that in the modern era improved monitoring of cardiorespiratory dynamics has markedly reduced the risk of elective surgery in the aged population, and we did not find a significant increase in the fatality rate after cholecystectomy in the patients over 50 as compared to those under the age of 50.

More important in its influence on surgical mortality is the addition of choledocholithotomy to simple cholecystectomy. The Booth Memorial Medical Center mortality for the latter operation was 2.5%, a tenfold increase over the risk of simple cholecystectomy. One third of the deaths were due to acute pancreatitis following manipulation of the common bile duct for the extraction of calculi. In municipal hospitals, where the patient population contains a higher percentage of patients with acute suppurative cholangitis or other types of advanced sepsis than are to be found in voluntary hospitals, the mortality rate of CBD explorations is often much higher than 2.5%.

Not only is the magnitude of choledocholithotomy considerably greater than that of cholecystectomy but the patient suffering from CBD stones tends to be much older and to have had biliary tract disease for a longer period of time. Also, virulent bacteria are found in the bile much more frequently when stones are present in the CBD. The striking increase in mortality for choledocholithotomy as compared with cholecystectomy is one of the strongest arguments for the early removal of gallbladders that contain symptomatic calculi.

Laparoscopic Cholecystectomy

Cholecystectomy can be performed by laparoscopic techniques with the same safety as open cholecystectomy by adequately trained skilled surgeons (Soper and associates). Patients presenting with early acute cholecystitis can in most cases be treated by this technique, although patients who have previously experienced extensive upper abdominal surgery should have an open operation.

Symptomatic Cholelithiasis Symptoms Produced by Gallstones

When a gallbladder stone becomes impacted in the orifice of the cystic duct, the classical symptoms of "gallbladder colic" are produced. This symptom complex consists of intermittent colicky pain, generally of sudden onset, located most frequently in the high epigastrium and radiating directly to the back or to the right scapula. The initial episode of pain may last 1–8 hours to be followed by a period of respite. The cycle may be repeated several times. Often, a single injection of Demerol will terminate the attack of biliary colic. Most episodes of biliary colic terminate within 12 hours either because the stone passes through the cystic duct or because the stone falls back out of the cystic duct into the gallbladder.

Other symptoms that have long been attributed to gallbladder disease, such as fatty food intolerance, belching, excessive flatus, or flatulent dyspepsia, *are not due to gallstones or to cholecystitis*. Because removal of the gallbladder cannot be expected to relieve these symptoms, the patient will generally be disappointed following cholecystectomy if he has been told something to the contrary. On the other hand, cholecystecomy does relieve gallbladder colic.

Diagnosis of Cholelithiasis

In the hands of experienced technical personnel, sonography can confirm the diagnosis of gallstones in 95% of cases.

An oral cholecystogram X ray can also confirm the diagnosis of cholelithiasis by demonstrating the calculi. When the cholecystogram shows no gallbladder visualization after a second dose of dye, this, too, confirms the diagnosis of gallstones unless the radiographic contrast tablets have been lost by vomiting or diarrhea, or unless the patient has a significant bilirubin elevation.

Use of the computerized tomographic (CT) scan is not indicated for the diagnosis of gallstones because calculi that do not contain calcium will not be detected by this device.

Biliary Colic with Negative Cholecystogram and Sonogram; the Cholecystoses

About 3%–5% of patients with normal cholecystograms and an equal number with normal sonograms do indeed have gallstones, generally of small size. Consequently, the surgeon will occasionally encounter a patient with classical symptoms of biliary colic, who nevertheless has normal X rays and sonograms. While some of these patients are suffering from undetected gallstones, others may be experiencing their symptoms due to one of the "cholecytoses," noncalculous disease of the gallbladder such as cholesterosis or cholecystitis glandularis proliferans. In this group of patients, if they suffer repeated episodes of typical gallbladder colic, cholecystectomy is indicated even in the presence of normal X ray and sonographic studies.

Atypical Pain with Negative Cholecystogram

When a patient has chronic, recurrent, ill-defined upper abdominal pain, and the X-ray and sonographic studies are normal, cholecystectomy is not indicated. These patients require careful gastroenterological studies, including upper gastrointestinal and barium colon enema X rays, gastroscopy, and liver function tests. The symptoms in most of these patients will be found to be functional in origin, although in a few cases the symptoms may be atypical manifestations of biliary tract calculi. Occasionally an endoscopic radiographic cholangiopancreatogram (ERCP) will disclose calculi in the CBD or even in the gallbladder when previously the cholecystogram and the sonogram were normal. Some surgeons believe that symptomatic noncalculous cholecystitis can be detected by the use of cholecystokinin cholangiogram X ray because the hormone cholecystokinin, by inducing contraction of the gallbladder, will reproduce the patient's symptoms.

Asymptomatic Cholelithiasis

Occasionally the diagnosis of gallstones will be made by X ray or sonogram in a patient who has no symptoms. There has been considerable debate concerning whether such a patient should have a "prophylactic" cholecystectomy under these conditions.

Considerable light has been shed on this debate by the study of Gracie and Ranshoff, who followed 123 male university faculty members with asymptomatic gallstones for many years. Surgery was not performed unless or until the patients developed unacceptable symptoms or acute complications. After 20 years of observation, only 18% of the patients developed pain or complications. It appeared that none of the observed patients died as a result of this conservative approach. For patients who are likely to seek medical attention when acute symptoms develop, it is safe to postpone surgery pending the development of symptoms.

Acute Obstructive Cholecystitis

Pathogenesis and Diagnosis

In 95% of cases, acute cholecystitis results from impaction of a calculus in the cystic duct. At first, this impaction produces the classical picture of biliary colic. When the stone remains impacted for a period of 24–48 hours, acute inflammation of the gallbladder wall develops. After a few days, the gallbladder bile becomes infected, presumably by migration of intestinal bacteria through the biliary lymphatics. Occasionally necrosis of the gallbladder wall produces perforation. This is generally walled off by adjacent colon or omentum. In about 2% of cases, a free perforation of the gallbladder occurs, causing a generalized bile peritonitis. This complication has a high mortality rate.

A typical patient with acute cholecystitis will present with fever, leukocytosis, and a tender globular mass in the right upper quadrant. The most rapid confirmatory procedure is a Technetium Tc 99 m dimethyl acetanilid imine diacetic acid (HIDA) or similar nuclear scan. This study should demonstrate radioactivity in the CBD but none in the gallbladder. Under these conditions, one can diagnose complete cystic duct obstruction, which confirms the diagnosis of acute cholecystitis.

Sonography may help by demonstrating gallstones and even thickening of the gallbladder wall.

If a patient is critically ill and will not tolerate anesthesia, acute cholecystitis may be managed in the emergency situation by having a skilled interventional radiologist insert a percutaneous drainage tube into the gallbladder under the guidance of computed tomography.

Early versus Late Operation for Acute Cholecystitis

When to operate on patients with acute cholecystitis has long been a point of controversy. Some surgeons believe in treating the acute episode conservatively with nasogastric suction and antibiotics, postponing cholecystectomy for 4–6 weeks in the expectation that the operation will be both technically simpler and safer after the delay. On the other hand, we have found that cholecystectomy, performed 24–48 hours after hospital admission, permits adequate time for diagnostic study, fluid replacement, diabetic regulation, and fine-tuning of the cardiovascular function, while at the same time eliminating a long period of convalescence from the episode of acute cholecystitis and then a second period of convalescence a month or two later following the delayed operation. Our mortality rate for early cholecystectomy has been identical with that following elective cholecystectomy. Operations *in the early period* following the onset of acute cholecystitis are in fact not technically difficult in most cases. Some patients do indeed have marked inflammation, fibrosis, or localized perforation, which makes the operation difficult. However, this type of pathology is not always improved by a delay of even 6–8 weeks.

We agree with Jarvinen and Hastbacka that not only is early operation safe if done by a surgeon experienced in this type of surgery but such an operation also markedly shortens the period of illness experienced by the patient. These authors, in a prospective randomized clinical trial comparing early cholecystectomy versus operation delayed for 2–4 months, found no significant difference in 1) the operative mortality or 2) the incidence of technical difficulty. Postoperative morbidity was significantly greater after delayed operation. Also, 13% of patients assigned to the delayed group required emergency operations for spreading peritonitis, cholangitis, or unresolving gallbladder empyema. An additional 15% of the patients undergoing delayed cholecystectomy suffered attacks of recurrent acute cholecystitis, pancreatitis, or biliary colic while awaiting surgery. Finally, patients in the delayed group required an average of 7.5 days of increased hospitalization and lost 14.4 additional days of employment compared to those undergoing early cholecystectomy. In 100 consecutive cholecystectomies for acute cholecystitis which we have performed within 1–5 days of admission, no fatalities nor any CBD injuries occurred.

Indications for Cholecystostomy

Although experienced surgeons may find in necessary to perform a cholecystostomy in only 1%–2% of operations for acute cholecystitis, there should be no hesitation on the part of any surgeon to perform a cholecystostomy when he feels that, for technical reasons, there will be a risk of damage to the bile ducts or any other vital structures if he attempts to perform a cholecystectomy. On rare occasions one will encounter a patient with advanced cardiac or other systemic disease in whom the surgeon may decide preoperatively that cholecystostomy is the operation of choice. A liberal incision and general anesthesia will be necessary if one desires to remove all of the calculi from the gallbladder and the cystic duct; this is difficult to accomplish through a small incision made with local anesthesia. Remember that in patients who are critically ill, an interventional radiologist can insert a tube into the gallbladder for drainage with CT guidance. This therapy is adequate, together with antibiotics, to abort most cases of acute cholecystitis.

In summary, we believe a cholecystectomy should be performed on a patient diagnosed as having acute cholecystitis within 1 or 2 days of hospital admission rather than delayed in the hope of making the operation easier at a later date.

Hyperamylasemia

Some patients with acute obstructive cholecystitis present with marked elevations of the serum amylase level. In most cases there will be no clinical signs of acute pancreatitis. For instance, there will be no epigastric or left upper quadrant tenderness and rigidity; there will be no hypotension or oliguria or other signs of a large shift of extracellular fluid into the "third space"; there will be no hypocalcemia and hyperglycemia. When the clinical diagnosis of acute obstructive cholecystitis has been confirmed by one of the tests mentioned above in patients without symptoms of acute pancreatitis, the elevation in serum amylase should not be a contraindication to early cholecystectomy, since most of the patients with these manifestations do not, in fact, have evidence of acute pancreatitis when the pancreas is observed at laparotomy.

If, on the other hand, one observes at operation a *normal* gallbladder with an acutely inflamed pancreas, the proper procedure is simply to close the abdomen without any further dissection. Do not drain the gallbladder, the CBD, the lesser sac, or the retropancreatic space. The inflamed pancreas should neither be disturbed nor drained. If the patient has more than three grave signs (Ranson, Rifkind, Roses, Fink et al.), then a peritoneal dialysis catheter can be inserted at operation prior to closing the abdomen without any other drains. Inserting a drain in a patient, mistakenly operated on early in the course of acute pancreatitis, serves only to increase the incidence of pancreatic abscess, and there are no data to suggest that the drain has any beneficial effect.

Acalculous Acute Cholecystitis

There is a group of patients who suffer from acalculous acute cholecystitis, often following major surgery unrelated to the biliary tract, or following trauma, burns, or other serious illnesses. Because of the antecedent illness, the diagnosis of acute cholecystitis is often overlooked or not even considered by the attending physician. Another instance where this type of acute cholecystitis occurs is in a patient who has been fed parenterally for a prolonged period of time. The pathogenesis of this disease is not clear. In some instances it may be related to the "low flow" state combined with the stasis of bile.

In any case, a high index of suspicion is necessary for early diagnosis in this group of patients. There is a high incidence of gangrene or free perforation of the gallbladder because the progress of the disease in acalculous acute cholecystitis appears to be much more rapid than in acute obstructive cholecystitis. Conservative treatment is *not* indicated in these patients. Prompt cholecystectomy is mandatory. Otherwise the mortality rate will be exceedingly high. The HIDA scan and the sonogram are not of great diagnostic value in these patients. Operation must be performed, in general, on the clinical findings. In critically ill patients, percutaneous catheter drainage is often successful.

Gallstone Pancreatitis

Acute pancreatitis in the nonalcoholic patient generally follows the passage of a relatively small calculus through the CBD and ampulla. This hypothesis has been supported by the finding of gallstones in the stool of patients admitted with nonalcoholic acute pancreatitis. In almost all of these cases there are additional calculi in the gallbladder. However, it is the *exceptional* patient with acute gallstone pancreatitis who also suffers from an impacted CBD stone. Traditional management of acute gallstone pancreatitis consisted of the usual treatment of acute pancreatitis by means of intravenous fluids, nasogastric suction, and antibiotics until all signs of the acute process had subsided. Then the patient was generally discharged from the hospital with instructions to return in 4–6 weeks for cholecystectomy.

In our experience and in the experience of others "20–30% of these patients would develop recurrent acute pancreatitis during this period of delay" (Paloyan, Simonowitz, and Skinner). Studies by Ranson and by Tondelli, Stutz, Harder, and colleagues also agree with this concept. Consequently, as soon as the acute pancreatitis has subsided and after the diagnosis of cholelithiasis has been confirmed, either by oral cholecystogram X rays or by a gallbladder sonogram, cholecystectomy and cystic duct cholangiography are performed. This is about 2 weeks from the date of admission in the average case. Of course, there are some cases of gallstone pancreatitis that may be extremely severe, even life threatening. These patients may take a number of weeks before all the signs of acute pancreatitis subside, and in these cases cholecystectomy should be delayed. This type of patient will generally have three or more of the grave signs listed by Ranson and colleagues.

Incidental Cholecystectomy

A patient undergoing surgery for hiatus hernia, duodenal ulcer, or colon cancer, who also has symptomatic gallstones, should have his gallbladder removed if the primary surgery has gone smoothly and if the patient is a good risk. When gallstones are discovered during the course of another operation and there has been no history of gallbladder symptoms, the decision whether or not to perform incidental cholecystectomy is more controversial. In general, in a good-risk patient, whose primary operation has gone smoothly without significant contamination, we remove the gallbladder as a prophylactic measure if the incision for the primary operation provides excellent exposure as well for the cholecystectomy. We have not found that this adds to the risk or the morbidity of the primary operation. In the patient with nonsymptomatic gallstones, we do not perform routine cholangiography during incidental cholecystectomy.

References

Gracie WA, Ranshoff DF. The natural history of silent gallstones. N Engl J Med 1982;307:798.

Jarvinen HJ, Hastbacka J. Early cholecystectomy for acute cholecystitis. Ann Surg 1980;191:501.

Martin JK Jr, van Heerden JA. Surgery of the liver, biliary tract, and pancreas. Mayo Clin Proc 1980;55:333.

McSherry CK, Glenn F. The incidence and causes of death following surgery for non-malignant biliary tract disease. Ann Surg 1980;191:271.

Paloyan D, Simonowitz D, Skinner DB. The timing of biliary tract operations in patients with pancreatitis associated with gallstones. Surg Gynecol Obstet 1975;141:737.

Ranson JHC, Rifkind KM, Roses DF, Fink SD et al. Prognostic signs and the role of operative management in acute pancreatitis. Surg Gynecol Obstet 1974;139:69.

Ranson JHC. The timing of biliary surgery in acute pancreatitis. Ann Surg 1974;189:654.

Soper NJ, Stockman PT, Dunnegan DL et al. Laparoscopic cholecystectomy: the new "gold standard"? Arch Surg 1992;127:917–923.

Tondelli P, Stutz K, Harder F et al. Acute gallstone pancreatitis: best timing for biliary surgery. Br J Surg 1982;69:709.

60 Cholecystectomy

Indications

(See Chap. 59.)

Gallbladder calculi with symptoms

Acute cholecystitis, both calculous and acalculous

Chronic acalculous cholecystoses and cholesterosis, when accompanied by symptoms of gallbladder colic

Carcinoma of gallbladder

Preoperative Care

Diagnostic confirmation of gallbladder disease as discussed above in Chap. 59

Perioperative antibiotics in patients suspected of having acute cholecystitis or choledocholithiasis and in patients undergoing simple cholecystectomy, if over age 70

Nasogastric tube for patients with acute cholecystitis or choledocholithiasis

Pitfalls and Danger Points

Injury to bile ducts

Injury to hepatic artery or portal vein

Hemorrhage from cystic or hepatic artery, or from liver bed

Injury to duodenum or colon

Operative Strategy

Anomalies of the Extrahepatic Bile Ducts

Anomalies, major and minor, of the extrahepatic bile ducts are quite common. A surgeon who is not aware of the variational anatomy of these ducts is much more prone to injure them during biliary surgery. The most common anomaly is a right segmental hepatic duct that drains the dorsal caudal segment of the right lobe. This segmental duct may drain into the right hepatic duct, the common hepatic duct (**Fig. 60–1a**), the cystic duct (**Fig. 60–1b**), or into the common bile duct (CBD) (**Fig. 60–1c**). Division of this segmental duct may result in a postoperative bile fistula that drains as much as 500 ml of bile per day. Longmire and Tompkins advocate ligating a damaged segmental duct rather than attempting an anastomosis because, "unless unobstructed, uninfected biliary flow can be achieved through a segmental or lobar duct, it is better that the duct be completely obstructed and the affected liver parenchyma allowed to atrophy, provided there is normal biliary flow from the residual 50% of liver." If a small duct of this type is anastomosed and if the anastomosis becomes stenotic, cholangitis and liver abscess are apt to develop. Longmire and Tompkins assert that the same policy may be applied to either the right or the left main lobar duct. If such a duct is damaged in the operating room and there is no infection, it may be safely ligated because, "unobstructed drainage of 50% of an otherwise normal liver through either the right or left uninfected hepatic duct is adequate to restore normal liver function, even if the obstructed lobe remains in

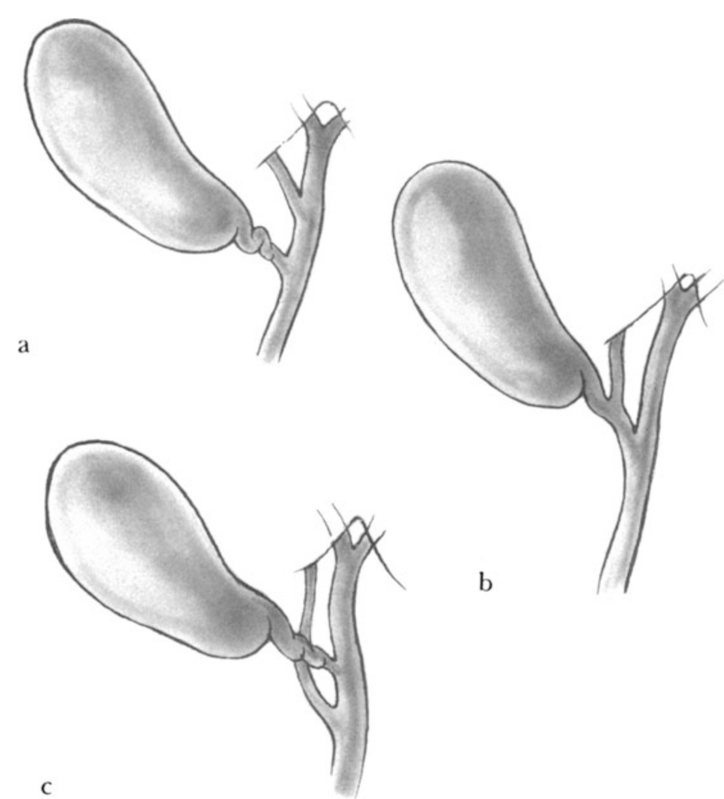


Fig. 60–1 Anomalous segmental right hepatic ducts

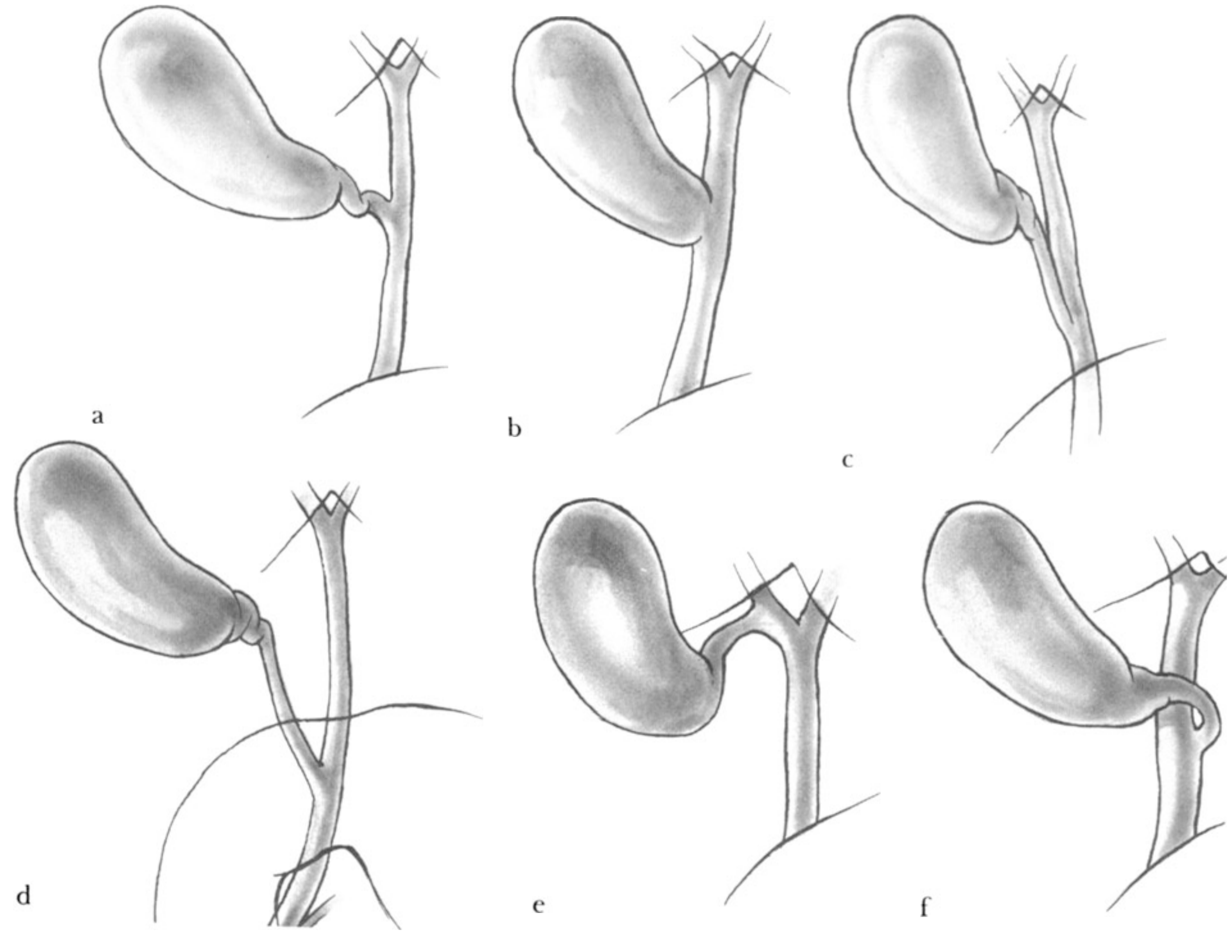


Fig. 60–2 Variations in entry of cystic duct into CBD

place." In some of the cases that these authors reported, a bile fistula nevertheless ensued following deliberate ligature of a segmental duct. However, bile drainage eventually ceased, presumably owing to fibrotic obstruction of the duct, and no infection developed. It is, of course, far preferable to identify these anomalies in the operating room and to avoid injuring the ducts.

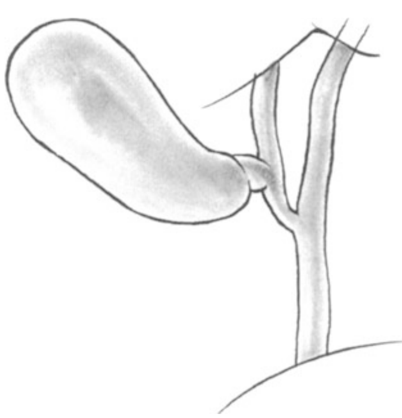


Fig. 60–3 Anomalous entry of right hepatic duct into cystic duct

Important cystic duct anomalies (**Fig. 60–2**) include the entrance of the cystic duct into the right hepatic duct (**Fig. 60–2e**), a low entrance of the cystic duct which occasionally joins the CBD rather close to the ampulla (**Fig. 60–2c**), and a cystic duct that enters the left side of the CBD (**Fig. 60–2f**).

Another extremely important anomaly of which the surgeon should be aware is the apparent entrance of the right main hepatic duct into the cystic duct. The latter duct, in turn, joins the left hepatic duct to form the CBD. This is illustrated in **Fig. 60–3**. In this case, dividing and ligating the cystic duct at its apparent point of origin early in the operation will result in occluding the right hepatic duct. If the technique that is described in the next section is carefully followed, this accident can be avoided.

Avoiding Injury to the Bile Ducts

Most serious injuries of the bile ducts are not caused by congenital anomalies or by unusually severe pathological changes. In most cases iatrogenic trauma results because the surgeon who mistakenly ligates and divides the CBD thinks that it is the cystic duct. It is important to remember that the diameter of the normal CBD may vary from 2 to 15 mm (Longmire). It is easy to clamp, divide, and ligate a small CBD as the first step in cholecystectomy under the erroneous impression that it is the cystic duct. The surgeon who makes this mistake will also have to divide the common hepatic duct before the gallbladder is freed from all its attachments. This will leave a 2–4 cm segment of common and hepatic duct attached to the specimen (**Fig. 60–4**). Because this is the most common cause of serious duct injury, *we never permit the cystic duct to be either clamped or divided until the entire gallbladder has been dissected free down to its junction with the cystic duct.* Division of the cystic duct is always the very last step in the cholecystectomy. When the back wall of the gallbladder is being dissected away from the liver, it is important to carefully dissect out each structure that may enter the gallbladder from the liver. Generally, there are only a few minor blood vessels that may be divided by sharp dissection and then occluded by electrocoagulation. Any structure that resembles a bile duct must be carefully delineated by sharp dissection. In no case should the surgeon apply a hemostat to a large wad of tissue running from the liver to the gallbladder, as this may contain the common hepatic duct.

Although it has often been stated that there are anomalous bile ducts that enter the gallbladder directly from the liver bed, we have not in our experience encountered any such duct.

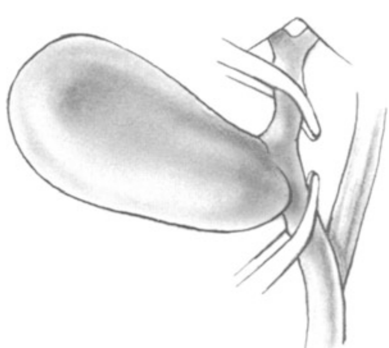


Fig. 60–4

Ligating the Hepatic Artery Inadvertently

Careful dissection will prevent injury or inadvertent ligature of one of the hepatic arteries. However, in case one of these vessels should be ligated accidently, this complication is not ordinarily fatal because hepatic viability can usually be maintained by the remaining portal venous flow and by arterial collaterals, such as those from the undersurface of the diaphragm. This is true only if the patient has normal hepatic function and there has been no jaundice, hemorrhage, shock, trauma, or sepsis. Generally, based on findings from experimental work on animals, antibiotics are administered in cases of this type. However, the necessity for antibiotic therapy has not been firmly established in humans.

In some of the reports on hepatic dearterialization for the treatment of metastatic cancer to the liver, there has not been a high mortality rate. On the other hand, neither has the mortality rate been 0%. Consequently, if a major lobar hepatic or the common hepatic artery has been inadvertently divided or ligated, an end-to-end arterial reconstruction may be performed if local factors are favorable. For other branches of the hepatic artery, arterial reconstruction is not necessary (Brittain, Marchioro, Hermann,

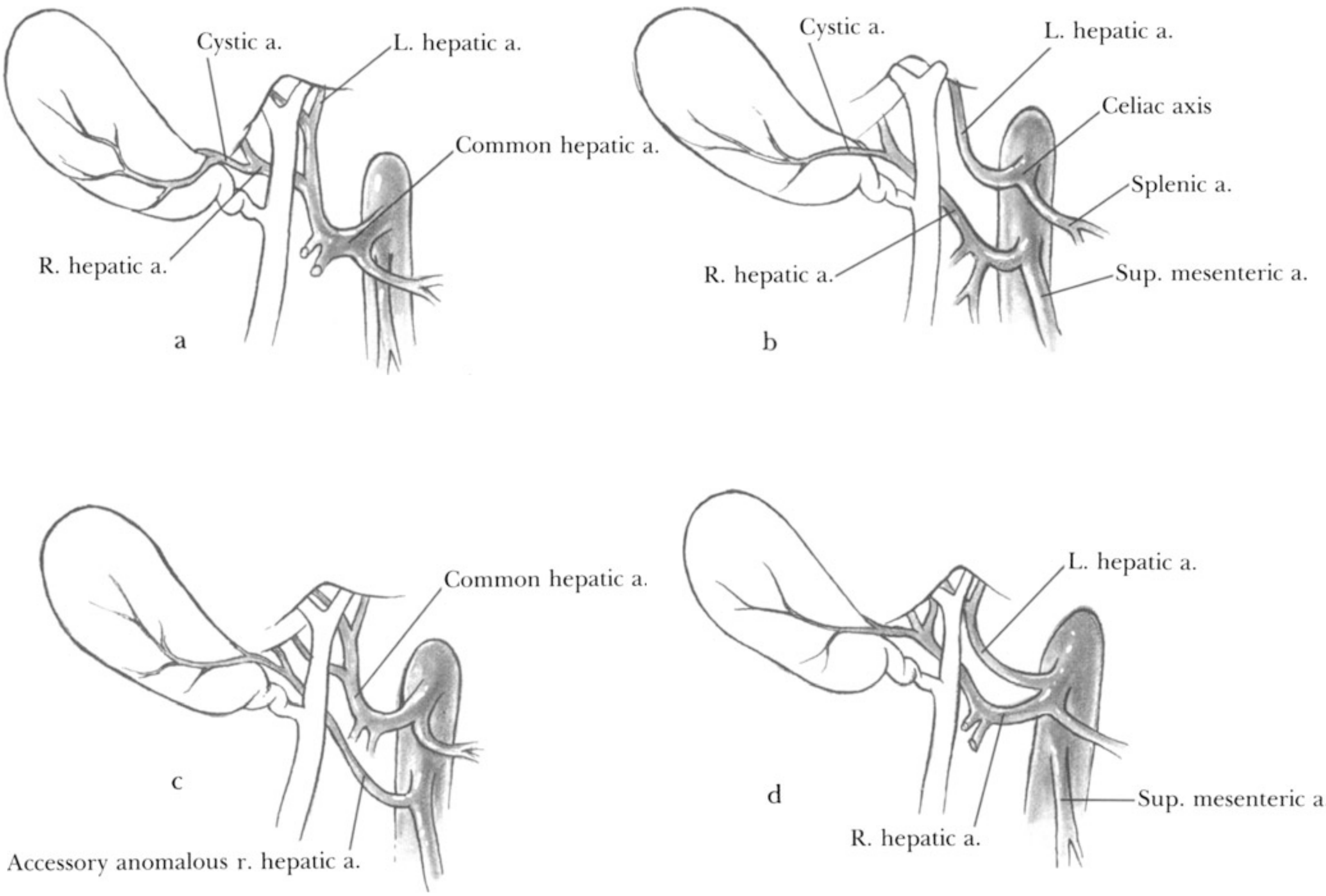


Fig. 60–5 Variations in anatomy of hepatic arteries

and associates). Variations in the anatomy of the hepatic arteries are shown in **Fig. 60–5**.

Avoiding Hemorrhage

In most cases, hemorrhage during the course of cholecystectomy is due to inadvertent laceration of the cystic artery. Often the stump of the bleeding vessel will retract into the fat in the vicinity of the hepatic duct and make accurate clamping difficult. If the bleeding artery is not distinctly visible, do not apply any hemostats. Rather, grasp the hepatoduodenal ligament between the index finger and thumb of the left hand and compress the common hepatic artery. This will stop the bleeding temporarily. Now check whether the exposure is adequate and whether the anesthesiologist has provided good muscle relaxation. If necessary, have the first assistant enlarge the incision appropriately. After adequate exposure has been achieved, it is generally possible to identify the bleeding vessel, which is then clamped and ligated. Occasionally the cystic artery has been torn off flush with the right hepatic artery. This will require that the defect in the right hepatic artery be closed with a continuous vascular suture such as 6–0 Prolene. On rare occasions it may be helpful to occlude the hepatoduodenal ligament by the application of a noncrushing vascular clamp. It is safe to perform this maneuver for as long as 15–20 minutes.

The second major cause of bleeding during the course of performing a cholecystectomy is hemorrhage from the gallbladder bed in the liver. Bleeding occurs when the plane of dissection is too deep. This complication may be prevented if the plane is kept between the submucosa and the "serosa" of the gallbladder. If this layer of fibrous tissue is left behind on the liver, there will be no problem in controlling bleeding. With this plane intact, it is easy to see the individual bleeding points and to control them by electrocoagulation. Occasionally, a small artery requires a suture-ligature or a Hemoclip for hemostasis. With proper exposure, hemostasis should be perfect. On the other hand, when this fibrous plane has been removed with the gallbladder, and liver parenchyma is exposed, the surface is irregular and the blood vessels retract into the liver substance making electrocoagulation less effective. Blood may ooze from a large area. In this case, apply a layer of Surgicel or Avitene to the bleeding surface and cover it with a dry gauze pad; use a retractor to apply pressure to the gauze pad. After a period of 15 minutes, remove the gauze pad carefully. In most cases, it will also be possible carefully to remove the layer of Surgicel, if desired, although leaving a flat layer of oxidized cellulose over the liver bed has not proved harmful in our experience.

Cystic Duct Cholangiography

For the past 20 years the proper role of cystic duct cholangiography has been subject to considerable controversy. Most instances in which stones were left behind in the CBD following biliary tract surgery have occurred in patients who have had many calculi removed from the CBD. Consequently, all patients who have undergone choledocholithotomy should have a *completion* cholangiogram through the T-tube. Because instrumentation produces spasm of the ampulla, about one-quarter of these cases will not show passage of the dye into the duodenum on a *completion* cholangiogram. For this reason, we always perform a cystic duct cholangiogram *prior to* exploring the CBD. Failure of the dye to enter the duodenum in the course of a cystic duct cholangiogram, done *prior to* opening the CBD, indicates obstruction owing to a calculus.

Studies by Jolly, Baker, Schmidt, and associates and by Schulenberg disclose that in 4%–6% of cases routine cystic duct cholangiography will reveal CBD stones in patients who have no other indication of choledocholithiasis. It is probable that some of these nonsymptomatic CBD stones would have passed spontaneously, but perhaps half of them would have required secondary cholecholithotomy during the course of the next 5–10 years. Counterbalancing the discovery of these nonsymptomatic common duct stones is a 2%–4% incidence of false positive cystic duct cholangiograms that may lead to an unnecessary CBD exploration.

A major advantage of cystic duct cholangiography is that the percentage of patients undergoing CBD exploration has been reduced from 40% to 20%. Patients having palpable stones in the CBD, a markedly dilated and thickened duct, a recent history of chills, fever, and a bilirubin over 5 mg/dl, should probably have CBD explorations. Other cases (e.g., patients with small calculi in the gallbladder and a large cystic duct, a history of pancreatitis, or moderate enlargement of the CBD) do not require CBD exploration if the cystic duct cholangiogram is normal. Thus, routine cystic duct cholangiography has eliminated the need for CBD exploration in about half the cases. Because the addition of a CBD exploration to a simple cholecystectomy may result in a higher mortality rate, the use of routine cystic duct cholangiography appears to be valuable. It has the additional virtue of delineating the anatomy of the bile ducts, which will help prevent inadvertent injury. When cholangiography is used routinely, it requires only 5–10 minutes of additional operating time, and the surgical and radiological team gains expertise with the technique, making the results more accurate.

Modifications in Operative Strategy Owing to Acute Cholecystitis

Decompressing the Gallbladder

Often there is a marked tense enlargement of the gallbladder owing to an obstruction of the cystic duct. This interferes with exposure of the vital structures around the gallbladder ampulla. For this reason, it is generally necessary to insert a trocar or an 18-gauge needle attached to suction in order to aspirate the bile or pus from the gallbladder and to permit the organ to collapse. After the trocar has been removed, apply a large hemostat to the wound in the gallbladder.

Sequence of Dissection

Although there is sometimes so much edema and fibrosis around the cystic and common ducts that the gallbladder must be dissected from the fundus down, in most patients an incision in the peritoneum overlying the cystic duct near its junction with the CBD will reveal that these two structures are not intimately involved in the acute inflammatory process. When this is the case, identify and encircle—but do not ligate—the cystic duct with 4–0 silk and then dissect out the cystic artery.

If the cystic artery is not readily seen, make a window in the peritoneum overlying Calot's triangle just cephalad to the cystic duct. Next, insert the tip of a Mixter right-angle clamp into this window and elevate the tissue between the window and the liver, on the tip of this clamp. This will improve the exposure of this area. By carefully dissecting out the contents of this tissue, one can generally identify the cystic artery. Ligate it with 2–0 silk and divide the artery. When this can be done early in the operation, there will be less bleeding during the liberation of the fundus of the gallbladder.

Dissecting the Gallbladder Away from the Liver

Use a scalpel incision on the back wall of the gallbladder. Carry it down to the mucosal layer of the gallbladder. If part of the mucosa is necrotic, then dissect around the necrotic area in order not to lose the proper plane. If it has not been possible to delineate the proper plane and the dissection inadvertently is between the outer layer of the gallbladder and the hepatic parenchyma, complete the dissection quickly and apply either Surgicel or Avitene to the oozing liver bed. Then apply a moist gauze pad and use a retractor over the gauze pad to maintain exposure while the dissection is being completed.

If the cystic artery has not been ligated in the previous step, it will be identifiable as it crosses from the region of the common hepatic duct toward the back wall of the gallbladder.

Management of the Cystic Duct

Cholangiography

Cholangiography is performed in patients with acute obstructive cholecystitis, even in the absence of significant jaundice, because the incidence of CBD stones in this group approaches 20%. If the cystic duct is not patent, perform a cholangiogram through a small scalp vein needle inserted directly into the CBD.

Occasionally, the cystic duct is so inflamed that it is easily avulsed from its junction with the CBD. If this accident occurs, suture the resulting defect in the CBD with a 5–0 Vicryl suture. If the cystic duct has been avulsed and its orifice in the CBD cannot be located, simply insert a sump or closed suction catheter down to a point deep to the CBD in the right renal fossa after accomplishing a cholangiogram.

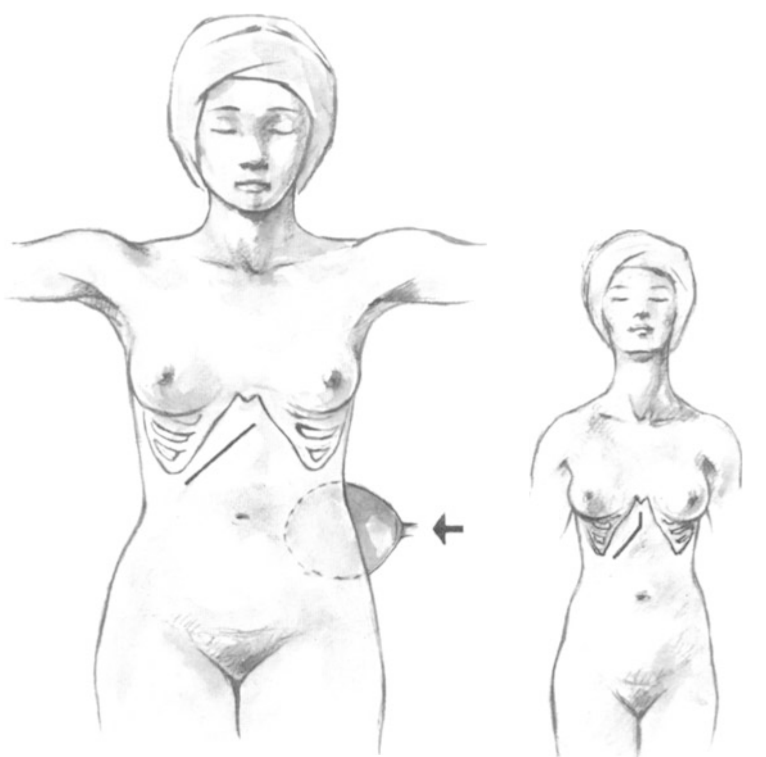


Fig. 60–6 A B

When to Abandon Cholecystectomy and Perform Cholecystostomy

If at any time during the course of dissecting the gallbladder such an advanced state of fibrosis or inflammation is encountered that continued dissection may endanger the bile ducts or other vital structures, all plans for completing the cholecystectomy should be abandoned. Convert the operation to cholecystostomy. If a portion of the gallbladder has already been mobilized or removed, it is possible to perform a partial cholecystectomy and to insert a catheter into the gallbladder remnant. Then sew the remaining gallbladder wall around the catheter. Place additional drains into the renal fossa. Remove the gallbladder remnant at a later date, after the inflammation has subsided. Meanwhile, the pus has been drained out of the gallbladder. The technique of cholecystostomy is illustrated in Chap. 62.

The necessity for abandoning cholecystectomy for a lesser procedure will occur in no more than 1% of all cases of acute cholecystitis if the surgeon is experienced in this type of surgery. The less-experienced surgeon should have no hesitation to perform a cholecystostomy when he feels that removing the gallbladder may damage a vital structure.

Summary

By strictly following this strategy and the technique described below in the course of performing personally a series of 1300 cholecystectomies, I have encountered no known case of transection, ligation, or significant operative trauma to the bile ducts, during either elective or emergency operations.

Operative Technique

Incision

We prefer to make a subcostal incision in almost all cases of cholecystectomy because of the excellent exposure afforded in the region of the gallbladder bed and cystic duct. It is important to start the incision at least one centimeter to the left of the linea alba. Then incise in a lateral direction roughly parallel to and 4 cm below the costal margin (**Fig. 60–6a**). Continue for a variable distance depending on the patient's body build. This incision will divide the 9th intercostal nerve, which emerges just lateral to the border of the rectus muscle. Cutting one intercostal nerve will produce a small area of hypoesthesia of the skin but no muscle weakness. If more than one intercostal nerve is divided, a bulge in the abdominal musculature sometimes occurs.

In a thin patient with a narrow costal arch, a Kehr hockey-stick modification is useful (**Fig. 60–6b**). This incision starts at the tip of the xiphoid and goes down the midline for 3–4 cm and then curves laterally in a direction parallel to the costal margin until the width of the right belly of the rectus muscle has been encompassed. If a midline incision is utilized, excellent exposure will often require that the incision be continued 3–6 cm below the umbilicus.

When the liver and gallbladder are high under the costal arch and this anatomical configuration interferes with exposure or when necessary in obese patients, add a Kehr extension (up the midline to the xiphoid) to a long subcostal incision and divide the falciform ligament. This vertical extension of the incision often improves exposure to a remarkable degree. Also, apply an Upper Hand or Thompson retractor to the costal arch and draw it upward.

After the incision has been made, thorough exploration of the entire abdomen is carried out. Then direct attention to the gallbladder, confirming the presence of stones by palpation. Check the pancreas for pancreatitis or carcinoma and palpate the descending duodenum for a possible ampullary cancer.

Dissecting the Cystic Duct

Expose the gallbladder field by applying a Foss retractor to the inferior surface of the liver just medial to the gallbladder as well as a Richardson or a Balfour self-retaining retractor to the costal margin. Alternatively, affix a Thompson retractor to the operating table. Then attach a blade to the Thompson and use it to elevate and to pull the right costal margin in a cephalad direction. Then apply a gauze pad over the hepatic flexure and another over the duodenum. Occasionally adhesions between omentum, colon, or duodenum and the gallbladder must be divided prior to placing the gauze pads. Then, have the first assistant retract the duodenum away from the gallbladder with his left hand. This will place the common bile duct on stretch.

Place a Kelly hemostat on the ampulla of the gallbladder. With traction on the ampulla of the gallbladder, slide a Metzenbaum scissors beneath the peritoneum that covers the area between the wall of the gallbladder ampulla and the CBD (**Fig. 60–7**). By alternately sliding the Metzenbaum beneath the peritoneum to define the plane and then

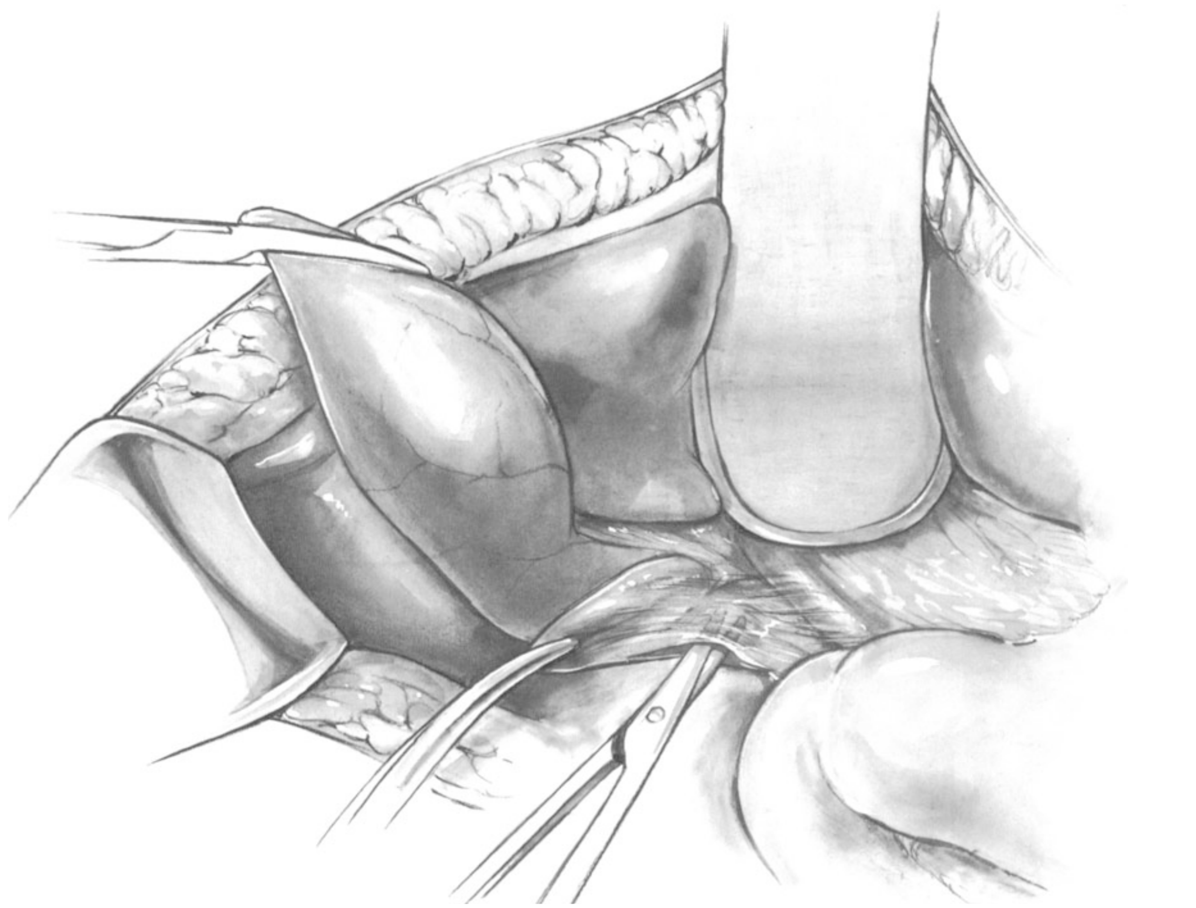


Fig. 60–7

cutting along the gallbladder wall, expose the cystic duct. If the inferior surface of the gallbladder ampulla is dissected free and elevated, this plane of dissection must lead the surgeon to the cystic duct, provided that the plane hugs the surface of the ampulla. By inserting a right-angle Mixter clamp behind the gallbladder, the cystic duct can be easily delineated. Apply a temporary ligature of 4–0 silk to the cystic duct with a single throw in order to avoid inadvertently milking calculi from the gallbladder into the CBD. The cystic duct should not be injured by strangulating it with this ligature because this structure will, on occasion, prove to be a small-size CBD and not the cystic duct. If you do not elect to do a cholangiogram, proceed to the step of ligating and dividing the cystic artery. Otherwise, at this point in the operation perform a cystic duct cholangiogram.

Cystic Duct Cholangiography

For reasons discussed in the previous chapter, we routinely perform a cholangiogram during cholecystectomy. There are two major impediments to catheterizing the cystic duct. First, the internal diameter may be too small for the catheter. Second, the valves of Heister will frequently prevent the passage of the catheter or needle even for the 4–5 mm that are necessary to properly secure the catheter tip with a ligature. Although the valves may be disrupted by the insertion of the silver probe or a pointed hemostat, this maneuver will sometimes result in shredding the cystic duct. One method that will facilitate intubating the cystic duct is to isolate the proximal portion of the duct, including its junction with the gallbladder ampulla. Here the duct is large enough to permit introduction of the catheter at a point *proximal* to the valves of Heister, simplifying the entire task.

After the cystic duct has been isolated, continue the dissection proximally until the infundibulum of the gallbladder has been freed. The diameter at this point should be 4–5 mm. Then milk any stones up out of the cystic duct into the gallbladder and ligate the ampulla with a 2–0 silk ligature (**Fig. 60–8a**). Pass another 2–0 ligature loosely around the cystic duct. Make a small transverse scalpel incision in the ampulla of the gallbladder near the entrance of the cystic duct.

At this point attach a 2-meter length of plastic

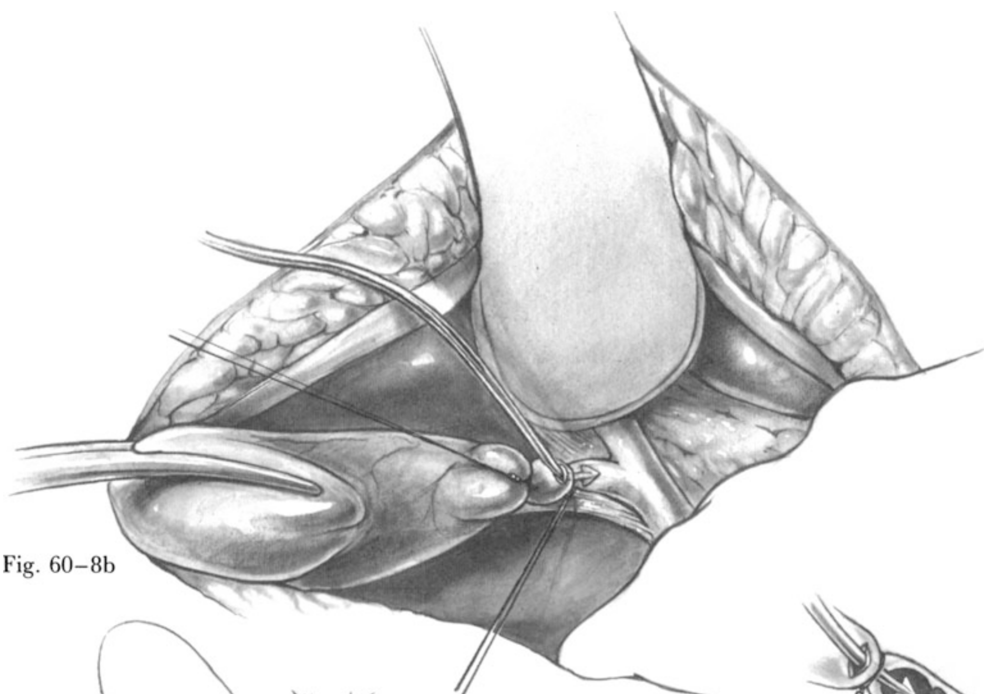


Fig. 60–8b

Fig. 60–8a

Fig. 60–8c

tubing to a 50-ml syringe that has been filled with a solution of half Conray and half saline. Then check to see that the entire system, including syringe, 2 meters of plastic tubing, and the cholangiogram catheter are *absolutely free of air bubbles.* Pass the catheter into the incision in the ampulla and for a distance of 5 mm into the cystic duct (**Fig. 60–8b**). Tie the previously placed 2–0 ligature just above the bead at the termination of the cholangiogram catheter (**Fig. 60–8c**). Under no condition should the surgeon consider confirming the position of the catheter by attempting to aspirate bile into the system because this maneuver will often result in aspirating air bubbles into the tubing. Some surgeons prefer a ureteral or an intravenous catheter over the Taut cholangiogram catheter to intubate the cystic duct.

The left side of the patient should be elevated about 10 cm above the horizontal table in order to prevent the image of the CBD from being superimposed upon the vertebral column with its confusing shadows. This is done either by having the anesthesiologist inflate a previously positioned rubber balloon under the left hip and flank (see Fig. 60–6a) or, alternatively, two folded sheets may be placed beneath the patient's left hip and flank.

The surgeon now takes his place behind a portable lead shield covered with a sterile sheet. After the film and X-ray tube have been positioned, slowly inject no more than 4 ml of contrast medium for the first exposure. A second X-ray film is then put into position and a second exposure taken after an additional injection of 4–6 ml. When X-raying a hugely dilated bile duct, as much as 30–40 ml may be required in *fractional* doses. On rare occasions, spasm in the region of the ampulla of Vater will not permit passage of contrast medium into the duodenum unless a small dose of nitroglycerine is administered intravenously. We have found nitroglycerine to be superior to intravenous glucagon (1 mg) in relieving sphincter spasm. If, after this is done, the duodenum is still not visualized, choledochotomy and exploration are indicated.

While waiting for the films to be developed, continue with the next step in the operation, ligating and dividing the cystic artery, without removing the cannula from the cystic duct. In order to insure objectivity, interpretation of the cholangiographic films should be made *by a radiologist* rather than exclusively by the operating surgeon.

When cystic duct cholangiography is performed prior to instrumentation of the CBD and ampulla, dye will almost always enter the duodenum if there is no CBD or ampullary pathology. When T-tube cholangiography is performed after completing the bile duct exploration, spasm will often prevent visualization of the terminal CBD and ampulla. This problem can be averted by routine cholangiography prior to choledochotomy, even if CBD exploration has already been decided upon.

Common Errors of Operative Cholangiography

Injecting too much contrast material. When a large dose of contrast material is injected into the ductal system, the duodenum is frequently flooded with dye. This may obscure stones in the distal CBD.

Dye too concentrated. Especially when the CBD is somewhat enlarged, the injection of concentrated contrast material can mask the presence of small radiolucent calculi. Consequently, dilute the contrast material 1:2 with normal saline solution when the CBD is large.

Air bubbles. Compulsive attention is necessary to eliminate air bubbles from the syringe and the plastic tubing leading to the cystic duct. Also, never try to aspirate bile into this tubing since the ligature fixing the cystic duct around the cholangiogram cannula may not be airtight and thus air may often be sucked into the system and later injected into the CBD; then it may be impossible to differentiate between air bubble and calculus.

Poor technical quality. If the radiograph is not of excellent quality, there is a greater chance of achieving a false negative interpretation. It is useless to try to interpret a film that is not technically satisfactory. One technical error is easily avoided by elevating the left flank of the patient for a distance of about 8–10 cm in order that the image of the bile ducts is not superimposed on the patient's vertebral column (see Fig. 60–6a). Especially in obese patients it is important to be sure that all the exposure factors are correct by using a scout film prior to starting the operation. Using an image-enhancing film holder with a proper grid also improves technical quality. If the *hepatic ducts* have not been filled with the contrast material, repeat the X ray after injecting another dose into the cystic duct. Otherwise hepatic duct stones will not be visualized. It is sometimes helpful to administer morphine sulfate. This drug will induce sphincter spasm. Then, dye injected into the cystic duct will fill the hepatic ducts.

Performing cystic duct cholangiograms routinely serves to familiarize the technicians and the surgical team with all of the details necessary to provide superior films. It also serves to shorten the time requirement for this step to 5–10 minutes.

Sphincter spasm. Spasm of the sphincter of Oddi sometimes prevents the passage of the contrast medium into the duodenum. Although this outcome is far more frequent after CBD exploration with instrumentation of the ampulla, it also does occur on rare occasions during a cystic duct cholangiogram. We have found that giving nitroglycerine intravenously seems to be more effective than using glucagon intravenously to relax the sphincter. Simultaneous with sphincter relaxation, there is generally a mild drop in the patient's blood pressure. At this time inject the contrast medium into the CBD. This medication is also useful when performing a completion cholangiogram after the CBD exploration has been completed.

Failing to consult with the radiologist. It is not reasonable for the operating surgeon to be the only physician responsible for interpreting the cholangiographic films. The surgeon tends to be overoptimistic, tends to accept poor technical quality, and is responsible for an excessive number of false negative interpretations. Always have a consultation with a radiologist familiar with this procedure before forming a final conclusion concerning the cholangiogram.

Ligating the Cystic Artery

Gentle dissection in the triangle of Calot will reveal the cystic artery, which may cross over or under the common or right hepatic duct on its way to the gallbladder. It frequently divides into two branches, one anterior, one posterior. Confirmation of the identity of this structure is obtained by tracing the artery up along the gallbladder wall and demonstrating the lack of any sizable branch going to the liver. Often the anterior branch of the cystic artery can be seen running up the medial surface of the gallbladder. By tracing this branch from above down, its point of origin will lead to the location of the cystic artery. Ligate this artery in continuity after passing a 2–0 silk ligature around it with a Mixter right-angle hemostat (**Fig. 60–9**). Apply a Hemoclip to the gallbladder side of the vessel and transect the cystic artery, preferably leaving a 1-cm stump of artery distal to the ligature (**Fig. 60–10**). If there is fibrosis in Calot's triangle and the artery is not evident, pass a Mixter clamp beneath these fibrotic structures. While the first assistant exposes the structures by elevating the Mixter clamp, the surgeon can more easily dissect out the artery from the surrounding scar tissue. In case the cystic artery is torn and hemorrhage results, this is easily controlled by inserting the left index finger into the foramen of Winslow and then compressing the hepatic artery between the thumb and forefinger until the exact source of bleeding is controlled by a clamp or a suture.

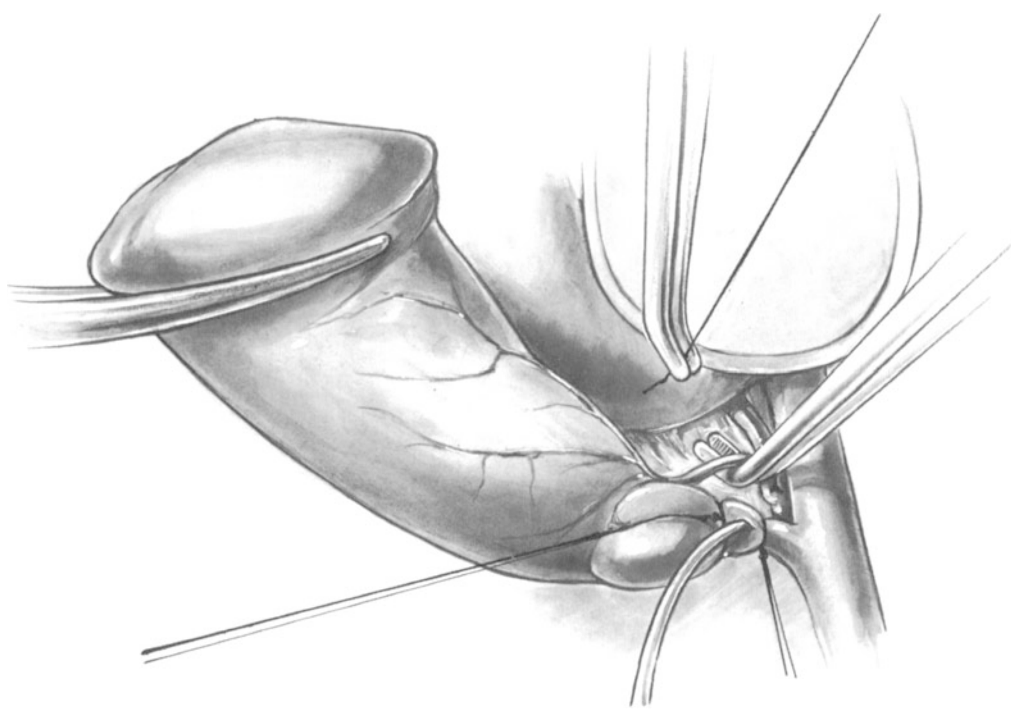


Fig. 60–9

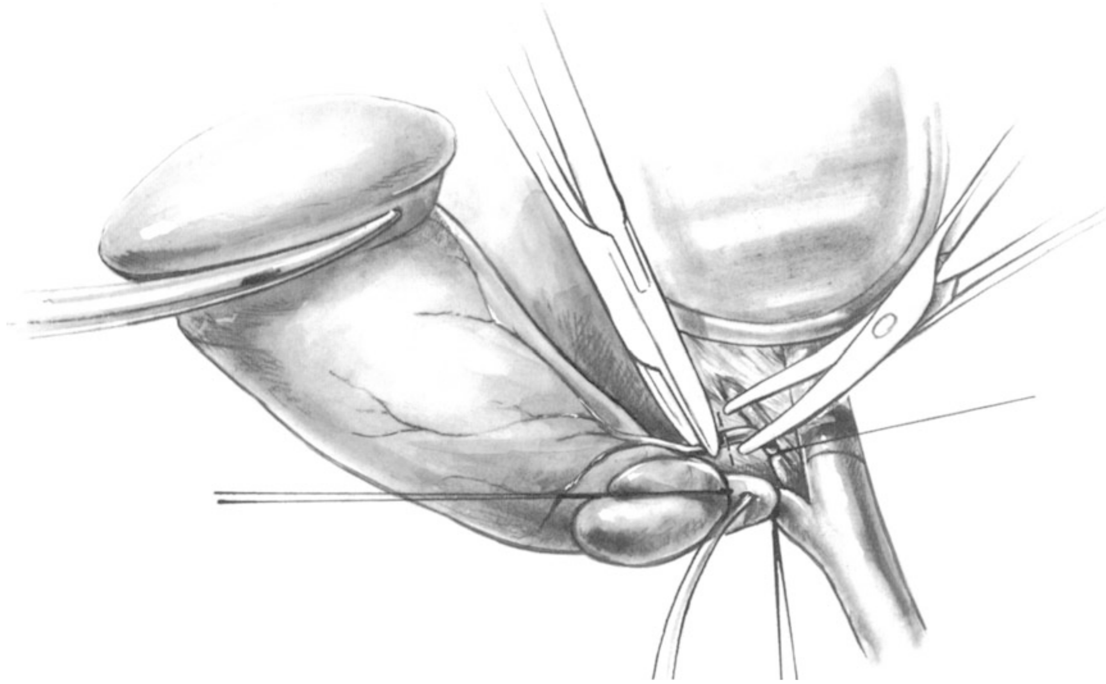


Fig. 60–10

Dissecting the Gallbladder Bed

In no case of cholecystectomy is the cystic duct transected or clamped prior to complete mobilization of the gallbladder. This mobilization may be done by taking advantage of the incision in the peritoneum overlying Calot's triangle as described above and simply continuing this peritoneal dissection from below upward along the medial border of the gallbladder. Insert a Mixter clamp beneath the peritoneum while the first assistant makes an incision using electrocautery (**Fig. 60–11**). Alternatively, make a scalpel incision in the superficial layer of the gallbladder wall across its fundus. Use the electrocautery to dissect the mucosal layer of the gallbladder away from the serosal layer, *leaving as much tissue as possible on the liver side*. This leaves a shiny layer of submucosa on the gallbladder. Tiny vessels coming from the liver to the gallbladder can be identified and individually occluded with electrocautery. When the plane of dissection is deep to the serosa, raw liver parenchyma presents itself. Oozing from raw liver is difficult to control with electrocoagulation. In this case, either prolonged pressure with moist gauze or the application of a small sheet of Surgicel to the area of raw liver surface can provide excellent hemostasis after 10–15 minutes of local compression.

As the dissection proceeds down along the liver, do not apply any hemostats, as the vessels in this plane are small. Near the termination of this dissection along the posterior wall of the gallbladder, a bridge of tissue will be found connecting the gallbladder ampulla with the liver bed. Instruct the assistant to pass a Mixter clamp through the opening in Calot's triangle that was previously made when

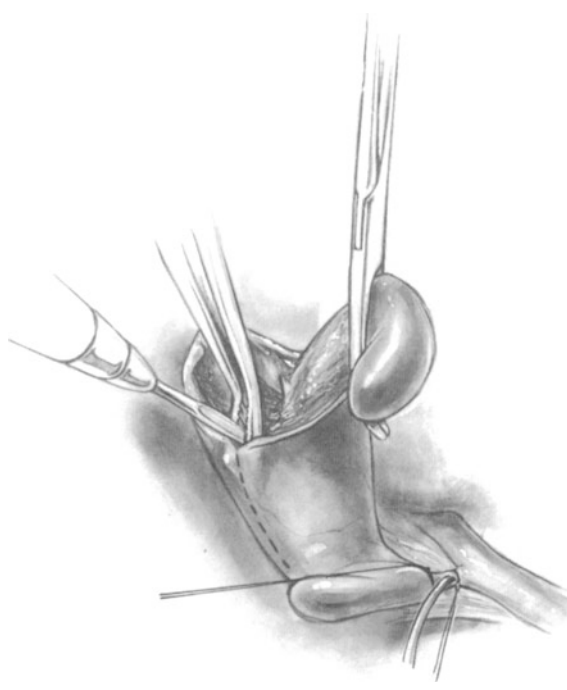


Fig. 60–11

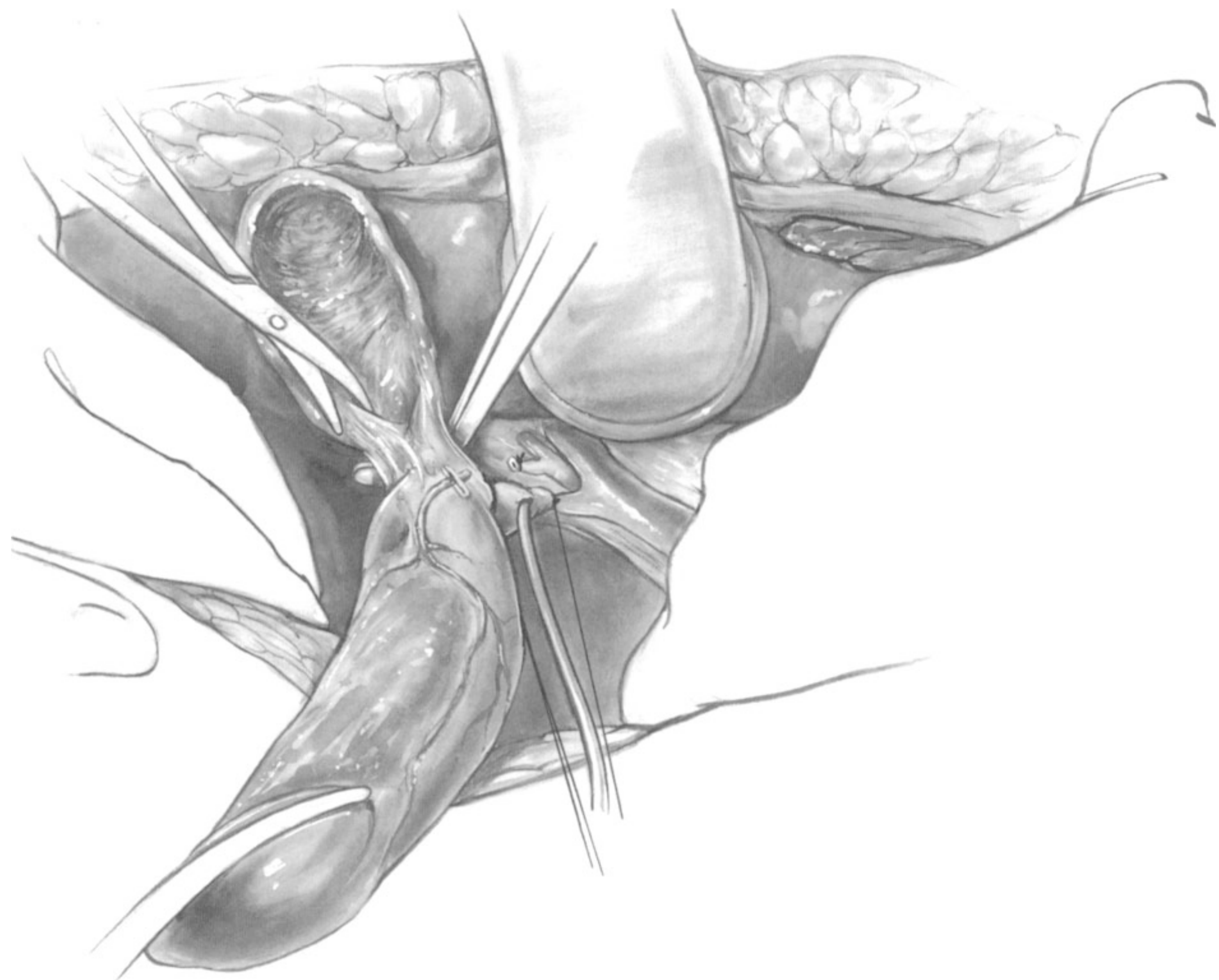


Fig. 60–12

the cystic artery was ligated (**Fig. 60–12**). This clamp will elevate the bridge of tissue and the surgeon will dissect out its contents by carefully nibbling away at it with his Metzenbaum scissors in order to rule out the possibility that it contains the common hepatic duct. In cases where excessive fibrosis has prevented the prior identification and ligature of the cystic artery, there is generally, at this stage of dissection, no great problem in identifying this vessel coming from the area near the hilus of the liver toward the back wall of the gallbladder.

With the gallbladder hanging suspended only by the cystic duct, dissect the duct down to its junction with the common hepatic duct. Exact determination of the junction between the cystic and the hepatic ducts is usually not difficult after electrocoagulating one or two tiny vessels that cross over the acute angle between the two ducts. Rarely, a lengthy cystic duct continues distally towards the duodenum for several centimeters.

The cystic duct may even enter the CBD on its *medial* aspect near the ampulla of Vater. In these cases, it is hazardous to dissect the cystic duct down into the groove between the duodenum and pancreas; thus, it is preferable to leave a few centimeters of duct behind. Confirmation of the anatomy may be accomplished by cholangiography. In general, the cystic duct is clamped at a point about 1 cm from its termination and divided (**Fig. 60–13a**). Transfix the cystic duct stump with a 3–0 PG suture-ligature (**Fig. 60–13b**). *Never is the cystic duct clamped or divided except as the last step in a cholecystectomy.*

Achieve complete hemostasis of the liver bed with the electrocoagulator (**Fig. 60–14**). If necessary, use suture-ligatures; in unusual cases, leave a sheet of Surgicel in the liver bed to control venous oozing.

Palpating the CBD

Prior to terminating the operation, especially if cholangiography has not been performed, it is es-

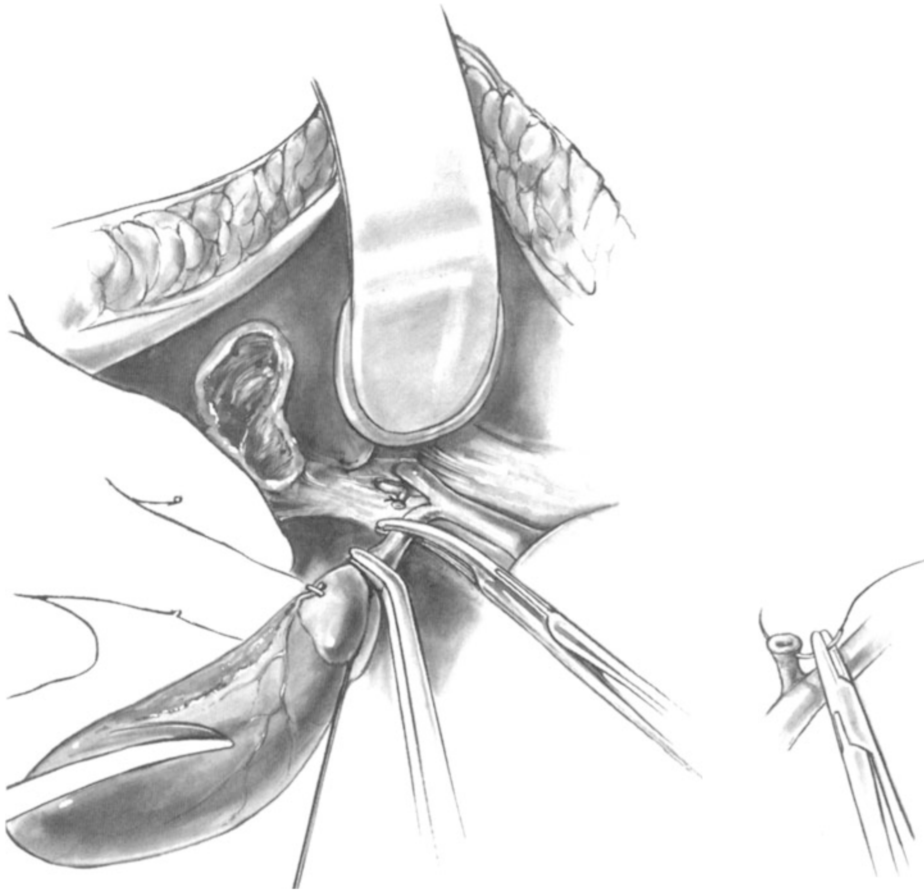


Fig. 60–13 A B

sential to properly palpate the CBD in order to reduce the possibility of overlooked calculi. This is done by inserting the index finger into the foramen of Winslow and palpating the entire duct between the left index finger and thumb. Since a portion of the distal CBD is situated between the posterior wall of the duodenum and the pancreas, *it is necessary to insert the index finger into the potential space posterior to the pancreas and behind the second portion of the duodenum.* It is not necessary to perform a complete Kocher maneuver. If the surgeon will gently insinuate the left index finger behind the CBD and continue in a caudal direction behind the pancreas and the duodenum, he will not encounter bleeding unless he is too rough. In this fashion, with the index finger behind the second portion of the duodenum and the thumb on its anterior wall, carcinomas of the ampulla and calculi in the distal CBD may be

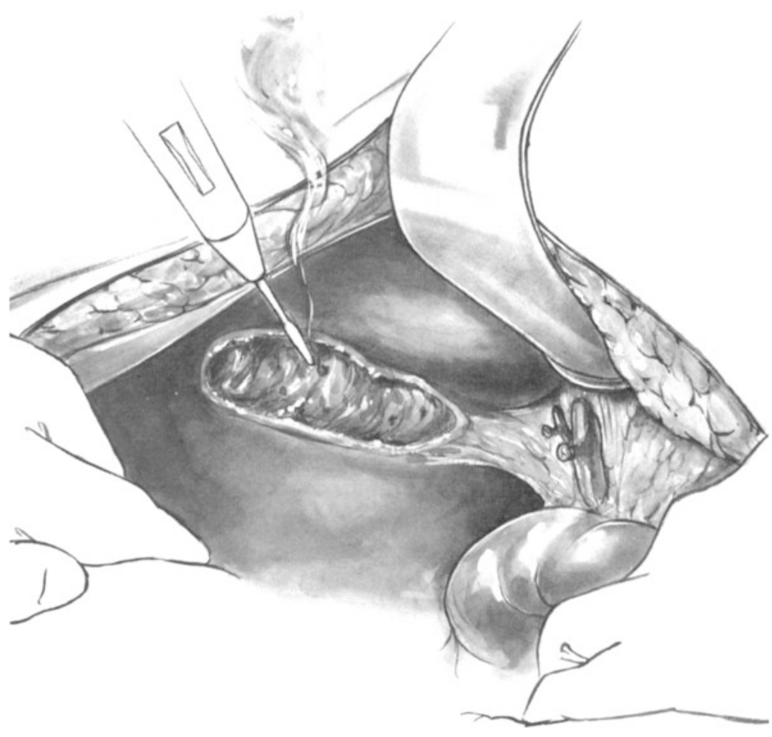


Fig. 60–14

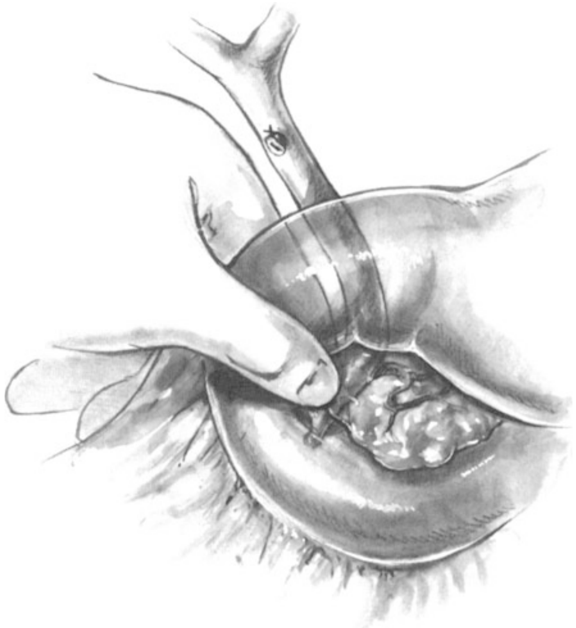


Fig. 60–15

detected (**Fig. 60–15**). If this maneuver is not successful, perform a formal Kocher maneuver.

Drainage and Closure

We insert a flat Silastic Jackson-Pratt closed-suction catheter following cholecystectomy only in cases of acute cholecystitis. Bring the catheter out from the renal fossa through a puncture wound just lateral to the right termination of the subcostal incision (**Fig. 60–16**).

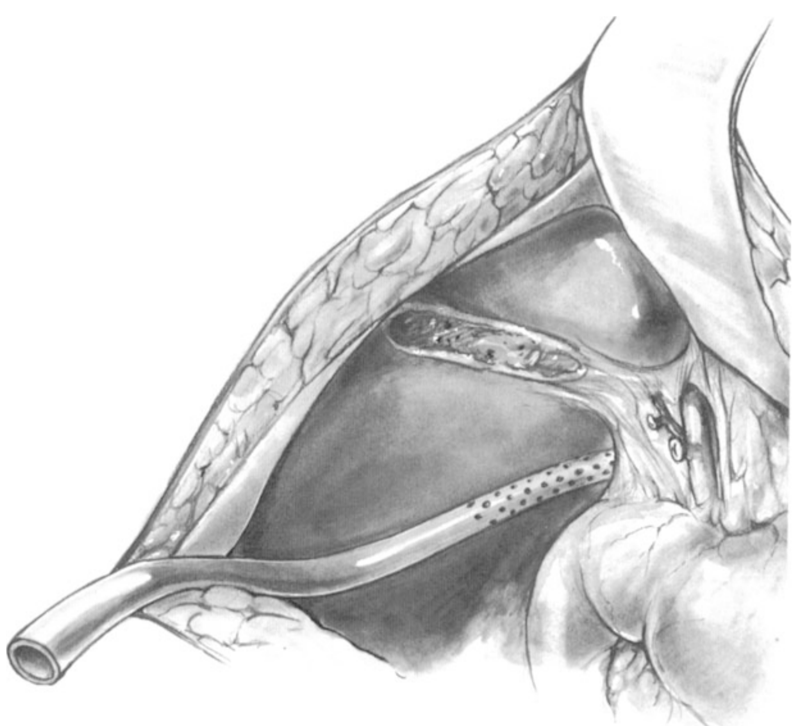


Fig. 60–16

There is abundant evidence that a patient who has undergone a technically precise and uncomplicated simple cholecystectomy does not require the insertion of any type of drain (Budd, Cochran, and Fouty; also Elboim, Goldman, Hann et al.).

Do not reperitonealize the liver bed since this step serves no useful purpose. Close the abdominal wall in routine fashion (see Chap. 5). We use 1 PDS suture material for this step.

Postoperative Care

After an uncomplicated cholecystectomy, nasogastric suction is not necessary. In patients with acute cholecystitis, paralytic ileus is not uncommon; thus nasogastric suction will be necessary for 1–3 days.

After uncomplicated cholecystectomy, antibiotics are not necessary except in the older age group (over 70). The elderly patients have a high incidence of bacteria in the gallbladder bile and should have perioperative antibiotics prior to and for 2–3 doses after operation. Following cholecystectomy for acute cholecystitis, administer antibiotics for 4–5 days, depending on the Gram stain of the gallbladder bile sampled in the operating room.

Unless there is a significant amount of bilious drainage, remove the drain on approximately the 4th postoperative day.

Postoperative Complications

Bile leak. Minor drainage of bile may follow the interruption of some small branches of the bile ducts in the liver bed. This does not occur if the outer layer of the gallbladder serosa is left behind on the liver bed. On very rare occasions a duct of significant size may enter the gallbladder, but we have never encountered such an instance. Bile drainage of 100–200 ml will occur if the surgeon has inadvertently transected an anomalous duct draining the dorsal caudal segment of the right lobe. If this complication is diagnosed by a sinogram X ray, expectant therapy may result in gradual diminution of drainage as the tract becomes stenotic. However, if there is any infection in the area drained by the duct, recurrent cholangitis or liver abscess may occur. In this case, permanent relief may eventually necessitate resecting the segment of the liver drained by the transected duct.

If the volume of bile drainage exceeds 400 ml/day, transection of the hepatic or the common bile duct may be suspected.

Jaundice. Postcholecystectomy jaundice is usually due either to ligature of the CBD or an overlooked CBD stone. If other causes are ruled out, an endoscopic radiographic cholangiopancreatogram (ERCP) is indicated to identify the obstruction.

Hemorrhage. If the cystic artery has been accurately ligated, postoperative bleeding is an extremely rare complication. Occasionally oozing from the liver bed may continue postoperatively and may require relaparotomy for control.

Subhepatic abscess; hepatic abscess. Following cholecystectomy these two complications are seen primarily in cases of acute cholecystitis. Postoperative abscesses are extremely rare in patients whose surgery was for chronic cholecystitis unless a bile leak occurs. Treatment by percutaneous CT-guided catheter drainage is usually successful.

References

Brittain RS, Marchioro TL, Hermann G et al. Accidental hepatic artery ligation. Am J Surg 1964;107:822.

Budd DC, Cochran RC, Fouty WJ Jr. Cholecystectomy with and without drainage: a randomized prospective study of 300 patients. Am J Surg 1982;143:307.

Elboim CM, Goldman L, Hann L et al. Significance of post-cholecystectomy subhepatic collections. Ann Surg 1983;198:137.

Jolly PC, Baker JW, Schmidt HM et al. Operative cholangiography: a case for its routine use. Ann Surg 1968; 168:551.

Longmire WP Jr. The diverse causes of biliary obstruction and their remedies. Curr Probl Surg 1977;14:1.

Longmire WP Jr, Tompkins RK. Lesions of the segmental and lobar hepatic ducts. Ann Surg 1975;182:478.

Schulenberg CAR. Operative cholangiography: 1,000 cases. Surgery 1969;65:723.

61 Laparoscopic Cholecystectomy

Indications

Confirmed diagnosis of symptomatic gallstones

Acute or chronic cholecystitis

Availability of a skilled team that has completed its learning curve

Contraindications

Prior major surgery of the upper abdomen

Liver cirrhosis

Bleeding disorders

Preoperative Preparation

Ultrasound or oral cholecystogram demonstrating the presence of gallbladder calculi

Perioperative antibiotics initiated prior to the induction of anesthesia

Insert nasogastric tube

Insert Foley catheter

In patients whose common bile duct measures over 7 mm on ultrasound examination and whose liver chemistry profile shows abnormalities, an endoscopic radiographic cholangiopancreatogram (ERCP) is indicated for the detection of possible common bile duct calculi. If calculi are present and a skilled operator is available, endoscopic papillotomy with extraction of the stones is advisable. Subsequent to this procedure, the passage of 2–3 days will permit the surgeon to rule out the complication of postpapillotomy acute pancreatitis prior to performing laparoscopic cholecystectomy. For a team that is skilled at laparoscopic choledocholithotomy, preoperative ERCP may not be necessary.

Operative Strategy

Bleeding

Meticulous hemostasis is essential in laparoscopic cholecystectomy, not only to avoid blood loss, but because bleeding impairs the visibility so necessary to perform this operation safely and with precision. Careful use of electrocautery will accomplish this end.

Cautery versus Laser

Despite the extensive early publicity concerning the use of lasers in laparoscopic cholecystectomy, randomized prospective studies have shown no advantage of lasers, and anecdotal reports suggest an increased danger of injury to vital structures with the use of lasers. With any source of energy great care must be exercised, especially in the triangle of Calot, as there have been reports of lengthy strictures of the common and hepatic ducts presumably due to careless application of the laser or electrocautery in this area (Davidoff et al.). In employing the cautery near the bile ducts, use a hook and elevate the tissues to be electrocoagulated above the underlying structures in Calot's triangle. This will minimize damage to the bile ducts.

Preventing Bile Duct Damage

As discussed under "Complications" at the conclusion of this chapter, most serious bile duct injuries result from the surgeon's mistaking the common bile duct for the cystic duct, resulting in transection of the common bile duct and occasionally the excision of the common bile duct and most of the common hepatic duct. In laparoscopic cholecystectomy, the cephalad retraction of the gallbladder fundus results in abnormal displacement of the usual pathway of the common and hepatic ducts. Normally the common duct and common hepatic duct are aligned essentially in a straight line ascending from the duodenum to the liver. However, with forceful cephalad retraction of the gallbladder fundus, the common bile duct appears to run in a straight line with the cystic duct directly into the gallbladder, as illustrated in **Fig. 61–1**. In this situation, the common hepatic duct appears to join this straight line at a right angle. It is dangerous to initiate the dissection in the region of the bile ducts. This may lead to the mistake of assuming that the common bile duct is indeed the cystic duct. A dissection going in an ascending direction towards the gallbladder may very well transect the common hepatic duct. Two precautions must be taken to avoid this error. One, always initiate the dissection on the gallbladder and remove all areolar tissue in a downward direction

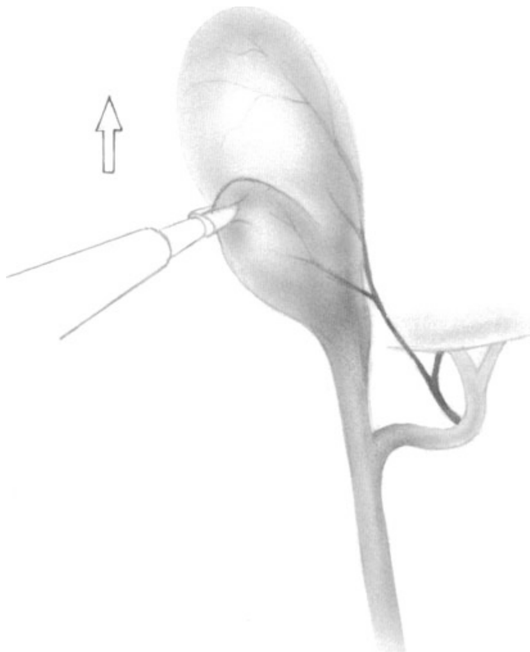


Fig. 61–1

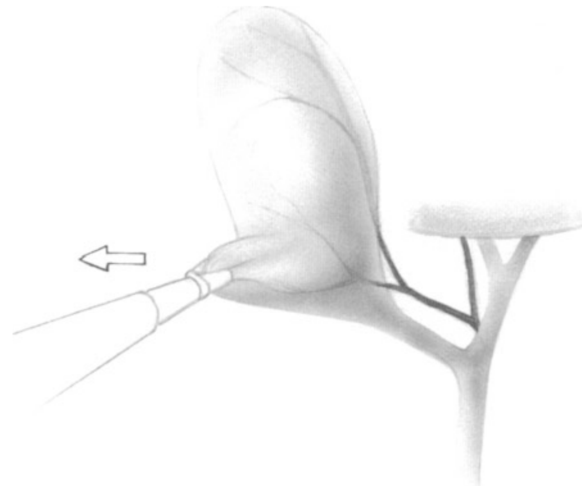


Fig. 61–2a

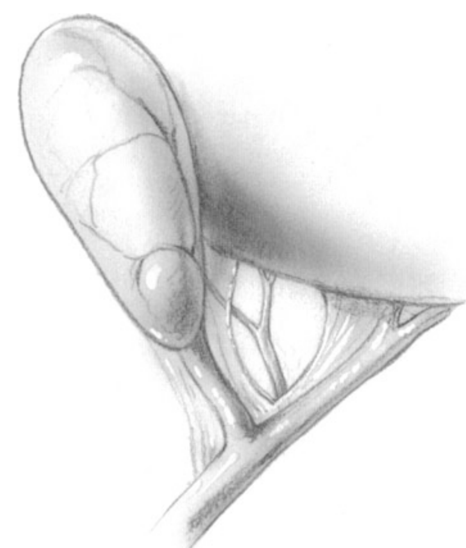


Fig. 61–2b

so that the dissection continuously proceeds from the gallbladder ampulla downward toward the cystic duct. Two, after the gallbladder ampulla and infundibulum have been cleared of areolar tissue and fat, retract these structures laterally toward the patient's right, as seen in **Fig. 61–2a**. This helps restore the normal anatomy of the common and hepatic ducts and serves to open up the triangle of Calot and the space between the cystic and common hepatic ducts.

The final essential component of a technique that will avoid damaging the common bile duct is to *create a window behind the gallbladder ampulla and infundibulum* by dissecting the gallbladder away from the liver. Then, having exposed the posterior surface of the ampulla, continue to clear the posterior walls of the infundibulum and the cystic duct until there is a 3–4 cm window of empty space behind the cystic duct, infundibulum, and gallbladder ampulla (**Fig. 61–2b**). If the continuum between gallbladder, infundibulum, and cystic duct is clearly identified after elevating the structures, one can then be assured of the identity of the cystic duct. If by mistake one had initiated the dissection by freeing up the common bile duct caudal to its junction with the cystic duct, then as the dissection proceeded cephalad toward the gallbladder, the common hepatic duct would be encountered joining the cystic duct on its medial aspect (see Fig. 61–1). This approach puts the hepatic and common ducts at risk of major injury.

Assuring Good Exposure

Since excellent visibility is essential to prevent unnecessary damage, do not hesitate to install an additional cannula for the insertion of a retracting device, to depress the transverse colon, or to retract the liver whenever necessary.

Intraoperative Cholangiogram

Many experienced laparoscopic surgeons feel that an intraoperative cholangiogram, performed as soon as the cystic duct is identified, is an excellent means of ascertaining the exact anatomy of the biliary tree. This will confirm your identification of the cystic duct and will also detect an anomalous hepatic duct in time to avoid operative trauma.

Conversion to Open Cholecystectomy

Whenever there is any doubt about the safety of a laparoscopic cholecystectomy, whether due to inflammation, scarring, poor visibility, equipment deficiencies, or any other reason, have *no hesitation* to convert the operation to an open cholecystectomy. Every patient's preoperative consent form should acknowledge the possibility that an open cholecystectomy may be necessary for the patient's safety. *Conversion to open cholecystectomy is not an admission of failure, but an expression of sound judgment by a surgeon who gives first priority to the safe conduct of the operation.*

Pitfalls and Danger Points

Be aware that some patients may have a very *short cystic duct*, which increases the risk of bile duct damage by misidentification. Again, if the dissection is initiated to free the posterior wall of the gallbladder ampulla and infundibulum, one will expose the common hepatic duct behind the gallbladder early in the dissection (**Fig. 61–3**). This should prevent misidentification of the anatomy. If one suspects the presence of a short cystic duct but is not certain, then be sure to perform an intraoperative cholecystocholangiogram by injecting the contrast material into the gallbladder with a long needle.

Damage to aorta, vena cava, iliac vessels, or bowel during trocar insertion

Damage to common or hepatic duct due to misidentification

Bleeding due to avulsion of the posterior branch of the cystic artery that has not been properly identified

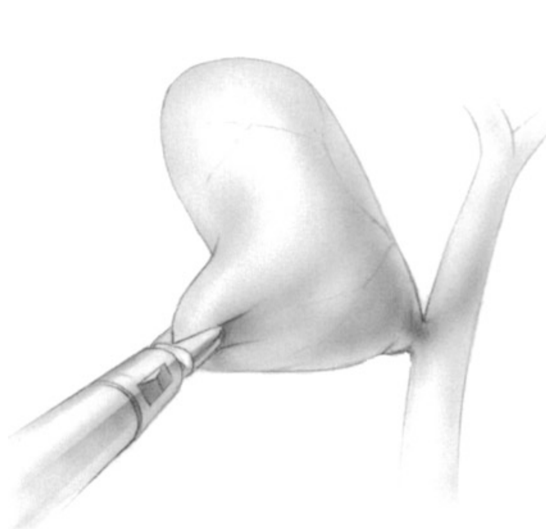


Fig. 61–3

Operative Technique

Creation of Pneumoperitoneum—Veress Needle

An essential condition for performing this operation is that the surgeon have a complete understanding of the particular mechanical devices and equipment that are to be used. Each manufacturer produces devices that have points of difference when compared to other brands.

Place the patient in a 10–15° Trendelenburg position. Estimate the distance between the abdominal wall and the abdominal aorta by palpating the aorta. In a thin patient this distance may be only 3 cm. Make a 1-cm transverse incision along the lower margin of the umbilicus exposing the anterior rectus fascia. Expose fascia for a distance of about 10 mm in a vertical direction. Then apply a Kocher clamp to the lower margin of the exposed fascia and elevate the clamp in an anterior direction to increase the distance between the abdominal wall and the great vessels. Now grasp the Veress needle between thumb and forefinger. Hold it like a dart. After the tip of the needle has been inserted into the abdominal wall, place one drop of saline in the hub of the needle. Now aim the needle roughly in the direction of the sacral promontory. As the needle passes through the abdominal wall, one should feel a pop as it passes through the fascia and another when it penetrates the peritoneum. At this point, the drop of saline in the hub should be drawn into the peritoneal cavity because of the negative pressure that exists in the peritoneal cavity with traction upward on the abdominal wall. This can be confirmed by placing another drop of saline into the hub of the needle and then elevating the abdominal wall to create more negative pressure. If the drop of fluid is not drawn into the peritoneal cavity, readjust the position of the needle. If this is unsuccessful, withdraw the needle and reinsert it. When the needle appears to be in the proper position, perform a confirmatory test by attaching a syringe containing 10 ml of saline into the hub of the needle and inject the saline into the abdominal cavity. Then attempt to aspirate the fluid. If the needle is in the peritoneal cavity, no fluid will be aspirated. If turbid fluid is aspirated, suspect that the needle has entered bowel. If blood returns, remove the needle and perform a prompt insertion of a Hasson cannula as described below and quickly insert the laparoscope to inspect the abdominal cavity for vascular injury.

Assuming that the Veress needle has entered the abdominal cavity uneventfully, attach the tube leading to the CO_2 insufflator. Regulate the inflow to a rate of 1 liter per minute. The initial reading in the gauge measuring intra-abdominal pressure should be in the 5–10 mm Hg range if the needle is in the free peritoneal cavity. After 3–4 liters of gas have been injected into the peritoneal cavity, percuss the four quadrants of the abdomen to confirm that the gas is being evenly distributed. Finding this to be true will confirm the fact that the needle is in the proper location. One can then increase the flow rate until the intra-abdominal pressure has reached 15 mm Hg. At this stage, remove the Veress needle and insert the trocar-cannula into the previous umbilical incision. We prefer a disposable device for the initial trocar insertion, such as the Surgiport (U.S. Surgical Corp.). Direct this device in the direction of the sacral promontory and exert gradual pressure with no sudden motions, until it has penetrated the abdominal cavity. Then connect the insufflation device to the cannula and continue insufflation to maintain the desired intra-abdominal pressure. The initial cannula should have a diameter of 10–11 mm.

Remove the trocar and insert the laparoscopic telescope into the cannula. Inspect the organs of the pelvis and posterior abdominal wall. Look for evidence of trauma that might have been inflicted during the needle insertion, either to the vascular structures or to the bowel. If no evidence of trauma is seen, aim the telescope at the right upper quadrant and make a preliminary observation of the upper abdominal organs and gallbladder.

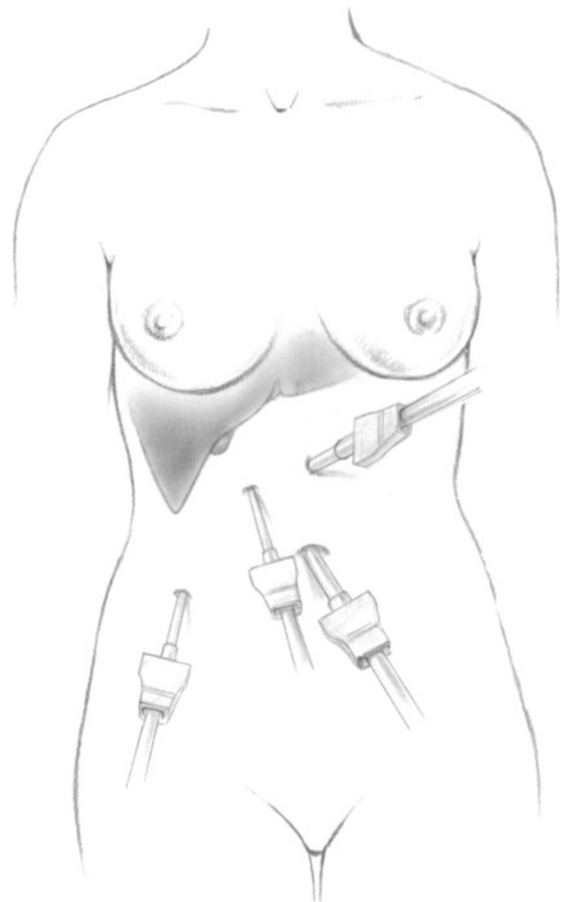


Fig. 61–4

Insertion of Secondary Trocar-Cannulas

A second 10–11 mm cannula will be inserted in the epigastrium at a point about one-third of the distance between the xiphoid process and the umbilicus. This generally is placed just to the right of the midline in order to avoid the falciform ligament. With a finger, depress the abdominal wall in this general area and observe with the telescope to define the exact location at which to insert the trocar. Make a 1-cm transverse skin incision at this point and then insert the trocar-cannula under direct vision by aiming the telescope-camera at the entry point of the trocar. Apply even pressure with no sudden motions. Serious injuries of the liver and other organs have been reported following vigorous insertions of the trocar. As soon as the cannula has entered the abdominal cavity, remove the trocar. This will constitute the main operating port.

Two secondary ports are established, one in the midclavicular line about 2–3 cm below the costal margin, and a third in the anterior axillary line at a point about level with the umbilicus. These two are 5-mm ports mainly for grasping and retraction. Insert each of these ports after making a 5-mm skin incision. Observe and control the entry of each of these trocars carefully by watching the television monitor.

The objective is to position the ports to enable the surgeon to manipulate the dissecting instruments at a point in front of and roughly at right angles to the telescope. **Fig. 61–4** illustrates a typical arrangement of cannulas and the surgical team.

Creating Pneumoperitoneum—Hasson Cannula

A patient who has had extensive surgery in the right upper quadrant is generally a poor candidate for laparoscopic cholecystectomy. However, it is quite feasible to perform this operation in patients who have had *lower* abdominal surgery even if the incision encroaches upon the umbilicus. This may be accomplished by inserting the initial trocar-cannula in the epigastrium instead of the umbilicus. Alternatively, one may make a vertical 1–2 cm incision in the umbilicus and adjacent subumbilical area with a scalpel. Then identify the rectus fascia in the midline. Make a scalpel incision through the fascial layer and identify the peritoneum. Insert the index finger and carefully explore the undersurface of the fascia for adherent bowel. Open the peritoneum under direct vision with a scalpel. After this dissection has been completed and finger exploration ascertains that the abdominal cavity has been entered, insert a Hasson cannula under direct vision. The cannula has an adustable olive-shaped obturator which will partially enter the small incision. Insert a heavy PG suture, one on the left and another on the right aspect of the incision. Then attach each of these sutures to the respective wing of the Hasson cannula. This will firmly anchor the olive obturator in the incision and prevent loss of pneumoperitoneum. After this step has been accomplished, insufflation of CO_2 gas can be initiated. When the pressure reaches 12–15 mm Hg, the telescope is inserted and the operation can begin.

Whenever there is any difficulty or uncertainty about inserting the initial trocar-cannula into the abdomen, do not hesitate to abandon the blind steps of inserting the Veress needle or the trocar-cannula and switch to an open "mini-laparotomy" for the insertion of a Hasson cannula. Some surgeons use the Hasson cannula for all laparoscopic procedures.

The secondary trocar-cannulas are inserted under direct observation as described above.

Management of Hypotension Following Needle or Trocar Insertion for Creation of Pneumoperitoneum

Insufflation of CO_2 may result in a cardiac arrhythmia which constitutes one cause of hypotension. If this is the case, discontinue CO_2 insufflation and the anesthesiologist will hyperventilate the patient until the arrhythmia is corrected. All patients undergoing laparoscopic surgery should be monitored with a pulse oximeter as well as for end-tidal CO_2 by the anesthesiologist.

Another cause of hypotension is tension pneumothorax, which should be checked if unexpected hypotension occurs during the operation. In the absence of these complications, one should suspect that intra-abdominal bleeding secondary to trocar insertion may have caused the hypotension. A quick survey of the abdomen with the laparoscope is indicated. Look for hematomas, especially arising in the retroperitoneal area. If laparoscopic search is not adequate, do not hesitate to make an emergency midline laparotomy incision, leaving all of the instruments and trocars in place. Explore the retroperitoneal area for damage to the great vessels, including the aorta, the vena cava, and the iliac vessels.

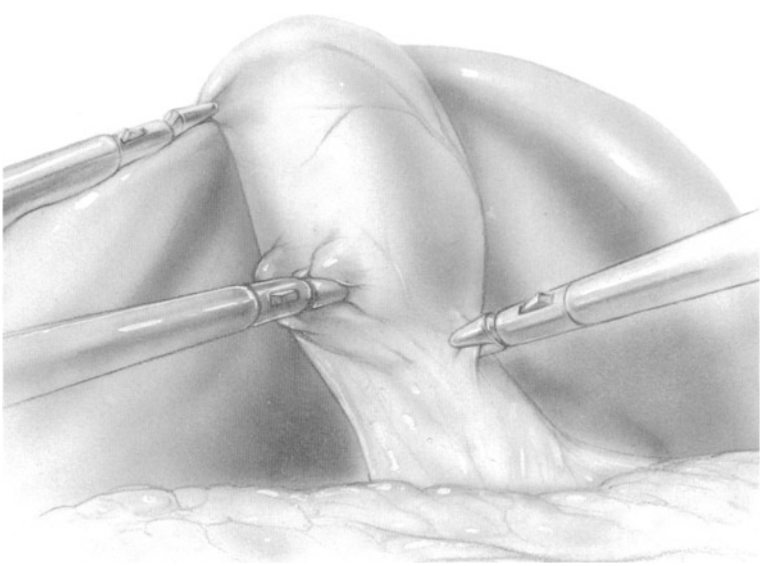


Fig. 61–5

Dissecting the Gallbladder Ampulla

To expose the gallbladder, elevate the head of the table to a 30° reverse Trendelenburg position. Apply suction to the nasogastric tube as necessary to deflate the stomach. Sometimes moderate upward rotation of the right side of the operating table is also helpful in improving exposure. Insert a grasping forceps through the right lateral port and grasp the upper edge of the gallbladder. Push the gallbladder in a cephalad direction anterior to the liver. Utilizing the midclavicular port, have the assistant insert a second grasping forceps to grasp the gallbladder ampulla and apply countertraction while the surgeon uses an appropriate dissecting forceps inserted through the upper midline port.

The first objective is to expose the gallbladder ampulla by dissecting away any adherent omentum and other structures. Then grasp the areolar tissue and fat overlying the ampulla with a grasping forceps (**Fig. 61–5**), apply a burst of electrocoagulating current, and pull the tissue in a caudad direction. While this is being done, the assistant's grasping forceps draws the ampulla of the gallbladder gently toward the patient's right, as illustrated in Fig. 61–2. Either a hook electrocoagulator or an electrified scissors can also be used to divide the peritoneal layers that cover the infundibulum of the gallbladder and cystic duct. Use the hook dissector to liberate the lower portion of the gallbladder from its attachment to the liver, both laterally and medially. *Create a large window of space behind the gallbladder ampulla, the infundibulum, and the cystic duct* (see **Fig. 61–2a**). The dissection should continuously be directed from the gallbladder downward toward the cystic duct. Always consider that the common bile duct and hepatic ducts may be closer to the gallbladder than you think, especially in the case of patients who have a short cystic duct (see **Fig. 61–3**). Concentrating on the lower portion of the gallbladder and infundibulum is much safer than initiating the dissection behind what you *think* is the cystic duct, but which may indeed be the common bile duct.

After dissecting on both sides of the cystic duct by manipulating the ampulla from right to left, pass a right-angled Maryland dissector or a hook behind the cystic duct and free up several centimeters so that there is *complete exposure of the continuum of the posterior cystic duct going up to the infundibulum and the lower portion of the gallbladder ampulla* (**Fig. 61–6**).

Cystic Duct Cholangiogram

When one is certain that the cystic duct has been identified, apply a Hemoclip to the area of the infundibulum of the gallbladder and use a straight scissors to make an incision in the cystic duct just below the clip (**Fig. 61–7**). For the cholangiogram we prefer a balloon-tip catheter of the type made by the Arrow Company. This may be inserted into either the upper midline or the midclavicular port. The curvature of the catheter tip may be adjusted by pushing or withdrawing the catheter through its curved plastic catheter holder. After having tested the balloon, insert the catheter into the cystic duct incision for no more than 1 cm (**Fig. 61–8**). This point is marked by two black lines on the catheter body. Inflate the balloon and tentatively inject some contrast material to determine that leakage does not take place. Do not insert the catheter too far into the cystic duct. Otherwise, it will enter the common duct and the catheter balloon will occlude the common duct at the point of injection, resulting in an image only of the distal common duct from the catheter tip to the ampulla of Vater. This image will not prove that the common hepatic duct is intact. In this case, back out the catheter for a short distance and repeat the cholangiogram. Inject 4 ml of contrast material for the first film and an additional 8 ml for the second.

If the cholangiogram demonstrates satisfactory filling of the hepatic and common bile ducts as well as the duodenum, remove the catheter and continue to the next step of dividing the cystic duct as described below. If the cholangiogram demonstrates a calculus in the common bile duct, one may then perform a laparoscopic common bile duct exploration if the technology and skill are available. Otherwise, one has the choice of performing an open chole-

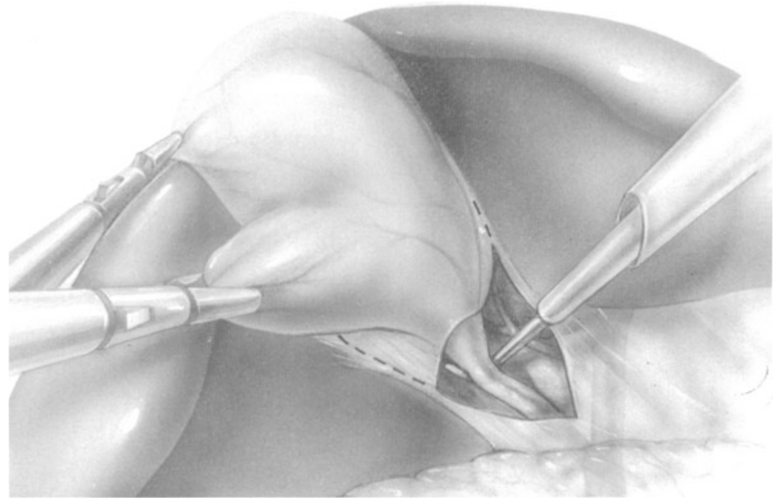


Fig. 61–6

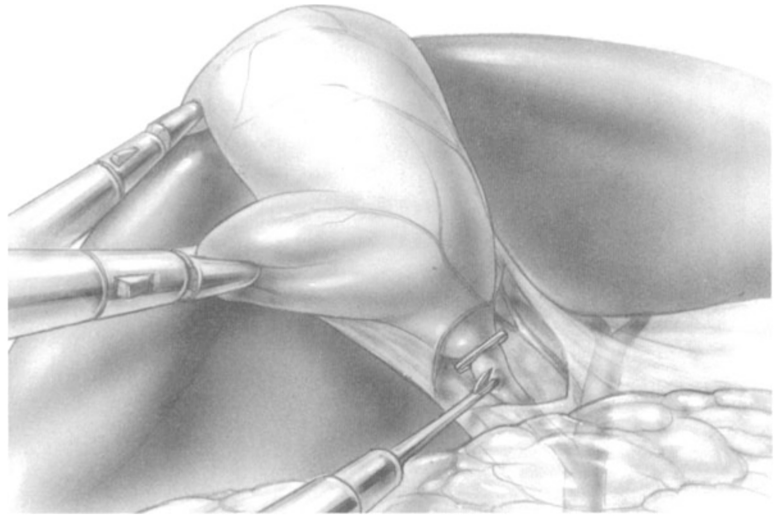


Fig. 61–7

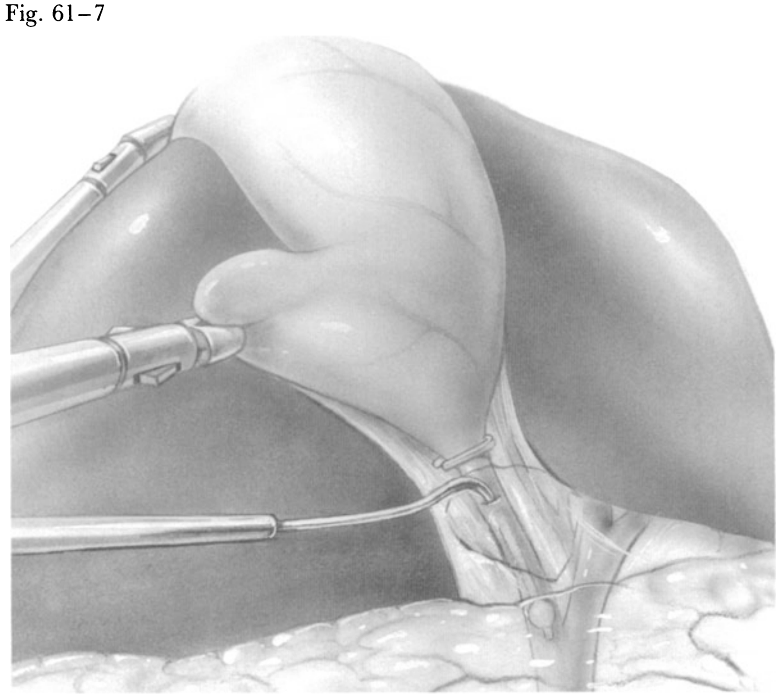


Fig. 61–8

cystectomy and choledocholithotomy or scheduling the patient for a postoperative endoscopic papillotomy for stone extraction. If the stone is exceedingly large, approaching 2 cm, an open choledocholithotomy is preferable. This is also the case if the patient has an exceedingly large number of stones or the patient has had a previous Bilroth II gastrectomy, making endoscopic papillotomy an unlikely task.

There need be no hesitation on the part of the surgeon if he chooses to perform open cholecystectomy and choledocholithotomy. This is a safe operation which will generally accomplish the complete clearing of the common bile duct in one procedure. This clearance may take the endoscopist several attempts to accomplish by endoscopic papillotomy. Remember also that endoscopic papillotomy for common duct extraction has a 1% mortality. One advantage of the open choledocholithotomy in patients who have 10–20 calculi is the ability to incorporate into the operation a biliary-enteric bypass like choledochoduodenostomy.

Since endoscopic papillotomy is feasible in only about 90% of patients due to anatomical variability or periampullary diverticula, it may be helpful to insert a guidewire through the opening in the cystic duct and pass this down the common duct into the duodenum. Duodenal placement can be confirmed by an abdominal X ray. In the presence of this guidewire, endoscopic papillotomy can be performed in almost 100% of patients. In cases where passage of the cholangiogram catheter is obstructed by the valves of Heister, the obstruction may be corrected by inserting the tip of the scissors into the cystic duct. Keep the scissors closed upon entering the duct and then open the scissors with mild force in order to dilate the valves.

Removing the Gallbladder

Remove the cholangiogram catheter and apply another Hemoclip on the gallbladder side of the incision (**Fig. 61–9**). Then apply two Hemoclips on the distal portion of the cystic duct. Divide the cystic duct with scissors.

During the dissection of the cystic duct, the cystic artery will generally be identified slightly cephalad to the cystic duct. Whenever this structure has been clearly identified, elevate it with either a Maryland dissector or a hook so that at least 1 cm is dissected completely from surrounding structures. Then apply one Hemoclip above and two Hemoclips below, and divide the artery with scissors (**Fig. 61–10**). Note that the point at which the cystic artery divides into its anterior and posterior branches can be somewhat variable. When you think you have divided the main cystic artery, you may have divided only the anterior branch. Keep alert in the latter part of the dissection for a posterior branch that will often have to be clipped and divided when the infundibulum of the gallbladder is freed. If this branch is small enough, it may be handled by electrocoagulation instead of clipping.

Now continue to dissect the gallbladder away from the liver. This can be done with the electrocautery using either a hook or a spatula dissection. Divide the peritoneum between the gallbladder and the liver on each side of the gallbladder. Then continue the dissection on the posterior wall of the

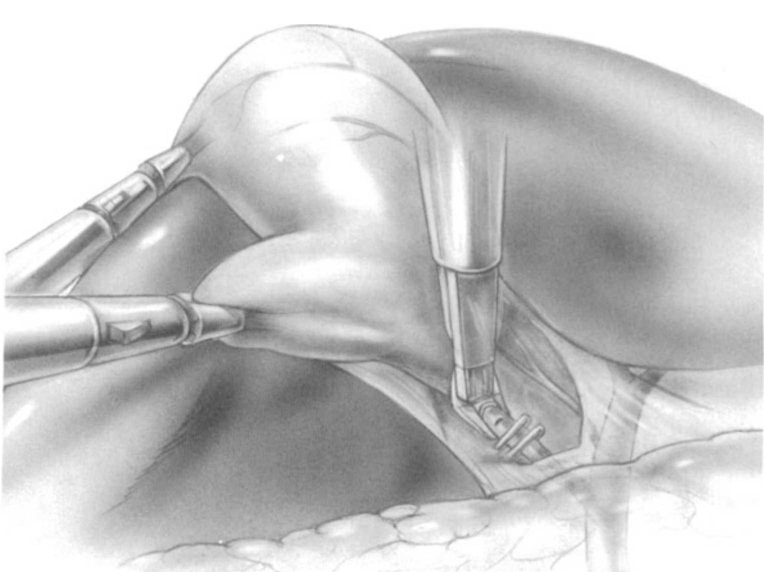


Fig. 61–9

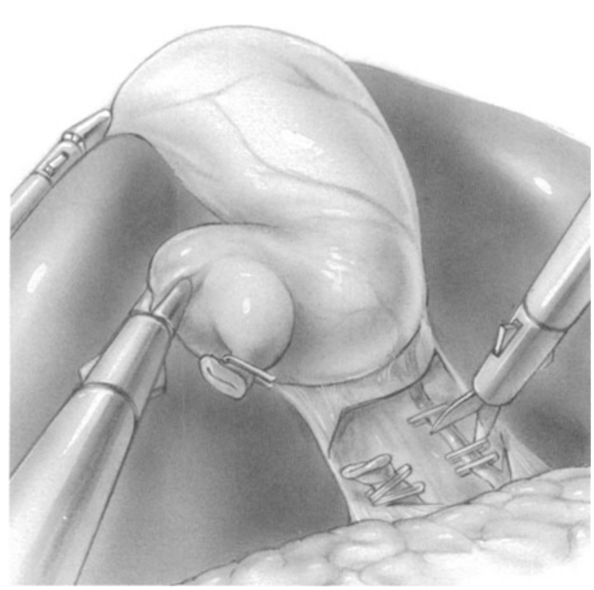


Fig. 61–10

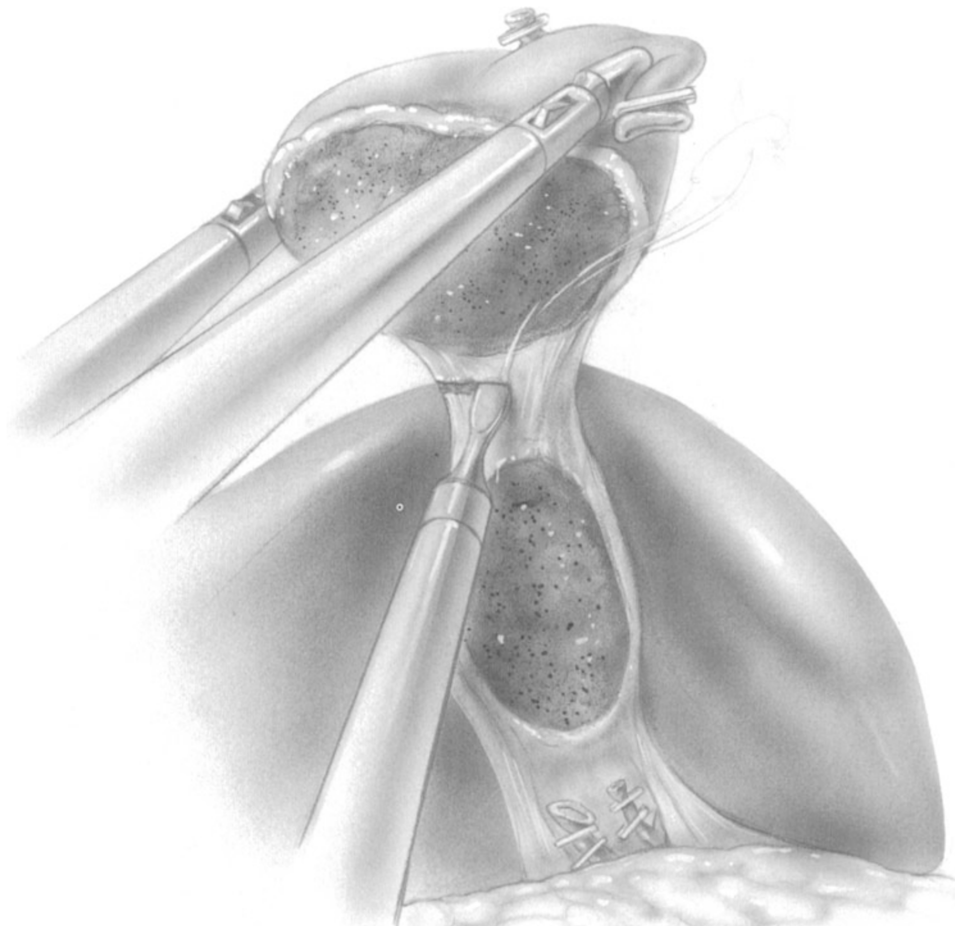


Fig. 61–11

gallbladder. This will require that the first assistant maneuver his two grasping forceps to expose various aspects of the gallbladder in such fashion that countertraction is applied for the surgeon performing the dissection. Before the gallbladder is totally free of its attachment to the liver, carefully inspect the liver bed for bleeding points. Irrigate the area. If there are any bleeding points in the liver bed, these can be occluded by applying a suction-electrocoagulator.

Finally, by elevating the gallbladder, its final attachment can be divided (**Fig. 61–11**). Leave the gallbladder in position over the dome of the liver being held in the lateral port grasper.

Remove the laparoscope from the umbilical cannula and place it through the upper midline sheath. Insert a large claw grasper through the umbilical cannula. Pass the claw along the anterior abdominal wall to reach the gallbladder over the dome of the liver. Follow the action with the camera. The claw will grasp the gallbladder at its neck. Then pull the gallbladder into the umbilical cannula as far as it will go. Now remove the cannula together with the gallbladder. As soon as the neck of the gallbladder is seen outside the umbilicus (**Fig. 61–12**), make an

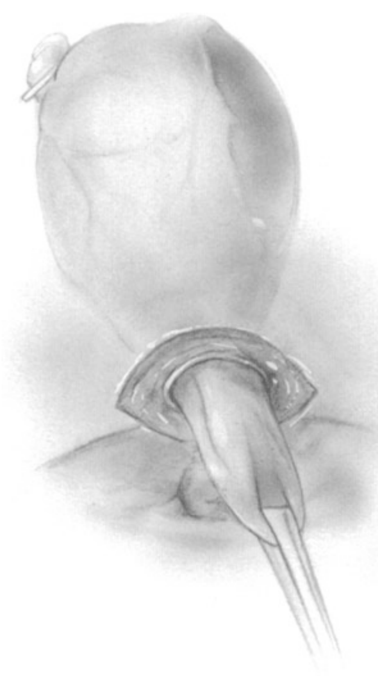


Fig. 61–12

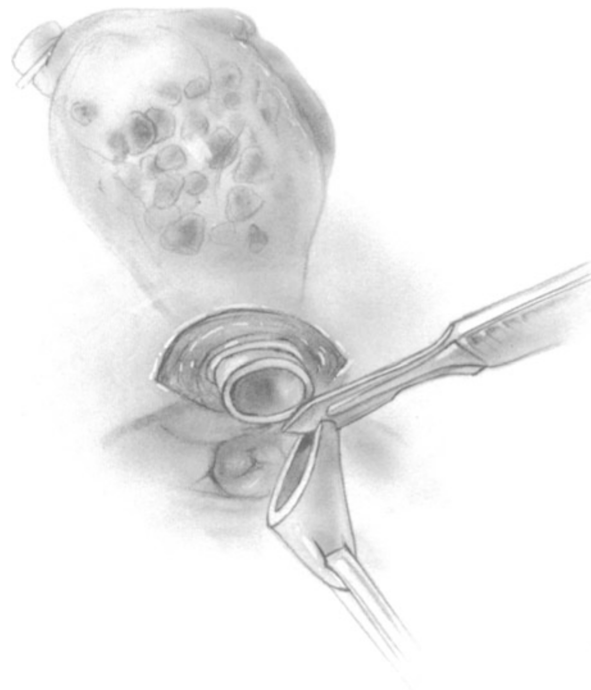


Fig. 61–13

Fig. 61–14

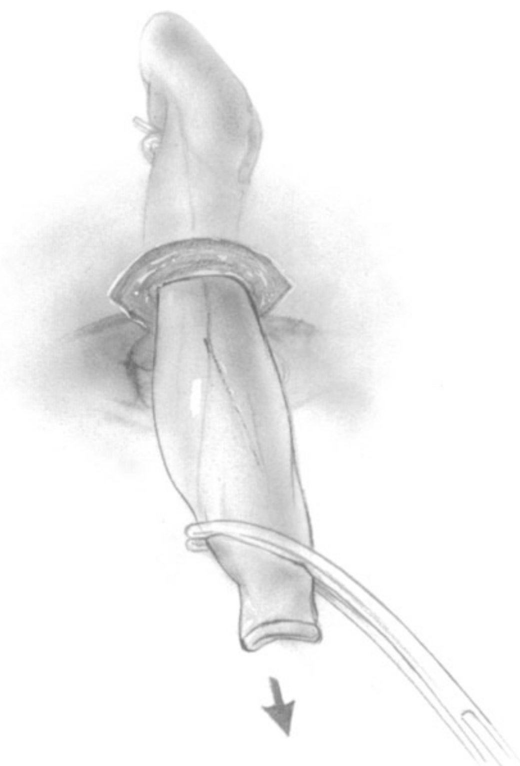


Fig. 61–15

incision in the gallbladder (**Fig. 61–13**) and insert a suction device to aspirate bile (**Fig. 61–14**). Apply a Kelly hemostat to the neck of the gallbladder and gradually extract it from the abdomen while observing the action on the video monitor (**Fig. 61–15**). If the gallbladder is too large to pass through the umbilical incision, the incision can be enlarged somewhat by inserting a large hemostat and stretching the width of the incision. Alternatively, the incision may be lengthened by several millimeters in both directions using the scalpel until the gallbladder can be removed.

In a patient who has a small gallbladder, do not move the telescope from the umbilical port. Rather, pass the claw grasper through the epigastric port and draw the gallbladder through the epigastric incision.

If the laparoscope has been transferred to the epigastric port, return it to the umbilical cannula and make a last inspection of the abdominal viscera, the pelvis, and the gallbladder bed. If there are any signs of retroperitoneal hematomas in the region of the aorta, vena cava, or iliac vessels, assume that there has been a major injury to these vessels and perform a laparotomy if necessary to rule out this possibility. Remember, even with disposable trocars that have plastic shields, forceful collision of the shielded trocar with the vena cava may result in perforation of this vessel. Bleeding from the great vessels constitutes the main cause of the rare fatality that follows laparoscopic cholecystectomy. Carefully observe the withdrawal of each cannula to ascertain the absence of bleeding in each case. Finally, permit the escape of carbon dioxide from the abdominal cavity and remove the final cannula. Insert sutures of heavy Vicryl in the two 10-mm incisions in the midline of the abdomen. The 5-mm incisions do not require closure. Close the skin with either sterile adhesive tape or subcuticular sutures.

Postoperative Care

Remove the nasogastric tube and urinary catheter before the patient leaves the recovery room.

Mild pain medication may be necessary.

Ambulate the patient as soon as he or she awakens.

A regular diet may be ordered unless the patient is nauseated.

Discharge the patient a day or two following surgery. He or she may resume full activity by the end of one week.

Complications

Needle or Trocar Damage

Retroperitoneal bleeding from damage to one of the great vessels during insertion of the initial trocar can be fatal. A retroperitoneal hematoma noted during laparoscopy requires open exploration for great-vessel injury.

Bowel injury can be the result of the introduction of the Veress needle or a trocar, especially if the trocar is passed through adherent bowel. Careful inspection of the abdomen by laparoscopy after the insertion of the initial trocar and again before terminating the operation is essential if these injuries are to be detected early and then repaired.

Insufflation-Related Complications

Cardiac dysrhythmias may be induced by carbon dioxide pneumoperitoneum which may produce hypercapnia and occasionally hypoxia. The anesthesiologist should monitor all patients with a pulse oximeter as well as continuous end-tidal CO_2 measurements. A sudden increase in the end-tidal CO_2 level may indicate subcutaneous emphysema, preperitoneal trapping of CO_2, or injection of CO_2 into the liver by incorrect positioning of the Veress needle. Subcutaneous emphysema may be the result of an excessively high intra-abdominal pressure. Extraperitoneal CO_2 insufflation may progress to pneumomediastinum and subcutaneous emphysema. After checking all of these items, the anesthesiologist can generally maintain the patient with hyperventilation.

Bile Duct Damage; Excision of Common and Hepatic Ducts

Davidoff and associates, in a report of 12 patients who were referred to the Duke University Medical Center for treatment of bile duct injuries, state that the classic laparoscopic biliary injury includes the resection of large sections of the common bile duct and the common hepatic duct together with the cystic duct and the gallbladder (**Fig. 61–16**). They reviewed the videotapes of each of the 12 operations during which the bile ducts were injured. The most common error was to mistake the common bile duct for the cystic duct and apply clips to the common bile duct. The common bile duct was then dissected in a cephalad direction as though it were the cystic duct with transection of the proximal hepatic ductal system with or without clip ligation. In a number of these cases there was also a perforation or transection of the right hepatic artery by cautery or laser dissection. It was noted that before dividing the common duct the surgeons clipped and divided a small artery adjoining the common bile duct, erroneously assuming that this was the cystic artery. In most cases there was significant leakage of bile into the operative field but this was ignored. It was also noted that the dissection in most of these cases was

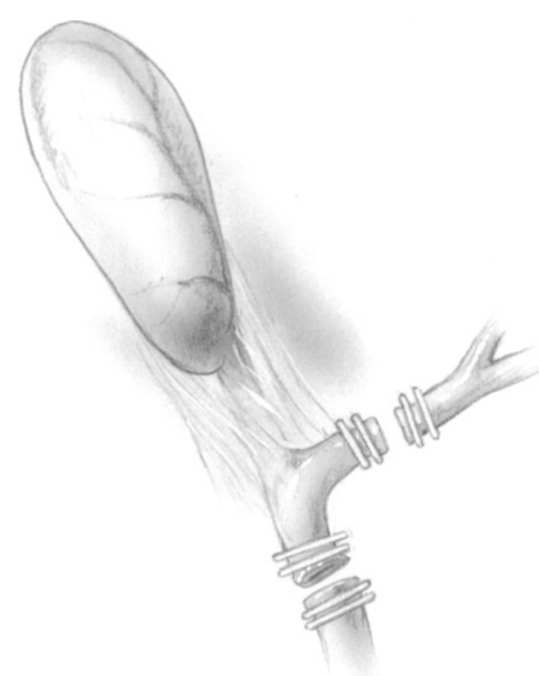


Fig. 61–16

aimed toward the gallbladder rather than away from it. Inadequate visualization of the operative field often contributed to these errors as did, in some cases, significant bleeding.

If, in fact, a surgeon divides the common bile duct by mistake, there is certainly no excuse for failing to detect this error when the dissection encounters the common hepatic duct. As seen in Fig. 61–16 (modified from Davidoff et al.), if one dissects the proximal divided end of the common bile duct in a cephalad direction, it is not possible to remove the gallbladder without transecting the common hepatic duct. With proper surgical dissection, it should be obvious that the presence of this duct indicates that the operative strategy is quite wrong and requires an immediate course correction.

Rossi et al. described the repair of laparoscopic bile duct injuries in 11 patients referred to Lahey Clinic. They found that fibrosis or scarring in Calot's triangle was an important factor contributing to the injury in many of their cases. Their conception of the mechanism of injury is illustrated in **Fig. 61–17**. The cystic duct is densely adherent to the common hepatic duct for several centimeters above the junction of the cystic and common ducts. This injury will not occur if the dissection is initiated at the ampulla of the gallbladder and if the posterior portion of the gallbladder infundibulum is dissected away from the liver before dissecting the cystic duct. Dissection should always progress from the gallbladder toward the cystic duct, completely freeing the entire circumference of the ampulla, the infundibulum of the gallbladder, and the cystic duct.

Fig. 61–17

Fig. 61–18

Davidoff and associates also described a variant of the classical common duct injury. This is illustrated in **Fig. 61–18**. Here, clips were applied to the common bile duct just below its junction with the cystic duct, but the transection took place across the distal portion of the cystic duct. In this case the patient will have a total biliary fistula into the peritoneal cavity. These authors also described two patients who presented 4–6 weeks after surgery with jaundice and extensive strictures of their common and hepatic ducts. They hypothesize that this pathology resulted from thermal injury in the region of Calot's triangle by either laser or electrocoagulation.

Branum, Schmitt et al. reported an additional type of bile duct injury that occurred when the Hemoclip applied to the proximal portion of the cystic duct also encompassed the right hepatic duct. This occurred in patients who suffered from fibrosis in Calot's triangle which placed the right hepatic duct in close proximity to the cystic duct. In reviewing the videotape recording of the operations the authors noted that the surgeon did not properly dissect the gallbladder infundibulum and cystic duct from above down prior to applying the clips. Division of the cystic duct by the surgeon resulted in a combined transection of the right hepatic and cystic ducts.

In summary, prevention of damage to the bile ducts requires good visibility (this is sometimes facilitated by the use of a 30° angled laparoscope), lateral traction on the ampulla and infundibulum of the gallbladder to separate the cystic duct from the common hepatic duct, directing the dissection from the ampulla and infundibulum of the gallbladder downward toward the cystic duct rather than the reverse, using electrocautery with caution, routine cholangiography early in the operation, and converting to open cholecystectomy whenever there is any doubt concerning the safety of the laparoscopic cholecystectomy. A satisfactory intraoperative cholangiogram must show intact bile ducts from the right and left hepatic ducts down to the duodenum. When there is doubt concerning which duct to use for the cholangiogram, a cholecystocholangiogram may be performed by injecting 30–40 ml of contrast material directly into the gallbladder.

Bile Leak

Leakage of bile into the right upper quadrant following laparoscopic cholecystectomy does not necessarily indicate an injury to the bile duct. It may simply mean that the occluding clips have slipped off the cystic duct or that a minor accessory bile duct is leaking. Symptoms generally develop a few days after laparoscopic cholecystectomy and consist of generalized abdominal discomfort, anorexia and fatigue, and sometimes some degree of jaundice. Sonography can reveal the presence of fluid in the subhepatic space. A HIDA radioactive scan demonstrates the presence of bile outside the biliary tree. ERCP or percutaneous transhepatic cholangiography will demonstrate the point of leakage. In the absence of any obstruction in the common bile duct, these leaks will generally heal spontaneously. This may be expedited by percutaneous insertion of a drainage catheter into the right upper quadrant or insertion of a stent into the common bile duct following endoscopic papillotomy.

Of course, major ductal injury requires surgical reconstruction, generally by hepaticojejunostomy-Roux-en-Y.

Intraoperative Hemorrhage from Cystic Artery

Occasionally brisk bleeding will result when the cystic artery is cut or torn. This is generally a minor complication in an open cholecystectomy because grasping the hepatic artery between two fingers in the foramen of Winslow (Pringle maneuver) insures prompt if temporary control of bleeding. In laparoscopic cholecystectomy losing 30–40 ml of blood may be serious because the blood obscures visibility through the laparoscope. Frequently you will be able to control cystic artery bleeding by grasping the gallbladder ampulla near the bleeding vessel and pushing the ampulla firmly against the liver (**Fig. 61–19**). If this maneuver successfully controls the bleeding, then insert one or more additional cannulas for suction and retraction and attempt to localize and clip the bleeding vessel. It is not worth spending much time on occluding this bleeder laparoscopically because making a subcostal incision will afford an opportunity to localize and control the bleeder quickly with no risk.

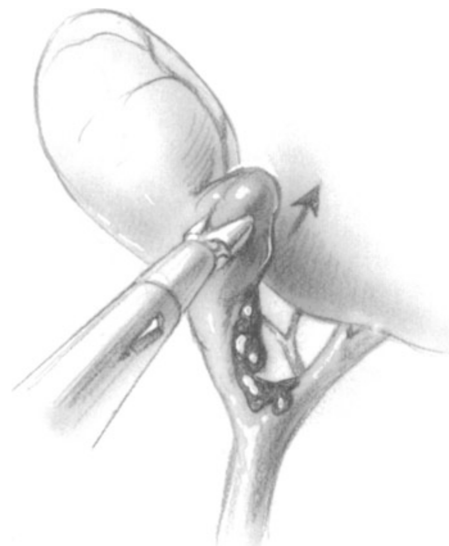


Fig. 61–19

References

Branum G, Schmitt C, Bailie J et al. Management of major biliary complications after laparoscopic cholecystectomy. Ann Surg 1993;217:532–541.

Davidoff AM, Pappas TN, Murray EA et al. Mechanisms of major biliary injury during laparoscopic cholecystectomy. Ann Surg 1992;215:196–202.

Rossi RL, Schirmer WJ, Braasch LW et al. Laparoscopic bile duct injuries: risk factors, recognition, and repair. Arch Surg 1992;127:596–602.

62 Cholecystostomy

Indications

Patients suffering from acute cholecystitis when cholecystectomy may be hazardous for technical reasons.

For very poor-risk patients CT-guided percutaneous catheter drainage may be the most pragmatic method of managing acute cholecystitis.

Contraindication

Patients who have acute cholangitis owing to common bile duct obstruction

Preoperative Care

Appropriate antibiotics

Pitfalls and Danger Points

Overlooking acute purulent cholangitis
Overlooking gangrene of gallbladder
Postoperative bile leak

Operative Strategy

When Is Cholecystostomy an Inadequate Operation?

Gagic and Frey reported an operative mortality of 27% in 22 cases of cholecystostomy for acute cholecystitis. Most of the deaths were due to suppurative cholangitis and septicemia. This group of patients had chills, fever, upper abdominal pain, and serum bilirubin levels averaging 12 mg/dl. Whenever the serum bilirubin rises above 6–7 mg/dl, the patient is probably suffering from common bile duct (CBD) obstruction secondary to calculi. Either eliminate this possibility by means of an endoscopic radiographic cholangiopancreatogram (ERCP) or drain the CBD with a T-tube. Cholecystostomy does *not* provide adequate drainage for an infected bile duct.

In most cases it is not difficult to differentiate acute cholecystitis from acute cholangitis. In acute cholecystitis there is usually marked localized tenderness and muscle spasm in the right upper quadrant and only slight elevation of the serum bilirubin. The patient with acute cholangitis is generally more acutely ill and suffers from pain, chills, fever, and jaundice. In most cases, right upper quadrant tenderness is not a prominent part of the clinical picture, and a tender mass is not palpable except in the very unusual case where the patient has both acute cholecystitis and acute cholangitis.

When a patient with acute cholangitis does not respond immediately to antibiotic treatment, prompt drainage of the CBD is lifesaving. This must be accomplished by laparotomy and choledochostomy, although in the poor-risk patient ERCP-catheterization of the CBD has proved successful in achieving drainage of an infected bile duct. Undrained acute purulent cholangitis is often rapidly fatal. In performing cholecystostomy, one must be alert not to overlook this disease of the bile duct.

Another complication of acute cholecystitis, for which cholecystostomy is an inadequate operation, is gangrene of the gallbladder. This may occur in the deep portion of the gallbladder fundus, where it may be hidden by adherent omentum or bowel. Performing a cholecystostomy through a small incision under local anesthesia, where only the tip of the gallbladder is exposed, could easily result in overlooking this patch of necrosis. When a necrotic area is found in the gallbladder, it is preferable to perform a cholecystectomy, either complete, or, if this is impossible for technical reasons, a partial cholecystectomy around a catheter with removal of the gangrenous patch (**Fig. 62–1**).

Choice of Anesthesia

Because of the danger of overlooking disease of the CBD as well as gangrene or perforation of the gallbladder, it is preferable to perform the cholecystostomy through an adequate incision under general anesthesia. By using modern anesthesia techniques, including monitoring of the pulmonary artery pressure and cardiac output during the operation, and pharmacological manipulation to maintain homeostasis, it is safe for most bad-risk patients to undergo a biliary operation under general anesthesia. Otherwise, perform percutaneous catheter drainage of the gallbladder.

Fig. 62–1

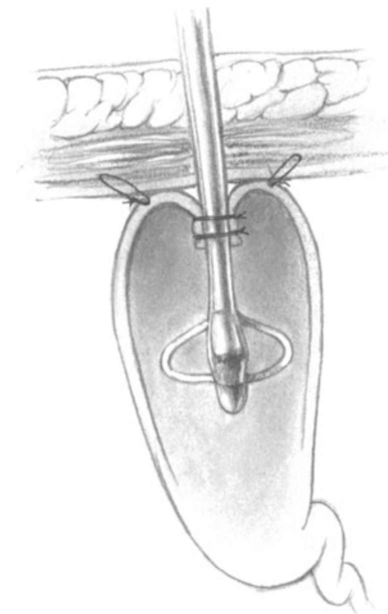


Fig. 62–3

Preventing Bile Leaks

One distressing complication that occasionally follows cholecystostomy is leakage of bile around the catheter into the free peritoneal cavity resulting in bile peritonitis. This complication may generally be avoided by using a large-size catheter and suturing the gallbladder around the catheter (**Fig. 62–2**). It is important also to suture the fundus of the gallbladder to the peritoneum around the exit wound of the drainage catheter (**Fig. 62–3**). In addition, adequate drainage in the vicinity of the gallbladder is necessary.

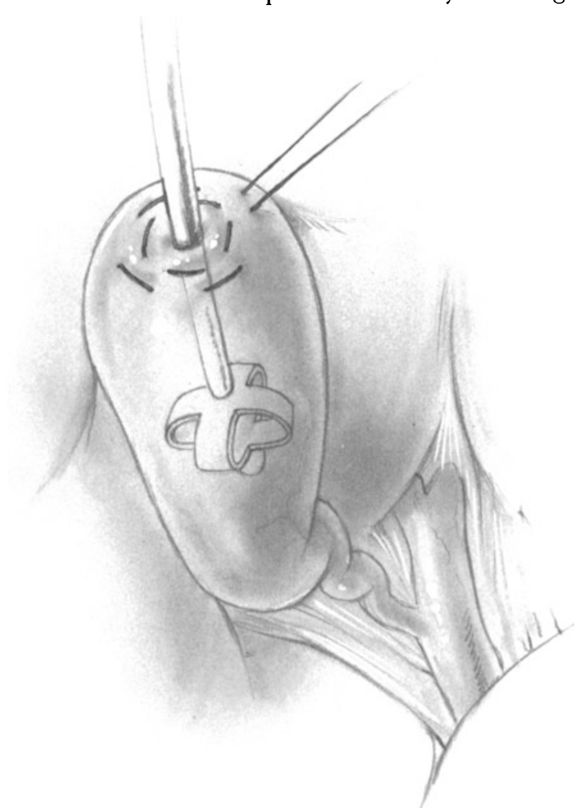


Fig. 62–2

Operative Technique

Incision

Under general anesthesia, make a subcostal incision at least 10–12 cm in length. Find the plane between the adherent omentum and the inflamed gallbladder. Once this plane is entered, the omentum may generally be freed by gentle blunt dissection from the gallbladder wall. Continuing in this plane, inspect the gallbladder and its ampulla.

Emptying the Gallbladder

After ascertaining that there is no perforation of the gallbladder nor any patch of gangrene, empty the gallbladder either with a No. 16 needle or a suction-trocar that is inserted into the tip of the gallbladder. Also, order an immediate Gram stain. Enlarge the stab wound in the gallbladder. Attempt to remove the gallbladder calculi with pituitary scoops and Randall stone forceps. It may be necessary to compress the gallbladder ampulla manually to milk stones up toward the fundus. After flushing the gallbladder with saline, insert a 2OF straight or

Pezzar catheter 3–4 cm into the gallbladder. Close the defect in the gallbladder wall with two inverting purse-string sutures of 2–0 PG suture material (Fig. 62–2). If the gallbladder wall is unusually thick, it may be necessary to close the gallbladder around the catheter with interrupted Lembert sutures.

If the patient is in satisfactory condition, a cholangiogram through the gallbladder catheter may be attempted. On the other hand, it is not always possible to extract a stone that is impacted in the cystic duct. This will eliminate the possibility of obtaining a cholangiogram by this route.

Now make a stab wound through the abdominal wall close to the fundus of the gallbladder. Draw the catheter through the abdominal wall and then suture the fundus of the gallbladder to the peritoneum alongside the stab wound (Fig. 62–3). Make a stab wound and insert either latex drains or sump-suction catheters or both. These drains should be placed as follows: one in the vicinity of the cholecystostomy and one in the right renal fossa.

Then close the abdominal incision in routine fashion as described in Chap. 5. We use 1 PDS sutures for this closure.

Postoperative Care

Connect the cholecystostomy catheter to a sterile plastic collecting bag for gravity drainage.

Continue antibiotic treatment for the next 7–10 days. Until bacterial culture and sensitivity studies have been reported on the gallbladder bile, use antibiotics that are effective against the Gram-negative bacteria, the enterococcus, and the anaerobes.

Employ nasogastric suction if necessary.

Measure the daily output of bile and replace with an appropriate dose of sodium.

Do not remove the gallbladder drainage catheter for 12–14 days. Perform a cholangiogram before removing the catheter.

Postoperative Complications

Bile peritonitis

Subhepatic, subphrenic, or intrahepatic abscess

Septicemia

Patients with acute cholecystitis generally respond promptly to adequate drainage of the infection. If the patient shows persistent signs of sepsis and bacteremia, it is likely that this complication stems from an undrained focus of infection. This may be an obstructed CBD with cholangitis or a subhepatic, *intrahepatic*, or subphrenic abscess. ERCP and CT scanning may be helpful in detecting these complications.

Reference

Gagic N, Frey CF. The results of cholecystostomy for the treatment of acute cholecystitis. Surg Gynecol Obstet 1975;140:255.

63 Common Bile Duct Exploration

Concept: When to Explore the Common Bile Duct (CBD)

As pointed out by Way, Admirand, and Dunphy, the true incidence of CBD stones in patients undergoing surgery for gallstones is probably between 12% and 15% in the United States. By using indications essentially identical to those stated below and by performing routine preexploratory cystic duct cholangiography, Way performed CBD explorations in only 21% of 952 cholecystectomies. These explorations were positive for calculi in 65% of the patients explored. Of the 952 cholecystectomy cases, 14% had CBD stones. In 6 additional reports collected by Way in which routine cystic duct cholangiography was employed, the results were similar. On the other hand, the same author cited 3 other reports from the Lahey Clinic of cases in which preexploratory cholangiography was not performed. Here, of 33% of patients undergoing CBD exploration only 30% of the ducts contained stones. Whereas the use of routine cystic duct cholangiograms resulted in the recovery of CBD stones in over 14% of the cholecystectomies reported by Way and colleagues, the authors who omitted preexploratory cholangiography were able to discover CBD stones in only 10% of their cholecystectomy cases. In other words, *routine preexploratory cholangiography markedly reduces the number of CBD explorations performed yet achieves a higher recovery rate of CBD stones* (see Table 63–1).

Table 63–1. Detection of CBD Stones during Routine Cholecystectomy

Routine Cholecystectomy	Cases: CBD Stones Retrieved (%)	Cases: CBD Explorations Undertaken (%)
With preexploratory cholangiogram (N = 952)	14	21
Without preexploratory cholangiogram (N = 4187)	10	33

Source: Adapted from Way et al., 1972.

In the absence of cystic duct cholangiography, opening the CBD for the indication that the duct is dilated or that the gallbladder contains many small stones will yield no more than 10%–14% positive explorations. The presence of jaundice, with serum bilirubin below 7 mg/dl as the *only* indication for exploring the CBD yielded, in Way's series, positive results in 35% of explorations. Consequently, we do not consider the presence of many small stones, of mild jaundice, or of a dilated CBD to be an absolute indication for duct exploration if the preexploratory cystic duct cholangiogram is negative.

Counterbalancing the advantage of a greater yield of CBD calculi for a smaller number of duct exploration is the fact that cholangiography does produce an occasional false positive result. Most often this is due to inexperience on the part of the surgeon in that air bubbles are permitted to enter the system causing the false positive interpretation. With increasing experience, the incidence of false positives should be no more than 2%–3%.

Even when there is an absolute indication for CBD exploration, we prefer to do preexploratory cystic duct cholangiography. Not only does this delineate the anatomy and anomalies of the ductal system but also it may provide the only opportunity to visualize radiographically the distal CBD and ampulla. Often, following instrumentation of the CBD, sphincter spasm prevents the passage of dye into the distal CBD and the duodenum during the postexploratory T-tube cholangiogram. Preexploratory cholangiography is omitted in patients suffering acute suppurative cholangitis.

Patients presenting with signs of *suppurative cholangitis* often will require emergency CBD drainage after only a few hours of preoperative preparation because without CBD drainage the disease is often fatal within 24 hours. In the classical case, the patient will experience chills, fever, jaundice, some degree of mental confusion and septic shock due to Gram-negative bacteremia. Occasionally, a *Clostridium* is involved. After inserting a central venous or pulmonary artery pressure monitor, pursue vigorous fluid replacement and antibiotic therapy.

At operation, the typical case will demonstrate purulent material in a dilated CBD obstructed by calculi. The most important feature of surgery is to drain the CBD with a large T-tube. Remove all of the calculi if this step can be accomplished safely. In most cases emergency drainage can be accomplished by the percutaneous transhepatic or the endoscopic radiographic cholangiopancreatogram (ERCP) approach.

Concept: How to Manage Multiple and "Primary" CBD Stones

Multiple (CBD) Stones

Some surgeons advocate performance of either choledochoduodenostomy or sphincteroplasty in patients who have multiple calculi in the bile ducts. They reason that the surgeon who has removed 10 stones from the bile ducts has a high likelihood of having overlooked 1 or 2 additional calculi. On this basis, these enthusiasts advocate biliary-intestinal bypass or sphincteroplasty so that the residual stones may pass into the duodenum without obstructing the bile ducts. It is true that the patients who suffer from retained CBD calculi are most often those who have had a large number of stones removed from their CBDs rather than those who have had a negative CBD exploration or whose CBD was not explored at all.

Nevertheless, we are not convinced that there are sufficient data to mandate that every patient who has more than, say, 8 or 10 stones should automatically have a bypass or a sphincteroplasty. Neither of these operations is free of complications. Even though experts with a large experience, like Madden and Jones, can perform choledochoduodenostomy or sphincteroplasty with a mortality rate of 1%–2%, such favorable results as these will not be achieved by a large number of surgeons. Furthermore, with the aid of cholangiography and choledochoscopy in the operating room, it is possible to reduce the incidence of retained bile stones to 0–2%. It does not seem logical to perform bypass surgery or sphincteroplasty for the 2% of patients who will have retained bile stones if the other 98% do not require this additional surgery.

On the other hand, when there is evidence of one or more retained stones in the bile ducts that cannot be retrieved in the operating room, bypass or sphincteroplasty may be indicated. This is so even though it is sometimes simple to remove some of these stones by ERCP-papillotomy or by instrumentation through the T-tube tract 6 weeks after the operation. In patients with Caroli's hepatic duct lithiasis, where intrahepatic stones are present, bypass is indicated.

"Primary" CBD Stones

Madden has emphasized the concept that many CBD stones are formed in the bile duct, hence the term "primary" stones. Most surgeons believe that the vast majority of stones found in the CBD originated in the gallbladder. Madden contends that, in his experience, careful observation of the morphology of CBD stones has disclosed that over 60% of these calculi are primary stones, even in patients who have not had previous cholecystectomy and who in fact also may have stones in their gallbladders.

Madden describes the morphology of a primary CBD stone as follows:

> Characteristically, the primary bile duct stone is ovoid, conforming in shape to the common duct, and easily morcellated between the thumb and fingers to give the "earthy" appearance so aptly described by Aschoff. On cross-section, it is laminated and commonly has a yellow nidus with a brownish-yellow periphery. Some primary stones have laminated rings of variegated colors or simply a symmetrical brownish-yellow pigmentation. When multiple, they may be faceted and appear like secondary or gallbladder stones, but the ease with which they are crushed is the differentiating feature.

Since many of these characteristics can be noted in stones contained in the gallbladder, there is some skepticism whether morphological considerations alone can determine that a stone found in the CBD is indeed a primary stone. The reason that this differentiation assumes importance is Madden's insistence that even at the patient's first exploration, the presence of a primary CBD stone is a definite indication for choledochoduodenostomy. Saharia, Zuidema, and Cameron found that clearing the CBD of all the primary stones with insertion of a T-tube had excellent long-term results in 82% of their patients who had primary CBD stones. In commenting on Saharia's paper, Warren and Sandblom both vigorously opposed the routine use of choledochoduodenostomy for primary CBD stones. Thomas, Nicholson, and Owen as well as Rutledge both strongly favored routine sphincteroplasty for primary CBD stones on the basis that these calculi are the result of bile stasis, even where there is no apparent mechanical obstruction at the ampulla. Pending further study, we remain conservative in this situation and simply remove all of the calculi as well as the gallbladder. If soft calculi and sludge reappear in later years after once having been completely removed, then biliary-intestinal bypass or a sphincteroplasty is indicated (Allen, Shapiro, and Way).

Although primary stones may be caused by bile stasis and the CBD may be markedly enlarged, *ampullary stenosis in these cases is rare.* Indeed, Saharia and colleagues mentioned that in many of their operations for primary stones, the ampulla was widely patent despite the presence of a very large CBD, which suggested that the stasis of bile might be due to an "abnormal functional dilation" of the duct. Only 1 in 30 of their patients had a significant ampullary stenosis. It is difficult to comprehend how sphincteroplasty will help most of the patients who suffer from primary CBD stones but do not have ampullary stenosis.

Indications

Positive Indications

Chills, fever, and jaundice prior to operation indicates that in over 90% of cases CBD exploration will reveal calculi.

Palpation of calculus in CBD

Acute suppurative cholangitis

Positive finding of calculus on routine cystic duct cholangiography or preoperative ERCP, or percutaneous transhepatic cholangiogram

Relative Indications

Moderate elevation of the serum bilirubin (4–6 mg/dl), especially in the presence of acute cholecystitis, is *not by itself* a positive indication for choledochotomy since the ampulla of a distended gallbladder may compress the CBD, thereby producing jaundice in the absence of choledocholithiasis. In these cases, negative cholangiography avoids the necessity for opening the CBD, provided the films are of proper quality.

Some surgeons feel that the presence of a thick-walled CBD with an external diameter of over 1.6 cm requires duct exploration even in the presence of apparently normal cholangiography, since small calculi may be obscured in the radiography of a large duct. If the contrast medium is properly diluted, one need not explore a large duct if the cholangiogram is normal.

A recent history of acute pancreatitis in the absence of alcoholism requires either CBD exploration or a normal cystic duct cholangiogram.

The presence of multiple small calculi in the gallbladder by itself does not constitute an indication for choledochotomy, even if the cystic duct is large in diameter. Adequate cholangiography will detect calculi of a size sufficient to require choledochotomy. Although this may on occasion result in overlooking a stone 1–2 mm in diameter, this policy will also avoid the performance of a large number of unnecessary CBD explorations. A tiny calculus will almost always spontaneously pass into the duodenum. On the other hand, the addition of an unnecessary CBD exploration to a cholecystectomy may increase the mortality rate.

Failure of contrast medium to enter the duodenum during preexploratory cystic duct cholangiography requires choledochotomy to rule out the presence of a stone at the ampulla.

Patients with biliary colic who have no *gallbladder* stones at laparotomy require a cholangiogram because many of these patients do have *common bile duct* calculi.

Preoperative Care

Order a sonogram or CT scan of the bile ducts and pancreas as the initial diagnostic test in the jaundiced patient. If a CBD stone is demonstrated, no further diagnostic studies are indicated. If the sonogram shows dilated bile ducts right down to the ampulla, but no stones, then an ERCP will help by providing a picture of the biliary and pancreatic ducts as well as a biopsy of any periampullary tumor. When the intrahepatic ducts are large on the sonogram, but not the CBD, then a percutaneous transhepatic cholangiogram (PTC) will identify intrahepatic tumors of the bile ducts and other unusual lesions. In the absence of the expertise to accomplish an excellent PTC or ERCP, good cystic duct cholangiography and careful choledochoscopy will generally accomplish the same results. Whenever either PTC or ERCP is to be performed, give the patient parenteral antibiotics before these procedures to protect against the bacteremia that they often induce.

Abnormalities of the serum prothrombin should be corrected preoperatively with injections of vitamin K1 oxide. When CBD exploration is planned, the patient should receive perioperative intravenous antibiotics beginning 1 hour prior to operation. In order to assure an adequate antibacterial blood level, repeat the dose in 3 hours, during the operation. We use either cephazolin or a penicillin–aminoglycoside combination.

Pitfalls and Danger Points

Injuring the bile ducts

Creating a false passage into the duodenum when probing the CBD; damaging the ampulla or pancreas; inducing postoperative pancreatitis

Perforating a periampullary duodenal diverticulum

Sepsis
Failing to remove all of the biliary calculi

Operative Strategy

Avoiding Postoperative Pancreatitis

With reference to the decision for or against adding choledochotomy to simple cholecystectomy, it should be noted that the mortality rate at the author's hospital increased from 0.25% to about 2.5% when a CBD exploration was added to a simple cholecystectomy. Although many of these deaths were due to sepsis accompanying neglected choledocholithiasis in aged patients, we have witnessed fatalities after negative CBD explorations on rare occasions. These deaths were generally caused by postoperative acute pancreatitis. Consequently, all manipulations carried out in the distal CBD and ampulla must be done with great delicacy in order to avoid this potentially fatal complication. Due to the increased operative risk of choledochotomy, use routine cholangiography in order to minimize the number of unnecessary CBD explorations. When CBD exploration is necessary, execute the procedure with meticulous care to avoid trauma to the ampulla or pancreas, which may induce pancreatitis.

CBD Perforations

Another *serious and often fatal* error is to perforate the distal CBD and penetrate the pancreas with an instrument such as the metal Bakes dilator. When the surgeon experiences any difficulty in negotiating the ampulla with an instrument, duodenotomy and direct exposure of the ampulla is preferable to repeated blunt trauma from above. Using either the olive-tip (Coudé) woven or a 10F whistle-tip rubber catheter rather than a metal dilator lessens the risk of ampullary trauma and of postoperative acute pancreatitis. Never employ forcible dilatation of the sphincter of Oddi; this procedure serves no useful purpose, and the trauma to the ampulla not only increases the risk of postoperative acute pancreatitis but also produces lacerations and hematomas of the ampulla.

If an instrument has perforated the distal CBD and the head of the pancreas, this may be detected when the CBD is irrigated with saline by noting a leak of saline from the posterior surface of the pancreas. The perforation may also be detected by cholangiography. This type of trauma, which leads to a flow of bile directly into the head of the pancreas, often causes a fatal pancreatitis. For this reason, when this complication is identified, divide the CBD just above its entry into the pancreaticoduodenal sulcus; transfix the distal end of the duct with a suture and anastomose the proximal cut end of the CBD to a Roux-en-Y segment of jejunum. When this procedure is carried out, diverting the bile from the traumatized pancreas may prove lifesaving. Also insert a closed-suction drain behind the pancreatic head to remove the leaking pancreatic secretions.

If the CBD has been perforated at a point proximal to the head of the pancreas, suture the laceration with a 5–0 Vicryl suture if the laceration is accessible. If the laceration is not accessible, simply insert a large-caliber T-tube into the CBD for decompression proximal to the laceration. Then place a closed-suction catheter drain down to the region of the laceration.

Locating and Removing Biliary Calculi

In order to avoid overlooking biliary calculi, it is important to perform a cystic duct cholangiogram before exploring the CBD. Be sure that the X ray clearly shows both the hepatic ducts and the distal CBD. If the hepatic ducts cannot be seen because the dye runs into duodenum, either administer morphine to induce spasm of the ampulla or open the CBD, insert an 8F Foley catheter into the proximal CBD, and use this device to obtain an X ray of the intrahepatic radicals.

Once the CBD has been opened, the safest and most effective device for extracting stones is the pituitary scoop with a malleable handle. Available with various size cups, this device can bend in the exact direction required to pass through the CBD down to the ampulla. By delicate maneuvering, the surgeon can remove most stones with the scoop. Also, it is often easy to palpate a stone against this metallic instrument.

Always perform a Kocher maneuver before exploring the CBD. This permits the surgeon to place the fingers of his left hand behind the ampullary region with the thumb on top of the anterior wall of the duodenum. In this fashion he can more accurately direct the manipulation of the instrument while he is palpating its distal tip.

Other methods that are helpful in retrieving stones are the Randall stone forceps, the Fogarty balloon, and thorough saline irrigation. On rare occasions a Dormia basket may retrieve a stone that is otherwise inaccessible.

Choledochoscopy, which is discussed below, is another excellent means of helping to identify residual biliary calculi in the operating room.

When the ampullary region contains an impacted stone that cannot be removed with minimal trauma by the usual methods, *there must be no hesitation to* *perform a sphincteroplasty for the purpose of extracting the stone* under direct vision. Otherwise, excessively traumatizing the ampullary region may cause a serious postoperative acute pancreatitis.

A completion cholangiogram through the T-tube after the exploration has been concluded is an essential part of the maneuvers required to minimize the number of stones overlooked at operation.

It is important to use a T-tube that is size 16F or larger following choledocholithotomy. Otherwise, the tract remaining when the T-tube is removed may not be large enough to admit the instruments required for removal of residual stones by the technique of Burhenne. Since Burhenne's method has a success rate of over 90%, it is important that the T-tube tract be large enough to retrieve a stone that has been left behind. Even small ducts will admit a 16F T-tube if the tube is trimmed by the technique described below (see Fig. 63–5).

Operative Technique—CBD Exploration Simultaneous with Cholecystectomy

Cholangiogram

If for some reason the cystic duct was not a suitable route for cholangiography by the technique described in Chap. 60, then perform this procedure by inserting a 21-gauge scalp vein needle into the CBD. Aspirate in order to confirm that the needle is in the duct lumen. Use a suture to fix the needle to the CBD. Attach a 2-meter length of sterile plastic tubing filled with the proper contrast medium. The remaining details of cholangiography are the same as those described in Chap. 60.

Kocher Maneuver

After the gallbladder has been removed and it is determined that a CBD exploration is indicated, perform a Kocher maneuver (see Figs. 7–14, 7–15, and 7–16) by incising the lateral peritoneal attachments along the descending duodenum. Then incise the layer of avascular fibrous tissue that attaches the posterior duodenum to Gerota's fascia and to the foramen of Winslow. With the left index and the middle fingers situated behind the pancreas and duodenum and the thumb applied to the anterior wall of the duodenum, palpate the distal CBD and the ampulla. Pay special attention to the ampullary region in order not to overlook a small ampullary carcinoma, which may often be felt as a hard protrusion into the lumen from the back wall of the duodenum.

Choledochotomy Incision

Incise the peritoneum overlying the CBD in order to identify accurately the duct's anterior wall. Select an area for the choledochotomy preferably distal to the entrance of the cystic duct. Insert 2 guy sutures of 5–0 Vicryl, one opposite the other on the anterior wall of the duct. If there are any obvious blood vessels located in this area, either transfix them with 5–0 Vicryl suture-ligatures or apply careful electrocoagulation. Use a No. 15 scalpel blade to make a short incision in the anterior wall of the CBD while the assistant holds up the guy sutures. Then use a Potts angled scissors to enlarge the incision in both directions. Pay attention to the possibility that the cystic duct may share a common wall with the CBD for a distance of 2 cm or more. If the incision is made in the vicinity of this common wall, it is possible to open the cystic duct instead of the CBD. This will produce considerable confusion. It is even possible to make an incision along the common wall and not encounter the lumen of either the cystic duct or the CBD and to expose the portal vein. If the anteromedial aspect of the CBD is used for the choledochotomy incision, this problem will be avoided.

Exploring the CBD

As soon as the CBD has been opened, take a sample of the bile for a bacteriological culture and make a Gram stain for prompt identification of the bacteria that are frequently present.

Using the left thumb and index finger, milk down any possible stones from the common hepatic duct into the choledochotomy incision. Perform the same maneuver on the distal CBD. This maneuver will often deliver several calculi into the choledochotomy.

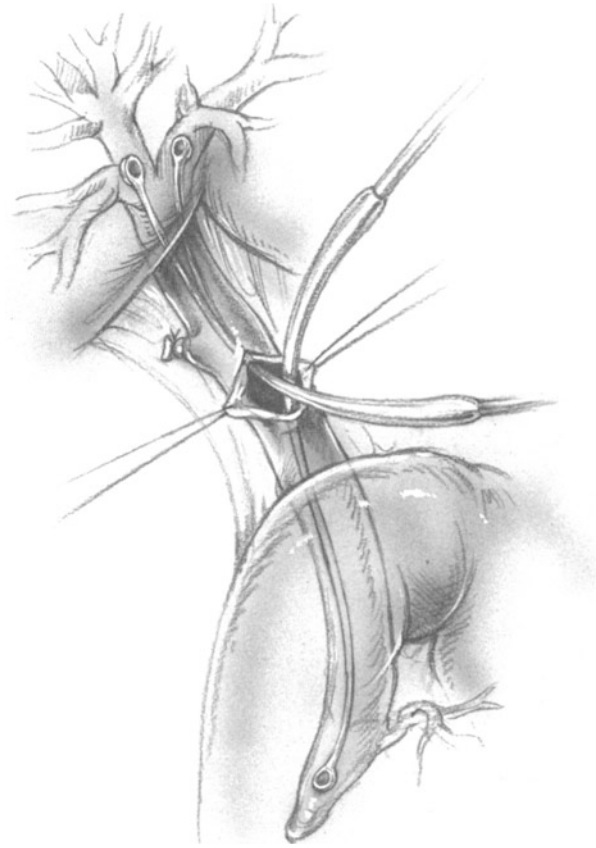


Fig. 63–1

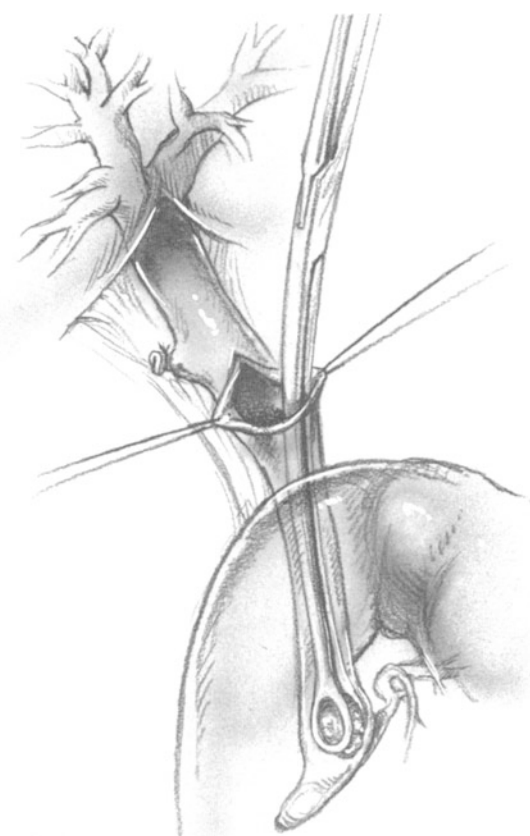


Fig. 63–2

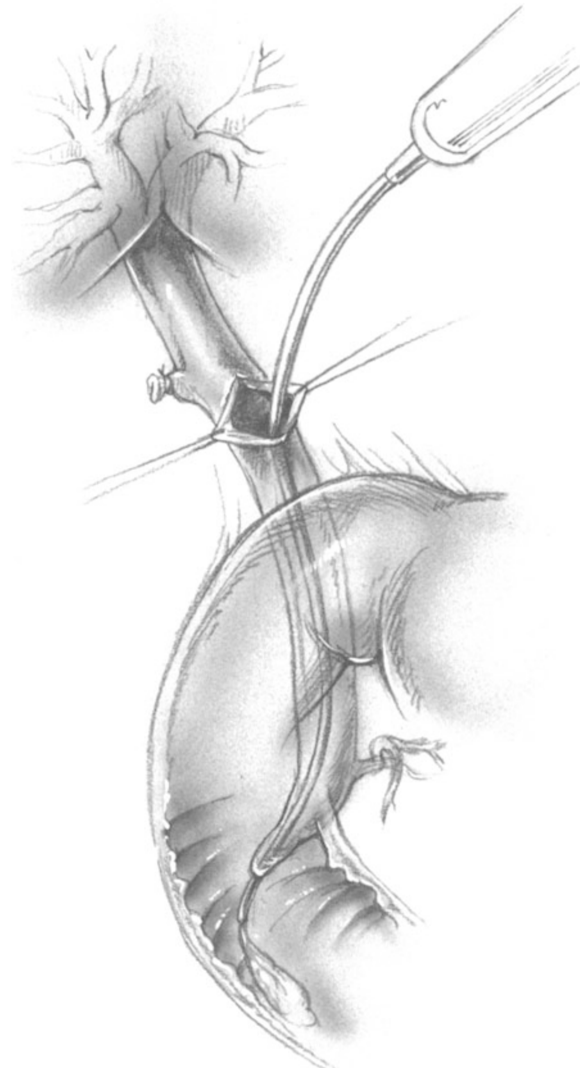


Fig. 63–3

Pass a pituitary scoop of the appropriate size up into the right and the left main hepatic ducts for the removal of any possible calculi (**Fig. 63–1**). Then, with the left index finger placed behind the ampulla, use the right hand to pass a pituitary scoop down to the region of the ampulla and remove any calculi encountered in this maneuver. It is helpful simultaneously to palpate with the left index finger behind the distal CBD while the scoop is being passed. Avoid excessive trauma to the ampulla. A Randall stone forceps (**Fig. 63–2**) may be inserted into the CBD for the purpose of removing stones, but we have not found this instrument to be particularly valuable as compared to the pituitary scoop. Following these maneuvers, use a small straight catheter to irrigate both the hepatic ducts and the distal CBD with normal saline solution (**Fig. 63–3**).

Now try to pass a 10F olive-tip (Coudé) catheter, preferably of the silk-woven type, through the ampulla. Injecting the catheter with saline will confirm its presence in the duodenum if the saline enters the duodenum without washing back through the choledochotomy incision. If the surgeon prefers to use the metal Bakes dilators to determine the patency of the ampulla, he should perform this maneuver with great delicacy as it is easy to perforate the distal CBD and to make a false passage through the head of the pancreas. It is not necessary to pass any instrument larger than a No. 3 Bakes dilator through the ampulla. Some surgeons feel that if the No. 3 dilator cannot pass, this is diagnostic of ampullary stenosis and is an indication for sphincteroplasty. *We do not agree with this concept*, as we explain in Chap. 66.

If there appears to be a calculus in the distal end of the CBD and it is not easily removed by means of the scoop, insert a Fogarty biliary catheter down the CBD into the duodenum. Blow up the baloon; this will help identify the ampulla. Gradually decompress the balloon as the catheter is withdrawn. As soon as the balloon is inside the CBD, reinflate it and withdraw. This will occasionally remove a stone that has been overlooked. Repeat the same maneuver in the right and left hepatic ducts. It is in the retrieval of the hepatic duct stones that the Fogarty catheter has its greatest usefulness.

Another maneuver that occasionally will successfully remove a stone is to use a 16F rubber catheter. Cut most of the flared proximal end of the catheter off and insert this end down the CBD to make contact with the stone. Amputate the tip of the catheter and attach a syringe to the distal tip of the catheter; apply suction while simultaneously withdrawing the catheter. The suction sometimes traps the calculus in the end of the catheter, after which it is easily removed.

If an impacted stone in the distal CBD cannot be removed in a nontraumatic fashion by these various maneuvers, do not hesitate to perform a sphincteroplasty, the technique for which is described below (Chap. 66). Sphincteroplasty is safer than traumatizing the ampulla.

Choledochoscopy

An intregal part of the CBD exploration is, we believe, choledochoscopy. This procedure can detect and retrieve stones or detect and biopsy ductal tumors, in some cases when all other methods have failed. Of the instruments currently available for endoscopy of the bile ducts, the rigid right-angle choledochoscope manufactured by Storz-Endoscopy, which contains a Hopkins rod-lens system that is illuminated by a fiberoptic channel, gives the best image quality. It is simpler to operate and less expensive than the flexible fiberoptic endoscopes. The Storz choledochoscope shares with the flexible scopes the disadvantage that they require ethylene oxide gas sterilization, which precludes repeated utilization of the same scope on the same day. Flexible fiberoptic choledochoscopes are manufactured by ACM, Olympus, Fuji, and Machida. Although these flexible instruments have a higher initial cost, more expensive upkeep, shorter lifespan, much greater susceptibility to damage, and somewhat inferior optical properties, they do indeed have one important advantage over the rigid scopes. The flexible scope can be passed for greater distances up along the hepatic radicals for the extraction of an otherwise inaccessible stone in this location. Similarly, the flexible scope can be passed right down to the ampulla and in about one-third of cases into the duodenum to rule out the presence of stones in the distal ampulla. Even if the scope does not enter the duodenum, when it is passed down to the ampullary orifice and the flow of saline enters the duodenum without refluxing back up into the CBD, this constitutes good evidence that the distal duct is free of calculi. The rigid scopes are not generally of sufficient length to accomplish this mission. Another area, in which the flexible scope is occasionally useful, is to extract retained calculi via the T-tube tract subsequent to CBD exploration.

Because of their lower cost and greater durability, the rigid scopes have been adopted more widely than have the flexible, despite the handicap mentioned above.

The horizontal arm of the Storz choledochoscope comes in two lengths: 40 mm and 60 mm. The vertical limbs of both models are identical. The cross section of the horizontal limb, which has to pass into the bile duct, is 5 by 3 mm, approximately the diameter of a No. 5 Bakes dilator. If the CBD will not admit a No. 5 dilator, choledochoscopy by this technique is contraindicated.

The choledochoscope operates in a liquid medium. This requires that a continuous stream of sterile saline under pressure be injected into the sidearm of the scope. The saline will then flow into the bile ducts. By crossing the two guy sutures over the choledochotomy incision, the CBD can be maintained in a state of distention by the flow of saline, providing optimal visualization. If the CBD is large enough, a metal instrument channel can be attached to the choledochoscope. Through this channel can be passed a flexible biopsy punch, a flexible forceps (7F size), a Dormia stone basket, or a Fogarty biliary catheter (5F caliber).

To use the choledochoscope, stand on the left side of the patient. Make the choledochotomy incision as far distal in the CBD as possible. Insert the choledo-

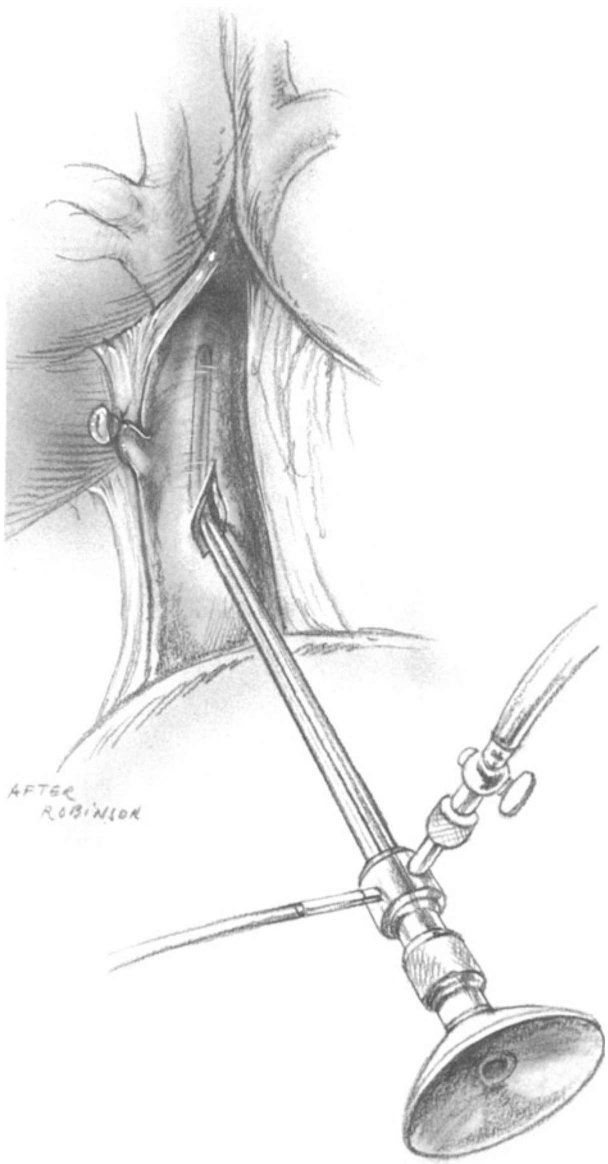


Fig. 63–4

choscope toward the hepatic duct (**Fig. 63–4**). Initiate the flow of saline and cross over the two guy sutures to reduce the loss of saline from the choledochotomy incision. Enclose the 1-liter bag of sterile saline in a pressure pump (Fenwall) and use sterile intravenous tubing to connect the bag of saline to a 3-way stopcock. Insert the stopcock into the saline channel on the side of the choledochoscope.

Pass the horizontal limb of the scope up the common hepatic duct. Very soon the bifurcation of the right and left ducts will be seen. Occasionally the first branch of the right main duct will open into the bifurcation so that it resembles a trifurcation. Generally the left duct appears to be somewhat larger and easier to enter than the right. By properly directing the scope, it is possible to see into the orifices of many of the secondary and tertiary ducts. Withdraw the scope until the bifurcation is again seen and then pass the instrument into the right main duct using the same technique.

Before passing the scope down into the distal CBD, be sure that the duodenum has been completely Kocherized. By placing slight traction with the left hand on the region of the ampulla, the surgeon will help elongate and straighten the course of the CBD. This is important because the scope visualizes the duct with clear focus to infinity. What the surgeon really wants to learn from the choledochoscopy is whether there are any residual calculi between the scope and the ampulla. This requires an exact knowledge of the appearance of the ampulla, which has been described as an inverted cone with a small orifice that opens and closes intermittently to permit the passage of saline. However, we have found that using these landmarks as the only criterion for identifying the ampulla may lead to error. Occasionally, this type of error will permit a stone in the distal CBD to go undetected. Consequently, we believe there are only two positive methods of identifying the distal termination of the CBD. One is the passage of the 60-mm choledochoscope through a patulous ampulla (rarely possible). When this step can be accomplished, if the duodenum is inflated with saline, one can see quite clearly the duodenal mucosa that is markedly different from the smooth epithelium of the CBD. If the duodenum is not filled with saline, the mucosa will not be seen. If the scope does not pass into the duodenum spontaneously, make *no* attempt to pass it forcibly. A second method of positively identifying the termination of the CBD is to pass a Fogarty balloon catheter alongside the choledochoscope into the duodenum. Then inflate the balloon and draw back on the catheter. By following the catheter with a choledochoscope down to the region of the balloon one can be more certain that the entire CBD has been visualized and that no residual calculi remain in the CBD.

Occasionally, the view of the distal CBD is impeded by what appear to be shreds of either fibrin or ductal mucosa that may hang as a partially obscuring curtain across the lumen of the duct. Despite some of these difficulties in interpreting choledochoscopic observations, this procedure does indeed detect stones that have been missed by all other methods. In the hands of an experienced observer, choledochoscopy is probably the most accurate single method of detecting CBD stones. Calculi are easily identified. It may at first be confusing to find that a calculus 3 mm in diameter looks as big as a chunk of coal through the magnifying lens system. It is important to note that the Storz type of choledochoscope achieves a clear focus at distances from about 5 mm to infinity, and that any object within 0–5 mm from the tip of the scope will not be in focus.

If stones are seen, remove the choledochoscope and extract the stones by the usual means. If this is not possible, reinsert the choledochoscope and use a flexible alligator forceps, the Fogarty catheter, or the Dormia stone basket, *all under the direct visual control of the choledochoscope.*

If any lesion of the mucosa which is suspicious of carcinoma is identified, insert a flexible biopsy punch and obtain a sample. Sometimes an ampullary carcinoma can be identified and biopsied in this manner. Occasionally patients with ampullary carcinoma will have a second carcinoma in either the common or the hepatic duct. Under direct visual control, accurate biopsy is not difficult through the choledochoscope.

Results reported by Berci, Shore, Morgenstern, and associates and by Nora, Berci, Dorazzio, and others indicate that routine CBD exploration and removal of calculi is accompanied by a 5% incidence of retained stones and that, following choledochoscopy, the incidence of residual stones can be reduced to 0–2%.

Using choledochoscopy routinely during CBD exploration adds no more than 10 minutes to the procedure and, in our experience, does occasionally detect a stone that has been missed by all other modalities. Because it appears to be devoid of dangerous complications, we have adopted choledochoscopy as a part of routine CBD exploration. We have seen one complication that was possibly related to the saline flush under pressure during choledochoscopy, namely, a mild case of postoperative pancreatitis. However, we have no data to indicate that the incidence of postoperative pancreatitis is indeed increased by the use of choledochoscopy.

Sphincterotomy for Impacted Stones

Perform a complete Kocher maneuver down to the third part of the duodenum and insert a folded gauze pad behind the duodenum and the head of the pancreas. Pass a stiff catheter or a No. 4 Bakes dilator into the choledochotomy incision and down to the distal CBD. Do not pass it into the duodenum. By palpating the tip of the catheter or the Bakes instrument through the anterior wall of the duodenum, ascertain the location of the ampulla. Make a 4-cm incision in the lateral wall of the duodenum opposite the ampulla. Insert small Richardson retractors to expose the ampulla. Often the impacted stone is not in the lumen of the CBD but partially buried in the duct wall. This permits the Bakes dilator to pass beyond the stone and to distend the ampulla. If this is the case, make a 10-mm incision with a scalpel through the anterior wall of the ampulla down to the metal instrument at 11 o'clock, a location far away from the entrance of the pancreatic duct. A 10-mm incision will allow the dilator to enter the duodenum. Remove the Bakes dilator through the choledochotomy incision, and explore the distal CBD through the sphincterotomy incision. Use the smallest size pituitary scoop. Often the stone can be easily removed in this fashion. If the papillotomy incision has to be extended a significant distance to provide adequate exposure, then a complete sphincteroplasty should be undertaken. This technique is described in Chap. 66. If the sphincterotomy is only 10 mm in length, it is generally not necessary to suture the mucosa of the CBD to that of the duodenum. Rather, if there is no bleeding, leave the papillotomy undisturbed after the impacted stone has been removed. Repair the duodenotomy by the same technique as described following sphincteroplasty (see Chap. 66). Then insert the T-tube into the CBD incision.

Checking for Ampullary Stenosis

Before completing the CBD exploration, the diameter of the ampulla of Vater may be calibrated by passing either a catheter or a Bakes dilator. If a 10F rubber catheter passes through the ampulla, no further calibration is necessary. If this device is too soft, use a Coudé olive-tip silk-woven catheter, borrowed from the urologist. The Coudé catheter is stiffer than rubber but softer than metal. Unfortunately, these catheters require gas sterilization, but they are a safer means of examining the ampulla than are Bakes dilators. If a 10F Coudé catheter passes into the duodenum, the diagnosis of ampullary stenosis can be eliminated. The presence of the catheter in the doudenum can be confirmed by injecting saline through the catheter. If the catheters fail to pass, insert the left hand behind the region of the ampulla and pass a No. 3 Bakes dilator gently through the ampulla. Failure to pass through the ampulla with ease is more often due to pushing the instrument in the wrong direction than to ampullary stenosis. In the absence of malignancy, we have found it to be indeed rare that we were unable to pass a catheter or dilator through the ampulla using manipulation. If the preexploration cystic duct cholangiogram showed dye passing through the duodenum, then failing to pass a 3-mm instrument through the ampulla is not by itself an indication for sphincteroplasty or biliary-intestinal bypass. We are not convinced that ampullary stenosis is a cause of clinical symptoms, save for the exceptional patient.

In any case, never use excessive force in passing these instruments because penetration of the intrapancreatic portion of the CBD may produce fatal complications, especially if the damage is not recognized during the operation.

Insertion of the T-Tube

Although it may be possible in some cases to avoid draining the CBD following the removal of stones, we believe that a T-tube should routinely be inserted to decompress the CBD and also to facilitate a cholangiogram 7–8 days following surgery. Do not use a silicone T-tube, as this substance is nonreactive. Consequently, there may be no well-organized tract from the CBD to the outside. When the silicone tube is removed, bile peritonitis will follow. Use a 16F rubber tube. If a smaller size is used, it may not be possible to extract a residual stone postoperatively through the T-tube tract. A 16F tube can almost always be used, even in a small CBD, if half the circumference is excised from the horizontal limb as illustrated in **Figs. 63–5a and 5b**. After inserting the T-tube, close the choledochotomy incision with a continuous 5–0 atraumatic Vicryl suture (**Fig. 63–6**). Make this closure snug around the T-tube to avoid leakage during cholangiography.

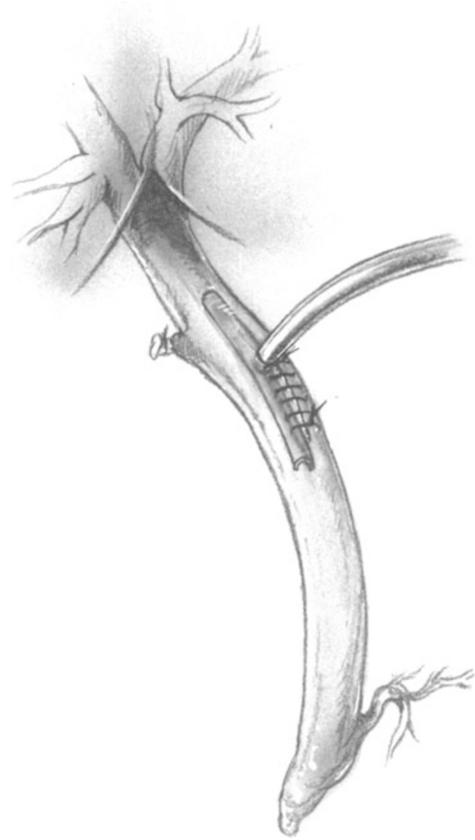


Fig. 63–6

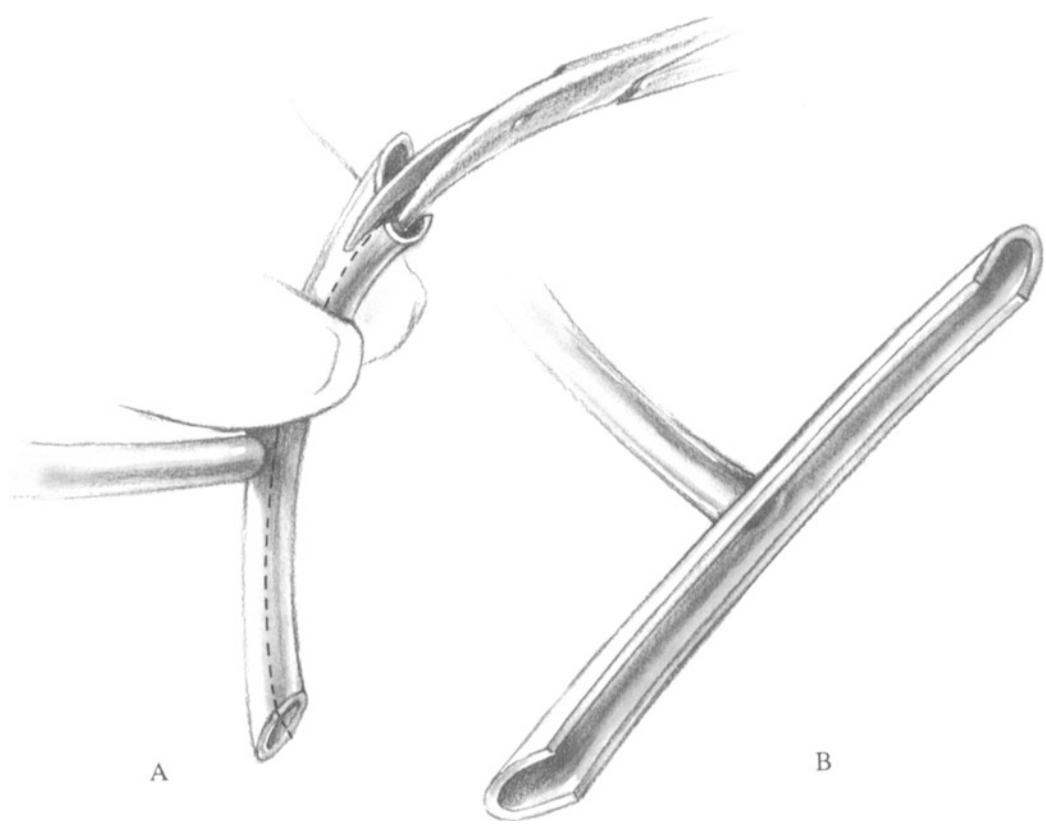


Fig. 63–5a and Fig. 63–5b

Completion Cholangiogram

Eliminate the air in the long limb of the T-tube by inserting the long cholangiogram catheter that was used for the cystic duct cholangiogram down into the vertical limb of the T-tube for its full distance. Then, gradually inject the contrast medium into this limb while simultaneously removing the plastic catheter. This will fill the vertical limb with contrast material and displace the air. Then, attach the T-tube directly to a long plastic connecting tube that is in turn attached to a 30 ml syringe.

Elevate the left flank about 10 cm above the horizontal operating table. Stand behind a lead screen covered with sterile sheets and perform the cholangiogram by injecting 4 ml of diluted contrast medium for the first radiograph and an equal amount for the second and third pictures. We use a mixture of 1 part Conray and 1 or 2 parts saline. The larger the duct, the more dilute the solution.

If the contrast material has not entered the duodenum, repeat the sequence after giving nitroglycerine intravenously. If the contrast material still does not enter the duodenum but the X ray is otherwise negative, discontinue the study. Severe sphincter spasm often follows ampullary instrumentation and cannot be overcome during the completion cholangiogram.

Drainage and Closure

Bring the T-tube out through a stab wound near the anterior axillary line together with a radiopaque latex drain. The stab wound should be large enough to admit the surgeon's fingertip. Suture the T-tube to the skin, leaving enough slack between the CBD and the abdominal wall to allow for some abdominal distention.

Close the abdominal wall by the Smead-Jones technique utilizing No. 1 PDS by the technique described in Chap. 5.

Postoperative Care

Attach the T-tube to a sterile plastic bag. Permit it to drain freely by gravity until a cholangiogram is performed through the T-tube in the X-ray department on the 5th postoperative day. Do not permit any contrast material to be injected into the T-tube under pressure since this may produce pancreatitis or bacteremia. Injection by gravity flow is preferable. If the cholangiogram is negative and shows free flow into the duodenum, clamp the T-tube. Unclamp it if the patient experiences any abdominal pain, nausea, vomiting, shoulder pain, or leakage of bile around the T-tube. Remove the T-tube on the 21st postoperative day.

Following choledocholithotomy, continue antibiotics for at least 3 days, depending on the nature of the Gram stain, the bacteriological studies, and the patient's clinical response.

Continue nasogastric suction for 1–3 days.

Remove the latex drain 4–7 days following surgery unless there has been significant bilious drainage.

Observe the patient carefully for the possible development of a postoperative acute pancreatitis by obtaining serum amylase determinations every 3 days. If there is significant elevation, continue nasogastric suction and intravenous fluids. Some patients with postoperative acute pancreatitis do not have pain or significant elevations of the serum amylase, but they do have intolerance for food with frequent vomiting after nasogastric suction has been discontinued. In these cases a sonogram or CT scan showing an enlarged pancreas is enough to confirm the diagnosis. In general, do not feed the patient following biliary tract surgery if his serum amylase is significantly elevated or if there is any other strong suspicion of acute pancreatitis, for this complication may be serious.

Postoperative Complications

Bile Leak and Bile Peritonitis

T-Tube Displaced

The T-tube is fixed at two points: (1) the CBD and (2) the point on the skin where the T-tube is sutured in position. Enough slack must be left in the long limb of the T-tube between the CBD and the skin so that an increase in abdominal distention will not result in the tube being drawn out of the CBD. Occasionally, the T-tube is inadvertently partially withdrawn from the CBD even before the abdominal incision is closed. When bile leaks around the choledochotomy incision, bilious drainage will be noted from the drain tract alongside the T-tube. If this leak occurs during the first few days following the operation, upper abdominal pain and tenderness may appear, indicating bile peritonitis. While a localized leak of bile is fairly well tolerated in the postoperative patient who has adequate drainage, the spreading of bile diffusely over a large part of the abdominal cavity may produce a generalized bile peritonitis if the bile is infected. Diffuse abdominal tenderness generally demands immediate laparotomy for replacement of the T-tube or insertion of an ERCP stent into the CBD.

Duct Injury

When a completion cholangiogram through the T-tube has been accomplished in the operating room, a *major* duct injury will be apparent on the film.

However, the cholangiogram may not disclose an injury to an *accessory* duct. If this becomes manifest by the continuous drainage of small to moderate amounts of bile along the drain tract and the cholangiogram is persistently normal, remove the T-tube and insert a small Foley catheter into the drain tract. Perform a cholangiogram through this catheter after the balloon has been inflated. Do this procedure 2 weeks following surgery. The most frequently injured anomalous bile duct is that which drains the dorsal caudal segment of the right lobe.

Postoperative Acute Pancreatitis

Acute pancreatitis following choledocholithotomy accounts for about half the postoperative fatalities. It is often caused by instrumental trauma to the ampullary region owing to excessive zeal either in dilating the ampulla or in extracting an impacted stone. In the case of the impacted stone, if it cannot be removed with ease through the choledochotomy incision, approach it via a duodenotomy and papillotomy. Treatment of acute pancreatitis calls for prolonged nasogastric suction, fluid replacement, and respiratory support when indicated. Antibiotics are probably also indicated.

Frequent determination of the serum amylase in patients following choledocholithotomy is necessary because some patients with postoperative pancreatitis do not complain of an unusual degree of pain. Their only symptom may be abdominal distention and vomiting, unless shock and hypoxia supervene. The mortality rate following postoperative acute pancreatitis is reported to be quite high, approaching 30%–50%. Total parenteral nutrition is indicated because many of these patients require from 3–6 weeks of nasogastric suction before the amylase returns to normal, at which time food may be given by mouth. Premature feeding in these cases may cause a severe and even fatal exacerbation.

Increasing Jaundice

After choledocholithotomy in the jaundiced patient, it is common for the serum bilirubin concentration to increase by 4–6 mg/dl in the first postoperative week. This does not mean that the patient necessarily has a CBD obstruction. Rather, the imposition of major surgery and anesthesia upon the liver, already damaged by a period of duct obstruction, temporarily aggravates the hepatic dyfunction. By the 10th–12th postoperative day, the bilirubin will have peaked and have started on its way down toward normal, unless the patient does indeed have another cause for his postoperative jaundice. This may be a blood clot or an overlooked carcinoma in the main hepatic duct. Obstruction of the distal CBD by a retained stone will not produce postoperative jaundice if the T-tube is functioning properly. Obtain a routine cholangiogram through the T-tube by the 7th postoperative day. This will clarify the cause of persistent jaundice.

Hemorrhage

Intra-Abdominal Hemorrhage

Intra-abdominal hemorrage is often manifested by red blood coming through the drain tract. If this is not accompanied by any systemic symptoms or abdominal signs, one may suspect that the bleeding arises from a blood vessel in the skin or the abdominal wound. Bleeding of sufficient magnitude to require one or more blood transfusions invariably originates from the operative area. The cause may be a defective ligature on the cystic artery or oozing from the liver or from some other intra-abdominal blood vessel. These patients require prompt reexploration through the same incision, complete evacuation of the blood clots, and identification of the bleeding point.

Hemobilia

Bleeding through the T-tube indicates hemobilia. This may arise from intrahepatic trauma during attempts to extract an intrahepatic calculus. Generally, expectant therapy is sufficient if any vitamin K deficiency has been corrected preoperatively. In case of persistent hemobilia, perform both a T-tube cholangiogram and a hepatic arteriogram as iatrogenic trauma to a specific branch of the hepatic artery during the hepatic duct exploration may be the source of bleeding. This type of complication occurred in less than 1 in 1,000 cases of CBD exploration (White and Harrison). Treatment consists of ligating the proper branch of hepatic artery, as identified on the arteriogram, or of occluding the vessel by transcatheter embolization in the angiography suite.

The Residual CBD Stone

Early Postoperative Treatment

Most often a residual CBD stone will be detected when the postoperative T-tube cholangiogram is performed. When this study is read as positive for calculi by the radiologist, carefully review the films. Request a repeat study to rule out the possibility that the shadow may be due to an air bubble. Shadows that are odd in shape may not be calculi but may be due to residual blood clot or debris. There is no necessity for early operative intervention aimed at removing a residual CBD stone, so long as the T-tube is draining well. This is true because the nonoperative methods of extracting calculi are extremely effective and have a low complication rate. Also, some of the radiographic shadows, interpreted as calculi, may indeed be artifacts that will disappear without treatment.

If the radiographic evidence is convincing and a stone less than 1 cm in diameter is seen in the lower portion of the CBD, an attempt at a saline flush with or without heparin solution may be indicated, if tolerated by the patient. This is performed not before the 12th postoperative day. Infuse 1,000 ml of normal saline with 5,000 units of heparin through the T-tube over a 24-hour period, provided this does not produce excessive pain. If the calculus completely obstructs the distal CBD, this technique is contraindicated. Repeat this therapy every day for 4–5 days if tolerated. Then repeat the cholangiogram. If the radiographic appearance of the stone shows reduction in size, repeat the series of saline flushes again the following week. Otherwise, send the patient home with the T-tube in place. If the stone is not obstructing and the patient tolerates clamping of the T-tube, keep the tube clamped. Prescribe a choleretic like Decholin in order to dilute the bile. Otherwise, have the patient inject 30–60 ml of sterile saline into the T-tube daily. Ask the patient to return to the hospital about 6 weeks following operation.

Subsequent Postoperative Treatment

When the patient returns for examination 6 weeks after the operation, repeat the T-tube cholangiogram in order to confirm the persistence of the residual stone, since in a number of cases there may be spontaneous passage of the calculus into the duodenum. The simplest and safest method of extracting residual calculi is that described by Burhenne. In this method, it is necessary that the long arm of the T-tube be at least the size of a 14F–16F catheter. After the cholangiogram is completed and does confirm the presence of stones, remove the T-tube and insert a flexible catheter that can be manipulated, like the one available from Medi-Tech. With a continuous flow of contrast medium through the catheter, insert the device down the T-tube tract until the CBD has been entered. Then, directing the tip of the catheter toward the calculus, insert a Dormia stone basket device through the Medi-Tech catheter. Under fluoroscopic control, trap the stone in the stone basket and withdraw the basket, the stone, and the catheter through the T-tube tract. Experienced radiologists, like Burhenne, have reported a success rate better than 90% with this technique. If the stone is quite large, it may not fit into the T-tube tract. However, really large stones are not commonly left behind by competent surgeons. For this reason, almost all residual stones can be removed by this technique. It is even possible to cannulate the right and left hepatic ducts to remove stones.

Another method of accomplishing the same end is to pass a flexible fiberoptic choledochoscope into the CBD via the T-tube tract.

If these methods have failed, endoscopic papillotomy by ERCP technique should be tried *if an expert is available*. Experienced endoscopists have reported performing ERCP-papillotomy and extraction of retained stones with 1%–2% mortality. If expertise with this technique is not available, a stone that is blocking the flow of bile to the CBD will require relaparotomy and choledochotomy for removal. A CBD stone that is not symptomatic when the T-tube is clamped presents a more difficult problem. Some surgeons may elect to remove the T-tube, continue to observe the patient, and reserve reoperation for those patients who later become symptomatic. Alternatively, it may well be argued that it is safer to perform an elective operation for removal of the stone rather than an urgent procedure in the presence of cholangitis. In most cases elective choledocholithotomy is indicated (see Chap. 64).

References

Allen B, Shapiro H, Way LW. Management of recurrent and residual common duct stones. Am J Surg 1981;142:41.

Berci G, Shore JM, Morgenstern L et al. Choledochoscopy and operative fluorocholangiography in the prevention of retained bile duct stones. World J Surg 1978;2:411.

Burhenne HJ. Complications of nonoperative extraction of retained common duct stones. Am J Surg 1976;131:260.

Jones SA. The prevention and treatment of recurrent bile duct stones by transduodenal sphincteroplasty. World J Surg 1978;2:473.

Madden JL. Primary common bile duct stones. World J Surg 1978;2:265.

Nora PF, Berci G, Dorazzio RA et al. Operative choledochoscopy. Am J Surg 1977;44:105.

Rutledge RH. Sphincteroplasty and choledochoduodenostomy for benign biliary obstructions. Ann Surg 1976;183:476.

Saharia PC, Zuidema GD, Cameron JL. Primary common duct stones. Ann Surg 1977;185:598.

Thomas CG Jr, Nicholson CP, Owen J. Effectiveness of choledochoduodenostomy and transduodenal sphincteroplasty in the treatment of benign obstruction of the common duct. Ann Surg 1971;173:845.

Way LW, Admirand WH, Dunphy JE. Management of choledocholithiasis. Ann Surg 1972;176:347.

White TT, Harrison RC. Reoperative gastrointestinal surgery. Boston: Little, Brown; 1973.

64 Concept: When to Perform Other Operations on the Common Bile Duct (CBD)

Operations for Retained or Recurrent CBD Stones

Choice of Operative Procedure

When stones are found in the bile ducts long after the first CBD operation has been done, the T-tube tract is healed and Burhenne's method of retrieval cannot be applied. The options then available to the surgeon are: endoscopic radiographic cholangiopancreatogram (ERCP)-papillotomy, transabdominal choledocholithotomy, biliary-intestinal bypass, or sphincteroplasty. The pros and cons of these procedures are discussed below.

ERCP-Papillotomy

Experienced operators have reported performing a large number of ERCP-papillotomies with a mortality rate of 1.5% (Reiter, Bayer, Mennicken et al.). With increasing experience, this rate may undergo further improvement. Consequently, if an expert with this technique is available, this may well be the procedure of choice especially in the poor-risk patient. In patients who have previously undergone Billroth II gastrectomy or who have unusually large calculi (over 2.0 cm in diameter), ERCP-papillotomy is contraindicated. ERCP-papillotomy has, on occasion, provided a brilliant solution to the problem of a recurrent CBD stone in the patient with disabling cardiac disease. However, when the ERCP-papillotomy is performed by an endoscopist lacking experience and expertise, the results may be disastrous, just as one may expect disastrous results when a secondary choledocholithotomy is performed by a poorly trained surgeon. Whether the ERCP-papillotomy performed by an expert is superior to secondary choledocholithotomy also performed by an expert is a question that cannot be answered with precision at this time because of inadequate data. The poor-risk patient, however, should be referred to a center where expertise in ERCP-papillotomy is available.

Laparotomy for Secondary Choledocholithotomy; Bypass; Sphincteroplasty

Reexploring the CBD for residual stones during the first month following primary choledocholithotomy has a mortality rate of 10.7%, according to Bergdahl and Holmlund. Relaparotomy for retained stones is rarely indicated during the first 4–6 weeks after the primary operation for several reasons. First, small stones often pass spontaneously. Second, by using Burhenne's method, one can extract 80%–90% of the stones through the T-tube tract if the T-tube is 14–16F or larger in size. Third, relaparotomy is safer when it is performed after a delay of 4–6 weeks. In our experience, a secondary choledocholithotomy performed after the 6th week is not more dangerous than an elective primary choledocholithotomy. Girard and Legros confirm this observation. There should be no hesitation about operating to remove stones from the CBD, once they have been detected either by sonogram, percutaneous transhepatic cholangiogram (PTC), or ERCP, especially if the stones produce symptoms. In the good-risk patient, the operation for removal of the stones should be performed unless the stone is so small (less than 1.0 cm) that it is likely to pass spontaneously.

The major controversy in this area centers about the question whether a biliary-intestinal bypass or a sphincteroplasty should be added to the choledocholithotomy procedure.

When to Perform Bypass or Sphincteroplasty for Secondary Choledocholithiasis

There is a wide variety of opinion concerning when a biliary-intestinal bypass or sphincteroplasty should be performed in patients with common duct stones. For instance, Schein and Gliedman advocate doing a choledochoduodenostomy whenever a CBD is encountered that is 1.4 cm or more in diameter during the performance of either a primary or a secondary choledocholithotomy. They also routinely perform a choledochoduodenostomy whenever they open a CBD for retained or recurrent stones or when a patient suffers from ampullary stenosis. Their operative mortality rate is 3.2%.

In a study of 126 consecutive CBD explorations, Madden diagnosed the presence of "primary" CBD stones in 60% of the cases and performed a choledochoduodenostomy in each to prevent recurrence.

Jones advocates sphincteroplasty during a primary CBD operation:

> *when one encounters impacted distal common duct stones, stenosis of Papilla (defined as inability to pass a 3-mm dilator or catheter from above or below and from either side of the table), benign stricture of the distal duct (e.g., from pancreatitis), irremovable hepatic duct stones, ductal mud, sludge, or stasis stones pathognomonic of chronic intermittent distal ductal obstruction, and multiple ductal calculi by which is meant a sufficient number of stones present to make complete clearing of the ducts doubtful . . . When operating for residual stones, sphincteroplasty is indicated when the stones are of the stasis type with mud and sludge present in the bile, and when any of the indications described under primary duct exploration are present. Sphincteroplasty is not advised at primary or secondary choledocholithotomy when the calculi appear to be of gallbladder origin, the bile is clear, only a few large calculi are present, the papilla is 3 mm in diameter or larger, choledochodoscopy shows a clear duct, and the completion cholangiogram is normal.*

In a series of 312 patients undergoing sphincteroplasty, Jones encountered a mortality rate of 0.96%. This enviably low mortality rate unfortunately will not be duplicated by less-experienced surgeons.

We are in general agreement with the above quotation from Jones's paper. However, together with Longmire, and with White and Harrison, we do not believe that the failure to pass a 3-mm catheter or dilator through the ampulla constitutes proof of a diseased ampulla or, by itself, is an indication for bypass or sphincteroplasty. We also disagree with Jones on several other points. When a duodenotomy is required to remove a stone impacted in the ampulla, a simple sphincterotomy about 8–10 mm long will usually release the stone without the necessity of a longer incision in the sphincter of Oddi, the exposure of the duct of Wirsung, or the choledochoduodenal suturing that is required when a long sphincteroplasty is performed. Cases of multiple ductal calculi in which a skilled surgeon is unable to clear the ducts completely with the aid of choledochoscopy and cholangiography are uncommon. Consequently, the percentage of patients undergoing either primary or secondary choledocholithotomy who will require a bypass or a sphincteroplasty is quite low.

In cases of "primary" CBD stones or sludge, encountered at secondary choledocholithotomy, Saharia, Zuidema, and Cameron found that 82% of their patients who underwent simple *choledocholithotomy* without any additional bypass or sphincteroplasty did well during a follow-up period that averaged 4 years and 9 months.

There are no data to substantiate the policy advocated by Schein and Gliedman that a choledochoduodenal bypass be performed for every patient who has a large CBD or who has a retained or recurrent CBD stone. The fact that these patients did well during their brief period of postoperative follow-up observation does not constitute proof that they needed the choledochoduodenostomy in the first place. No prospective study comparing simple choledocholithotomy with bypass procedures has been reported. It is for this reason that this controversy continues.

We perform a bypass or a sphincteroplasty when we believe that we have not cleared the bile ducts of all stones; after one or two previous choledocholithotomy operations for multiple "primary" type CBD stones; and when there is an obstruction of the distal CBD because of a stricture or obstruction of the distal 3–4 cm of the CBD by chronic pancreatitis. Apart from the few exceptions described above, secondary choledocholithotomy followed by negative choledochoscopy and cholangiography, will give results equal to or better than those following bypass procedures or sphincteroplasty, and without the increased risk that these procedures will add to a simple choledocholithotomy when they are executed by surgeons who have *not* performed 100 (Schein and Gliedman), 175 (Degenshein), 138 (Partington), or 312 (Jones) operations. The postoperative mortality rates for choledochoduodenostomy have been reported to be 3.2% (Schein and Gliedman), 3.2% (Degenshein), 3.0% (average of 10 reports summarized by Thomas, Nicholson, and Owen), and 7.8% (Kraus and Wilson). For sphincteroplasty, the mortality rates have been 0.96% (Jones), 2.9% (Partington), and 4.6% (average of 10 reports by Thomas and colleagues). Choledochoduodenostomy and sphincteroplasty are procedures that add to the operative risk; they should be employed only for serious indications.

A more realistic appraisal of the mortality following sphincteroplasty and choledochoduodenostomy may perhaps be obtained from Hutchinson's review of 100 consecutive cases requiring duodenotomy by various staff members at the Swedish Hospital in Seattle. Ninety-three of these cases included either sphincterotomy or sphincteroplasty, often together with choledocholithotomy. Of these 93 patients, 6 (or 6.5%) died of complications directly related to the surgery. Three patients died of pancreatic and duodenal fistula: one from sepsis with cholangitis; one from hepatic necrosis (sepsis); and one from necrotising pancreatitis. Four other patients suffered from a postoperative duodenal fistula following sphincterotomy, but survived. There were two additional postoperative deaths in this series; they followed choledochoduodenostomy and were caused by pancreatic and biliary fistulas and sepsis.

In reviewing 100 contemporaneous cases of cholecystectomy and CBD exploration from the same hospital, Hutchinson found a 4% mortality, but all four of these patients were in their 9th decade of life and died of causes not directly related to the biliary tract or pancreas. These causes included general debility, pulmonary embolus, polycystic kidneys with perirenal abscess, and myocardial insufficiency. Two hundred fifty patients underwent cholecystectomy at the same institution with no deaths and only four complications, while 100 patients undergoing gastric resection encountered no fatalities and only 8% complications. All patients with neoplastic diseases were excluded from Hutchinson's study. One can conclude from these data that opening the duodenum, either for surgery on the sphincter or for choledochoduodenostomy, appears to be more hazardous than is generally appreciated. The duodenum and the sphincter of Oddi must be treated with great respect and the most meticulous surgical technique.

Operations for Noncalculous Biliary Tract Disease

Ampullary Stenosis

Papillitis or fibrosis of the papilla of Vater, with concomitant stenosis of the pancreatic duct orifice, as an important cause of abdominal symptoms is a concept that was emphasized by Nardi and Acosta. The clinical signs and symptoms caused by the ampullary stenosis were said to include postcholecystectomy pain, recurrent pancreatitis, jaundice, enlargement and thickening of the CBD, and liver dysfunction. These authors claimed that histological examination of tissue removed from the papilla by operative biopsy proved the presence of inflammation or fibrosis in these patients. Confirmation of the diagnosis of ampullary stenosis was obtained by operative cholangiography or the inability to pass a No. 3 Bakes dilator through the ampulla, or both. We agree with Longmire and with White and Harrison "that passage of dilators at operation to determine the presence of sphincter stenosis is an unreliable indicator." On the basis of cholangiographic studies, the only finding that suggests a diagnosis of ampullary stenosis is a large CBD in the absence of any other organic obstruction.

Concerning recurrent pancreatitis, White (1973) pointed out that sphincteroplasty appears to be of no value in the treatment of *alcoholic* pancreatitis. There are rare instances of rccurrent pancreatitis being caused by stenosis of the orifice of the duct of Wirsung. This diagnosis can be made on the basis of either an ERCP or an operative pancreatogram demonstrating a dilatation of the pancreatic duct beginning right at the orifice of the duct of Wirsung. In this case, a sphincteroplasty of the ampulla of Vater as well as a sphincteroplasty of the orifice of Wirsung's duct may be helpful (Bartlett and Nardi; Moody, Berenson, and McCloskey).

In patients suffering postcholecystectomy pain, recommended operative remedies have included relaparotomy for excision of cystic duct remnants or neuromata of the cystic duct stump, papillotomy for biliary dyskinesia, as well as a host of other procedures. It is extremely important to recognize that many patients classified as "postcholecystectomy syndrome" in reality are experiencing pain on the basis of some emotional disorder. Often the initial cholecystectomy was not performed for biliary calculi but for the complaints of epigastric discomfort and flatulence. Careful questioning will frequently disclose very little difference between the symptoms labeled as "postcholecystectomy syndrome" and those symptoms of which the patient complained *prior to* the initial cholecystectomy. Longmire stated, "stenosis of the sphincter of Oddi without demonstable common duct stones or debris is a rare cause of recurrent episodic upper abdominal pain with limited specific physical findings."

Schein felt that the diagnosis of ampullary stenosis could be made with the following criteria:

1) Dilated and thickened CBD
2) Delay of more than 90 minutes in the emptying of the CBD following intravenous cholangiography
3) Elevation of intraductal pressure on CBD manometry
4) Difficulty in passing a No. 3 Bakes dilator through the ampulla

Some of these criteria, such as elevation of the manometric pressure in the CBD and difficulty in passing a No. 3 dilator, can occur in patients who are devoid of symptoms. This discrepancy raises some question about the reliability of Schein's criteria in predicting whether sphincteroplasty is indicated.

At this time it appears that symptomatic ampullary stenosis is a rare disease that is difficult to diagnose with accuracy. Patients who have a dilated CBD, in the absence of any apparent additional etiology, and pain accompanied by some elevation of the serum bilirubin or liver enzymes may be benefited by sphincteroplasty. The likelihood of successful results following sphincteroplasty is enhanced if the patient also suffers from biliary sludge or primary stones. Otherwise, "sphincteroplasty is a procedure with potentially serious risk that should be used with the utmost discrimination and care" (Longmire).

Nardi, Michelassi, and Zannini reported a study of 85 cases of transduodenal sphincteroplasty with Wirsung ductoplasty (see Fig. 66–5) with a follow-up of 1–25 years. Overall, 50% of the patients experienced a successful long-term result. These authors perform the morphine-Prostigmin test as follows: 10 mg of morphine and 1 mg of Prostigmin methylsulfate are injected intramuscularly. Serum amylase and lipase levels are measured 1, 2, and 4 hours later. The test is considered positive only if enzyme levels rise to three times normal or higher. Sphincteroplasty-ductoplasty has relieved symptoms in 28% of patients when the test is *negative*. A positive morphine-Prostigmin test predicts good long-term results, especially in patients who have never had previous abdominal surgery and who do not suffer from alcoholism, narcotic abuse, or diarrhea. This report suggests that there is indeed a *small* cohort of patients who have recurrent severe abdominal pain secondary to recurrent acute pancreatitis caused by partial obstruction of Wirsung's duct and who may benefit from a ductoplasty.

CBD Obstruction Due to Periductal Chronic Pancreatic Fibrosis

An uncommon cause of obstruction to the distal 3–5 cm of the CBD is a chronic pancreatitis that produces periductal fibrosis and a long stricture-like condition of the distal duct. The degree of obstruction may sometimes be complete. Surgery for this condition requires a biliary-intestinal bypass, as sphincteroplasty is contraindicated in this situation because the length of the constriction is greater than one can encompass with sphincteroplasty. Whether this bypass should consist of a choledochoduodenostomy or a Roux-en-Y choledochojejunostomy is discussed below.

CBD Obstruction Due to Inoperable Carcinoma of Pancreas

In many hospitals the standard operation aimed at relieving jaundice in an inoperable carcinoma of the pancreas is a side-to-side cholecystojejunostomy or cholecystoduodenostomy (Dayton, Traverso, and Longmire). There are two drawbacks to these operations. One is the fact that the pancreatic carcinoma sometimes grows up along the wall of the CBD and occludes the cystic duct within a matter of a few weeks or months. This causes recurrence of the patient's jaundice and requires a second procedure for palliation. A second drawback is the fact that a leak from either a cholecystoduodenostomy or a side-to-side cholecystojejunostomy constitutes a serious complication with a significant mortality rate.

On the other hand, if a Roux-en-Y anastomosis is made between the jejunum and the anterior wall of the dilated hepatic duct in these cases, leakage from this anastomosis would consist of pure bile. In the presence of any type of external drainage, this type of leak is harmless. The argument that the Roux-en-Y technique, which requires a second jejunojejunal anastomosis, is more time consuming can be answered by constructing the jejunojejunostomy with a stapling device. This method takes only 2–3 minutes (see Chap. 68).

Biliary-Intestinal Bypass versus Sphincteroplasty

Once it has been decided that a patient requires some type of bypass procedure or sphincteroplasty for such conditions as recurrent stasis stones of the CBD or ampullary stenosis, which procedure should be chosen? Sphincteroplasty is indicated for patients who require septectomy for stenosis of Wirsung's duct and for patients with ampullary stenosis, especially if the CBD is less than 1.5 cm in diameter. Sphincteroplasty is contraindicated in the presence of some periampullary diverticula of the duodenum, a lengthy stenosis of the distal CBD secondary to pancreatic fibrosis, and Caroli's cholangiohepatitis.

The bypass is preferred by many surgeons in the elderly, poor-risk patient because it can be accomplished with greater speed and perhaps with a reduced risk of postoperative pancreatitis. If for some reason, an exploratory duodenotomy has already been performed, it may be difficult to construct a proper choledochoduodenal anastomosis since the duodenotomy is likely to be in an unfavorable location for this type of anastomosis. In these cases, either perform a sphincteroplasty or close the duodenotomy and create a choledochojejunal Roux-en-Y bypass.

A summary of the pros and cons of each procedure may be seen in Table 64–1.

Table 64–1. Relative Indications for Sphincteroplasty or Biliary-Intestinal Bypass

	Sphincteroplasty	Biliary-Intestinal Bypass
CBD diam. <1.5 cm	Preferred	Yes, if Roux-en-Y
CBD diam. >1.5 cm	Yes	Yes
Periampullary diverticulum	No	Yes
Poor-risk patient	No	Yes
Stenosis of Wirsung's duct or Vater's papilla	Yes	No
Long stricture of CBD (chronic pancreatitis)	No	Yes
Exploratory duodenotomy already made	Preferred	Yes
Caroli's cholangiohepatitis, hepatic duct stones	No	Yes
Carcinoma, head of pancreas, inoperable	No	Yes
Surgeon lacks experience with sphincteroplasty	Possible	Preferred

Concept: Choledochoduodenostomy versus Roux-en-Y Choledochojejunostomy

A proper choledochoduodenal anastomosis should be made about 2.5 cm in length so that any food material that passes into the CBD will easily pass back out again. If the surgeon aims at a 2.5-cm anastomosis, cholangitis secondary to intermittent obstruction by food particles will be uncommon. A proper anastomosis requires that the diameter of the CBD be at least 1.5 cm (Kraus and Wilson). When a patient has a CBD whose diameter is less than 1.5 cm, either a Roux-en-Y choledochojejunostomy or sphincteroplasty is indicated. Inflammation of the duodenal wall is another relative contraindication to choledochoduodenostomy, as is fibrosis of the duodenal wall of sufficient severity to make approximation of the CBD and duodenum difficult to achieve. Leakage from the choledochoduodenostomy produces a high mortality rate. The mortality rate of choledochoduodenostomy (3%) is higher than that of the Roux-en-Y anastomosis. Bismuth, Franco, Corlette et al. reported no hospital deaths following 123 consecutive Roux-en-Y hepaticojejunostomies.

Another drawback of the choledochoduodenostomy is the possibility of the "sump" syndrome being caused by food particles or calculi lodging in the CBD distal to the anastomosis. Although this complication was frequently observed endoscopically by Akiyama, Ikezawa, and Kameya, it is said to produce adverse symptoms in only a small percentage of cases. (In reviewing a number of reports concerning choledochoduodenostomy, we find that the authors of these reports do not make it clear whether or not they actually observed a high percentage of patients for a period of 5–10 years.) With the Roux-en-Y anastomosis, there is no opportunity for food to enter the bile duct.

Although the Roux-en-Y biliary-jejunal anastomosis is safer, most enthusiasists of the choledochoduodenostomy operation reject the Roux-en-Y operation in poor-risk patients because the second anastomosis (jejunojejunostomy) requires a longer operating time. If the Roux-en-Y jejunojejunostomy is performed by a stapling technique, the added operating time will occupy only a few minutes. The Roux-en-Y procedure has virtually no anastomatic failures and is indeed a good choice for the poor-risk elderly patient. We have found it to be particularly useful in bypassing inoperable carcinomas of the head of the pancreas. In these patients we perform a side-to-end sutured hepaticojejunostomy between the side of the common hepatic duct and the end of the jejunum. We also perform a stapled side-to-side antecolonic gastrojejunostomy, and an end-to-side stapled Roux-en-Y jejunojejunostomy.

Of 64 patients with advanced pancreatic carcinoma treated in this fashion, we have had no anastomatic failures and one postoperative death. The fatality was not related to the operation.

It is more important in the elderly, depleted patient to avoid a serious anastomotic complication than to worry about a few minutes of additional operating time, provided that competent physiological support is available from the anesthesiologist.

One complication that may follow the diversion of bile into the jejunum is the development of peptic ulcer in the duodenum. This occurred in only 2% of the patients studied by Bismuth and colleagues over a mean follow-up of 5.5 years. Nevertheless, patients having a Roux-en-Y anastomosis should be made aware of the presenting symptoms of duodenal ulcer. The history of peptic ulcer diathesis may constitute a relative contraindication to performing a Roux-en-Y choledochojejunostomy.

Following resection of bile duct strictures, reconstruction by a Roux-en-Y hepaticojejunostomy is preferable to hepaticoduodenostomy because it eliminates the possibility of food regurgitating into the anastomosis and causing cholangitis.

A summary of the relative indications for choledochoduodenostomy and the Roux-en-Y operation is listed in Table 64–2.

Table 64–2. Relative Indications for Choledochoduodenostomy or Roux-en-Y Choledochojejunostomy

	Choledochoduodenostomy	Roux-en-Y Choledochojejunostomy
CBD diam. <1.5 cm	No	Yes
CBD diam. >1.5 cm	Yes	Yes
Duodenal inflammation	No	Yes
Fibrosis of duodenum and/or CBD	No	Yes
Active duodenal ulcer	Yes	No
Carcinoma, head of pancreas, inoperable	No	Yes
Poor-risk patient	Yes	Yes
Caroli's cholangiohepatitis, hepatic duct stones	Yes	Preferred
CBD stricture	Yes	Preferred

References

Akiyama H, Ikezawa S, Kameya S et al. Unexpected problems of external choledochoduodenostomy: fiberscopic examination in 15 patients. Am J Surg 1980;140:660.

Bartlett MK, Nardi GL. Treatment of recurrent pancreatitis by transduodenal sphincterotomy and exploration of the pancreatic duct. N Engl J Med 1960;262:643.

Bergdahl L, Holmlund DEW. Retained bile duct stones. Acta Chir Scand 1976;142:145.

Bismuth H, Franco D, Corlette MB et al. Long term results of Roux-en-y hepaticojejunostomy. Surg Gynecol Obstet 1978;146:161.

Burhenne HJ. Nonoperative retained biliary tract stone extraction: a new roentgenologic technique. Am J Roentgenol Radium Ther Nucl Med 1973;117:388.

Dayton MT, Traverso LW, Longmire WP Jr. Efficacy of the gallbladder for drainage in biliary obstruction: a comparison of malignant and benign disease. Arch Surg 1980;115:1086.

Degenshein GA. Choledochoduodenostomy: an 18 year study of 175 consecutive cases. Surgery 1974;76:319.

Girard RM, Legros G. Retained and recurrent bile duct stones; surgical or nonsurgical removal? Ann Surg 1981;193:150.

Hutchinson WB. Duodenotomy. Am J Surg 1971;122:777.

Jones SA. The prevention and treatment of recurrent bile duct stones by transduodenal sphincteroplasty. World J Surg 1978;2:473.

Kraus MA, Wilson SD. Choledochoduodenostomy: importance of common duct size and occurrence of cholangitis. Arch Surg 1980;115:1212.

Longmire WP Jr. The diverse causes of biliary obstruction and their remedies. Curr Probl Surg 1977;14:5.

Madden LJ. Primary common bile duct stones. World J Surg 1978;2:465.

Moody FG, Berenson MM, McCloskey D. Transampullary septectomy for postcholecystectomy pain. Ann Surg 1977;186:415.

Nardi GL, Acosta JM. Papillitis as a cause of pancreatitis and abdominal pain: role of evocative test, operative pancreatography and histologic evaluation. Ann Surg 1966;164:611.

Nardi GL, Michelassi F, Zanni P. Transduodenal sphincteroplasty. Ann Surg 1983;198:453.

Partington PF. Twenty-three years experience with sphincterotomy and sphincteroplasty for stenosis of the sphincter of Oddi. Surg Gynecol Obstet 1977;145:161.

Reiter JJ, Bayer HP, Mennicken C et al. Results of endoscopic papillotomy: a collective experience from nine endoscopic centers in West Germany. World J Surg 1978;2:505.

Rolfsmeyer ES, Bubrick MP, Kollitz PR et al. The value of operative cholangiography. Surg Gynecol Obstet 1982;154:369.

Saharia PC, Zuidema GD, Cameron JL. Primary common duct stones. Ann Surg 1977;185:598.

Schein CJ. Postcholecystectomy syndromes. New York: Harper & Row; 1978.

Schein CJ, Gliedman ML. Choledochoduodenostomy as an adjunct to choledocholithotomy. Surg Gynecol Obstet 1981;152:797.

Thomas CG Jr, Nicholson CP, Owen J. Effectiveness of choledochoduodenostomy and transduodenal sphincterotomy in the treatment of benign obstruction of the common duct. Ann Surg 1971;173:845.

White TT. Indications for sphincteroplasty as opposed to choledochoduodenostomy. Am J Surg 1973;126:165.

White TT, Harrison RC. Reoperative gastrointestinal surgery. Boston: Little, Brown; 1973.

65 Secondary Choledocholithotomy

Indications

Retained or recurrent common bile duct (CBD) stones subsequent to previous cholecystectomy. (See also Chap. 64.)

Preoperative Care

When patients present with the classical signs of biliary colic, chills, fever, and jaundice, no special diagnostic studies may be necessary prior to surgery since the diagnosis of choledocholithiasis would be obvious in such cases.

Patients who do not present with these classical symptoms should undergo an endoscopic radiographic cholangiopancreatogram (ERCP) or a percutaneous transhepatic cholangiogram (PTC). Intravenous cholangiography, once the mainstay among diagnostic procedures for the study of the CBD in the non-jaundiced patient, has fallen into disfavor because it is frequently inaccurate or inconclusive and is responsible for a 40% incidence of false negative reports in choledocholithiasis.

Additional preoperative preparation includes the restoration of the patient's normal prothrombin activity with vitamin K as well as the remaining routine measures to prepare a patient for major surgery.

Perioperative antibiotics are indicated.

Pitfalls and Danger Points

Trauma to adherent duodenum, colon, or liver
Trauma to CBD, hepatic artery, or portal vein

Operative Strategy

If the patient's first operation was not followed by any significant collection of bile, blood, or pus in the right upper quadrant, a secondary choledocholithotomy is not generally a difficult dissection. On the other hand, occasionally the right upper quadrant is obliterated by dense adhesions requiring a carefully planned sequential dissection. First, dissect the peritoneum of the anterior abdominal wall completely free from underlying adhesions. Carry this dissection to the right as far as the posterior axillary line. This will expose the lateral portion of the right lobe of the liver and the hepatic flexure of the colon.

The strategy now is to free the inferior surface of the liver from adherent colon and duodenum. Approach this from the lateral edge of the liver and proceed medially. After 5–6 cm of the undersurface of the lateral portion of the liver has been exposed, start to dissect the omentum and colon away from the anterior border of the undersurface of the liver. The dissection now goes both from lateral to medial as well as from anterior to posterior. If this dissection becomes difficult and there is risk of perforating the duodenum or colon, enter the right paracolic gutter and incise the paracolic peritoneum at the hepatic flexure. Placing the left hand behind the colon will give the surgeon entry into a virgin portion of the abdomen. This will aid in freeing the colon from the liver. The maneuver will uncover the descending portion of duodenum, also in virgin territory. Then perform a Kocher maneuver and bring the left hand up behind the duodenum. This will help guide the dissection toward the CBD. If the foramen of Winslow is uncovered, inserting the finger into this foramen will permit the surgeon to palpate the hepatic artery and give him helpful information concerning the probable location of the CBD.

Now, resume the lateral to medial and anterior to posterior dissection until the undersurface of the liver has been cleared down to the CBD and the hepatic artery. It is not necessary to free the undersurface of the liver for a large area medial to the CBD for adequate exposure.

Operative Technique

Incision

When the patient's previous incision for the cholecystectomy was subcostal in location, we prefer a long vertical midline incision. If the patient has previously been operated on through a vertical incision, then a long subcostal incision, about two fingers breadth below the costal margin, is preferred. Placing the incision in a site away from the previous operative field makes it easier for the surgeon to enter the abdominal cavity expeditiously. Once the peritoneum and falciform ligament have been identified, free the abdominal wall from all underlying adhesions over the entire right side of the upper abdomen.

Freeing Subhepatic Adhesions

In the usual case, initiate the dissection on the right lateral edge of the liver, clearing its undersurface from right to left. If this dissection goes easily, it may be a simple matter to use Metzenbaum scissors to divide filmy adhesions by the techniques described in Chap. 31. When difficulty is encountered in differentiating colon or duodenum from scar tissue, then identify the ascending colon. Incise the paracolic peritoneum and slide the left hand behind the ascending colon. Liberate the hepatic flexure up to the undersurface of the liver. Then free the colon from the liver.

If similar difficulties are encountered in identifying or dissecting the duodenum, perform a Kocher maneuver and slide the left hand behind the duodenum, dissecting this organ away from the renal fascia, vena cava, and aorta.

Now start dissecting the omentum, colon, and duodenum, as necessary, from the undersurface of the liver, going from anterior to posterior until the hepatoduodenal ligament has been reached. The identity of the hepatoduodenal ligament can be confirmed by inserting the left index finger into the foramen of Winslow and palpating the hepatic artery, which should be just to the left of the CBD. Final confirmation may be obtained by aspirating bile with a No. 25 needle and syringe.

Exploring the CBD

After the CBD has been identified, a cholangiogram may be obtained by inserting a No. 22 Angiocath into the duct. Remove the steel needle, leaving the plastic cannula behind. Suture the hub of this cannula to the CBD with 5–0 Vicryl and obtain a cholangiogram.

The technique of the CBD exploration is not different from that described in Chap. 63. Choledochoscopy and postexploratory cholangiography should be included in the operative procedure.

Draining the CBD

Insert a 16F T-tube trimmed as in Fig. 63–5, and close the choledochotomy with 5–0 Vicryl sutures, continuous or interrupted. The indications for sphincteroplasty or biliary-intestinal bypass are discussed in Chap. 64. That the common duct is thick-walled or dilated does not itself constitute an indication for additional surgery other than choledocholithotomy.

The abdomen is drained and closed as in Chap. 63.

Postoperative care and complications are similar to those discussed in Chap. 63.

66 Sphincteroplasty

Indications

Failed previous surgery for common bile duct (CBD) stasis with sludge, primary or recurrent stones

Doubt that multiple CBD stones have all been removed; hepatic duct stones that cannot be removed

Stenosis of Vater's ampulla and/or the orifice of Wirsung's duct with recurrent pain or recurrent acute pancreatitis (rare) (See also Chap. 65)

Preoperative Care

Perioperative antibiotics

Vitamin K in the jaundiced patient

Endoscopic radiographic cholangiopancreatogram (ERCP) indicated to identify CBD calculi or ampullary stenosis and to visualize the pancreatic duct

Pitfalls and Danger Points

Trauma to the pancreatic duct or pancreas resulting in postoperative pancreatitis

Postoperative duodenal fistula secondary to a leak from sphincteroplasty or duodenotomy suture line

Postoperative hemorrhage

Operative Strategy

Protecting the Pancreatic Duct

Make the incision in the ampulla on its superior wall at about 10 or 11 o'clock. After making the initial incision about 5–6 mm in length, locate the orifice of the pancreatic duct. In 80% of cases this can be identified at about 5 o'clock where it enters the ampulla just proximal to the ampulla's termination. Wearing telescopic lenses with a magnification of about 2½× for this operation will help a great deal. If the orifice of the pancreatic duct cannot be identified, inject secretin. Give an intravenous dose equal to 1 unit per kilogram of body weight. This will stimulate the flow of the watery pancreatic secretion and will facilitate the identification of the ductal orifice. Insert either a lacrimal probe or a No. 2 Bakes dilator into the orifice to confirm that it is indeed the pancreatic duct. Some surgeons prefer to insert a plastic tube, such as an infant (size 6F) feeding tube, into the duct to protect it while suturing the sphincteroplasty. We agree with Jones that keeping a tube in the duct is not necessary if one keeps the ductal orifice in view during the suturing process.

When the indication for the sphincteroplasty is ampullary stenosis, abdominal pain, or recurrent pancreatitis, it is essential to add a "ductoplasty" of the pancreatic ductal orifice by incising the septum that forms the common wall between the distal pancreatic duct and the ampulla of Vater. After the pancreatic duct's orifice has been enlarged, it should freely admit a No. 3 Bakes dilator.

Preventing Hemorrhage

In performing a long sphincterotomy for the sphincteroplasty operation, the incision cuts across the anterior wall of the distal CBD as well as the back wall of the duodenum for a distance of 1.5–2 cm. This requires a "blind" incision. Consequently, if the patient has an anomalous retroduodenal or an anomalous right hepatic artery arising from the superior mesenteric artery and crossing in the area between the distal CBD and the duodenum, then one of these vessels may be lacerated by the sphincterotomy incision. It is important to *palpate the area behind the ampulla for the pulsation of an anomalous artery.* If such a vessel is behind the ampulla, then sphincteroplasty by the usual technique may be contraindicated. We are aware, by anecdote, of two patients who died, subsequent to a classical sphincteroplasty by the Jones technique, owing to massive postoperative hemorrhage despite reexploration. In one case, autopsy demonstrated laceration of an anomalous right hepatic artery. The laceration had apparently been temporarily controlled by the 5–0 interrupted silk sutures that had been used to fashion the sphincteroplasty.

By Jones's technique, initially small straight hemostats grasp 3–4 mm of tissue on either side of the contemplated ampullary incision. Then the tissue between the hemostats is divided. Next, a 5–0 silk suture is inserted behind each of the two hemostats; two additional hemostats are then inserted, the sphincterotomy incision is lengthened, and silk sutures again are placed behind each hemostat. In this way, it is possible to partially divide a large anomalous vessel and achieve temporary control, first by the hemostat, and then by the 5–0 silk suture. During the postoperative period the artery may escape from the 5–0 stitch and serious hemorrhage may follow. Although hemorrhage is a rare complication, to omit the application of hemostats prior to making a sphincterotomy incision would appear to be a preferable technique. If the surgeon first makes a 3–4 mm incision with a Potts scissors, he should become immediately aware of any laceration of a major vessel at a time when proper reparative measures can be effectively undertaken. Otherwise, inflammation that occurs 5 or 6 days after the operation may make accurate identification of the anatomy difficult during any relaparotomy for hemorrhage. For this reason, we recommend making the incision first for a short distance, next the inserting of sutures, then the lengthening of the incision and the inserting of additional sutures sequentially until the proper size sphincteroplasty has been achieved.

Avoiding Duodenal Fistula

Leakage from the duodenum can occur from the apex of the sphincteroplasty because at this point the CBD and duodenum no longer share a single common wall. Here accurate suturing is necessary to reapproximate the incised CBD to the back wall of the duodenum.

A second source of leakage is the suture-line closing the duodenotomy. A longitudinal duodenotomy is preferred because it may be extended in either direction if the situation requires more exposure. Close this longitudinal incision in the same direction that the incision was originally made. Otherwise, distortion of the duodenum takes place and linear tension on the suture line may impair successful healing. Precise insertion of sutures, one layer in the mucosa and another layer in the seromuscular layer, can be accomplished without narrowing the duodenum. That the failure of the suture line is a real problem has been demonstrated by Hutchinson, who found that 7% of a series of 100 duodenotomy cases sustained a postoperative duodenal fistula. White reported detecting a number of duodenal leaks when performing T-tube cholangiograms. These leaks occurred a week after CBD exploration and duodenotomy for sphincteroplasty in patients who did not manifest any clinical symptoms. On the other hand, most leaks from incisions in the second portion of the duodenum cause serious if not lethal consequences; take special care in resuturing the duodenotomy incision.

Operative Technique

Incision and Exploration

Make a long right subcostal or midline incision, free adhesions, and perform a routine abdominal exploration. If a satisfactory preoperative ERCP has not been accomplished, perform a cholangiogram.

Kocher Maneuver

Execute a complete Kocher maneuver because this will simplify the performance of a sphincteroplasty by bringing the duodenum up almost to the level of the anterior abdominal wall, thus facilitating exposure of the ampulla. First incise the peritoneum just lateral to the descending duodenum. Then insert the left index finger behind the avascular ligament that attaches the duodenum to the renal capsule (of Gerota). By pinching this ligament between the thumb and index finger, push the areolar and vascular tissue away from this layer and divide the ligament. In some cases it is necessary to free the hepatic flexure of the colon in order to perform a thorough Kocher maneuver, which should be continued to the third portion of the duodenum almost as far as the point where the superior mesenteric vein crosses the anterior wall of the duodenum. In a cephalad direction, divide the ligament up to the foramen of Winslow. After this has been done, place the left hand behind the head of the pancreas and elevate it from the flimsy attachments to the vena cava and posterior abdominal wall. Place a gauze pad behind the pancreatic head.

CBD Exploration

Make an incision in the anterior wall of the CBD as close to the duodenum as possible because, if for some reason sphincteroplasty is not feasible, it may prove desirable to perform a choledochoduodenostomy. For the latter operation, an incision in the distal portion of the CBD allows the surgeon to make an anastomosis to the duodenum under less tension than an incision made at a higher level. If a CBD exploration for calculi is indicated, follow the same procedure as described in Chap. 63. Then pass a No. 4 Bakes dilator into the CBD down to, but not through, the ampulla of Vater. By palpating the tip of the dilator through the anterior duodenal wall, it is possible to place the duodenal incision accurately with reference to the location of the ampulla.

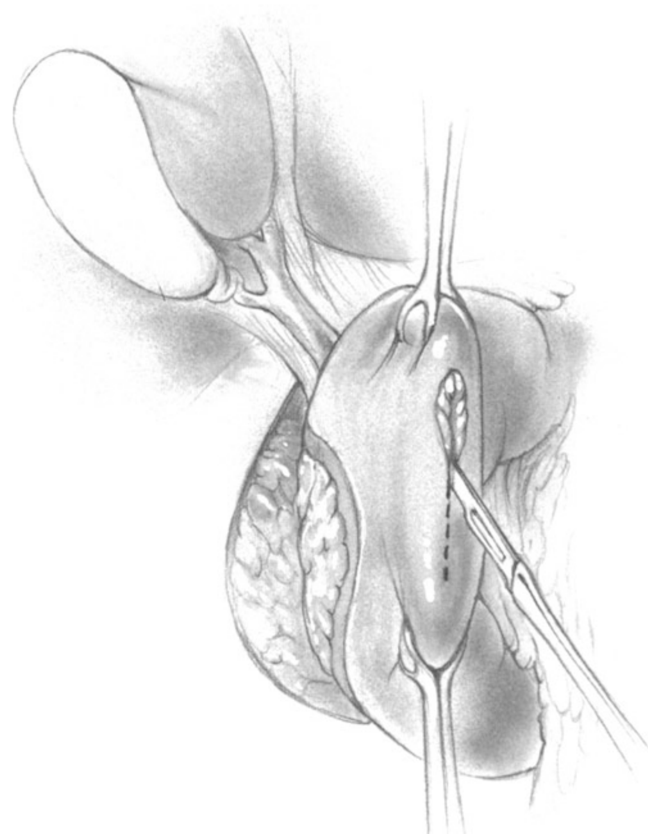


Fig. 66–1

Duodenotomy and Sphincterotomy

Make a 4-cm scalpel incision along the antimesenteric border of the duodenum (**Fig. 66–1**). Center this incision at the estimated location of the ampulla, as judged by palpating the tip of the Bakes dilator (**Fig. 66–2**). Control bleeding points by careful electrocoagulation and an occasional 5–0 PG suture.

Achieve exposure of the ampulla by inserting appropriately sized Richardson retractors, one at the proximal and one at the distal extremity of the duodenal incision.

Make a 5-mm incision at 10 or 11 o'clock along the anterior wall of the ampulla, using either a scalpel blade against the large Bakes dilator impacted in the ampulla, or a Potts scissors with one blade inside the ampulla (**Fig. 66–3**). Insert one or two 5–0 Vicryl sutures on each side of the partially incised ampulla (**Fig. 66–4**). Leave intact the tails of the tied sutures; they are useful for applying gentle traction by attaching small hemostats.

Now identify the orifice of the pancreatic duct, which enters the back wall of the ampulla at about 5

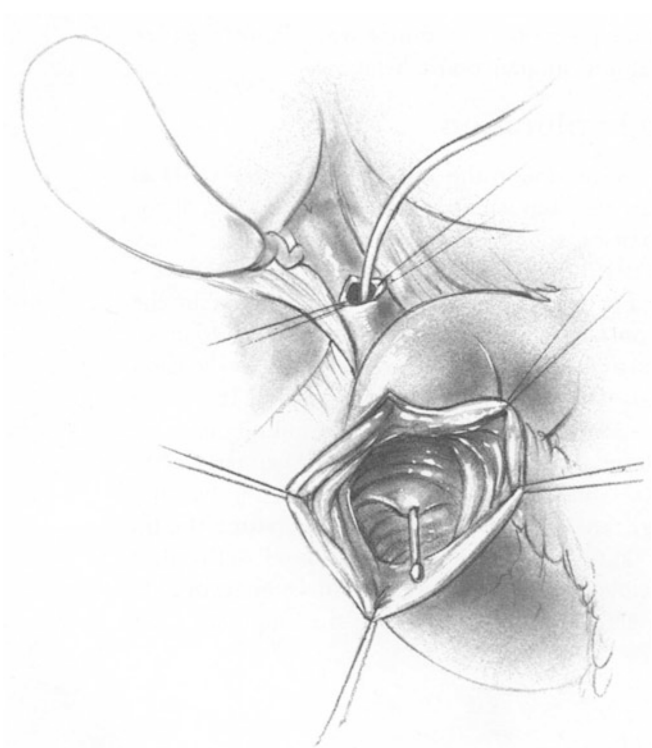


Fig. 66–2

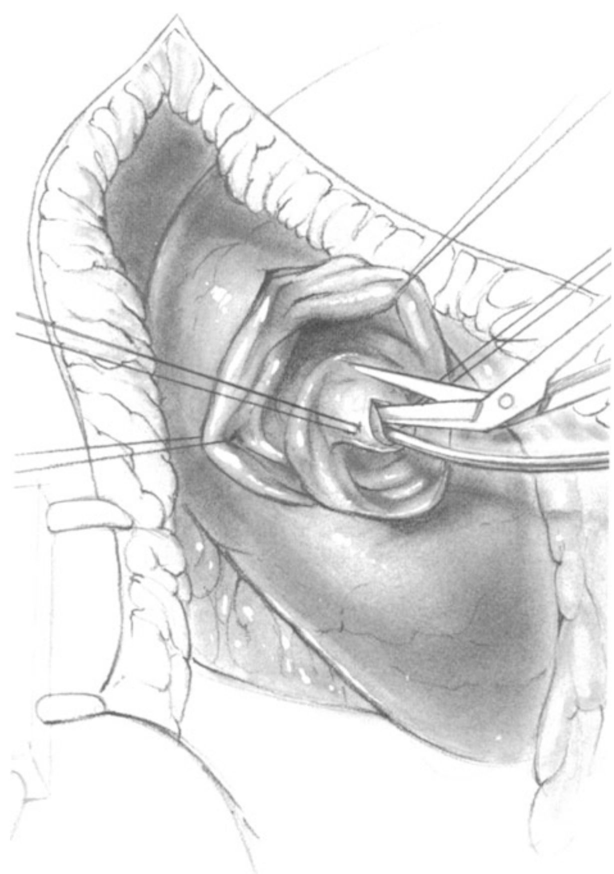


Fig. 66–3

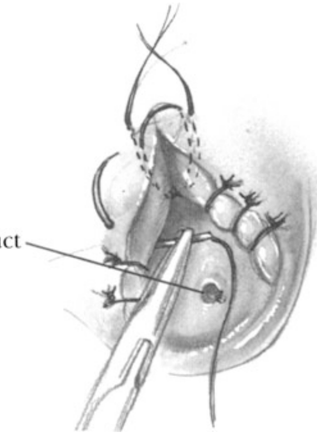


Fig. 66–4

o'clock near its termination. If the exposure of this portion of the ampulla is inadequate, extend the sphincterotomy by another 3–4 mm and insert an additional suture on each side. If the ductal orifice still has not been located, inject secretin (1 unit per kilogram of body weight) intravenously to stimulate the flow of pancreatic juice into the duodenum. Verify the location of the ductal orifice by inserting either a lacrimal probe or a No. 2 Bakes dilator. Then make a mental note to avoid traumatizing this area by inaccurate dissecting or suturing. Continue the sequence of incising the ampulla for about 3 mm at a time and inserting interrupted sutures (**Fig. 66–5**). In order to incise the entire sphincter of Oddi, the sphincterotomy must be almost 2 cm in length. Additionally, if it is suspected that there are residual calculi and the CBD is large, the length of the sphincterotomy incision should at least equal the diameter of the CBD.

Nardi has reported gaining valuable data confirming the presence of fibrosis by biopsying the ampulla.

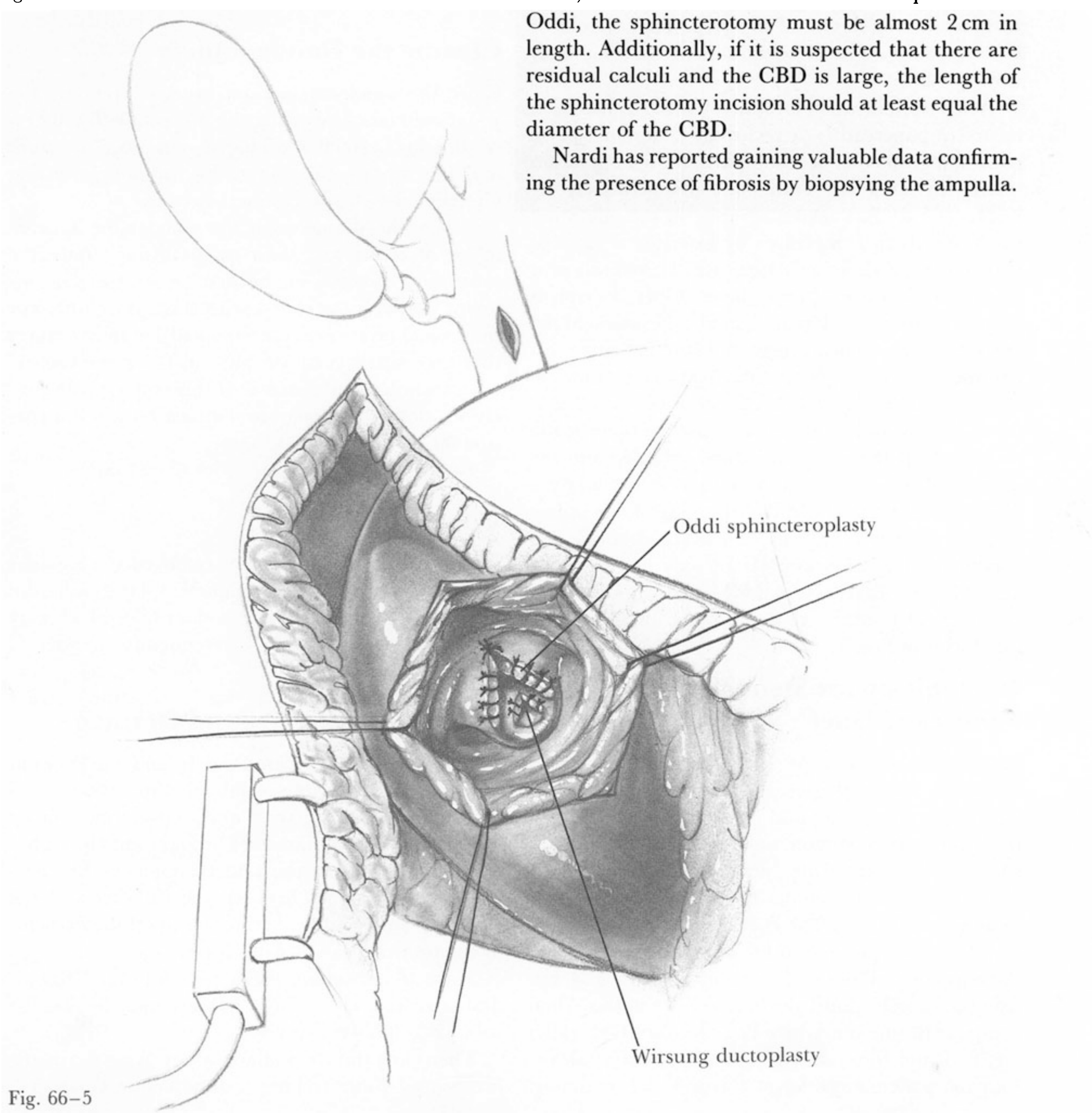


Fig. 66–5

He obtains the ampullary biopsy before performing the sphincterotomy by inserting a Doubilet sphincterotome into the ampulla. By closing the jaws of this instrument, one can obtain a narrow wedge of tissue for biopsy while simultaneously initiating the sphincterotomy. Other students of this subject have not been able to obtain valuable information concerning fibrosis or inflammation of the sphincter, although it is obvious that any area suspicious of cancer should always be biopsied for frozen-section examination.

It is important to insert a figure-of-eight suture at the apex of the sphincterotomy in order to minimize the possibility of leakage. Carefully inspect the sutures at the conclusion of this step. They should be close together, and bleeding should be completely controlled.

When the indication for sphincteroplasty has been recurrent pancreatitis or recurrent abdominal pain, pancreatography is a vital part of the operation unless this step has been done preoperatively by means of ERCP. Pancreatography in the operating room may be accomplished by inserting a suitable plastic tube such as an Angiocath, a ureteral, or a small whistle-tip rubber catheter. Only 2–3 ml of diluted Conray or Hypaque should be used. Make the injection without pressure. Most patients with chronic recurrent pancreatitis will have multiple areas of narrowing and dilatation of the pancreatic duct, making sphincteroplasty a useless therapeutic procedure. If the pancreatic duct is dilated and the ductal orifice is narrowed so that it does not admit a No. 3 Bakes dilator, then the enlarging of this orifice by a ductoplasty may prove beneficial, although this combination of conditions occurs only rarely. Nardi and Moody, Berenson, and McCloskey have reported good results with ductoplasty for stenosis of the ductal orifice.

Ductoplasty for Stenosis of Orifice of Pancreatic Duct

Magnify the orifice of the pancreatic duct by wearing telescopic lenses. Insert a Potts scissors into the pancreatic duct orifice and incise the septum, which constitutes the common wall between the anterior surface of the pancreatic duct and the posterior wall of the ampulla. Sometimes the orifice is too narrow to admit the blade of the Potts scissors. In this case, insert a metal probe into the ductal orifice and cut the anterior wall of the duct by incising for 3–4 mm using a scalpel against the metal of the probe. Then complete the incision with a Potts scissors. Generally, an 8–10 mm incision will permit the easy passage into the pancreatic duct of a No. 3 Bakes dilator. Insert several 5–0 Vicryl sutures to maintain the approximation of the pancreatic duct to the mucosa of the ampulla (see Fig. 66–5).

After this step, White and Harrison insert an infant size (6F or 8F) polyvinyl feeding tube into the orifice of the pancreatic duct. They next lead the tube through the duodenotomy incision and then through a stab wound in the abdominal wall to drain away the pancreatic secretions in the effort to minimize the ill effects of a possible minor leak of the duodenotomy repair. Jones does not use any drainage tube in the pancreatic duct when he performs a sphincteroplasty. Nor have we adopted this step.

Closing the Duodenotomy

Close the duodenal incision in two layers by the usual method of inverting the mucosa with either a continuous Connell, Cushing, or seromucosal suture and the seromuscular layer by carefully inserting interrupted 4–0 silk Lembert sutures.

When the diameter of the duodenum appears to be more narrow than usual, include only the protruding mucosa in the first layer; make no attempt to invert the serosa with this suture line. For the second layer, insert interrupted Lembert sutures that take small accurate bites of the seromuscular coat, including submucosa. If this is done with precision, closing the longitudinal incision will not narrow the duodenum.

Cover the duodenotomy with omentum.

Cholecystectomy

If the gallbladder has not been removed at a previous operation, performing a sphincteroplasty will produce increased stasis of gallbladder bile, which may lead to stone formation. Consequently, perform a cholecystectomy.

Abdominal Closure and Drainage

After irrigating the operative site and the incision with a dilute antibiotic solution, drain the area of the sphincteroplasty with a closed-suction plastic catheter (4–5 mm diameter) brought out through a puncture wound in the upper abdomen. Be careful to avoid contact between the catheter and the duodenal suture lines. Suture the tip of the catheter in the proper location with fine catgut.

Place an indwelling 14F T-tube into the CBD for drainage and close the CBD around the T-tube using a 5–0 Vicryl suture.

Then close the abdominal wall by using the modified Smead-Jones technique described in Chap. 5.

Postoperative Care

Continue nasogastric suction for a few days or until evidence of peristalsis is present with the passage of flatus.

Monitor the serum amylase every 2 days.

Continue perioperative antibiotics for 24 hours. If the bile is infected, continue antibiotics for 7 days.

Perform a cholangiogram on the 7th postoperative day and remove the T-tube on the 14th postoperative day if the X ray shows satisfactory flow into the duodenum without leakage.

Remove the closed-suction drain by the 7th postoperative day unless there is bilious or duodenal drainage.

Postoperative Complications

Duodenal Fistula

A suspected duodenal fistula can often be confirmed by giving the patient methylene blue dye by mouth and looking for the blue dye in the closed-suction catheter, or by performing a T-tube cholangiogram. In cases of minor duodenal fistulas where there is neither significant systemic toxicity nor any abdominal tenderness, it is possible that a small leak will heal when managed by continuing the closed-suction drainage, supplemented by systemic antibiotics and intravenous alimentation.

A major leak from the duodenum is a life-threatening complication. If systemic toxicity is not controlled by conservative management, relaparotomy is indicated. Resuturing the duodenum will generally fail because of the local inflammation. In this situation, insert a sump-suction catheter into the duodenal fistula. Isolate the fistula by performing a Billroth II gastrectomy with vagotomy. Divert the bile from the duodenum by dividing the CBD and anastomose the proximal cut end of the duct to a Roux-en-Y segment of jejunum so that bile drains into the efferent limb of the jejunum distal to the gastrojejunostomy.

References

Hutchinson WB. Duodenotomy. Am J Surg 1971;122:777.

Jones SA. The prevention and treatment of recurrent bile duct stones by transduodenal sphincteroplasty. World J Surg 1978;2:473.

Moody FG, Berenson MM, McCloskey D. Transampullary septectomy for postcholecystectomy pain. Ann Surg 1977;186:415.

Nardi GL. Papillitis and stenosis of the sphincter of Oddi. Surg Clin North Am 1973;53:1149.

Saharia PC, Zuidema GD, Cameron JL. Primary common duct stones. Ann Surg 1977;185:598.

White TT, Harrison RC. Reoperative gastrointestinal surgery. Boston: Little, Brown; 1979.

67 Choledochoduodenostomy

Indications

Common bile duct (CBD) stasis with sludge, primary, or recurrent stones, only if bile duct is more than 1.5 cm in diameter

Doubt that multiple CBD stones have all been removed, only if CBD is more than 1.5 cm in diameter

Constriction of distal CBD because of chronic pancreatitis

(See also Chap. 64)

Contraindications

Diameter of CBD less than 1.5 cm

Acute inflammation or excessive fibrosis in duodenal wall

Carcinoma of pancreatic head

(Hepaticojejunostomy Roux-en-Y is our preferred bypass procedure for pancreatic carcinoma obstructing the CBD. It is a safer operation; also the anastomosis will not be obstructed by the advancing growth of the malignancy.)

Preoperative Care

Perioperative antibiotics

Vitamin K in jaundiced patients

Nasogastric tube

Pitfalls and Danger Points

Anastomotic stoma too small, resulting in postoperative recurrent cholangitits

Diameter of CBD too small

Anastomotic leak; duodenal fistula

Postoperative "sump" syndrome

Operative Strategy

Size of Anastomotic Stoma

As the anastomotic stoma after choledochoduodenostomy will permit the passage of food from the duodenum into the CBD, it is important that the anastomosis be large enough to permit the food to pass back freely into the duodenum. Otherwise, food particles will partially obstruct the anastomotic stoma and produce recurrent cholangitis. If the surgeon aims at constructing an anastomosis with a stoma 2.5 cm or more in diameter, postoperative cholangitis will be rare. The size of the stoma may be estimated postoperatively by an upper gastrointestinal barium X-ray study.

Obviously, if the diameter of the CBD is small, a large anastomotic stoma is difficult to achieve. Kraus and Wilson emphasize that choledochoduodenostomy is contraindicated in a patient whose CBD is less than 1.5 cm in diameter.

Location of the Anastomosis

There are several alternative locations for the incisions in the CBD and the duodenum. If postoperative anastomotic leakage is to be prevented, it is vitally important that these incisions be made in tissues of satisfactory quality and that there be no tension on the anastomosis.

Another problem presents itself when the surgeon has made an incision in the CBD in the vicinity of the cystic duct for the CBD exploration; he may also have made a duodenal incision opposite the ampulla for an impacted ampullary calculus. Under these conditions, even with an extensive Kocher maneuver, it may not be possible to approximate these two incisions by suturing because there will be too much tension on the anastomosis. In this situation a Roux-en-Y choledochojejunostomy or a sphincteroplasty is preferable. When the possibility of a choledochoduodenostomy can be anticipated prior to the CBD exploration, make the incision in the CBD near the point where it enters the sulcus between the pancreas and the duodenum. This will facilitate constructing the anastomosis by the technique described in Figs. 67–1 to 67–5, the method preferred by Schein and Gliedman.

When the incision in CBD has been made in a more proximal location, test the mobility of the duodenum after performing a Kocher maneuver. If the duodenum is easily elevated to the region of the CBD incision, a choledochoduodenostomy by the method illustrated in Figs. 67–6 and 67–7 is also acceptable. There must be no tension on the anastomosis.

Preventing the Sump Syndrome

Sporadic reports have appeared describing the accumulation of food debris or calculi in the terminal portion of the CBD following choledochoduodenostomy. This accumulation produces intermittent cholangitis and has been called the "sump syndrome." Akiyama observed considerable inflammation in the region of the stoma as well as food particles in the distal CBD by endoscopy. Smith, commenting on a paper by White, stated that he had found it necessary to operate on 25 patients with cholangitis caused by the sump syndrome following choledochoduodenostomy performed by other surgeons. McSherry and Fischer in 5 years encountered 6 patients who suffered from cholangitis, acute pancreatitis, or pain and fever owing to calculi in the blind "sump" following side-to-side choledochoduodenostomy (five cases) or choledochojejunostomy (one case). The symptoms were relieved by endoscopic papillotomy or by laparotomy and choledocholithotomy or sphincteroplasty. These authors state:

> Because of our observation that residual and recurrent common duct calculi are capable of producing symptoms in patients with biliary-intestinal anastomoses, we suggest that the indications for . . . choledochoduodenostomy be re-examined. If the condition of the patient permits, every effort should be made to remove all calculi from the common bile duct at operation . . . Choledochoduodenostomy is best reserved for those patients in the high risk category . . .

Tanaka, Ikeda, and Yoshimoto reported four cases of the sump syndrome following choledochoduodenostomy or side-to-side choledochojejunostomy. All were relieved by endoscopic sphincterotomy.

Enthusiasts of choledochoduodenostomy (Degenshein; Madden; Schein and Gliedman) report that they have not observed the sump syndrome in their cases. However, it is not clear from any of these authors that they had achieved a comprehensive long-term follow-up study of all of their patients. Certainly, if the stoma of the choledochoduodenostomy is small, postoperative cholangitis is common. There are no clear data to indicate precisely what is the incidence of postoperative symptoms from the sump syndrome.

One group (Escudero-Fabre et al.) followed 71 patients for 5 to 15 years subsequent to choledochoduodenostomy and found the results to be good. Only three patients suffered cholangitis and no one developed the "sump syndrome."

White described the technique of dividing the CBD and then performing an end-to-side choledochoduodenostomy in order to prevent this syndrome. White does not specify what the complication rate of this method is, but he does emphasize that the diameter of the end-to-side choledochoduodenal anastomosis should be over 1.5 cm.

If a choledochojejunostomy by the Roux-en-Y technique is constructed, then no food will enter the CBD even when the distal CBD has not been divided. However, residual or recurrent calculi in the blind sump may conceivably cause the problems described by McSherry and Fischer. For this reason, Bismuth, Franco, Corlette et al. divide the CBD and implant the proximal cut end into a Roux-en-Y limb of jejunum. This technique offers the lowest incidence of postoperative symptoms.

Operative Technique

Incision

Either a right subcostal or a midline incision from the xiphoid to a point 5 cm below the umbilicus is suitable for this operation. Divide any adhesions and explore the abdomen. Perform a complete Kocher maneuver. If the diameter of the CBD is less than 1.5 cm, do *not* perform a choledochoduodenostomy.

Choledochoduodenal Anastomosis

Free the peritoneum over the distal CBD. Make an incision on the anterior wall of the CBD for a distance of at least 2.5 cm. This incision should terminate close to the point where the duodenum crosses the distal CBD. Make another incision of equal size along the long axis of the duodenum at a point close to the CBD (**Fig. 67–1**). Insert the index

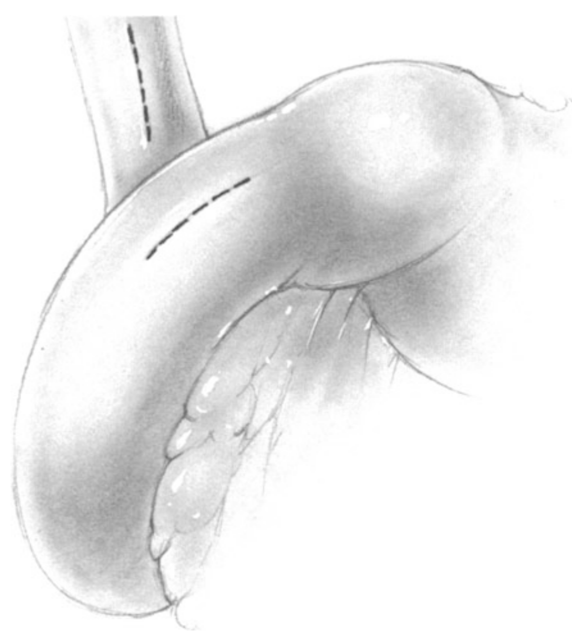


Fig. 67–1

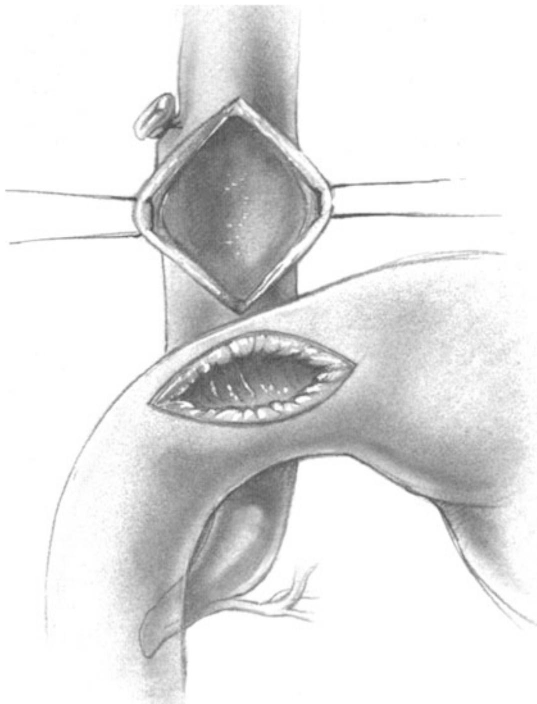


Fig. 67–2

finger into the duodenum and palpate the ampulla of Vater to be certain that a carcinoma of the ampulla has not been overlooked.

Place guy sutures at the midpoints of both the lateral and medial margins of the CBD incision.

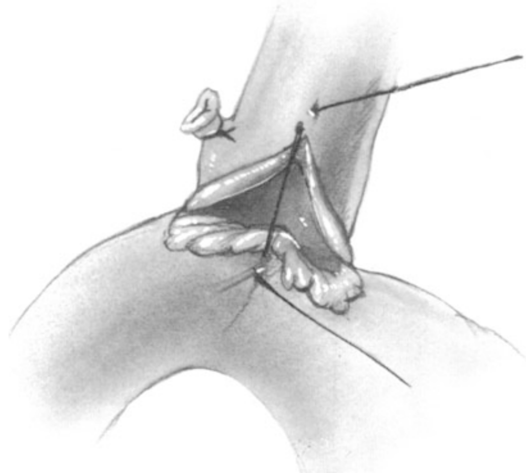


Fig. 67–4

Apply traction to these guy sutures in opposite directions to open up the choledochotomy incision (**Fig. 67–2**). One layer of interrupted 4–0 Vicryl sutures will be used for this anastomosis. Insert the first stitch of the posterior layer approximating the midpoint of the duodenal incision to the distal margin of the choledochotomy. Tie the stitch with the knot inside the lumen. Insert additional stitches going through the full thickness of the duodenum and of the CBD (**Fig. 67–3**) until the entire posterior layer has been completed. Cut all of the sutures except the

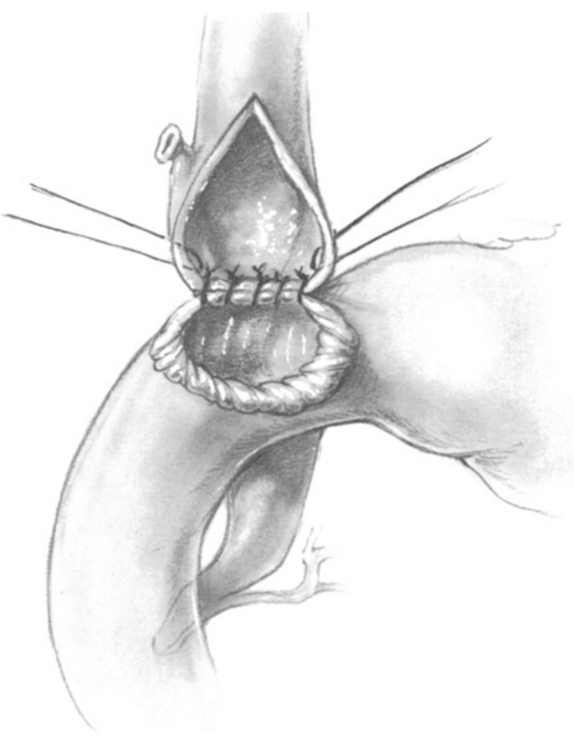


Fig. 67–3

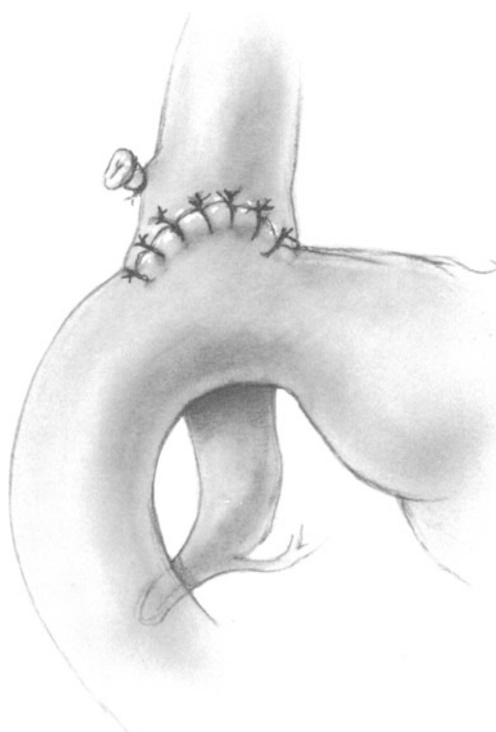


Fig. 67–5

most lateral and most medial stitches. Now approximate the proximal margin of the choledochotomy with the same suture material to the midpoint of the anterior layer of duodenum and tie this stitch so as to invert the mucosa of the duodenum (**Fig. 67–4**). Continue to insert interrupted through-and-through sutures until the anterior layer has been completed (**Fig. 67–5**). This anastomosis should be completed without tension.

Alternative Method of Anastomosis

In some cases the surgeon may elect to perform a choledochoduodenal anastomosis after he has already made the choledochotomy incision in a location too far proximal on the CBD to accomplish the anastomosis by the above technique. In this case, enlarge the choledochotomy so that it measures at least 2.5 cm in length.

Next, perform a thorough Kocher maneuver to increase the mobility of the duodenum. Then, move the duodenum toward the choledochotomy incision and determine which portion of the duodenum is most suitable for a side-to-side anastomosis *without tension*. If tension cannot be avoided, perform a Roux-en-Y anastomosis.

Make an incision in the duodenum that is parallel to the choledochotomy and approximately equal in length (**Fig. 67–6**). Approximate the posterior layer with interrupted sutures and tie them (**Fig. 67–7**). The knots will be inside the lumen. Leave the tails of the most cephalad and most distal sutures long but cut all other sutures. Then bisect the anterior layer of the anastomosis and insert a 4–0 PG Lembert suture to approximate the midpoint of the CBD incision to the midpoint of the duodenal incision. Tie this suture so that the duodenal mucosa is inverted. Insert additional sutures of the same type to complete the approximation. The knots will be on the outside surface of the anastomosis for the anterior layer.

Since the CBD is quite large in these cases and the duodenal wall is free of pathology, no T-tube or other stent is necessary.

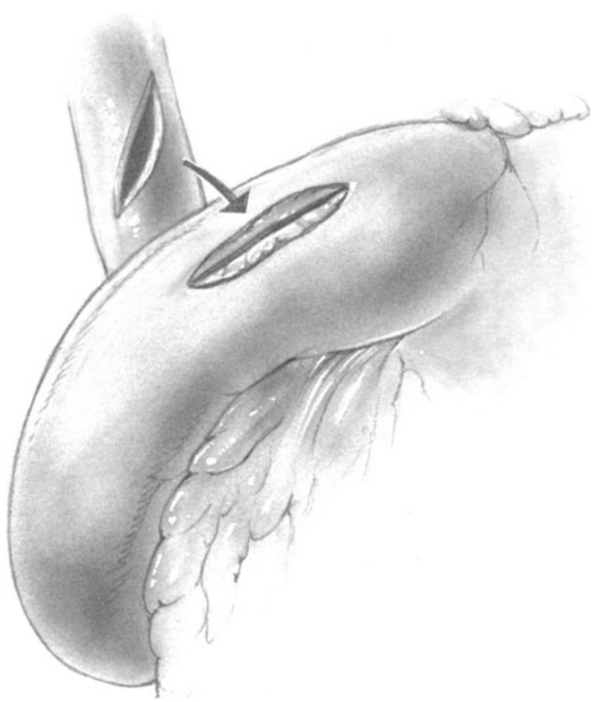


Fig. 67–6

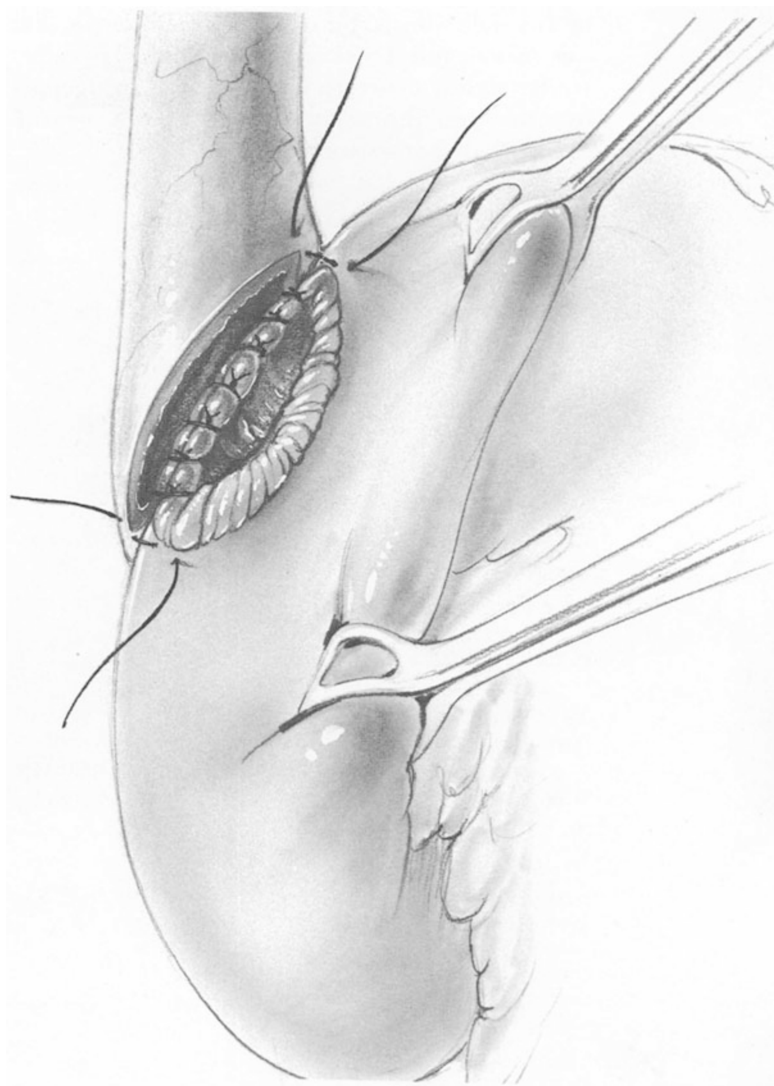


Fig. 67–7

Drainage and Closure

As bile has an extremely low surface tension, there is a tendency for a small amount of this substance to leak out along the suture holes during the first day or two following a biliary tract anastomosis. For this reason, insert a closed-suction drainage catheter through a puncture wound in the right upper quadrant and bring the catheter to the general vicinity of the anastomosis.

Postoperative Care

Continue nasogastric suction if necessary.

Do not remove the closed-suction drain for 5–7 days.

Postoperative Complications

Duodenal fistula (see Chap. 66)

Subhepatic abscess

Late development of cholangitis owing to anastomotic stoma being too small

Late development of "sump" syndrome

References

Akiyama H, Ikezawa H, Kameya S et al. Unexpected problems of external choledochoduodenostomy: fiberscopic examination in 15 patients. Am J Surg 1980;140:660.

Bismuth H, Franco D, Corlette MB et al. Long term results of Roux-en-y hepaticojejunostomy. Surg Gynecol Obstet 1978;146:161.

Degenshein GA. Choledochoduodenostomy: an 18 year study of 175 consecutive cases. Surgery 1974;76:319.

Escudero-Fabre A, Escallon A Jr, Sack J et al. Choledochoduodenostomy: Analysis of 71 cases followed for 5 to 15 years. Ann Surg 1991;213:635–644.

Kraus MA, Wilson SD. Choledochoduodenostomy: importance of common duct size and occurrence of cholangitis. Arch Surg 1980;115:1212.

Madden JL. Primary common bile duct stones. World J Surg 1978;2:465.

McSherry CK, Fischer MG. Common bile duct stones and biliary-intestinal anastomoses. Surg Gynecol Obstet 1981;153:669.

Schein CJ, Gliedman ML. Choledochoduodenostomy as an adjunct to choledocholithotomy. Surg Gynecol Obstet 1981;152:797.

Tanaka M, Ikeda S, Yoshimoto H. Endoscopic sphincterotomy for the treatment of biliary sump syndrome. Surgery 1983;93:264.

White TT. Indications for sphincteroplasty as opposed to choledochoduodenostomy. Am J Surg 1973;126:165.

68 Roux-en-Y Hepatico- or Choledochojejunostomy

Indications

Common bile duct (CBD) obstruction due to inoperable carcioma of the distal CBD, duodenum, or head of pancreas

CBD stasis with sludge, primary, or recurrent stones

Doubt that multiple CBD stones have all been removed

Constriction of the distal CBD due to chronic pancreatitis and fibrosis

CBD stricture

Preoperative Care

Perioperative antibiotics

Vitamin K in jaundiced patients

Pitfalls and Danger Points

Devascularizing the jejunal segment by inaccurate division of mesentery

Operative Strategy

If an isoperistalic Roux-en-Y segment of jejunum was anastomosed to the common hepatic or the CBD, the incidence of postoperative anastomotic failure was zero in the experience of Bismuth, Franco, Corlette et al., who studied 123 consecutive patients suffering from benign, nonprogressive biliary tract lesions. The postoperative mortality in the first 60 days was also zero. Bismuth and associates feel that the isolated Roux-en-Y segment should be 70 cm in length to prevent any possibility of food regurgitation into the bile ducts. Other authors feel that 60 cm is an adequate length. It is clear that a choledochojejunostomy with a Roux-en-Y construction is the safest biliary-intestinal anastomosis yet designed.

When the end of jejunum is anastomosed to the side of the bile duct or when a side-to-side biliary-jejunal anastomosis is constructed by the Roux-en-Y method, cholangitis will not be produced by the regurgitation of food material. It is conceivable that the blind end of the bypassed CBD may accumulate calculi as they pass down from the hepatic ducts. However, it is much more likely that any material of this type would pass through the large anastomosis into the jejunum rather than collect at the lower end of the CBD. Nevertheless, Bismuth and his colleagues advocate complete division of the CBD, suturing the distal duct closed and then implanting the cut end of the proximal duct into the side of the jejunum. It is not clear that this step is necessary. We often suture the end of the jejunum to the anterior side of the CBD when the CBD is enlarged. Otherwise, a side-to-side biliary-jejunal anastomosis is performed. Although it seems clear that the Roux-en-Y anastomosis is the safest and also seems to have the fewest long-term complications, most surgeons have been reluctant to abandon choledochoduodenostomy in favor of biliary-jejunal Roux-en-Y anastmoses because the Roux-en-Y technique requires a jejunojeunal anastomosis in addition to the choledochojejunostomy. If the jejunojejunostomy is performed by the stapling technique described below, it will take no more than 2–3 minutes of operating time. We have not encountered any complications with this technique of reanastomosing the jejunum.

When the Roux-en-Y biliary-intestinal bypass is performed for carcinoma of the pancreas, it is necessary to evaluate the root of the small bowel mesentery because some of these tumors can extend deeply into this mesentery, making impossible the proper dissection of the jejunal blood supply for the Roux-en-Y segment. In these few cases this operation is contraindicated and some other type of bypass must be considered. Under these conditions, anastomosing the gallbladder to the side of a loop of jejunum may prove satisfactory for the short life expectancy characteristic of patients with large pancreatic neoplasms (Dayton, Traverso, and Longmire).

In most cases the marginal artery of the jejunum is divided immediately distal to the artery supplying the second arcade. By dividing only one or two additional arcade vessels, sufficient jejunum can be mobilized to reach the hepatic duct without tension. The jejunum is passed through an incision in the avascular portion of the transverse mesocolon, generally to the right of the middle colic artery. This dissection must be done carefully and will be facilitated by transilluminating the jejunal mesentery by means of a spotlight or a sterilized fiberoptic illuminator.

Operative Technique

Incision and Biopsy

If there has been a previous operation on the biliary tract that utilized a subcostal incision, then make a long midline incision. If the previous incision was vertical, then make a long subcostal incision and enter the abdomen. In secondary cases, the first effort is to free the peritoneum of the anterior abdominal wall from all its underlying adhesions as far lateral as the midaxillary line. Then continue to free the structures as described in Chap. 65.

In primary operations for carcinoma of the pancreas, make a long midline incision from the xiphoid to a point 6–7 cm below the umbilicus. This will prove to be a good incision either for a bypass or partial or total pancreatectomy. Conduct the usual exploration in order to make an accurate diagnosis. In patients with pancreatic carcinoma that is inoperable, take biopsies from areas of obvious carcinoma with a scalpel or biopsy a metastatic lymph node. When these steps are not possible, we have generally been successful in confirming the diagnosis of carcinoma by inserting a syringe with a 22-gauge needle into the hardest part of the pancreas. As soon as the needle enters the suspicious area, apply suction and plunge the needle for 1-cm distances in two directions. Then, release the plunger of the syringe so that no further suction is being applied. Remove the syringe and the needle. Pass it promptly to the cytopathologist as *immediate* fixation is necessary for an accurate cytological diagnosis. This method has provided us with a higher percentage of positive diagnoses in carcinoma of the pancreas than the tissue techniques. The cytologist's report should not take more than 10–15 minutes.

Creating the Roux-en-Y Jejunal Limb

Inspect the proximal jejunal mesentery and look for the first two branches from the superior mesenteric artery to the jejunum just beyond the ligament of Treitz. Identify the marginal artery at a point 2 cm

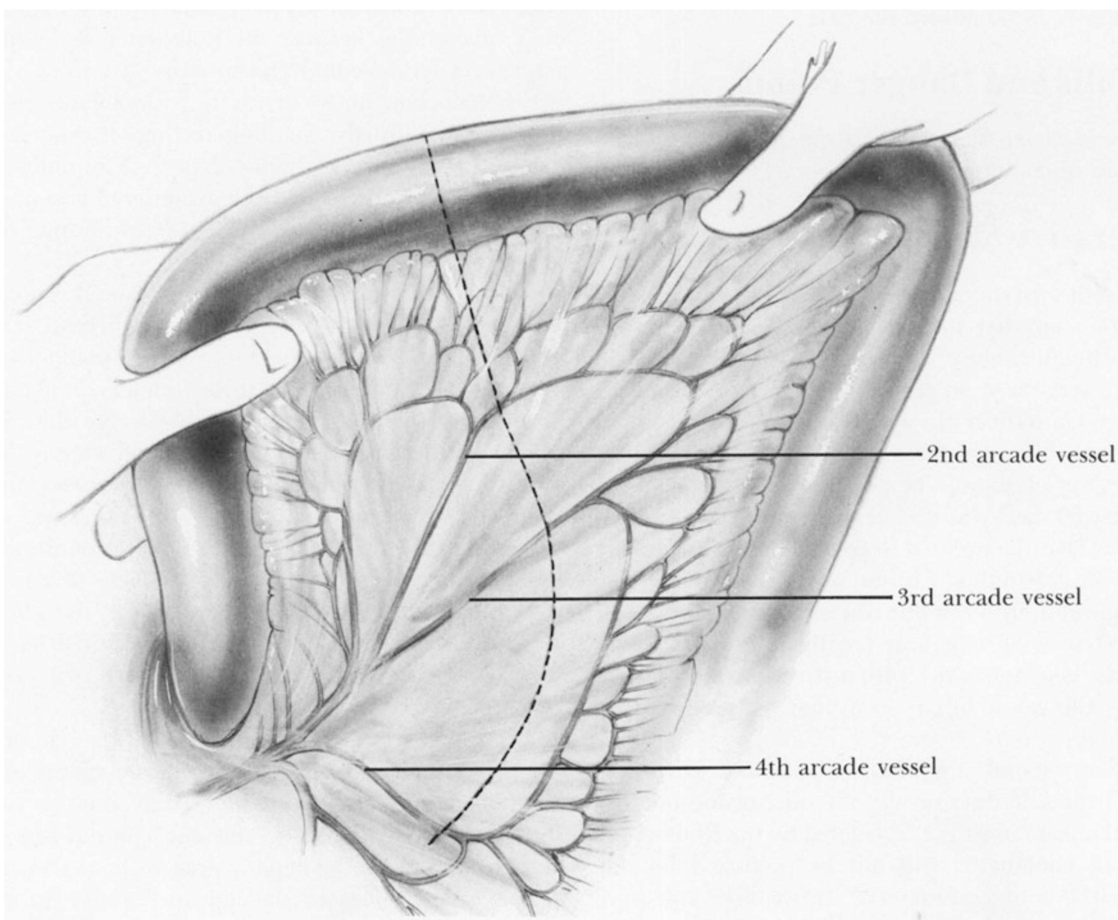


Fig. 68–1

beyond its junction with the second jejunal branch. This is generally about 15 cm from the ligament of Treitz. Make a light scalpel incision over the jejunal mesentery from the jejunum across the marginal artery and into the avascular area of the mesentery. Divide the mesentery in a distal direction until the third vessel is encountered. Divide and ligate this vessel and continue the incision in the mesentery down to the fourth vessel. This most often does not require division (**Fig. 68–1**).

Now clean the mesenteric margin of the jejunum and divide between Allen clamps.

Tentatively pass the liberated limb of jejunum up toward the hepatic duct to determine whether sufficient mesentery has been dissected. If this is so, then expose the right portion of the transverse mesocolon. Find an avascular area, generally to the right of the middle colic vessels and make a 2–3 cm incision through the mesocolon. Pass the liberated limb of jejunum through the incision in the mesocolon. It may be necessary to free some of the omentum from the area of the hepatic flexure in order to permit free passage of the jejunum up to the hepatic duct. The end of the jejunum should reach the proximal portion of the common hepatic duct with no tension whatever.

Hepaticojejunostomy

Remove the Allen clamp by incising the jejunum adjacent to the clamp with the electrocautery. If there is protrusion of more than 2 mm of jejunal mucosa beyond the incised seromuscular layer, then either amputate this excess mucosa flush with the seromuscular incision or else use a continuous suture of 5–0 PG in an over-and-over fashion to approximate the mucosa to the cut end of the seromuscular layer. This step is advisable because the hepaticojejunal anastomosis is performed with one layer of sutures. Clean the mesenteric border of the jejunum for a distance of about 5 mm from its cut end.

In cases of carcinoma, expose the proximal portion of the hepatic duct (**Fig. 68–2**) in order to place

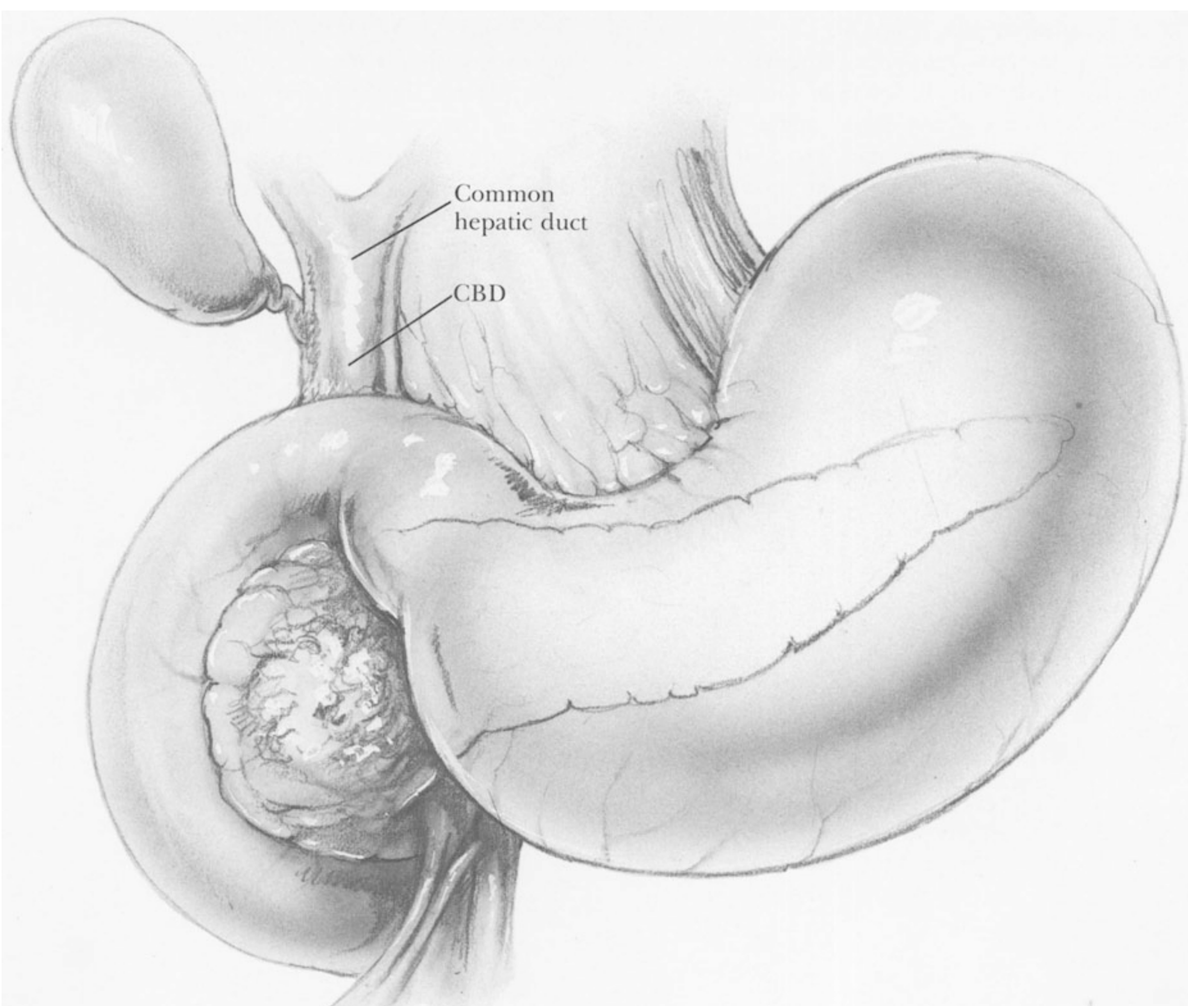


Fig. 68–2

the anastomosis as far from the tumor as possible because pancreatic and CBD malignancies grow upward along the wall of the CBD. Placing the anastomosis at a distance well generally avoid occlusion of the anastomosis by further growth of the malignancy. In the case of benign disease, the anastomosis may be made at any convenient location along the dilated hepatic or CBD. Incise the layer of peritoneum overlying the duct. Then make a 2.5–3.5 cm longitudinal incision in the anterior wall of the hepatic duct and evacuate the bile. If the gallbladder is enlarged and interferes with the exposure, gentle compression of the gallbladder should empty its contents after the hepatic duct has been opened. If the cystic duct is already obstructed by tumor and the gallbladder blocks exposure, perform a cholecystectomy. Also, perform a cholecystectomy whenever the hepaticojejunostomy is being performed for benign disease since the bypass anastomosis will produce stasis in the gallbladder and render it functionless.

Only one layer of seromucosal sutures is necessary for this anastomosis (**Fig. 68–3**). Each bite of the suture material should encompass 4 mm of the jejunum and the full thickness of the hepatic duct. Place the sutures about 4 mm apart. Initiate the anastomosis by inserting the first 5–0 Vicryl suture at the caudal end of the anastomosis, which will correspond with the mesenteric border of the jejunum. Tie the suture and tag it with a hemostat. Then insert the most cephalad stitch and tag this with a hemostat. Complete the right side of the anastomosis with interrupted 5–0 sutures by the technique of successive bisection (see appendix Figs. B–22 and B–23). Do not tie any of these sutures but tag each with a hemostat. After all the sutures have been placed, tie them and complete the right-hand side of the anastomosis (**Fig. 68–4**). All of the mucosa should have been inverted. If there is any difficulty in inverting this mucosa, it is altogether permissible to use an accurate Lembert type of stitch

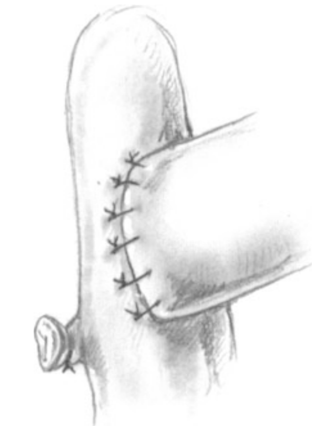


Fig. 68–4

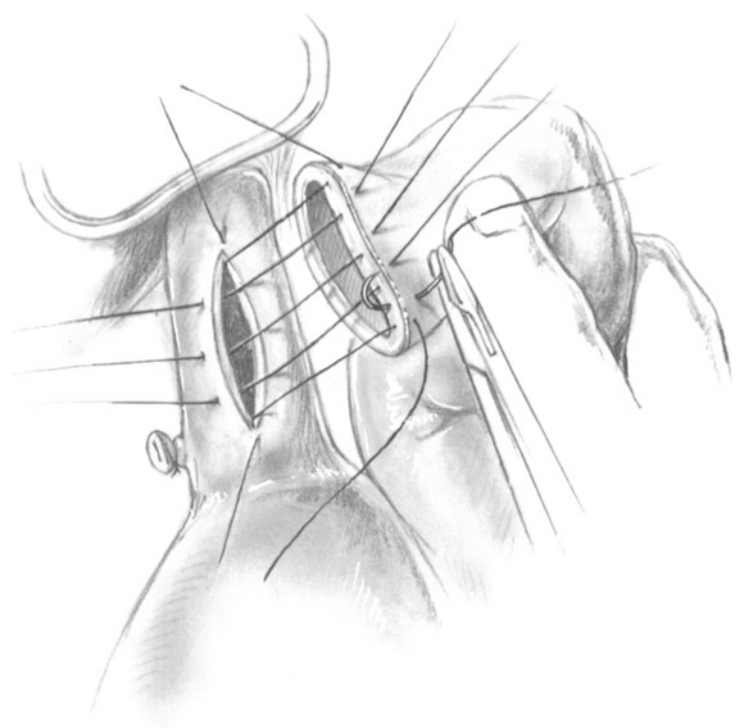


Fig. 68–3

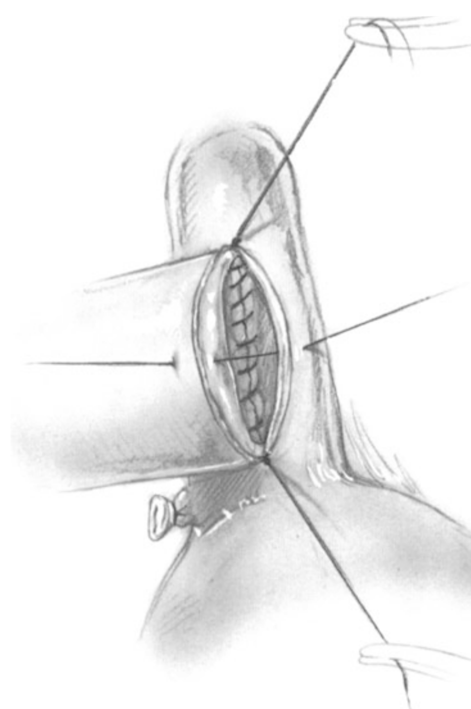


Fig. 68–5

on the jejunum and a through-and-through stitch on the CBD. Cut all the tails of the sutures except the most proximal and distal stitches, which are retained as guy sutures. Then retract the jejunum somewhat towards the patient's right. Now initiate the left half of the anastomosis by bisecting the area between the proximal and distal stitches. Insert the first stitch at this point (**Fig. 68–5**). If the hepatic duct is large, it is permissible to tie these sutures as they are inserted. If the duct is small enough to cause concern that you may catch the opposite wall of the bile duct while inserting stitches, do not tie any of them until all of the sutures have been inserted. Then the bile duct can be easily inspected prior to tying the stitches. Construction of this anastomosis with continuous sutures is also quite acceptable.

After all the sutures are tied, it will be evident that a quite large end-to-side anastomosis has been accomplished without much difficulty. All the knots will be tied outside the lumen of the anastomosis in this case, although the use of PG synthetic absorbable suture material makes it of no importance whether the knots are inside or outside the lumen. We see no indication at this time for the use of nonabsorbable sutures in the bile ducts. We have not used a stent, catheter, or T-tube in any of the Roux-en-Y biliary-jejunal anastomses, unless they were done for post-traumatic or iatrogenic bile duct strictures.

When a side-to-side hepaticojejunostomy is performed, close the end of the jejunum by applying the TA-55 stapler with 3.5-mm staples. Cut the excess jejunum off flush with the stapler. Lightly coagulate the mucosa. It is not necessary to invert this staple line with sutures. When the side-to-side anastomosis is being done, use the same 5–0 Vicryl suture material, insert through-and-through sutures on the posterior layer, and tie the knots inside the lumen. On the anterior layer of this anastomosis, the knots will be tied outside the lumen with mucosa being inverted. Again, a Lembert suture may be used if necessary because there is not much danger of inverting too much jejunum when only one layer of sutures is used and the duct is large.

If an anastomosis is contemplated between the divided cut end of the hepatic duct and the side of the jejunum, accomplish an oblique division of the hepatic duct. This will convert the anastomosis from a circular one to an elliptical shape and will have the effect of enlarging the diameter of the anastomotic stoma. In cases of bile duct strictures, try to dissect out and remove that portion of the bile duct that consists largely of scar tissue and has no mucosa. Make an incision on the antimesenteric side of the jejunum. This incision should be a millimeter or two larger than the diameter of the transected hepatic duct. Use 5–0 Vicryl suture material swaged onto atraumatic fine needles. Make the posterior anastomosis first with interrupted sutures. Excise any redundant protruding jejunal mucosa to facilitate a one-layer anastomosis. Take a bite of hepatic duct and then of jejunum, encompassing only 2–3 mm of tissue with each bite, but penetrate the entire wall of the bile duct and of the jejunum. Tie the knots on the inside of the lumen for the posterior half of the anastomosis. Then, for the anterior half of the anastomosis insert the sutures so that the knots are tied outside the lumen. The knots should be spaced 3–4 mm apart. After the anastomosis has been completed, inspect the back side as well as the anterior wall for possible imperfections.

To avoid any linear tension on the anastomosis by gravity, insert a few seromuscular sutures into the jejunum and attach the jejunum to the undersurface of the liver or to adjacent peritoneum.

Gastrojejunostomy

Patients undergoing bypass surgery because of pancreatic carcinoma have a 30% chance of developing duodenal obstruction from growth of the tumor (Blievernicht, Neifeld, Terz et al.). In order to avoid a secondary operation for duodenal obstruction, it is wise to invest a few minutes in performing a stapled side-to-side gastrojejunostomy. We generally create the anastomosis 60 cm distal to the hepaticojejunostomy and bring the jejunal limb in an antecolonic fashion to the greater curvature of the gastric antrum. Divide and ligate the branches of the gastroepiploic arcade along the greater curvature of the antrum so that a 5–7 cm area is free.

Use the electrocautery to make a stab wound on the greater curvature aspect of the stomach and on the antimesenteric side of the jejunum. Insert the GIA stapling device in a position where it will not

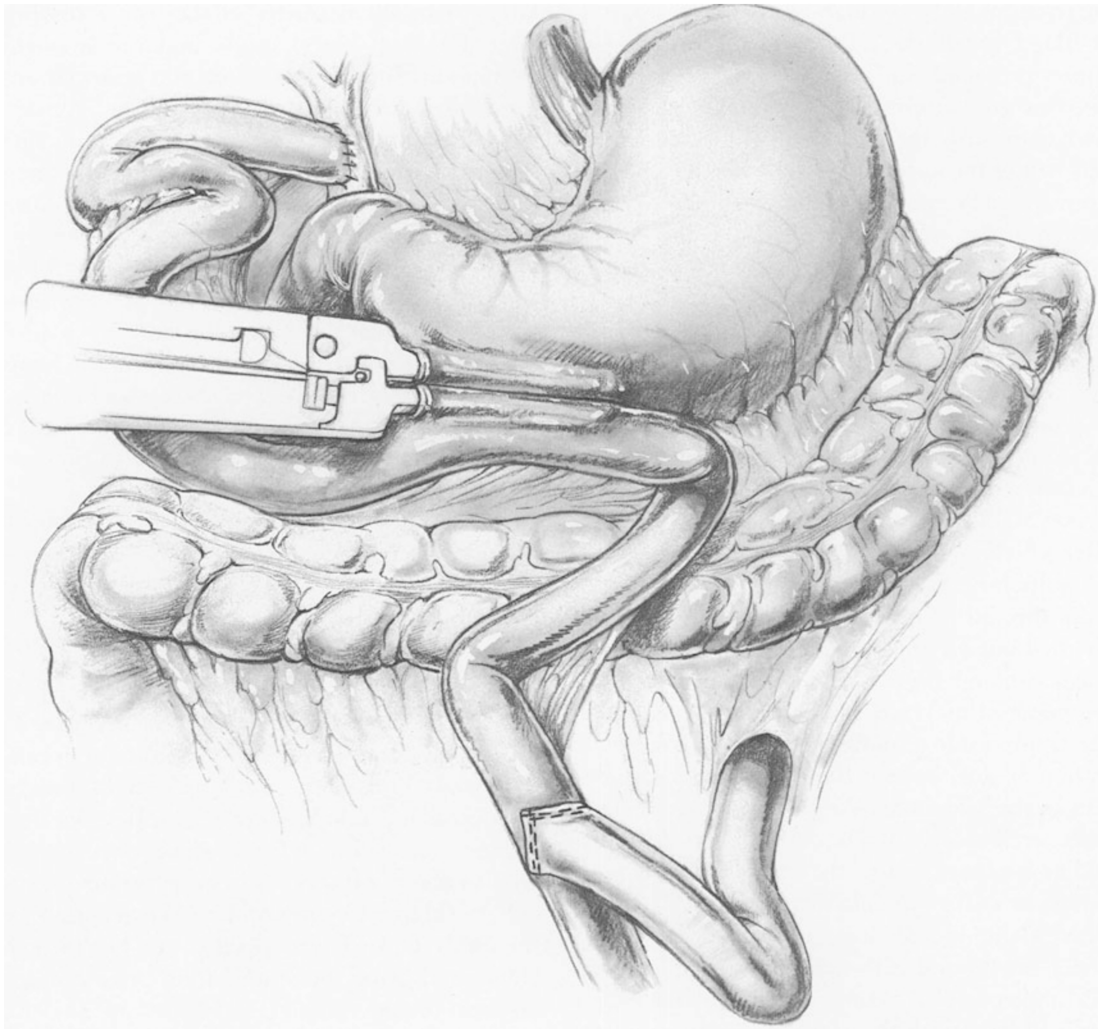


Fig. 68–6

transect any blood vessels. Lock the device (**Fig. 68–6**). Fire the GIA and remove it. Inspect the suture line for bleeding, which should be controlled either with cautious electrocoagulation or 5–0 PG suture-ligatures. Then grasp the two ends of the GIA staple line with Allis clamps. Apply additional Allis clamps to the gap between stomach and jejunum. Then close this gap with a single application of the TA-55 stapler using 4.8-mm staples. With a Mayo scissors amputate the redundant tissue and lightly electrocoagulate the mucosa. Remove the stapling device and inspect the anastomosis for any possible defects or bleeding (also see Figs. 23–5 to 23–7).

Stapling the Roux-en-Y Jejunojejunostomy

At a point 10–15 cm distal to the gastrojejunostomy, align the proximal cut end of the jejunum with the descending limb of jejunum, as depicted in **Fig. 68–7**. It is important to have the cut end of the proximal jejunum facing in a cephalad direction because the construction of the stapled anastomosis is facilitated thereby. Make a 1.5-cm longitudinal incision with the electrocautery on the antimesenteric border of the descending limb of jejunum 10–15 cm distal to the gastrojejunostomy. Now remove the Allen clamp from the proximal end of jejunum and insert the GIA device, one limb into the stab wound and the other limb into the open end of jejunum (**Fig. 68–7**). Lock the GIA device and fire the stapling device; then remove it. Inspect the staple line for bleeding.

Place a guy suture at the midpoint of the remaining defect approximating the descending limb of jejunum with the proximal open end of jejunum as in **Fig. 68–8**. Apply an Allis clamp to the anterior termination of the GIA staple line and another Allis clamp to the posterior termination of the GIA staple line (**Fig. 68–9**). Apply additional Allis clamps to

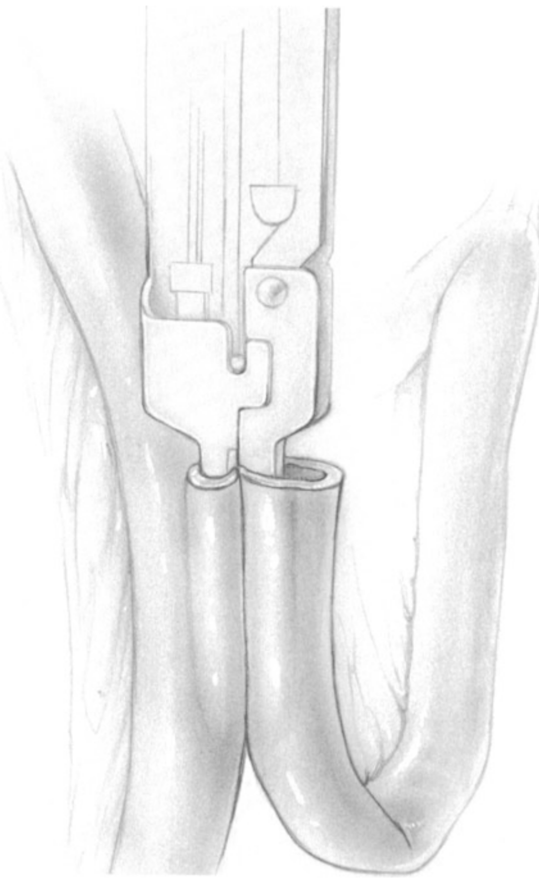


Fig. 68–7

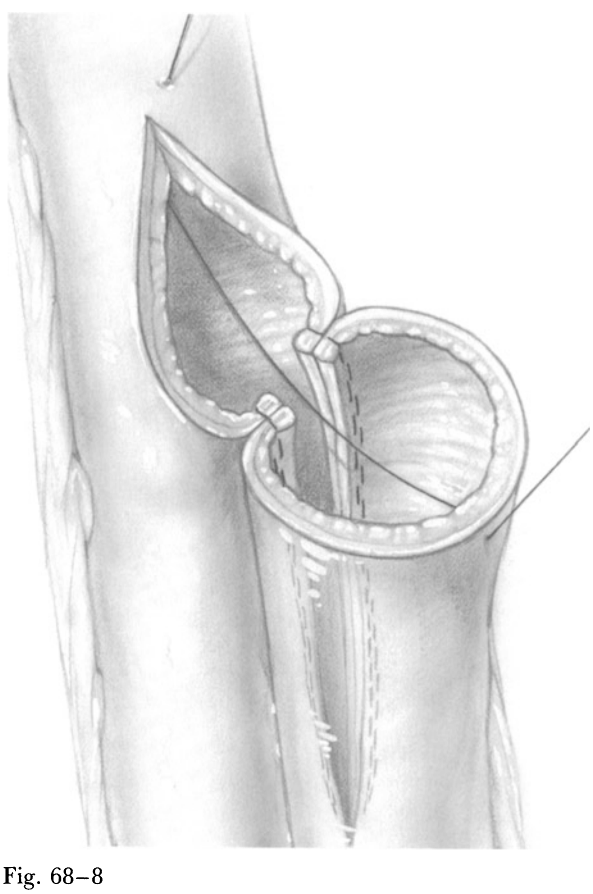


Fig. 68–8

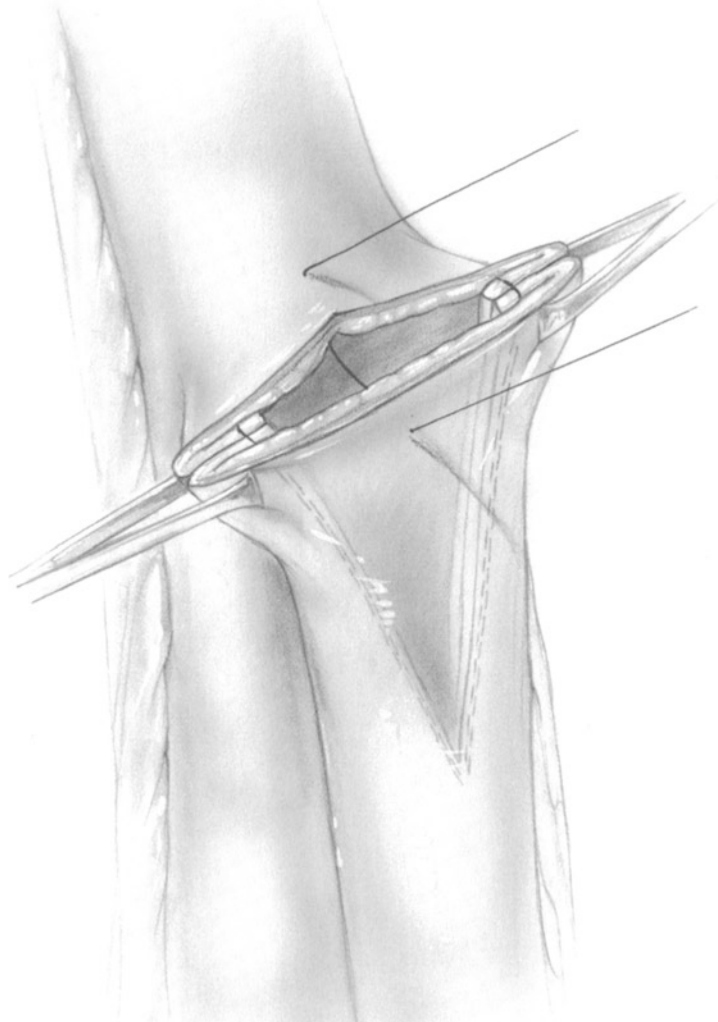


Fig. 68–9

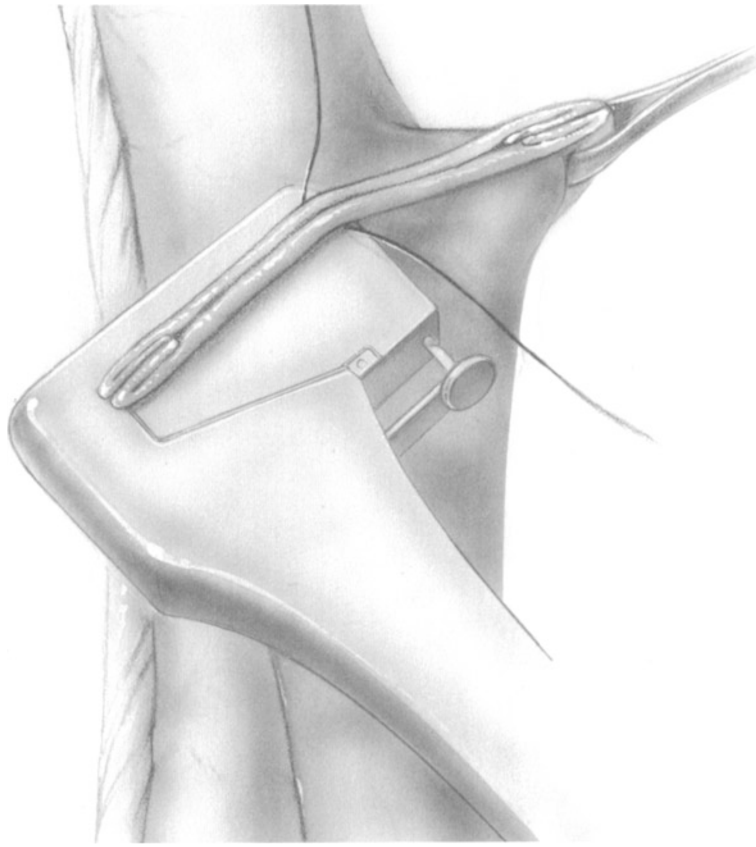


Fig. 68–10

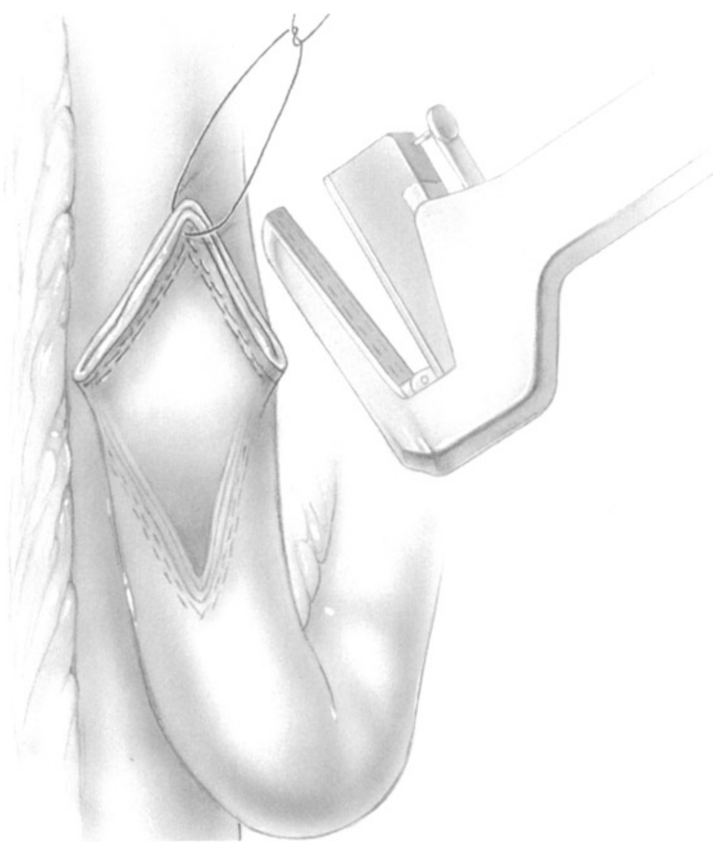


Fig. 68–11

close the remaining defect. Now, perform a stapled closure of this defect by triangulation. Apply a TA-55 stapler with 3.5-mm staples to include the guy suture and the anterior termination of the GIA staple line (**Fig. 68–10**). Fire the staples and amputate the redundant mucosa. Electrocoagulate lightly.

Next, apply a TA-55 stapler, again including the guy suture and also the Allis clamp on the posterior termination of the GIA staple line. Apply additional Allis clamps as necessary. Fire the TA-55 stapler, amputate the redundant tissue and lightly electrocoagulate the mucosa. Remove the stapler and check for the patency of the anastomosis (**Fig. 68–11**). This will generally be found to be quite large.

Closure of Mesenteric Gaps

Using 4–0 PG or other suture material, place interrupted sutures to attach the transverse mesocolon to the limb of jejunum, which has been brought up to the incision in the mesocolon. This will eliminate any gaps through which small bowel might herniate. Use the same technique to close the gaps in the mesentery of the jejunum in which the Roux-en-Y jejunojejunostomy has been constructed.

Abdominal Closure and Drainage

Close the abdomen in routine fashion.

Because bile has an extremely low surface tension, a small amount of bile may escape from the anastomosis in the 1–2 days following the operation. For this reason, insert a closed-suction drainage catheter through a puncture wound in the lateral abdominal wall. Bring the catheter up to the region of the hepaticojejunostomy.

Postoperative Care

Continue nasogastric suction for 1 or 2 days.

Administer cimetidine parenterally, 600 mg every 6 hours, until oral intake has been resumed. Then this may be replaced with antacid treatment until the patient is ready to go home.

Remove the closed-suction drain after drainage has essentially ceased.

Postoperative Complications

Bile Leak

Although there is occasional persistence of bile drainage for as long as 5–7 days, this has invariably ceased in our experience and has never constituted a significant problem following the Roux-en-Y anastomosis.

Stenosis of the Anastomosis

Late stenosis of the hepaticojejunostomy was reported by Bismuth and associates in only one case of 123. We have not encountered this complication. If a large anastomosis is made with one layer of sutures, this is a rare complication.

Cholangitis

Similarly, cholangitis is quite rare following a Roux-en-Y hepaticojejunostomy. In patients who have had multipe hepatic duct calculi, there may be transient cholangitis while a calculus is in transit from the hepatic duct down to the hepaticojejunostomy.

Postoperative Duodenal Ulcer

We have never encountered a duodenal ulcer when a Roux-en-Y hepaticojejunostomy has been applied to patients with nonresectable pancreatic cancer. In the patients with nonprogressive biliary tract disease studied by Bismuth and associates, only 2% developed duodenal ulcer over a 5.5 year average follow-up. McArthur and Longmire noted that as many as 10% of their patients had developed duodenal ulcer. Wheeler and Longmire introduced the concept of interposing a limb of jejunum between the hepatic duct and the duodenum as a possible substitute for the Roux-en-Y anastomosis in patients with an ulcer diathesis (**Fig. 68–13**). So far, experience with this operation has been limited. However, when a patient has chronic pancreatitis with minimal flow of akaline pancreatic juice into the duodenum and if that patient has all of his bile diverted into the Roux-en-Y hepaticojejunostomy, there may be an increased tendency for duodenal ulcer formation. These patients should be warned to return for prompt medical attention if they begin to develop symptoms of peptic ulceration. Alternatively, a hepaticojejunoduodenostomy may be performed in a patient known to have an ulcer diathesis.

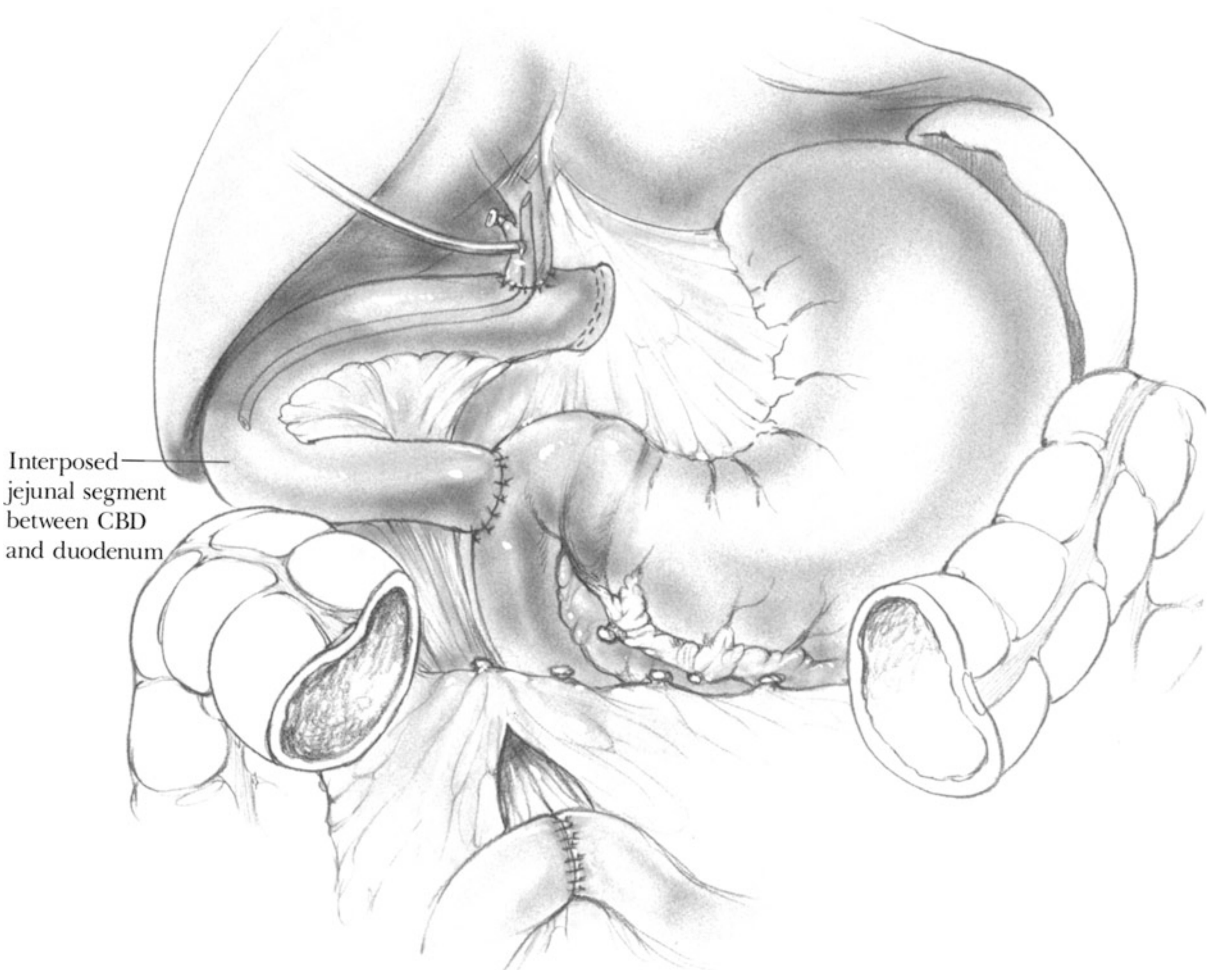


Fig. 68–12

Delayed Gastric Emptying

Following choledochojejunostomy, with or without concomitant gastrojejunostomy, 10%–20% of the patients develop delayed gastric emptying. All of our patients responded to a period of nasogastric suction, sometimes with the assistance of bethanecol or metoclopramide.

References

Bismuth H, Franco D, Corlette MB et al. Long-term results of Roux-en-Y hepaticojejunostomy. Surg Guyecol Obstet 1978;146:161.

Blievernicht SW, Neifeld JP, Terz JJ et al. The role of prophylactic gastrojejunostomy for unresectable periampullary carcinoma. Surg Gynecol Obstet 1980; 151:794.

Dayton MT, Traverso LW, Longmire WP Jr. Efficacy of the gallbladder for drainage in bilary obstruction: comparison of malignant and benign disease. Arch Surg 1980;115:1086.

McArthur MS, Longmire WP Jr. Peptic ulcer disease after choledochojejunostomy. Am J Surg 1971;122:155.

Wheeler ES, Longmire WP Jr. Repair of benign stricture of the common bile duct by jejunal interposition choledochoduodenostomy. Surg Gynecol Obstet 1978; 146:260.

69 Periampullary Diverticulectomy

Concept: When a Periampullary Diverticulum Should Be Excised

Complications of Duodenal Diverticula

Although the duodenal diverticulum, which occurs in about 1% of all gastrointestinal X-ray studies, is not an uncommon condition, Whitcomb reported that only one serious complication requiring surgery occurred in a series of 1,064 patients that he studied. More than two-thirds of all duodenal diverticula occur within 2 cm of Vater's ampulla (Eggert, Teichmann, and Wittmann; Thompson). While the pseudodiverticulum that results from the healing of a duodenal ulcer contains a seromuscular coat as well as mucosa, the periampullary diverticulum, being a true diverticulum, has a sac composed only of mucosa and submucosa. It ranges in size between 0.5 and 6.0 cm, in most cases. Diverticula that have a narrow entrance into the duodenum are more likely to produce symptoms than are wide-necked lesions. In the absence of a muscular coat the diverticulum is unable to expel food particles. This sequence of events may lead to *ulceration* and *bleeding* into the gastrointestinal tract, *compression of the common bile duct* (CBD) with episodes of *cholangitis*, recurrent *pancreatitis*, as well as *perforation* of the diverticulum will *abscess* formation or peritonitis.

Perforation of a duodenal diverticulum produces retroperitoneal sepsis that may resemble acute cholecystitis or acute pancreatitis in its manifestations. Since the serum amylase may be elevated with a perforated duodenal diverticulum, this condition is difficult to differentiate from acute pancreatitis. If the signs and symptoms are localized to the right upper quadrant, acute pancreatitis is less likely than if the patient has pain and tenderness in the epigastrium and the left upper quadrant. Patients with signs and symptoms that are atypical for acute pancreatitis should have a Hypaque gastrointestinal X-ray series and a computed tomography (CT) scan. If the abdominal X-ray film demonstrates air in the retroperitoneal tissues of the right upper quadrant, a duodenal perforation is highly likely. Immediate exploration is indicated. The lesion will not be detected in the operating room unless an extensive Kocher maneuver is performed. If operation is performed soon after the perforation, it may be possible to trace the diverticulum to its neck, excise it, and close the seromuscular and mucosal layers of the duodenal wall with interrupted fine sutures. It may be necessary to insert a catheter into the CBD, prior to suturing the orifice of an excised periampullary diverticulum, in order to prevent suture-occlusion of the terminal CBD. If the duodenal wall is markedly inflamed, it is likely that the duodenal suture line will not heal properly. In this case, it may be prudent to isolate the duodenal leak by performing a Billroth II gastrectomy to divert the gastric content to the jejunum and to divide the CBD and transplant its proximal end into a Roux-en-Y segment of jejunum. Following these procedures, a failure of the duodenal suture line will result in a fistula that releases primarily pancreatic juice. An uncomplicated pancreatic fistula is a relatively benign complication compared to a duodenal fistula that leaks pancreatic juice combined with bile. If the repair of the neck of the excised diverticulum appears to be reasonably secure, place a sump drain down to the vicinity of the repair. If a lateral duodenal fistula appears during the postoperative course, observe the patient carefully. If the patient's defenses appear to be unable to contain the duodenal fistula, do not hesitate to reoperate on the patient to perform a Billroth II gastrectomy and Roux-en-Y diversion of bile as described above. Instead of the Billroth II gastrectomy to divert the passage of food from the perforated diverticulum, the "duodenal switch" operation described by Silen (see Chap. 14) will adequately divert the stream of food without the necessity of performing a gastric resection.

In a literature review of 46 patients suffering from perforated duodenal diverticula from 1969 to 1990, Duarte, Nagy, and Cintron reported that divertulectomy and drainage was successful in 19 of 30 patients in whom it was performed, but the 11 patients who had unsuccessful results either died or developed doudenal fistulas.

Perforation of a diverticulum involving the third or fourth portions of the duodenum may be exposed by dividing the posterior peritoneal attachments of the right colon and the small bowel mesentery, as described in Chap. 29. After evacuating the abscess and excising the diverticulum, be certain to excise the duodenal wall back to relatively healthy tissue. If this defect is more than 1.5–2.0 cm in diameter, either resect a short segment of duodenum or else anastomose the duodenal defect to the open end of a Roux-en-Y limb of jejunum. Suturing diseased duodenal wall is doomed to failure.

Iatrogenic Perforation of Periampullary Diverticulum

Another type of perforation occurs when a surgeon passes a Bakes dilator through the CBD into the duodenum during the course of CBD exploration. If the patient is known to have a periampullary diverticulum, this step in the CBD exploration should be omitted and replaced by careful choledochoscopy and cholangiography. When a Bakes dilator passes into the ampulla, it may enter the orifice of a periampullary diverticulum. While the surgeon is passing the probe, thinking it to be in the duodenal lumen, the probe is in fact perforating not only the sac of the diverticulum but also the head of the pancreas. Although the mortality for operations on the biliary tract was only 0.7% in 806 patients undergoing surgery for gallstone disease, Eggert and associates noticed that the operative mortality in 73 patients who were undergoing surgery for gallstone disease and who also had periampullary diverticula was 7%. Two of their five postoperative deaths were caused by perforation of a periampullary diverticulum during operation. This type of complication may sometimes be detected in the operating room while irrigating the distal CBD with saline, for this condition is confirmed if the saline appears to leak through the posterior aspect of the pancreas. This leakage can be observed directly if a Kocher maneuver has been performed as part of the CBD exploration, a maneuver that we believe should always be completed prior to opening the CBD. Another method of identifying this complication is to perform a T-tube completion cholangiogram.

When perforation of a periampullary diverticulum has been caused by passing the Bakes dilator, it is aggravated by the fact that the surgeon, by attempting to palpate the dilator in the lumen of the duodenum, continues to push the dilator through the head of the pancreas. When this damage to the head of the pancreas is accompanied by the leakage of bile through the back wall of the duodenum, an explosive acute pancreatitis occurs, one that is often fatal. In some cases, when a perforation by means of the metal dilator is suspected, it cannot be determined whether the surgeon has perforated the intrapancreatic portion of the CBD or the sac of a periampullary diverticulum. In this situation it is advisable to divide the CBD and implant the proximal end into a Roux-en-Y limb of jejunum for complete biliary diversion. Then remove the diverticulum and close the orifice as described below. Although complete biliary diversion may seem to constitute excessively radical surgery for this type of perforation, remember that this perforation is often fatal, as indicated by the two fatal cases described by Eggert and associates, the one by Neill and Thompson, and one experienced in our department. If there has been no damage to the head of the pancreas by the probe, then simply excising the diverticulum and repairing its neck with a catheter in the CBD may constitute adequate treatment. It is these iatrogenic perforations that have led many surgeons to abandon the use of metal instruments in exploring the CBD.

Relationship between Periampullary Diverticulum and Biliary Tract Disease

Increased pressure secondary to the accumulation of food material in a periampullary diverticulum with a narrow neck may produce jaundice, cholangitis, and recurrent acute pancreatitis according to Manny, Muga, and Eyal. Landor and Fulkerson reported that 32% of 163 patients with periampullary diverticula either had concomitant gallstones or previous cholecystectomies. On the other hand, Pinotti, Tacka, Pontes, and Battarello, in studying 491 patients with biliary tract disease or pancreatitis, found that 16 patients (3.3%) had periampullary diverticula that were believed to be contributing to the symptoms of right upper quadrant pain, jaundice, or pancreatitis. Eleven of these patients did well after a primary operation that consisted of cholecystectomy, sphincteroplasty, and diverticulectomy. Five patients did not obtain relief of symptoms from cholecystectomy alone but became asymptomatic after a second operation that included diverticulectomy and sphincteroplasty. Manny and associates reported two patients who underwent cholecystectomy and choledochoduodenostomy for biliary calculi with an enlarged CBD. These patients did not have their periampullary diverticula removed. Both patients required reoperation at a later date for recurrent symptoms at which time a Billroth II gastrectomy was performed in order to divert the passage of food from the area of the diverticulum. Both patients experienced relief of symptoms from this procedure. These authors also reported that out of 12 patients with periampullary diverticula in whom gallstones were found, 3 became asymptomatic after cholecystectomy and diverticulectomy.

In the 9 patients who underwent cholecystectomy without diverticulectomy, 3 developed ascending cholangitis and the other 6 continued to have what was described as a "postcholecystectomy syndrome."

Although there is insufficient evidence to believe that a periampullary diverticulum may be the cause of gallstone formation, it is clear that following cholecystectomy and choledocholithotomy without diverticulectomy, a number of patients will have persistent symptoms and recurrent cholangitis, often with enlargement of the CBD. Certainly, in the group of patients with postcholecystectomy complaints, duodenal diverticulectomy is indicated. It is not clear that sphincteroplasty, in addition to diverticulectomy, is necessary in these patients, although this is advocated by Pinotti and associates because these authors believe that periampullary inflammation is associated with many of the diverticula. This has not been confirmed by other authors. When diverticulectomy is not feasible owing to local inflammatory changes, diversion of food by performing the "duodenal switch" operation (see Chap. 14) will likewise relieve the symptoms caused by the distention of a periampullary diverticulum with food.

Indications

Perforation of diverticulum

Hemorrhage from diverticulum, especially if proved by endoscopic localization of the source of bleeding

Postcholecystectomy patients with intermittent jaundice, pain, cholangitis, or recurrent pancreatitis who have a periampullary diverticulum

It is not clear that a patient undergoing surgery for biliary calculi and/or cholangitis should have concomitant diverticulectomy as a routine procedure, although some data in support of this concept have been accumulating.

Preoperative Care

The diagnostic workup of patients with postcholecystectomy symptoms should include gastrointestinal X rays and endoscopic radiographic cholangiopancreatography (ERCP) for the detection of periampullary diverticula.

Perioperative antibiotics

Pitfalls and Danger Points

Injury to pancreas, resulting in postoperative acute pancreatitis

Injury to distal CBD

Operative Strategy

The strategy of managing patients operated on because they have perforated a periampullary diverticulum depends on the degree of surrounding inflammation. Neill and Thompson stated that in some cases the neck of the diverticulum may be free of inflammation despite the perforation. In these cases it may be possible to accomplish primary closure of the neck of the sac with interrupted sutures. In many cases leakage of duodenal content through a perforated periampullary diverticulum will produce a violent inflammatory reaction. One cannot expect primary suture of the duodenal wall to be secure under these conditions. Consequently, as a lifesaving measure it may be necessary to divert the gastric content by means of a Billroth II gastrectomy or duodenal switch operation (see Chap. 14). Divert the bile by dividing the CBD and implanting it into a Roux-en-Y limb of jejunum. Then insert multiple suction drains to the area of perforation.

In elective cases *where the diverticulum is free of inflammation*, we prefer the technique described by Iida. This involves inverting the sac of the diverticulum through an incision in the second portion of the duodenum. The diverticulum is excised and the defect in the duodenal wall is closed from inside the lumen.

An alternative technique involves dissecting the duodenal diverticulum from surrounding pancreas and duodenal wall down to its neck near the ampulla. The terminal CBD must be identified as it enters the posterior wall of the duodenum. Place a catheter in the CBD. Then transect the diverticulum at its neck and repair the defect in the duodenal wall. This technique may be facilitated by inflating the duodenal diverticulum with air injected through a nasogastric tube. It requires meticulous dissection of the pancreas away from its attachments to the posterior duodenal wall. As the pancreas is dissected away from the duodenum, the terminal portion of the CBD and the diverticulum may be exposed. This dissection is tedious and sometimes difficult. It carries a greater risk of inducing a postoperative acute pancreatitis than does the transduodenal approach.

Operative Technique—Transduodenal Diverticulectomy

Incision

Make either a midline incision from the xiphoid to a point about 5 cm below the umbilicus or, alternatively, a long subcostal incision.

Kocher Maneuver

Incise the lateral peritoneal attachments of the descending duodenum and mobilize the duodenum and the head of the pancreas as shown in Figs. 7–14 to 7–16. Place a gauze pad behind the head of the pancreas to elevate the duodenum.

Duodenotomy and Diverticulectomy

Make a 4–5 cm longitudinal incision near the antimesenteric border of the descending duodenum (**Fig. 69–1**). Identify the ampulla by palpation or visualization (**Fig. 69–2**). If there is any difficulty in identifying the ampulla in this fashion, do not hesitate to make an incision in the CBD and pass a Coudé catheter gently down to the ampulla through the CBD incision.

Identify the orifice of the periampullary diverticulum. Insert a forceps into the diverticulum. Grasp the mucosal wall of the diverticulum (**Fig. 69–3**) and gently draw the mucosa into the lumen of the duodenum until the entire diverticulum has been inverted into the lumen of the duodenum (**Figs. 69–4 and 69–5**). Transect the neck of the diverticulum about 2–3 mm distance away from its junction with the duodenal wall.

Inspect the bed of the diverticulum through the orifice in the duodenum to check for bleeding. Then close the duodenal wall by suturing the seromuscular layer with interrupted 4–0 Vicryl and invert this layer into the lumen of the duodenum. Close the defect in the mucosa also with inverting sutures of interrupted 5–0 Vicryl (**Fig. 69–6**).

Close the duodenotomy incision in two layers using interrupted or continuous inverting sutures of 5–0 Vicryl for the mucosal layer and interrupted 4–0 atraumatic silk Lembert sutures for the seromuscular coat.

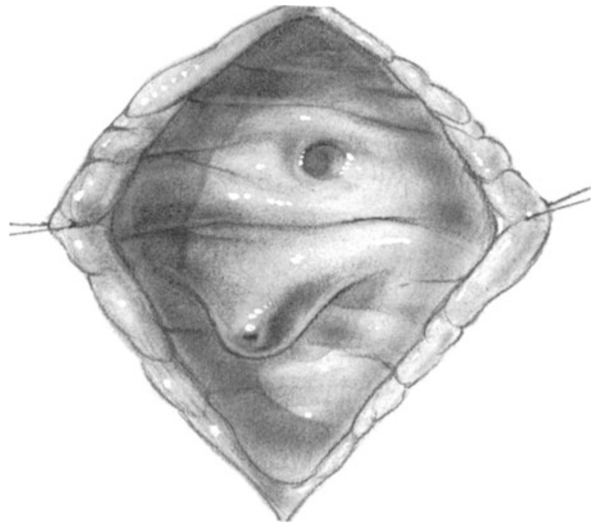


Fig. 69–2

Closure and Drainage

Bring a closed-suction drain out from the region of the head of the pancreas through a puncture wound in the right upper quadrant of the abdomen. Close the abdominal wall in routine fashion.

Postoperative Care

Continue nasogastric suction for 3–5 days.

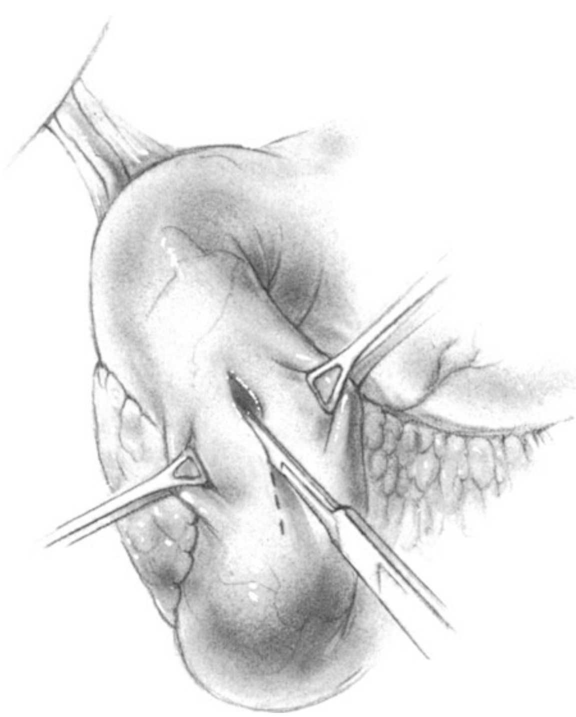


Fig. 69–1

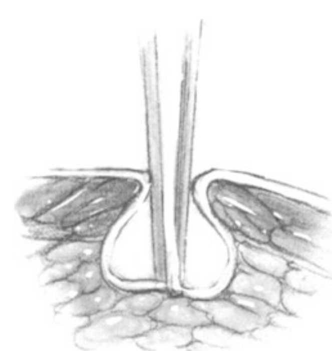


Fig. 69–3

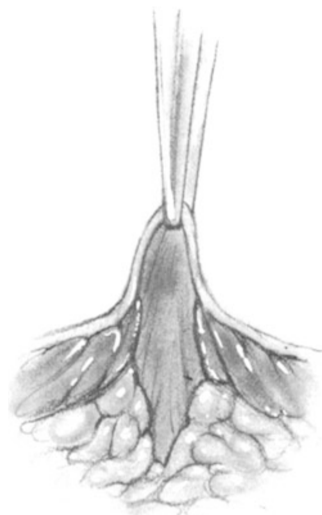


Fig. 69–4

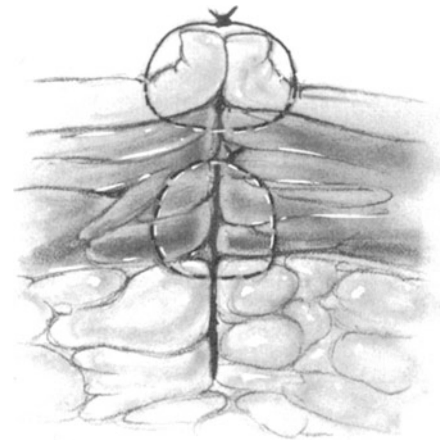


Fig. 69–6

Give the patient perioperative antibiotics.

Check postoperative levels of serum amylase to detect postoperative pancreatitis.

Postoperative Complications

Acute pancreatitis

Duodenal leakage

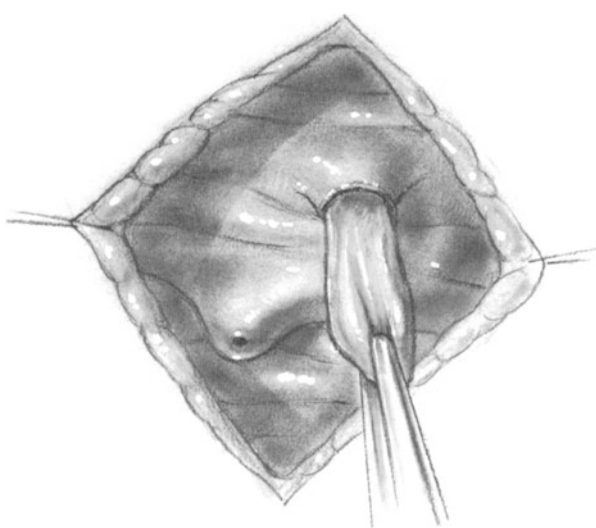


Fig. 69–5

References

Duarte B, Nagy KK, Cintron J. Perforated duodenal diverticulum. Br J Surg 1992;79:877–881.

Eggert A, Teichmann W, Wittmann DH. The pathologic implication of duodenal diverticula. Surg Gynecol Obstet 1982;154:62.

Iida F. Transduodenal diverticulectomy for periampullar diverticula. World J Surg 1979;3:103.

Landor JH, Fulkerson CC. Duodenal diverticula: relationship to biliary tract disease. Arch Surg 1966;93:182.

Manny J, Muga M, Eyal Z. The continuing clinical enigma of duodenal diverticulum. Am J Surg 1981; 142:596.

Neill SA, Thompson NW. The complications of duodenal diverticula and their management. Surg Gynecol Obstet 1965;120:1251.

Pinotti HW, Tacka M, Pontes JF et al. Juxtaampullar duodenal diverticula as a cause of biliopancreatic disease. Digestion 1971;41:353.

Thompson NW. Transduodenal diverticulectomy for periampullar diverticula: invited commentary. World J Surg 1979;3:135.

Whitcomb JG. Duodenal diverticula. Arch Surg 1964; 88:275.

70 Operations for Carcinoma of Hepatic Duct Bifurcation

Concept: When to Operate for Carcinoma of the Bile Ducts

Tumors of the Distal Third of the Bile Duct

For purposes of classification the bile ducts are generally divided into thirds. The proximal third extends from the cystic duct upward. The middle third starts at the cystic duct and includes that portion of the common bile duct (CBD) that is located cephalad to the pancreas. The distal third encompasses the CBD in its course between the pancreas and duodenum, ending at its termination in the ampulla of Vater. Operation for cure in the region of the distal third of the bile duct requires a Whipple pancreatoduodenectomy. Whereas Lees, Zapolanski, Cooperman et al. of the Cleveland Clinic were able to resect only 19% of 32 patients having carcinoma of the distal third of the duct, Tompkins, Thomas, Wile et al. performed the Whipple operation in 12 of their 18 cases with a mortality rate of 8%. Forty-two percent of the cases resected by Tompkins and associates survived for 5 years. There seems little question that pancreatoduodenectomy is the treatment of choice for lesions of the distal CBD.

In a paper published in 1991, Tompkins and his group reported an overall operative mortality rate of 4.8%. Those patients who underwent resection had a 5-year survival rate of 29%.

When the tumor is not resectable, generally a bypass between the hepatic duct and a Roux-en-Y limb of jejunum (see Chap. 68) offers the best palliation, perhaps supplemented by brachytherapy and chemotherapy.

Tumors of the Middle Third of the Bile Ducts

Although many patients with carcinoma of the hepatic or cystic ducts show early invasion of adjacent structures in the hepatoduodenal ligament (portal vein or hepatic artery), Tompkins and associates were able to resect 16 of the 26 tumors they encountered in this location with no mortality, including three patients who required pancreatoduodenectomy. Thirteen of the patients were treated by duct resection and biliary-enteric anastomosis. Eight underwent palliative long-term intubation of the bile duct. The overall 5-year survival in this group was 12%.

Each of these tumors of the hepatic duct should be evaluated by dissecting out the portal vein and the hepatic artery and tracing these structures to the vicinity of the tumor. If the tumor can be separated from these two vessels, resection is indicated with frozen-section histological examination of the duct margins. Reconstruction should include a hepaticojejunostomy of the Roux-en-Y type. If the tumor is contiguous with the pancreas, a pancreatoduodenectomy is indicated.

Tumors of the Proximal Third of the Bile Ducts

Resection of Bifurcation Tumors

Some bile duct tumors are located in the proximal portion of the intrahepatic ducts. These are managed by hepatic resection using the same techniques necessary for primary hepatic cell carcinomas of the liver (see Chap. 71). The majority of primary bile duct cancers seem to arise at or near the bifurcation of the common hepatic duct. Longmire, in discussing the paper by Hart and White, stated that he generally finds it unnecessary to excise liver parenchyma when resecting tumors at the hepatic duct bifurcation because in most patients the junction of the right and left hepatic lobar ducts is situated outside the liver. Tompkins and associates were able to resect 47% of the 47 patients with *proximal* lesions of the bile ducts. They experienced a 23% mortality rate and achieved no 5-year survivals. Cameron, also commenting on Hart and White's paper, stated that he was able to resect only about 20% of the malignant strictures he encountered at the bifurcation of the hepatic duct, while Lees and associates did not resect any of their 36 malignancies at the bifurcation. Tompkins and associates, Adson and Farnell, and Cameron, Gayler, and Zuidema all failed to note any statistically significant increase in survival following resection of ductal cancers in the region of the bifurcation. Since the mortality of resecting these lesions is higher than palliative management by intubating the ducts, it is difficult to advocate a high-risk, difficult resection in the absence of supporting data. In those cases where the tumor is localized, resection is relatively simple; here resection plus a regional lymphadenectomy, as advocated by Adson and Farnell, is indicated. Because of the high recurrence rate after resection, it is advisable to leave indwelling Silastic catheter-stents in the hepatic ducts indefinitely even when resection has been done.

Voyles, Bowley, Allison, and others found that they could identify preoperatively most cases of hilar cholangiocarcinoma, which proved to be unresectable, by performing percutaneous transhepatic cholangiography (PTC) followed by angiography of the hepatic arteries and the portal vein.

Intubation of Hepatic Ducts

If the patient presents with complete obstruction of the left hepatic duct and partial obstruction of the right duct, it is often not sufficient to drain only one duct, since the bile backed up behind an obstructed duct will often become contaminated with bacteria. The patient will generally develop cholangitis unless adequate drainage of both ducts is accomplished. When ducts are partially obstructed, drainage of both ducts is necessary as intubation of a single duct will cause chronic contamination of those portions of the biliary tree that are in communication with the intubated duct.

When a patient appears to have a large tumor at the bifurcation of the hepatic ducts, as determined by PTC, perform an angiogram to visualize the hepatic arteries and portal vein. If there is encasement of these structures and the percutaneous needle biopsy of the tumor is positive, operation is probably contraindicated. In this case, ask the radiologist to pass a drainage catheter into the partially obstructed right main duct. The catheter can sometimes be passed through the tumor and even into the duodenum; a "pig-tail" will anchor the catheter in place and no external drainage of bile will be necessary. A second catheter will be required in the obstructed left hepatic duct. If the radiologist cannot pass catheters through the tumor, then the patient will be required to wear a plastic bag to collect the bile from each of the catheters that have been inserted into the obstructed hepatic ducts.

When tumors do not appear to be large by cholangiography, laparotomy for possible resection of the tumor, or for the passage of Silastic catheters through the tumor to permit bile drainage, is indicated. It has been our impression that when a Silastic catheter, 4–6 mm in diameter, is inserted into the hepatic duct through the tumor at laparotomy, recurrent postoperative cholangitis occurs less frequently than when a smaller catheter is introduced percutaneously by the radiologist. In either case, the catheters should be changed in the radiology suite at least every 3 months following their insertion. There are insufficient data at this time to determine exactly which patients should be subjected to percutaneous intubation of hepatic ducts by the radiologist or to catheterization of the ducts at laparotomy, as advocated by Terblanche, Saunders, and Louw, and by Cameron, Gayler, and Zuidema.

Patients with carcinoma of the proximal hepatic duct and its bifurcation can be managed by an endoprosthesis inserted by endoscopic papillotomy for palliation of jaundice, according to Polydorou and associates. They were successful on their first attempt in 65% of cases. Repeated efforts at inserting the prosthesis improved this success rate somewhat, but the 30-day mortality for all patients was 22%, mostly due to the progression of the malignant condition.

Indications

Carcinoma of hepatic duct bifurcation

Preoperative Care

CT scan

PTC to demonstrate the proximal extent of the tumor

Hepatic artery angiography, in selected cases

Perioperative antibiotics

Nasogastric tube

Ask radiologist to pass Ring catheters into right and left hepatic ducts.

Pitfalls and Danger Points

Trauma to liver during transhepatic intubation at laparotomy

Trauma to portal vein or hepatic artery during tumor excision at hilus

Failure to achieve adequate drainage of bile

Operative Strategy

Resection

Cameron, Broe, and Zuidema emphasize that resection of malignant tumors at the bifurcation of the hepatic duct is safe when the surgeon can demonstrate that there is no invasion of the underlying portal vein or liver tissue, and if the proximal extent of the tumor does not reach the secondary divisions of the hepatic ducts. In these cases it is generally not necessary to resect hepatic parenchyma; 37% of Cameron, Broe, and Zuidema's bifurcation malignancies could be resected for cure with no deaths.

Patients who do not meet these criteria of resectability should undergo transhepatic intubation of the ducts and not resection.

Avoiding hemorrhage during the operation depends on careful dissection of the common hepatic duct and the tumor away from the bifurcation of the portal vein. This is best done by dividing the CBD, mobilizing the gallbladder, and elevating the hepatic duct together with the tumor to expose the portal vein and its bifurcation. In borderline cases, remove the gallbladder and make a preliminary assessment regarding invasion of the portal vein by dissecting beneath the common hepatic duct toward the tumor before dividing the CBD. Cameron and associates (1982) suggest that this dissection may be facilitated if a radiologist has passed percutaneous transhepatic catheters of the Ring type into both the right and left main ducts. Since the bifurcation of the common hepatic duct occurs, in almost all cases, outside the liver, the right and left hepatic ducts can be identified by palpating the transhepatic catheters that have been previously inserted.

Dilating Malignant Strictures of the Hepatic Duct Bifurcation

Most tumors of the hepatic duct involve the bifurcation. If the radiologist has passed percutaneous catheters through the tumor into the common hepatic duct or the common bile duct preoperatively, these catheters, in the right and left hepatic ducts, can be used to facilitate passage of larger, permanent Silastic catheter-stents. The stents should preferably be 6 mm in outer diameter and fairly thick-walled to prevent the tumor from occluding them. Since it is also desirable to catheterize both the right and left hepatic ducts, two such stents are required. Because these two stents rarely fit into the CBD, it is generally necessary to perform a Roux-en-Y hepaticojejunostomy to permit both stents to enter the jejunum and drain the bile in this fashion. If the occlusion of the left hepatic duct cannot be dilated from below, it is often possible to identify the left hepatic duct above the tumor and to pass a stent through an incision in the hepatic duct above the tumor.

Operative Technique—Resection of Bifurcation Tumors

Incision

In most cases a midline incision from the xiphocostal angle to a point about 5–8 cm below the umbilicus is suitable. It is helpful to apply a Thompson or an Upper Hand retractor to the right costal margin, to improve the exposure at the hilus of the liver.

Determination of Operability

Perform a cholecystectomy by the usual technique (see Chap. 60). Incise the layer of peritoneum overlying the common hepatic duct beginning at the level of the cystic duct stump and progressing in a cephalad manner. Also unroof the peritoneum overlying the hepatic artery so that the common hepatic duct and the common hepatic artery have been skeletonized (**Fig. 70–1**). Now dissect along the lateral and posterior walls of the common hepatic duct near the cystic stump and elevate the hepatic duct from the underlying portal vein. Try to continue the dissection along the anterior wall of the portal vein towards the tumor in order to make a judgment as to whether the tumor has invaded the portal vein. A more accurate determination will be made later in the dissection after the CBD has been divided and elevated. If there are no signs of gross invasion, then identify the anterior wall of the tumor and try to palpate the Ring catheters, if they have been placed in the right and the left hepatic ducts prior to operation. This will give the surgeon some idea of the cephalad extent of the tumor. Frequently, this judgment can be made from the preoperative transhepatic cholangiogram. If there is gross invasion by the tumor of hepatic parenchyma, this may be considered a relative contraindication to resection.

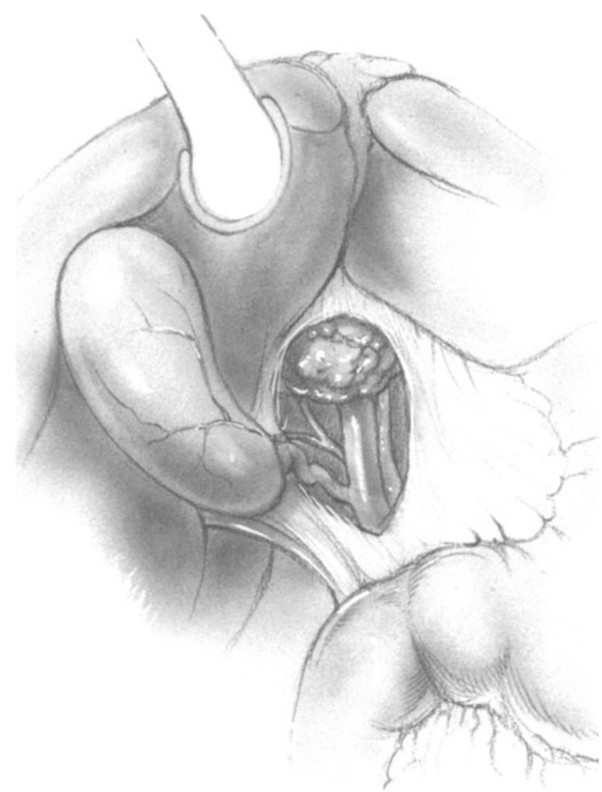


Fig. 70–1

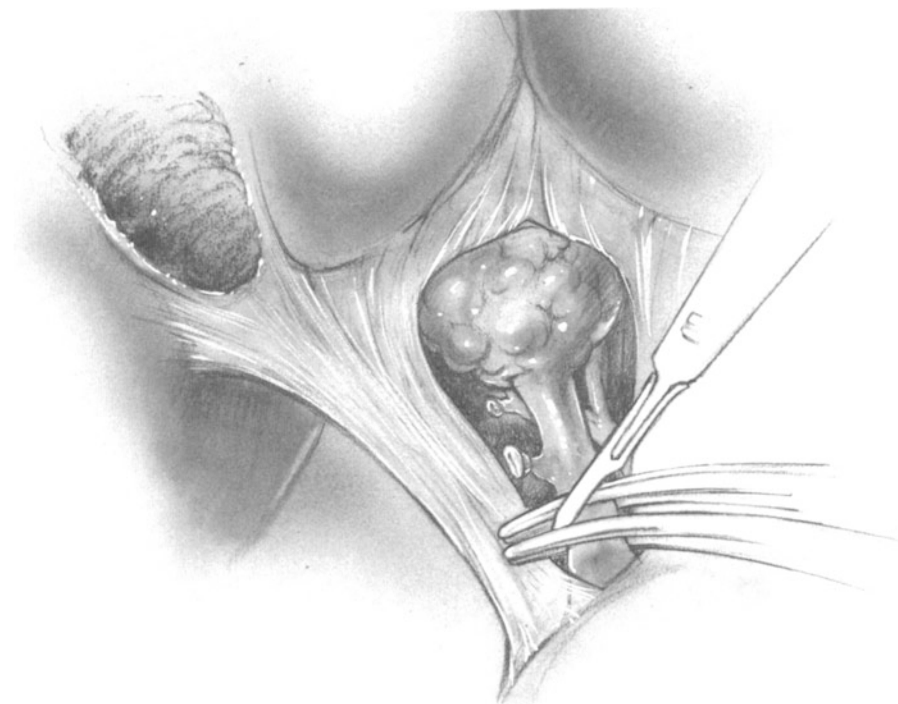


Fig. 70–2

For a final determination of the advisability of resecting the tumor, divide the CBD (**Fig. 70–2**) distal to the cystic duct stump. Oversew the distal end of the CBD with continuous 4–0 PG suture material. Dissect the proximal stump of the CBD off the underlying portal vein by going in a cephalad direction (**Fig. 70–3**). Skeletonize the portal vein and sweep any lymphatic tissue towards the specimen. Carefully identify the bifurcation of the portal vein behind the tumor. Perform this portion of the dissection with great caution because lacerating a tumor-invaded portal vein bifurcation will produce hemorrhage that will be difficult to correct if one side of the laceration consists of tumor. During this dissection, pay attention also to the common hepatic and the right hepatic arteries that course behind the tumor. Bifurcation tumors may occasionally invade or adhere to the right hepatic artery.

After demonstrating that the tumor is clear of the underlying portal veins and hepatic arteries,

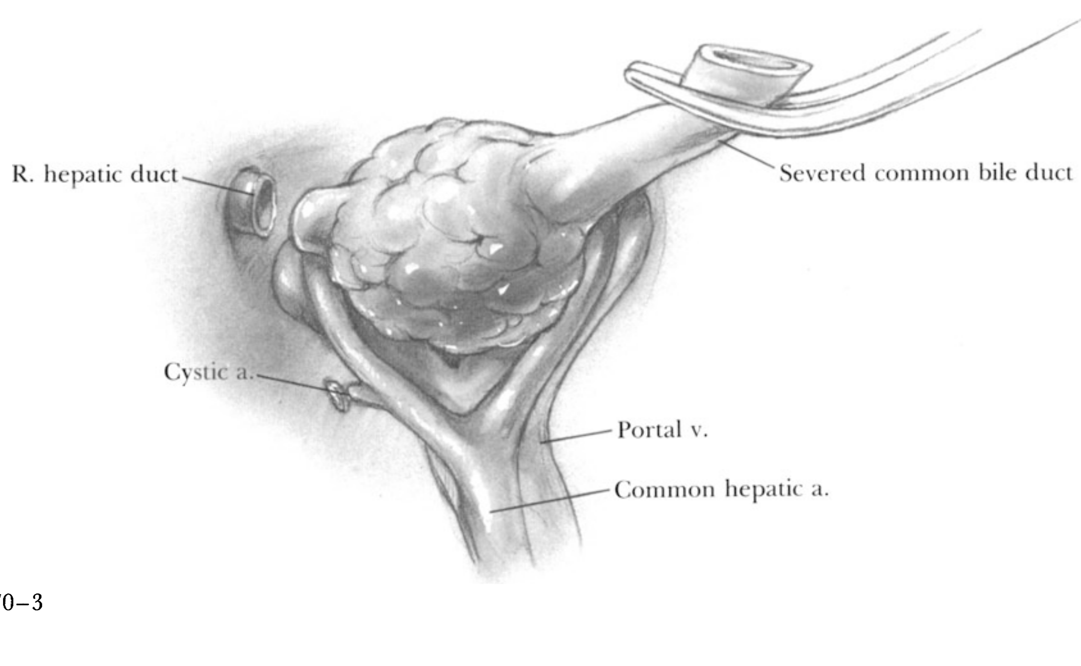


Fig. 70–3

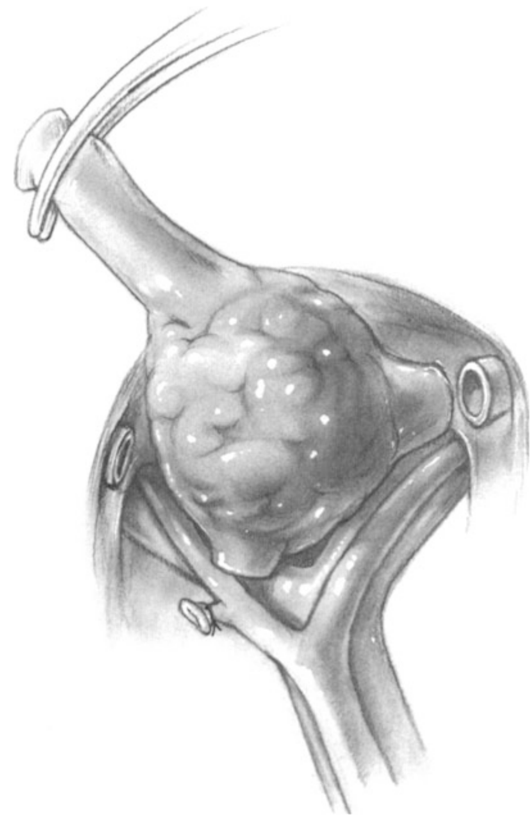


Fig. 70–4

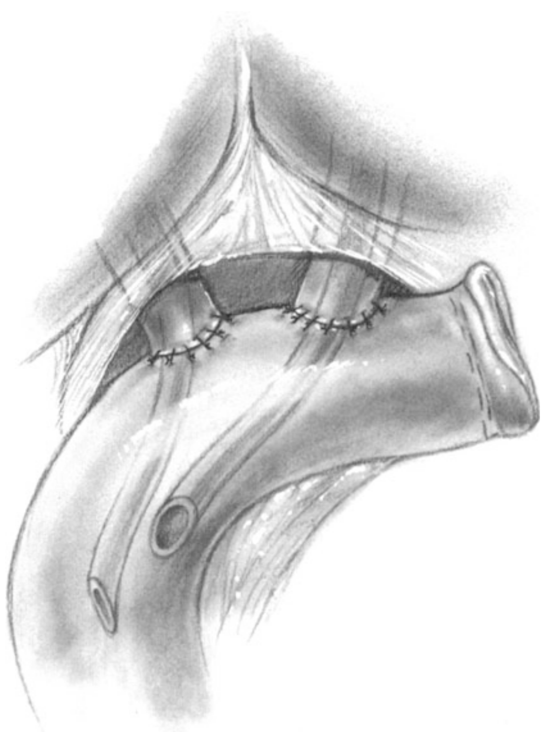


Fig. 70–5

continue the dissection along the posterior wall of the tumor. The right and left hepatic ducts and even secondary branches can often be identified without resecting hepatic parenchyma. It is sometimes difficult by palpation to determine the proximal extent of the tumor. If preoperative catheters have been placed, palpate the right and left duct for the presence of the catheters. After adequate exposure has been obtained, transect the ducts and remove the tumor (**Fig. 70–4**). Perform frozen-section examination of the proximal portions of the right and left ducts in the specimen to determine if the tumor has been completely removed. If the report is positive for tumor, determine whether removing a reasonable additional length of duct is feasible. If this additional duct is resected, it may be necessary to anastomose three and four hepatic ducts to the jejunum. Although some adjacent hepatic parenchyma may be left attached to the duct during blunt dissection, it may be necessary to perform a major hepatic resection for some tumors at the bifurcation. Insert Silastic tubes into each severed duct by one of the techniques described below.

Anastomosis

Construct a Roux-en-Y jejunal limb as described in Chap. 68. Apply a row of 3.5-mm staples with a TA-55 device across the open end of jejunum. Cut the mucosa flush with the stapling device and lightly electrocoagulate the everted mucosa. Bring the closed end of jejunum to the hilus of the liver. Make an incision in the antimesenteric border of the jejunum equal to the diameter of the open left hepatic duct. Anastomose the end of the left hepatic duct to the side of jejunum with interrupted 5–0 Vicryl sutures in one layer. Perform the same type of anastomosis between the right hepatic duct and a second incision in the jejunum. Pass each Silastic catheter through the anastomosis into the jejunum so that it projects for a distance of 5–6 cm into the jejunum (**Fig. 70–5**). Leave the catheters in place permanently because this tumor has a high rate of recurrence.

Drainage and Closure

At the site where the Silastic tube enters the left hepatic duct at the dome of the liver, insert a mattress suture of 3–0 PG into the liver capsule to minimize the possibility of bile draining around the tube at this point. Tie the two tails of this suture around the Silastic tube to anchor it in place. Accomplish the identical maneuver at the point where the second tube enters the anterior surface of the right lobe of the liver. Then make a puncture wound through the abdominal wall in the right upper quadrant. Pass the Silastic tube through this puncture wound. Leave enough slack to compensate for some degree of abdominal distention. Then suture the Silastic tube to the skin securely using 2–0 nylon. Perform the identical maneuver to pass the other Silastic tube that exits from the liver through a puncture wound in the left upper quadrant of the abdominal wall. In addition, place a 2-cm latex Penrose drain near each of the exit wounds in the right and left lobes of the liver and bring them through abdominal stab wounds. A third latex drain should be placed at the hilus of the liver near the hepaticojejunal anastomoses.

Close the abdominal incision in routine fashion.

Operative Technique—Intubation of Hepatic Ducts without Resecting Tumor

Incision

Make a midline incision from the xiphoid to a point 4–5 cm below the umbilicus.

Dilating the Malignant Structure

Identify the common hepatic duct below the tumor. Make a 1.5–2.0 cm incision in the anterior wall of the duct. If the patient has previously undergone percutaneous transhepatic catheterization of the right and left hepatic ducts and if both catheters have passed into the CBD, these catheters may be utilized to draw Silastic tubes into each hepatic duct.

In the absence of intraductal catheters, pass a Bakes dilator into the common hepatic duct and try to establish a channel leading into the right hepatic duct. After the channel has been established, dilate the passageway by sequentially passing Nos. 3, 4, 5, and 6 Bakes dilators if possible. Once this has been achieved, pass a Silastic catheter into the right hepatic duct by the technique shown in **Fig. 70–6**.

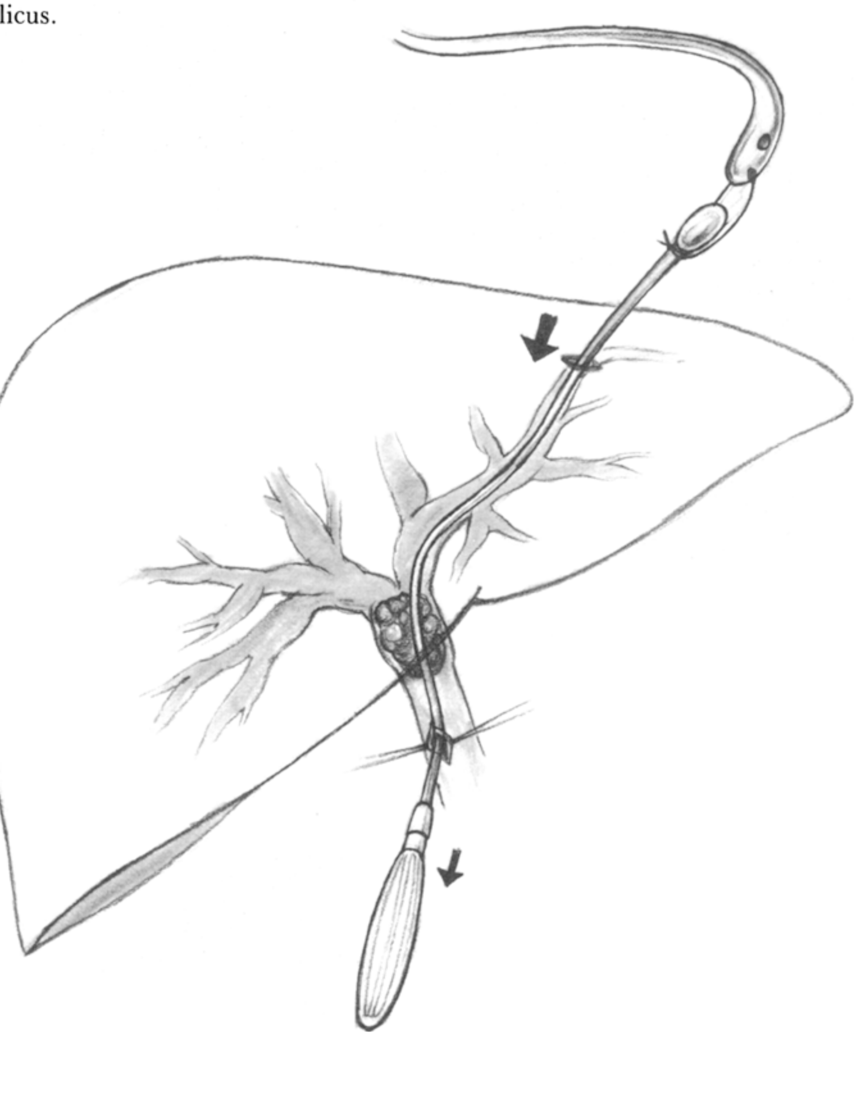


Fig. 70–6

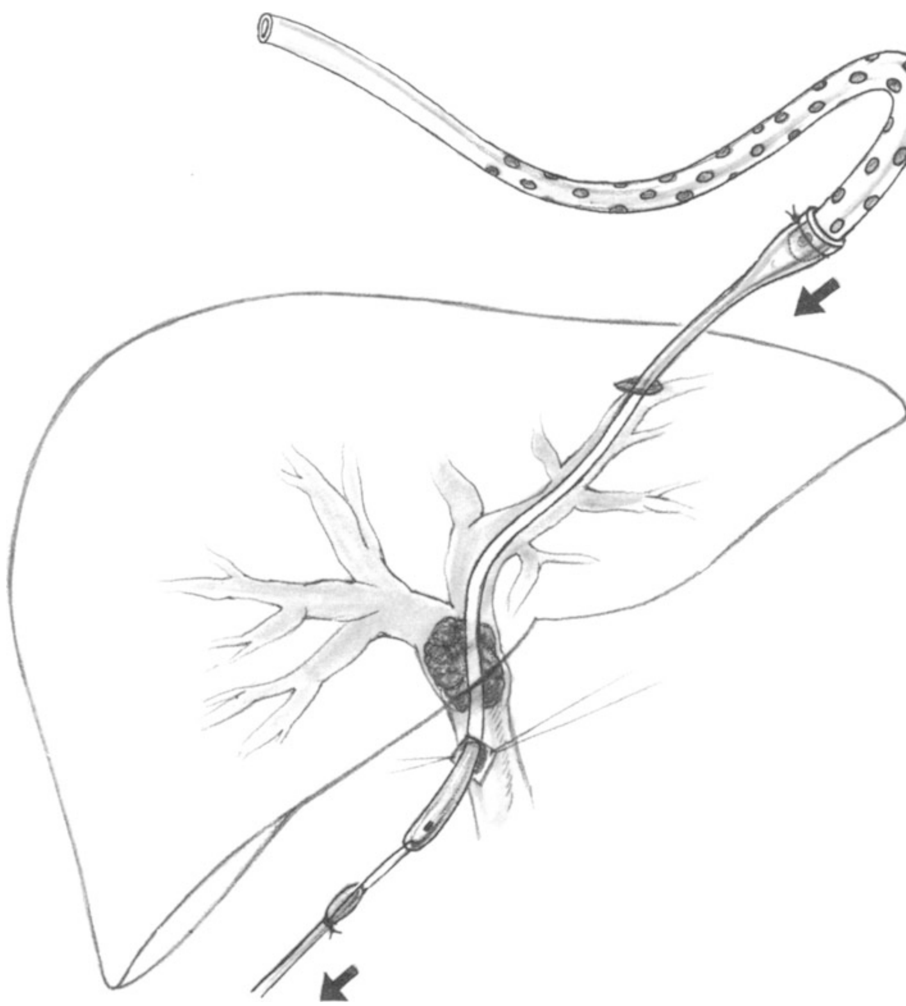


Fig. 70–7

Then try to identify the channel leading from the common hepatic duct into the left hepatic duct with a No. 2 or a No. 3 Bakes dilator (**Fig. 70–7**). If this channel cannot be established, try to identify the left hepatic duct just above the tumor. Having accomplished this, incise the duct and pass a Silastic tube through the duct and out the parenchyma of the liver on the anterior surface of the left lobe. It will be necessary to anastomose a Roux-en-Y limb of jejunum to this opening in the left hepatic duct. Pass the Silastic tube through the anastomosis into the jejunum.

Even if the channel can be established through the tumor into both the right and left hepatic ducts, often the CBD will not be sufficiently large to accommodate two Silastic tubes. Consequently, if both the right and the left ducts are intubated, suture a Roux-en-Y hepaticojejunostomy to the divided right and left hepatic ducts. Then pass each tube down into the jejunum for a distance of at least 6 cm (**Fig. 70–8**).

Perform the end-to-side jejunojejunostomy, in completing the Roux-en-Y anastomosis, at a point 60–70 cm distal to the hepaticojejunostomy, by the method illustrated in Chap. 68.

Other Intubation Techniques

There are many techniques aimed at minimizing trauma when passing a tube through the liver into the hepatic ducts. It is helpful to keep the hole in Glisson's capsule as small as possible to minimize the leakage of bile around the tube. If the patient has already undergone a preoperative transhepatic catheterization of the hepatic duct, and if the point at which this catheter penetrates the liver capsule is in a satisfactory location, one may suture a urological filiform to the end of the intraductal catheter. Then by withdrawing the catheter through the liver, the filiform will be brought through the opening in the liver capsule. Urological filiform-followers may then be attached to the end of the filiform so that the path of the catheter can be dilated about 6 mm. Following this step, the Silastic tube can be inserted into the

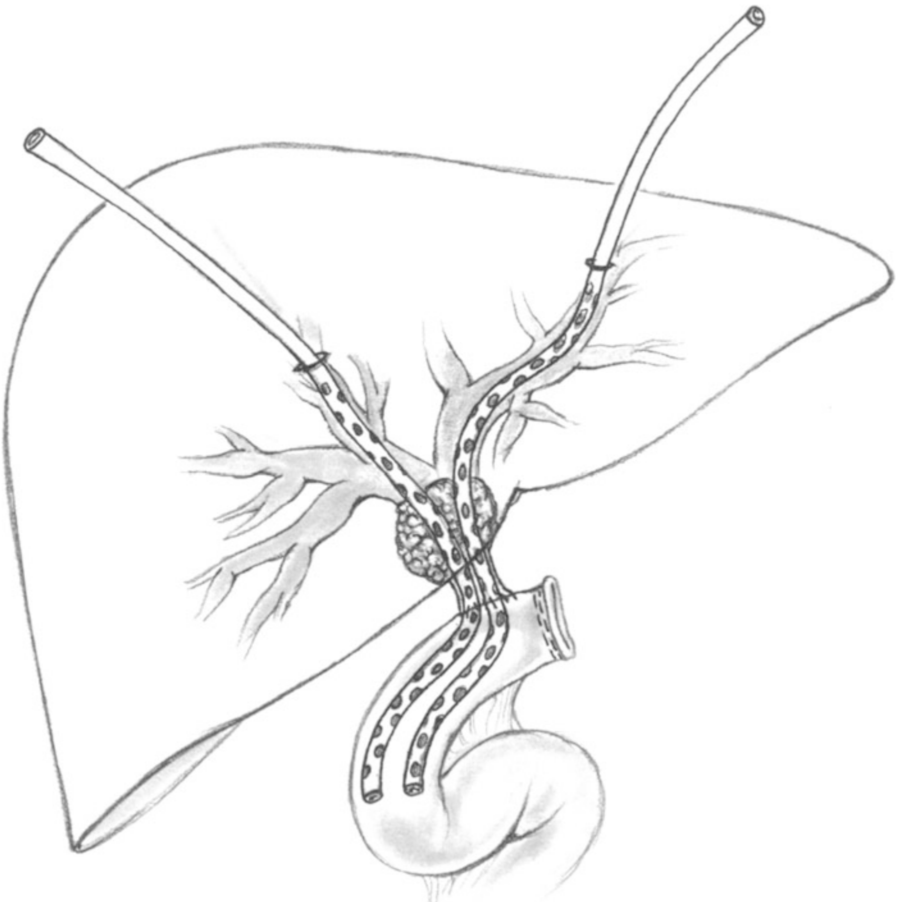


Fig. 70–8

open end of the follower from below, where it is sutured securely in place. By withdrawing the follower, the Silastic tube catheter can be brought through the liver with minimal trauma and then out through the skin.

In the absence of an intraductal catheter, one may utilize the technique of Sparkman (discussion of paper by Cameron, Broe, and Zuidema) by passing a Fenger flexible gall duct probe through the cut end of the hepatic duct at the hilus of the liver. This probe is then passed through the hepatic parenchyma to a point on the lower anterior surface of the right lobe. Suture a urethral filiform to the tip of the probe and draw it back to the hilus of the liver. To this filiform, sequentially attach urethral followers to gently dilate the tract. Finally, attach a Silastic catheter to the last follower and draw it through the liver and out through the cut end of the right hepatic duct. Follow a similar sequence for the left hepatic duct.

Another simple technique is to pass a No. 2 or No. 3 Bakes bile duct dilator through the cut end of the right or left hepatic duct. Pass the dilator through the duct until it reaches a point about 1–1.5 cm from Glisson's capsule in an appropriate location on the anterior surface of the liver. Then make a tiny incision in the capsule and push the metal dilator through the hepatic parenchyma. Suture the tip of the 10F straight rubber catheter to the Bakes dilator (see Fig. 70–6). This step may be simplified if a small hole has been drilled in the tip of the Bakes dilator to accept the suture (Tatarchuk and White). After drawing the Bakes dilator downward, the catheter will be led into the hepatic duct at the hilus of the liver. Then insert a Silastic tube, 6 mm in outer diameter, into the flared open end of the French catheter and suture it securely in this location (see Fig. 70–7). By drawing the catheter out of the hepatic duct at the hepatic hilus, the Silastic tube will be in the proper location. Make certain that holes have been punched in the Silastic prior to its insertion. These holes should be situated above and below the site of the tumor. One convenient source of the Silastic tubing is the round Jackson-Pratt drain.

Bring the Silastic catheters out through puncture wounds in the abdominal wall and insert latex drains to the sites from which the plastic catheters exit from the right and left hepatic lobes, and one drain to the hilus of the liver.

Postoperative Care

Attach the Silastic catheters to plastic bags for gravity drainage until there is no drainage of bile along any of the latex drains. Then occlude the Silastic catheters. Instruct the patient to irrigate each catheter twice daily with 25 ml of sterile saline. It will be necessary to replace the nylon suture fixing the catheter to the skin approximately once every 4–6 weeks.

Instruct the patient to return to the X-ray department every 3 months in order to have the catheters replaced, as sludge tends to occlude many of the openings as time goes by. Replacing the catheters is accomplished by passing a sterile guide wire through the Silastic tube; then remove the Silastic tube with sterile technique and replace it with another tube of the same type. Remove the wire and perform a cholangiogram in order to confirm that the tube has been accurately placed. Then suture the tube to the skin. If the patient develops cholangitis, it may be necessary to replace the tube at an earlier time interval than 3 months.

Remove the latex drains when there is no further drainage of bile.

Continue perioperative antibiotics until the latex drains have been removed.

Maintain nasogastric suction for 3–5 days.

Prescribe an H_2 blocker intravenously until the patient has resumed a regular diet to lower the incidence of postoperative gastric "stress" bleeding.

Modern methods of brachytherapy permit the insertion of radioactive pellets into the Silastic catheters in such fashion that a very large dose of radiation can be administered precisely to the bed of the tumor postoperatively. The range of the radiation is limited to a shallow depth, such as 2 cm.

Postoperative Complications

Sepsis, Subhepatic or Subphrenic

Cholangitis generally will not occur unless there is some element of obstruction to the drainage of bile. If the ducts draining only one lobe of the liver have been intubated, leaving the opposite hepatic duct completely occluded but not drained, cholangitis or even a liver abscess will frequently occur over a period of time. Consequently, in the presence of a tumor at the bifurcation of the hepatic duct which occludes both right and left hepatic ducts, drainage of each duct is necessary. If drainage of both ducts cannot be accomplished in the operating room, then request the radiologist to perform percutaneous transhepatic insertion of a catheter into the undrained duct postoperatively. Routine replacement of the Silastic tubes at intervals of 2–3 months will prevent most cases of postoperative cholangitis.

Leakage of bile around the Silastic tube may occur early if the puncture wound in Glisson's capsule is larger than the diameter of the Silastic tube. If leakage occurs late in the postoperative course, attempt to replace the tube, around which the bile is leaking, with a tube of somewhat larger diameter. If leakage occurs in the immediate postoperative course, check the position of the Silastic tubes by performing cholangiography to ascertain that none of the side holes in the tubes is draining freely into peritoneal cavity.

Upper gastrointestinal hemorrhage late in the postoperative course is reported to occur in as many as 7% of patients with hepaticojejunostomies that divert bile from the duodenum. Patients should be alerted to this possibility and treated promptly with antacid therapy and cimetidine.

References

Adson MA, Farnell MB. Hepatobiliary cancer—surgical consideration. Mayo Clin Proc 1981;56:686.

Cameron JL, Broe P, Zuidema GD. Proximal bile duct tumors: surgical management with Silastic transhepatic biliary stents. Ann Surg 1982;196:412.

Cameron JL, Gayler BW, Zuidema GD. The use of Silastic transhepatic stents in benign and malignant biliary strictures. Ann Surg 1978;188:552.

Hart MJ, White TT. Central hepatic resections and anastomosis for stricture or carcinoma at the hepatic bifurcation. Ann Surg 1980;192:299.

Lees CD, Zapolanski A, Cooperman AM et al. Carcinoma of the bile ducts. Surg Gynecol Obstet 1980;151:193.

Polydorou AA, Cairns SR, Dowsett JF et al. Palliation of proximal malignant obstruction by endoscopic endoprosthesis insertion. Gut 1991;32:685–689.

Tartarchuk JW, White TT. A new instrument for inserting a U-Tube. Am J Surg 1979;137:425.

Terblanche J, Saunders SJ, Louw JH. Prolonged palliation in carcinoma of the main hepatic duct junction. Surgery 1972;71:720.

Tompkins RK, Aizen BM, Saunders, KD. Carcinoma of the ductus choledochus. Am J Surg 1991;161:235–238.

Tompkins RK, Thomas D, Wile A et al. Prognostic factors in bile duct carcinoma: analysis of 96 cases. Ann Surg 1981;194:447.

Voyles CR, Bowley NJ, Allison DJ et al. Carcinoma of the proximal extrahepatic biliary tree; radiologic assessment and therapeutic alternatives. Ann Surg 1983;197:188.

71 Hepatic Resections*

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Concept: When to Resect

Hepatic resection is applicable for a wide variety of space-occupying abnormalities of the liver. Broadly, if nonoperative management fails and a refractory localized process persists within the liver, resection is indicated. Significant metabolic reserve and regenerative capacity of the liver permit a wide variety of resections. The major consideration in determining resectability is whether the extent of resection will leave sufficient functioning liver. Factors relevant to the hepatic mass which affect resectability include number, size, and location of lesions. Those factors relevant to hepatic function which affect resectability include the presence or absence of acute or chronic liver disease, biliary obstruction, or compromise of the hepatic vasculature. Preoperative assessment of patients must address each of these considerations.

Preoperative hepatic imaging should clearly define the previously mentioned factors relevant to the hepatic mass and its relationships to the hepatic vasculature and biliary tree. Metastases to other organs must be excluded. Computed tomography (CT) and ultrasound (US) are the basic imaging studies required for assessment of all liver masses. These studies complement each others' weaknesses and are accurate enough to evaluate most liver masses. Hepatic angiography and Magnetic Resonance Imaging may be indicated selectively to assess tumor–vessel relationships that are unclear on CT and US or to exclude occult multicentricity for vascular tumors. Hepatic function is estimated by liver function tests: serum aspartate aminotransaminase (AST), bilirubin (total and fractionated), alkaline phosphatase, serum protein electrophoresis, and coagulation profile. Significant impairment of liver function, indicated by marked abnormalities of these tests, requires definition of the cause and correction, if possible, prior to resection.

Concept: Hepatic Anatomy

Safe resection of the liver is predicated upon clear understanding of hepatic anatomy. Although the regenerative capacity and metabolic reserve of the liver permit a broad range of surgical interventions, resection based on consideration of the surgical anatomy reduces operative risk and optimizes function. The major anatomic features relevant to resection will be presented. A detailed description of anatomic variations has been presented by Professor Couinaud and provides the basis for this brief summary.

The gross morphology of the liver has little clinical application. However, the liver can be divided into functional anatomic units that are particularly relevant to hepatic surgery. The division is based on the hepatic arterial and portal venous blood supply and the biliary and hepatic venous drainage. Briefly, the liver is divided into two major units—right and left—based on the portal venous bifurcation and the corresponding main right and left bile ducts. These main units appropriately are called the right and left livers because they are separate functionally and embryologically. Alternatively, these have been termed the right and left lobes of the liver or the right and left hemilivers. The principal plane of the liver represents the interface between the two major units and extends from the gallbladder fossa to the inferior vena cava. The middle hepatic vein lies within this principal plane. The plane lies obliquely at approximately 45 degrees to the bisagittal plane of the body.

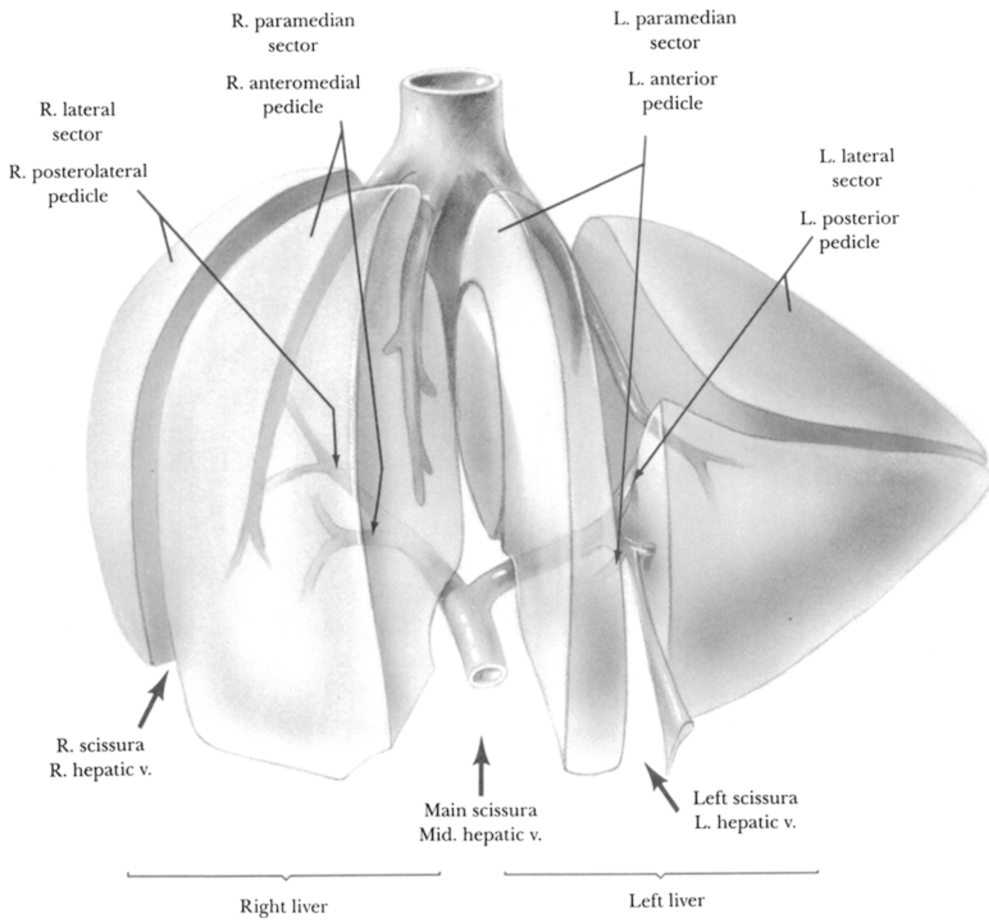


Fig. 71–1

Each major division (the right and left liver) is further subdivided into sectors on the basis of the distribution of the major hepatic veins and the portal pedicles (**Fig. 71–1**). Briefly, the three major hepatic veins divide the liver into four sectors: right lateral, right paramedian, left paramedian, and left lateral. Each plane dividing the liver along the major hepatic veins is called a scissura. Each sector is supplied by a separate portal pedicle. Each pedicle consists of a bile duct, hepatic artery, and portal vein branch. The portal pedicles are best identified as the initial divisions of the portal vein distal to the bifurcation of the main portal vein with the associated artery and bile duct. The hepatic sectors with their respective portal pedicles are: right lateral sector, right posterolateral pedicle; right paramedian sector, right anteromedial pedicle; left paramedian sector, left anterior pedicle; left lateral sector, left posterior pedicle. Unfortunately, there is frequent variability in portal pedicle origins, and careful identification is required prior to dividing a portal pedicle during resection.

The *sectors* composing each major functional division of the liver can be further subdivided into *segments* on the basis of the initial bifurcation of each portal pedicle. These bifurcations are called segmental pedicles. There are eight commonly recognized hepatic segments (**Fig. 71–2**). There are no clear morphologic boundaries between segments. They are identified numerically as segments 1 through 8. The numerical sequence of the segments proceeds clockwise when the liver is viewed from an anterior-posterior direction. Segments 1 through 4 lie to the left of the principal plane, and segments 5 through 8 to the right of the principal plane. Segment 1 has also been called the caudate or spigelian lobe. Segment 1 lies immediately anterior to the inferior vena cava, and its hepatic venous drainage is distinct from that of the remaining liver, flowing in a directly posterior direction, into the vena cava with no connection to any of the major hepatic veins. The left lateral sector is composed of segments 2, posteriorly, and 3, anteriorly. The left paramedian sector is composed of segment 4, which has two subsegments, 4a posteriorly and 4b anteriorly. The right paramedian sector is composed of segments 5 and 8. The right lateral sector is composed of segments 6 and 7.

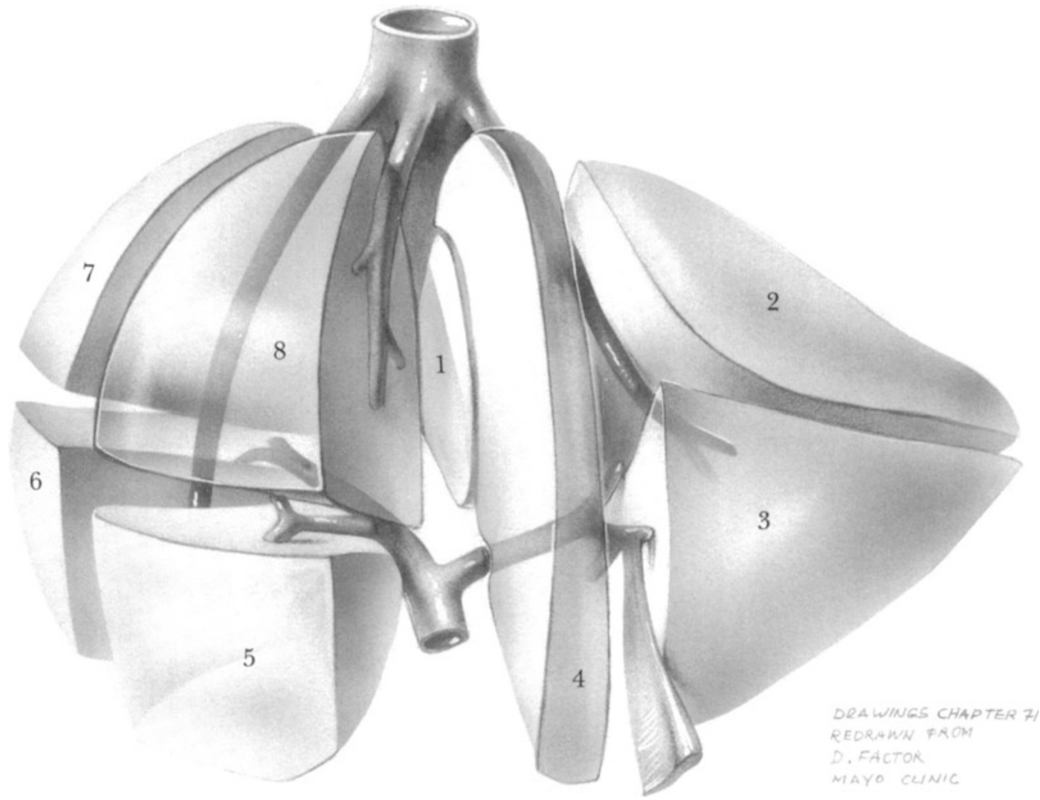


Fig. 71–2

In practice, liver segments represent the smallest functional subdivision of the liver in which anatomic resections can be performed reliably. Anatomic resection should incorporate ligation of the appropriate portal segmental pedicle and its corresponding hepatic vein. Preligation of the pedicle prior to parenchymal transection results in a sharp vascular demarcation of the segment for accurate excision.

The vasobiliary sheaths are particularly relevant to hepatic resection (**Fig. 71–3**). The vasobiliary sheaths represent fusion of the endoabdominal fascia around the bile ducts, portal vein, and hepatic artery.

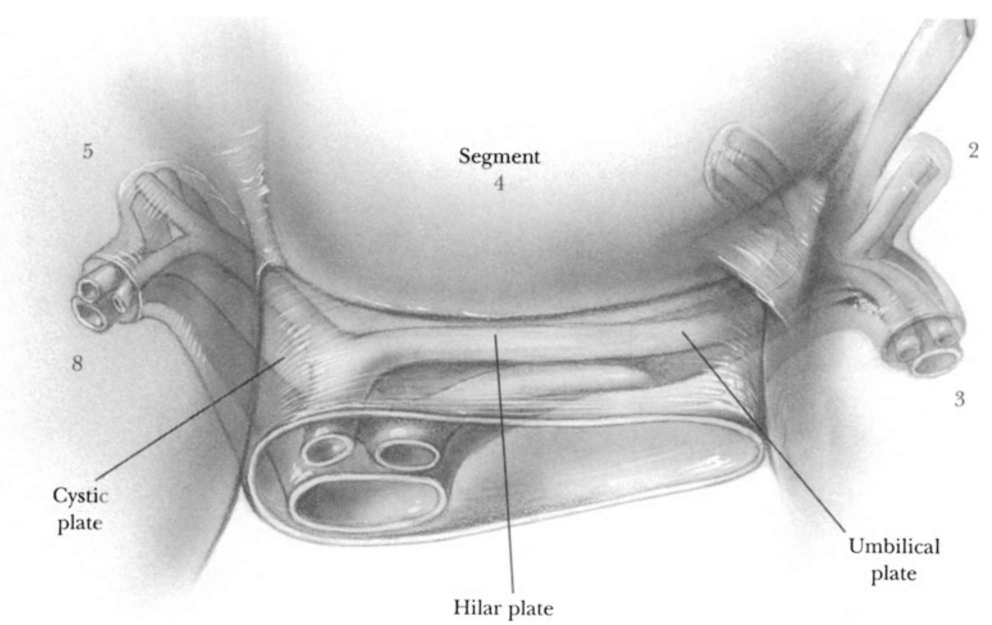


Fig. 71–3

These fibrous sheaths invest the components of the pedicles from the portal vein bifurcation to the sinusoids. In contrast, a similar fibrous envelope does not invest the hepatic veins; the lack of a sheath accounts for their relative fragility. The density of the vasculobiliary sheaths increases as the pedicle forms at the base of the liver. At the liver hilus, these sheaths fuse to form plates that surround the portal pedicles both anteriorly and posteriorly. Division of a plate is required to expose and mobilize a portal pedicle during resection. Three primary plates are recognized: the cystic, hilar, and umbilical plates. There are no distinct boundaries between plates. Lymphatic and neural elements are also incorporated within the fibrovascular sheaths and the pedicles. Recognition of the vasculobiliary sheaths and the liver plates allows precise access to the hilar structures for either resection or bilioenteric bypass procedures.

Indications

The primary indications for elective hepatic resection are symptomatic benign liver lesions, primary hepatic malignancies, and selected metastatic malignancies. Indeterminate masses also require excision. Infrequent indications for hepatic resection include parasitic or bacterial infections, hepaticolithiasis, and trauma. The major contraindications to hepatic resections are hepatic insufficiency and advanced stage of malignancy. In general, patients without a history or clinical evidence of acute or chronic liver disease can tolerate extensive resection (6 of 8 liver segments). Patients with liver disease require careful preoperative assessment. Because treatment of a localized liver process may also require treatment of the underlying liver disease, evaluation of patients with known chronic liver disease or cirrhosis should be done in centers performing orthotopic liver transplantation.

Benign liver masses are resected to alleviate symptoms, to prevent potential malignant transformation or future symptoms (prophylaxis), or to exclude malignancy. These broad indications are applicable to all benign liver masses. Preoperative diagnosis can be obtained by fine needle biopsy or cytology guided by noninvasive imaging if deemed necessary by the operating surgeon. Benign lesions should be excised completely; however, resection should never risk compromise of liver function. The extent of resection depends on the size, location, and relation to the tumor of the major afferent-efferent vasculature and bile ducts. Enucleation is effective for encapsulated or sharply demarcated lesions. Formal anatomic resection should be considered for large or deeply seated lesions or lesions whose margins are indistinct intraoperatively, e.g., hepatocytic adenomas or some cavernous hemangiomas.

Malignant hepatic tumors, whether primary or metastatic, require resection with a margin of normal liver. Ideally, a 1–2 cm margin is preferred to reduce risk of recurrence. Margins of resection for malignancies should not risk compromise of hepatic function sufficient to cause hepatic failure by damage to the major vasculature. The afferent and efferent vasculature of the anticipated postresection liver remnant must be protected scrupulously. Before approving a candidate for exploration or resection, be sure that gross bilobar tumor multicentricity and distant disease have been excluded. Intraoperative findings that preclude resection are bilobar multicentricity, peritoneal metastases, extensive regional lymph node involvement, unexpected pulmonary metastases discovered during a thoraco-abdominal approach, or malignant thromboses extending into the main portal vein or inferior vena cava. Formal anatomic resection is preferred for malignancies unless the malignancy is small and peripherally located.

Preoperative Care

Preparation for hepatic resection is similar to that undertaken for any major pancreaticobiliary procedure. Preoperative laxatives and enemas are given, coagulation profiles are corrected, and prophylactic antibiotics directed at upper gastrointestinal tract flora are administered. A central venous catheter is inserted preoperatively for intraoperative monitoring during major resections. If jaundice or cholangitis from bile duct obstruction is present, biliary decompression by endoscopic or percutaneous intubation is performed to improve hepatic function and control infection. In general, major hepatic resection is not undertaken unless the total serum bilirubin is less than 5 mg/dl and clinical infection is controlled. If it is necessary to reduce the bilirubin level, biliary drainage is established for the liver that is uninvolved with the disease process or, in other words, the anticipated postresection liver remnant. If malnutrition or extensive fatty infiltration is present, nutritional indices are corrected preoperatively. Resection should be deferred temporarily for diffuse fatty infiltration of the liver.

Pitfalls and Danger Points

Hemorrhage from hepatic or portal veins or hepatic arteries

Air embolism from hepatic venous injury

Injury to the biliary ductal system, with postoperative obstruction or fistula

Portal or hepatic vein compromise with subsequent ischemia or postsinusoidal portal hypertension

Prolonged vascular inflow occlusion leading to refractory liver ischemia

Injury to the diaphragm, inferior vena cava, or intestine (especially after prior gastric, hepatobiliary, or colon surgery)

Operative Strategy

Safe hepatic resection is primarily dependent upon *control of hemorrhage.* Circumferential access to the hepatoduodenal ligament must be secured early to permit total hepatic vascular inflow occlusion (Pringle maneuver) for control, if necessary, of hemorrhage from the high-pressure afferent vasculature at any time during resection. Hemorrhage from the low-pressure hepatic venous system can be controlled temporarily by digital pressure, parenchymal compression, or packing. Exposure of the hepatic veins at the junction of the inferior vena cava requires complete division of the ligamentous attachments to the liver. In particular, the retrocaval ligament bridging segments 6 and 7 must be divided fully to expose the right hepatic vein. *The hepatic vein should be approached only after the afferent vasculature is controlled.* If tumor obscures the hepatic venous anatomy at its junction with the inferior vena cava, total hepatic vascular isolation should be considered to permit safe exposure and control. The suprahepatic, infradiaphragmatic inferior vena cava should be circumferentially exposed for application of a large vascular clamp. Similarly, the infrahepatic suprarenal inferior vena cava is also exposed. No lumbar veins enter the retrohepatic inferior vena cava. Ligation of the right adrenal vein combined with infra- and suprahepatic inferior vena cava clamping and inflow vascular occlusion of the hepatoduodenal ligament results in total hepatic vasculature isolation and permits controlled exposure of the hepatic veins and direct vascular repair (Delva and associates).

Bile duct injury is also a potential source of major morbidity following hepatic resection. The ductal confluence must be identified unequivocally before ligation of any major lobar branches during formal lobectomy or extended lobectomy. If ductal anatomy is in question, two options exist. First, clear identification of major lobar branches can always be obtained by deferring ductal ligation until parenchymal transection exposes the major ducts at the level of the hilar plate. With the surrounding parenchyma transected, the major ducts can be traced from the parenchyma to the confluence and ligated or preserved accordingly. Parenchyma around the major ducts can be excised by the Cavitron ultrasonic aspirator (CUSA) if necessary. Division of the ducts within the parenchyma and probe cannulation distally allows unequivocal confirmation of patency of the ductal confluence. Alternatively, a choledochotomy permits cannulation of the proximal ducts with Bakes dilators or other intraluminal devices, which, in turn, allows both tactile and visual identification of the major ducts for appropriate management.

Operative Technique

Incision and Exposure

A bilateral subcostal incision affords wide exposure for any hepatic resection (**Fig. 71–4**). A long midline incision provides a satisfactory alternative for limited resections of segments 2 through 6. Tumor involving segments 7 and 8 or extended lobar resections are

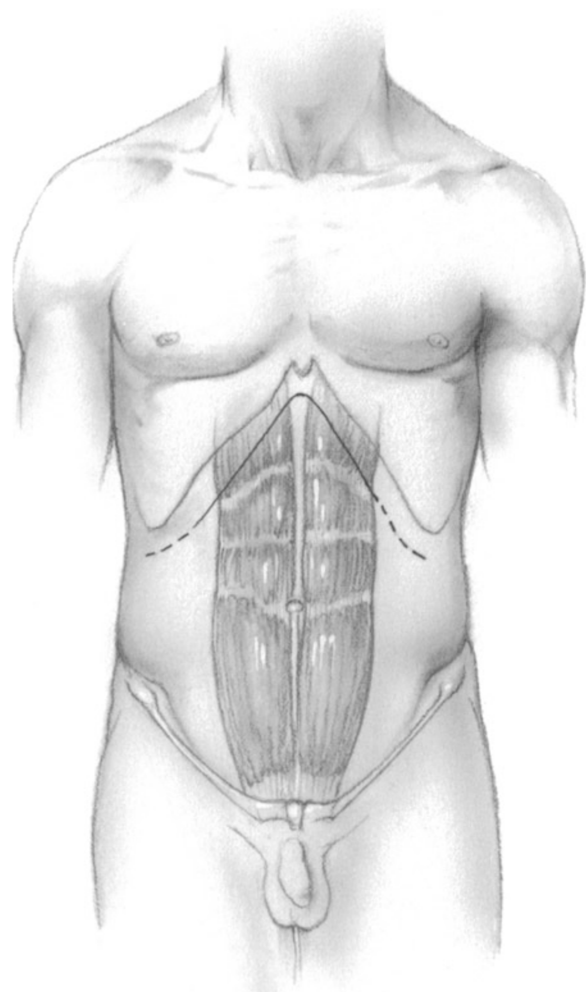


Fig. 71–4

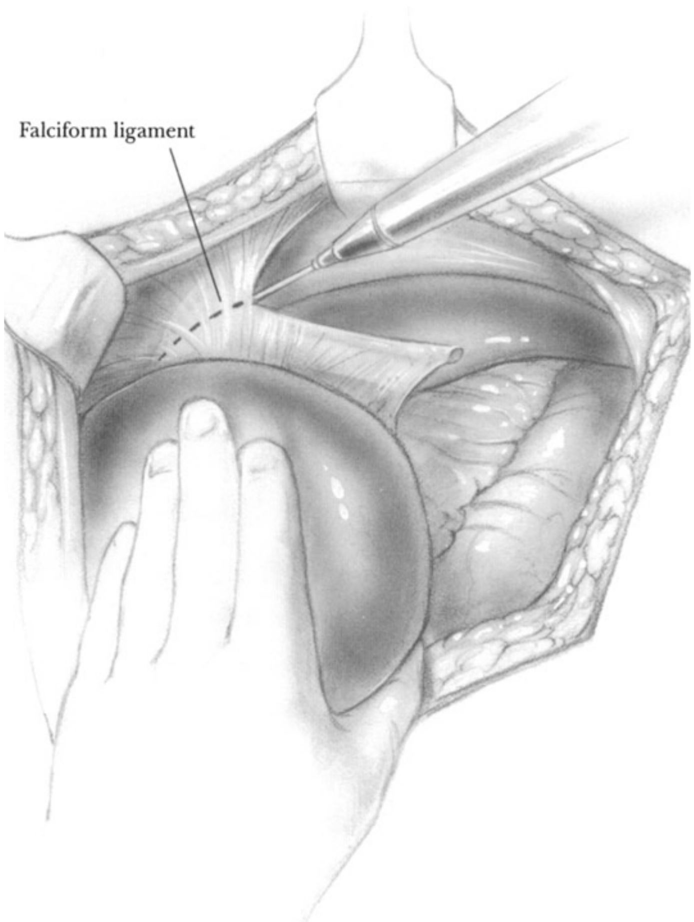


Fig. 71–5a

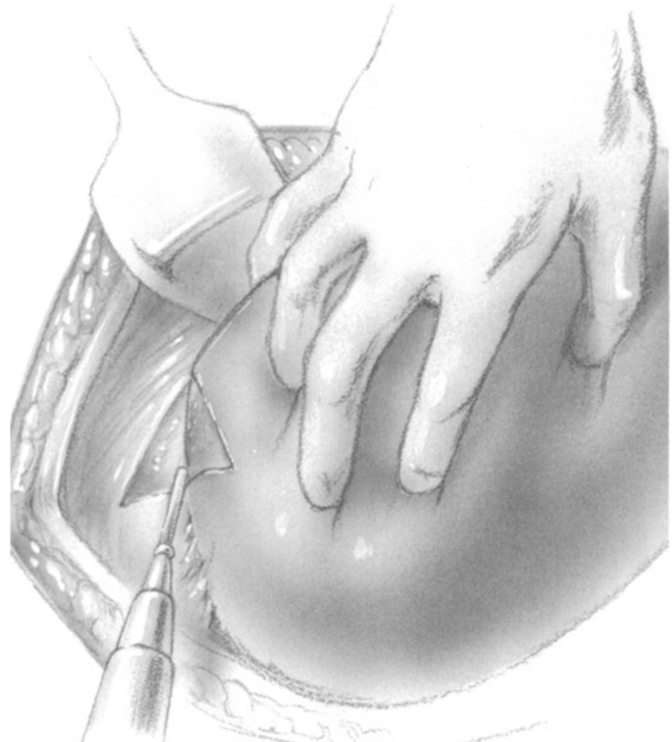


Fig. 71–5c

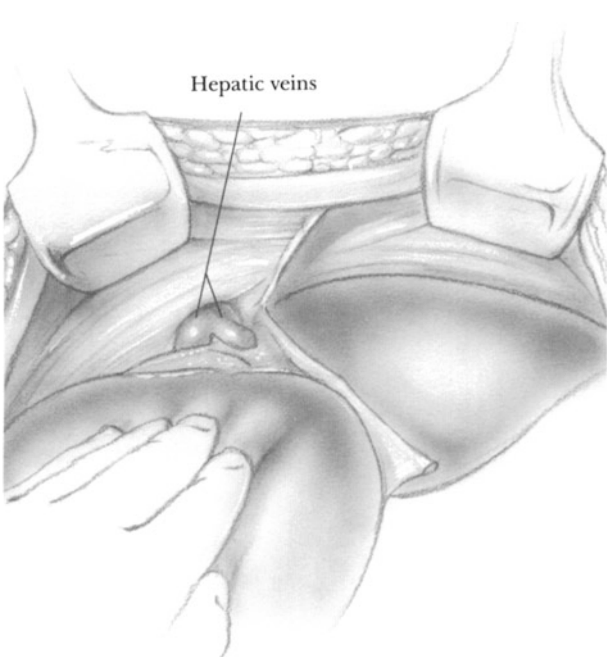


Fig. 71–5b

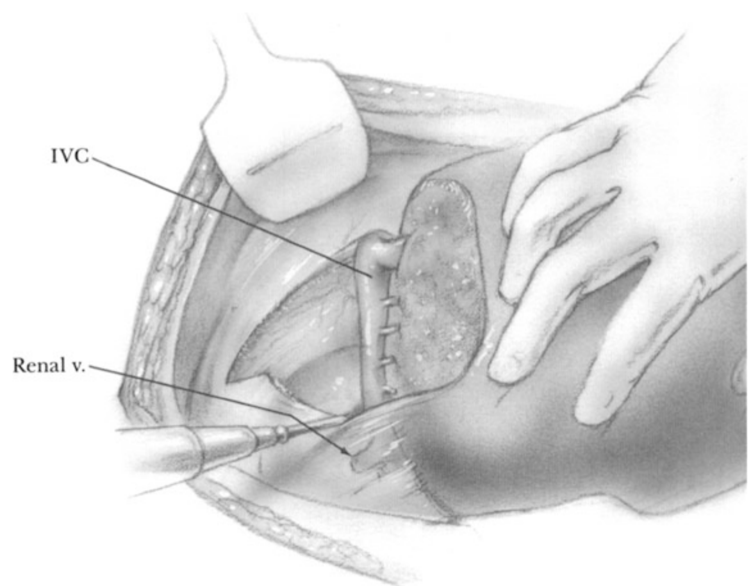


Fig. 71–5d

approached more safely through a bilateral subcostal incision with a right thoracic extension as necessary. Perihepatic adhesions are divided. The liver is mobilized fully by division of its ligamentous attachments (**Figs. 71–5a–d**). The gastrohepatic omentum is divided and the foramen of Winslow is exposed for inflow vascular occlusion. An Upper Hand or Thompson retractor should be used to elevate the rib cage cephalad. Additional retractors may be used to retract the hollow viscus caudally.

Wedge (Nonanatomic, Subsegmental, or Peripheral) Resection

Wedge resections are liver resections performed without reference to segmental or sectoral anatomic boundaries, i.e., nonanatomic resections. Wedge resections are typically subsegmental and frequently cross intersegmental planes. These resections are tolerated well by the liver because they are utilized for small, peripheral, nonhilar tumors. Wedge resections generally are undertaken for peripheral liver masses that are not adjacent to the hilus or hepatic veins. These resections are easiest for small (less than 4 cm) tumors arising within the anterior liver segments 3–6. Laparotomy pads are placed posteriorly between the liver and diaphragam after liver mobilization to enhance exposure by anterior displacement. Although benign tumors can be enucleated, indeterminate or malignant lesions require 1–2 cm margins for adequate clearance. The planned margin of resection is estimated by palpation and the liver capsule is scored with cautery to outline the margin. The parenchyma is transected with cautery, finger fracture, or CUSA. Hemorrhage is reduced by digital compression of the liver on both sides of the transection plane. The surgeon usually compresses the liver on the tumor side of the transection plane, and the assistant compresses the parenchyma opposite (**Fig. 71–6**). Typically, the operating surgeon disrupts the parenchyma with a CUSA or alternative instrument, the assistant surgeon uses the electrocautery to maintain hemostasis, and an additional assistant aspirates blood from the transection interface. Bile ducts or vessels greater than 2 mm are clipped or ligated with suture. After local bile stasis and hemostasis is obtained, the abdomen is closed. Drainage is generally not necessary for simple wedge resections within a single segment or adjacent segments unless concurrent biliary tract disease is present.

The liver parenchyma can be transected by a variety of methods. Conceptually, the surgeon simply disrupts the parenchyma along the planned transection plane to expose bile ducts and vessels for ligation. Because all branches of the portal pedicle are enveloped by extensions of the vasculobiliary sheath, the portal veins are less fragile than branches of the hepatic vein. Disruption of the small hepatic veins (less than 1–2 mm) during parenchymal transection is common. Hemorrhage from small hepatic veins is easily controlled by parenchymal compression, electrocautery, or a suture ligation.

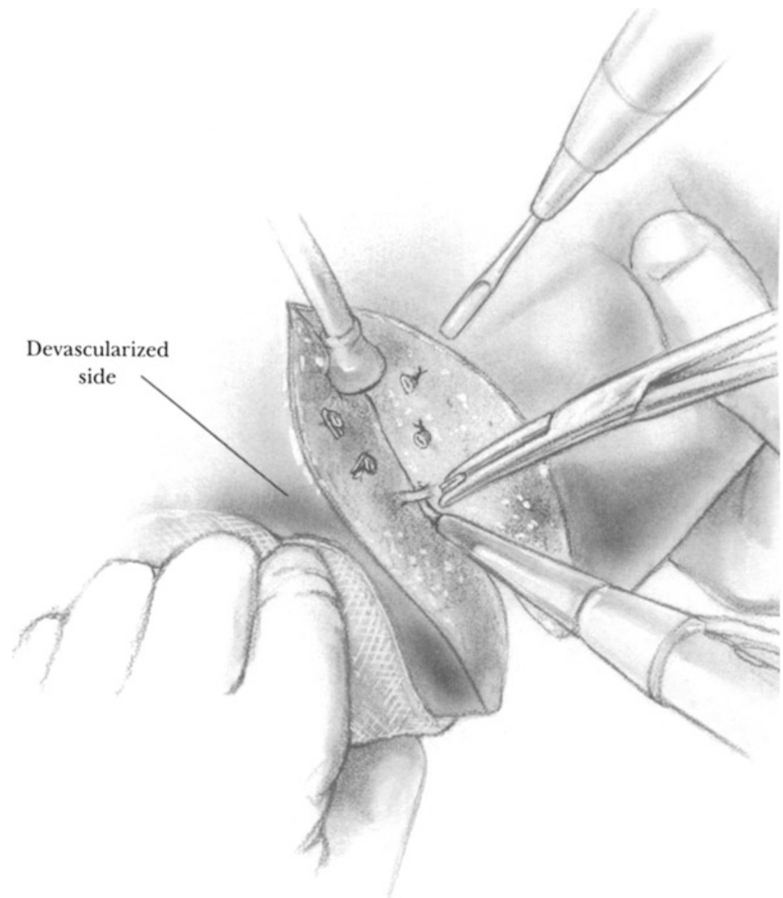


Fig. 71–6

Liver parenchyma can be disrupted by compression methods [finger fracture (digitoclasis), clamp fracture (Kellyclasis)], contact methods (CUSA, waterjet), or thermal methods (electrocautery, laser) (Tranberg et al.; Schroder et al.; Putnam). Each method has its advantages and disadvantages. Although the zone of parenchymal damage adjacent to the transection plane varies among these methods, the clinical significance of these microscopic zones of devitalized parenchyma is negligible unless the transection results in major damage to the vasculature of the liver remnant and significant regional ischemia occurs. Each method attempts to disrupt parenchyma to expose vessels and ducts for ligation. Typically, structures greater than 2 mm require ligation. Near-circumferential exposure of intraparenchymal structures optimizes secure ligation. Intraparenchymal portal pedicle branches and hepatic veins can be ligated between fine silk sutures, metal clips, or a combination of both. Avulsion of small hepatic vein branches from a major hepatic vein can be particularly troublesome. Hemorrhage from the orifice of an avulsed hepatic vein branch of an exposed major hepatic vein is best controlled by a very fine vascular suture (5–0 or 6–0 Prolene) carefully maintaining blood flow through the main hepatic vein. If bleeding results from a small hepatic vein without exposure of its major hepatic vein, a single figure-of-eight suture ligature is adequate. The surgeon must conceptualize a transection plane during parenchymal transection. Transection along the plane without deviation will result in a reduced risk of hemorrhage and elimination of partial devascularization of the adjacent liver segment at the interface.

Anatomic Unisegmental and Polysegmental Resections

Resection of a single liver segment or multiple contiguous segments requires identification and ligation of the segmental vasculobiliary pedicle and parenchymal division through anatomic intersegmental planes. Resection along intraoperatively defined anatomic boundaries is the major difference between nonanatomic wedge resections and anatomic segmental resections. In general, anatomic resections are preferable for primary malignancies because they address segmental intraportal metastases and enhance preservation of function in adjacent segments in cirrhotic livers.

Initially, segmental location of the tumor is defined with intraoperative ultrasound. Once localized, the portal pedicle(s) supplying the segment(s) is (are) identified. Ligation of the appropriate pedicle must be obtained for accurate anatomic segmental resection. Both portal and segmental pedicles can be accessed by proximal dissection from the hilar bile ducts and vasculature to the appropriate pedicle or by direct rapid parenchymal transection along an estimated intersegmental plane with ultrasound guidance. Dissection from the hilus is most applicable for anterior segments 3–6. The parenchymal transection approach is more appropriate for ligation of the posterior segmental pedicles to segments 7 and 8. Both approaches are facilitated greatly by temporary vascular inflow occlusion to reduce hemorrhage and the CUSA to rapidly expose the pedicle through the intervening parenchyma. Alternatively, methylene blue injection of the segmental or portal pedicle using US guidance can provide accurate segmental or sectoral definition. Once the appropriate portal venous branch is injected, segmental boundaries are defined by parenchymal staining, and resection proceeds according to the defined boundaries. Although precise, this approach is more technically demanding and requires expertise in operative ultrasound.

To approach the anterior liver segments 3, 4, 5, and 8 for resection, the liver is mobilized and the hilar plate is incised. The appropriate lobar pedicle is then identified. Dissection proceeds proximally until the segmental pedicle is exposed. Precise pedicle identification is confirmed by US. The pedicle is temporarily occluded to outline the segmental boundaries with cautery, to ensure that the tumor is included within the segmental demarcation, and to confirm that the pedicle will provide adequate margins. If appropriate, the segmental pedicle is ligated with a silk suture. The parenchyma is transected by cautery, finger fracture, or CUSA. Temporary inflow vascular occlusion is used both during dissection of the pedicle and during parenchymal transection as needed. Few vessels or ducts require ligation if the resection is truly along intersegmental planes. Hepatic veins do require ligation and they are individually ligated with silk. If the margins are narrow, the resection is extended nonanatomically into contiguous liver segments or anatomically by adjacent segmentectomy. After bile stasis and hemostasis is secured, a single suction drain is placed in the resection bed and abdominal closure is completed. Polysegmentectomy is performed in a manner similar to unisegmentectomy except that each segmental pedicle is ligated sequentially prior to extending the parenchymal transection. Once all appropriate pedicles are ligated, the contiguous liver segments are removed en bloc.

Lobar Resections (Polysegmentectomy 1–4: 5–8)

Lobar resections have also been termed right and left hemihepatectomy, lobectomy, or hepatectomy. Lobar resections are actually polysegmental resections based on the main right or left vasculobiliary pedicles. Operative risk of significant blood loss is reduced by ligation of the appropriate lobar hepatic artery and portal vein branch prior to parenchymal transection. Subsequent ligation of the corresponding hepatic vein, if technically possible, further reduces operative blood loss. Ligation of the respective bile duct is deferred until it is unequivocally identified (Adson and Beart; Starzl, Koep et al.; Starzl, Shaw et al.).

Major lobar resections may be extended either

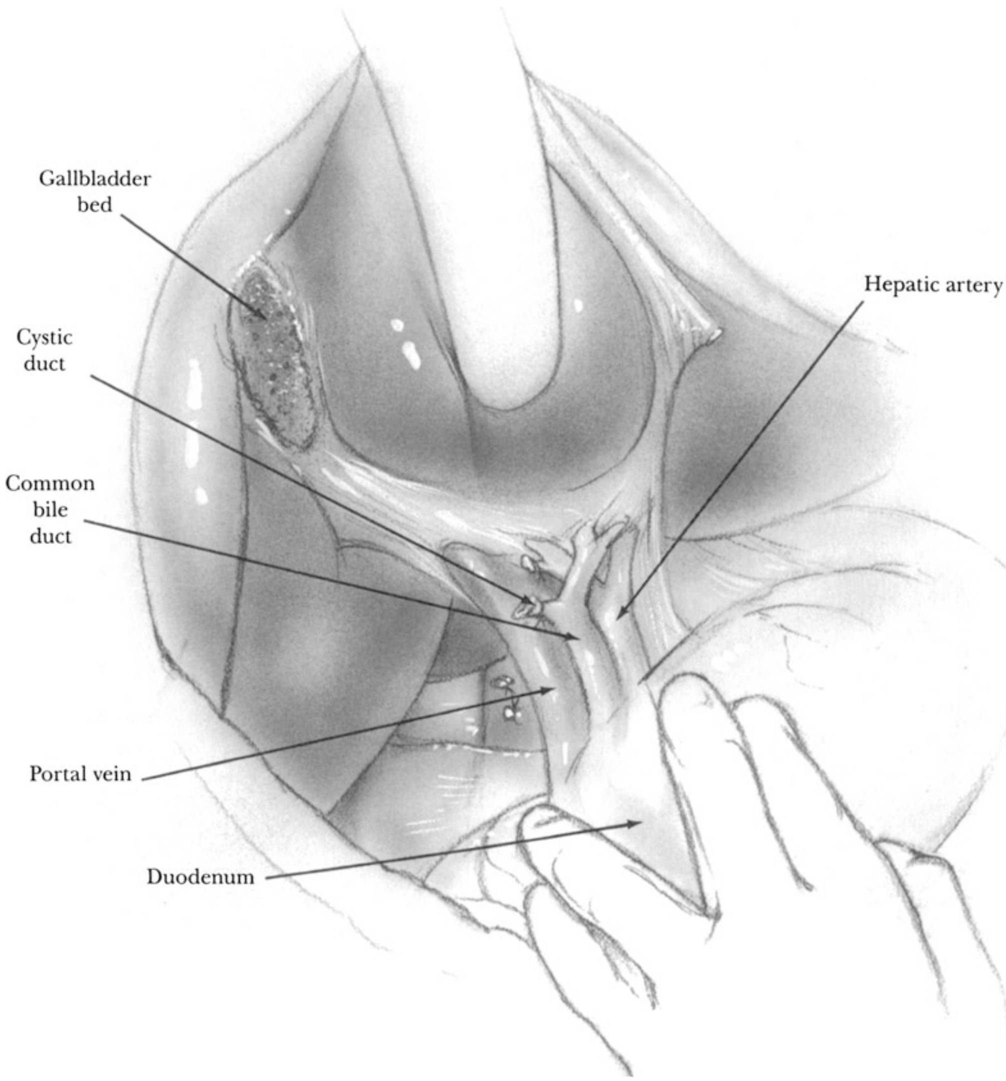


Fig. 71–7

anatomically or nonanatomically. Anatomic extensions are performed by removing the involved liver segments adjacent to the principal plane. For example, a right hepatectomy (polysegmentectomy 5–8) may be extended anatomically to include segment 4 (polysegmentectomy 4–8), or a left hepatectomy (polysegmentectomy 1–4) can be extended anatomically to include segments 5 and 8 (polysegmentectomy 1–5;8). Anatomic extensions imply formal ligation of the appropriate segmental pedicle and transection of the liver along intersegmental planes other than the principal plane. Nonanatomic extensions are sefl-explanatory.

The liver is mobilized fully and cholecystectomy is performed. The lobar hepatic artery is ligated initally. Cholecystectomy enhances exposure of the hilar vasculature. The right hepatic artery generally traverses the triangle of Calot. The pericholedochal lymph nodes are excised to further expose the bile duct, portal vein, and hepatic artery. For a right lobectomy, the right lateral aspect of the hepatoduodenal ligament is incised longitudinally just posterior to the bile duct (**Fig. 71–7**). The hepatic arteries are always found lateral to the common hepatic duct, at the point where they enter the liver parenchyma. The left hepatic artery is approached through the lesser sac, after division of the gastrohepatic omentum, through the left lateral aspect of the hepatoduodenal ligament. The main left hepatic artery is generally found just inferior to the base of the round ligament as it enters the left lobe between

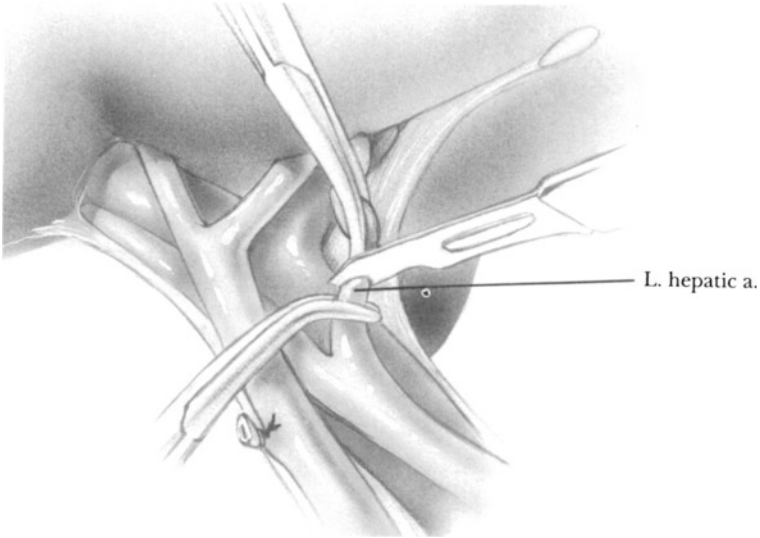


Fig. 71–8A

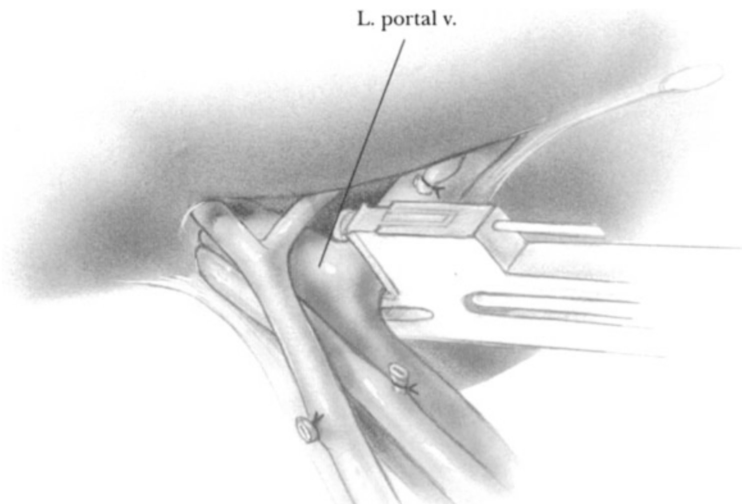


Fig. 71–8B

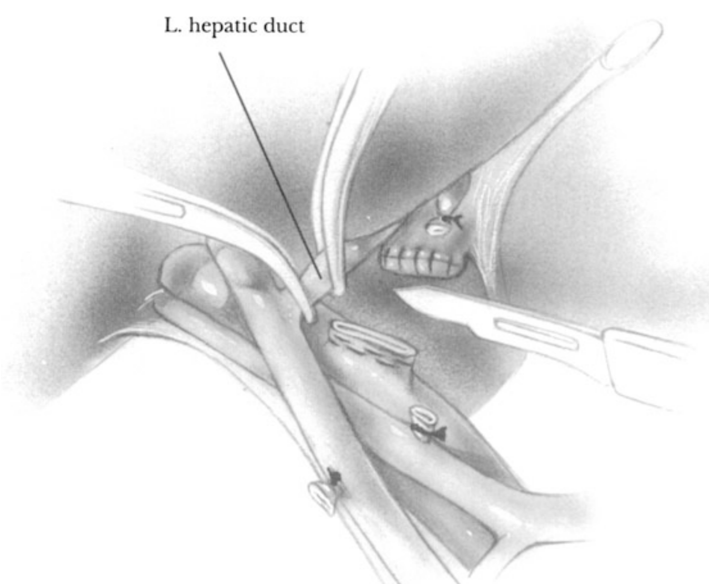


Fig. 71–8C

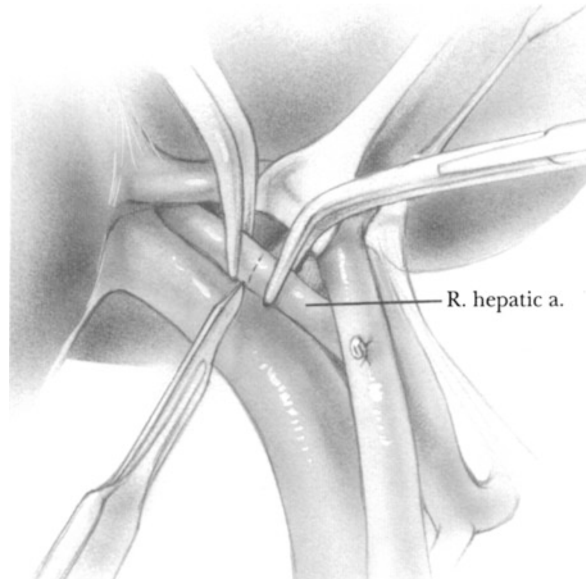


Fig. 71–9A

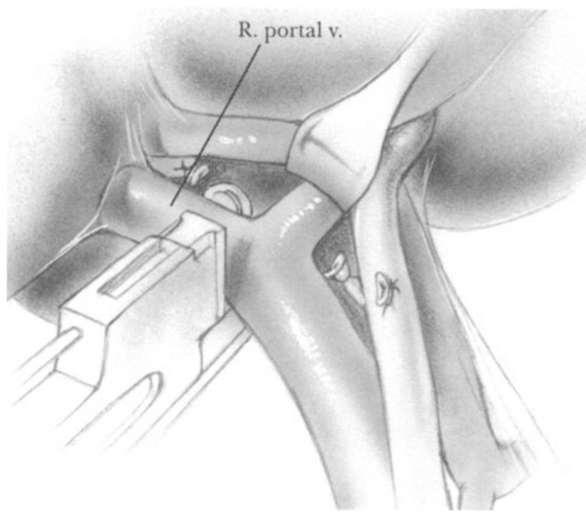


Fig. 71–9B

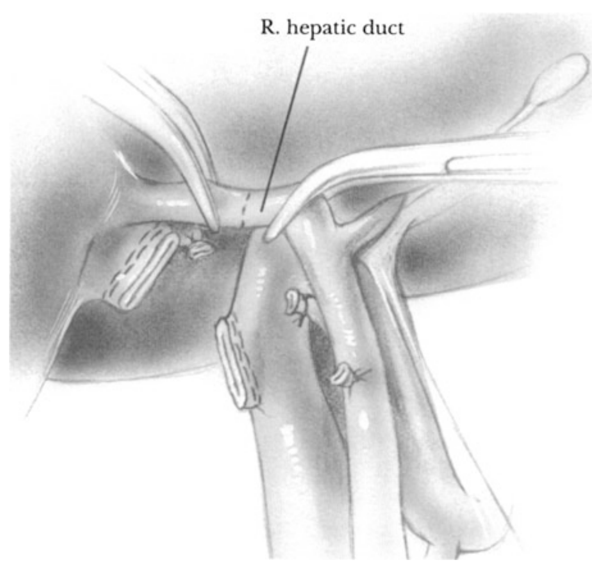


Fig. 71–9C

segments 3 and 4 (**Fig. 71–8**). An accessory left hepatic artery, arising from the left gastric artery, always courses through the gastrohepatic omentum and is often divided during division of the gastrohepatic omentum. Lymphatic vessels around the hepatic arteries are ligated prior to division to reduce postoperative lymph drainage. Regardless of whether a right or a left lobectomy is being performed, the artery supplying the lobe of resection is occluded temporarily while the artery to the opposite lobe is palpated to ensure patency of the arterial supply to the liver remnant. Once appropriately confirmed, the lobar artery is doubly ligated with heavy silk and divided (**Fig. 71–9**).

The bile duct is retracted anteriorly with a vein retractor to expose the portal vein bifurcation. Again, the right portal vein is exposed from the right of the hepatoduodenal ligament, and the left portal vein is exposed from the left of the hepatoduodenal ligament. The main left portal vein branch always bifurcates from the right main branch at approximately 90° and courses anterolaterally. The two major branches of the right portal vein (anterior and posterior) may arise separately without a common trunk, resulting in a portal vein trifurcation. The appropriate lobar portal vein branch is freed from surrounding lymphoareolar tissue and is ligated with a vascular stapler or a running vascular suture after division between clamps (Figs. 71–8B and 71–9B). A simple ligature is not used on the portal vein because ligature dislodgement risks life-threatening hemorrhage. A clear line of vascular demarcation along the principal liver plane between lobes confirms appropriate and complete lobar ligation (**Fig. 71–10**).

After the afferent vessels are controlled, the hepatic veins are approached. During a *right lobectomy*, multiple small short hepatic veins between the inferior vena cava and segments 1, 6, and 7 are ligated as the liver is retracted anteriorly and to the left (**Fig. 71–11**). Ligation starts infrahepatically and proceeds cephalad. Occasionally a large, right inferior hepatic vein enters the inferior vena cava from the posterior aspect of segment 6. Staple or suture closure for secure ligation is preferred.

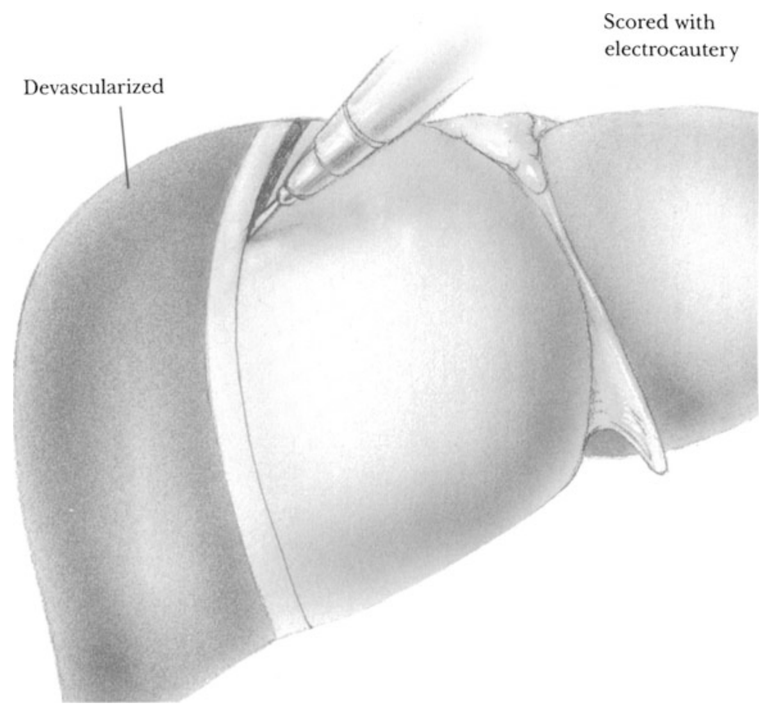


Fig. 71–10

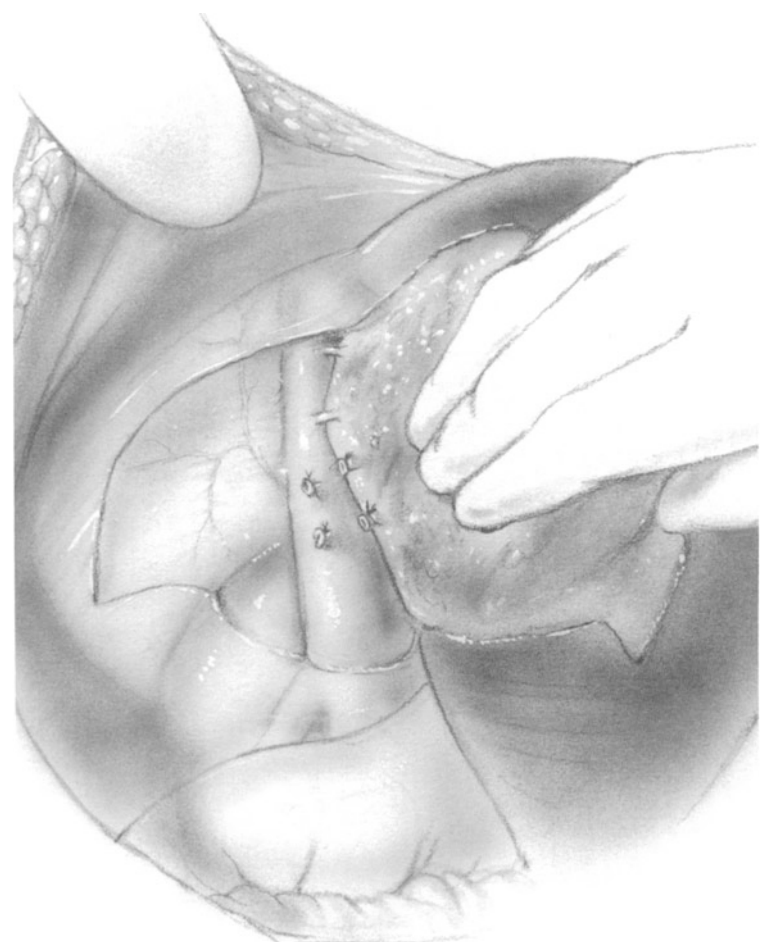


Fig. 71–11

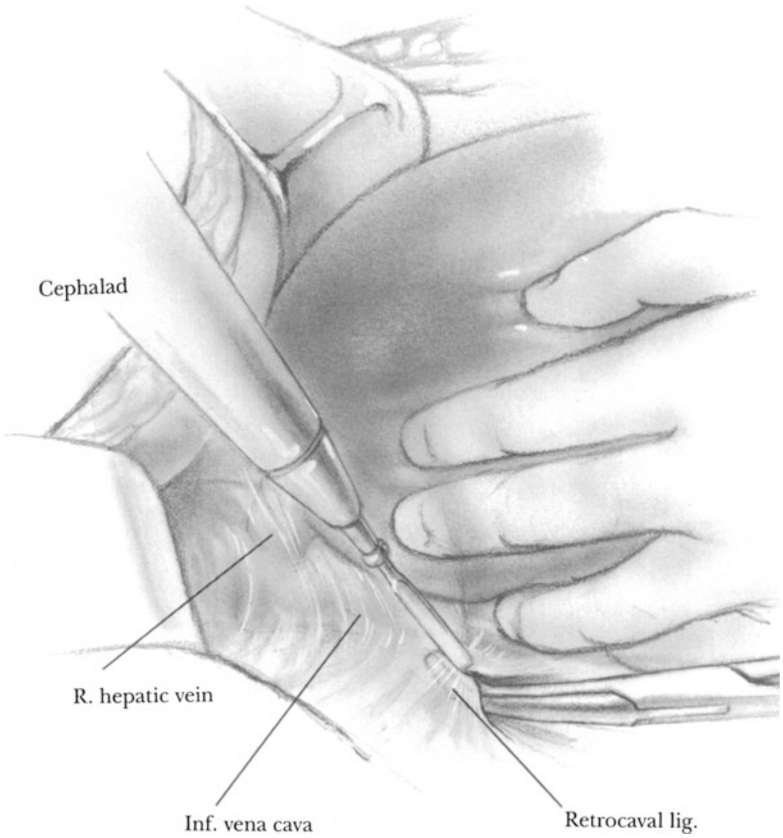


Fig. 71–12

To expose the main right hepatic vein, the retrocaval ligament bridging segments 1 and 7 is divided (**Fig. 71–12**). A moderate-sized vein frequently traverses the ligament and requires ligation. The main right hepatic vein is then dissected from the inferior vena cava and liver. Unless a large tumor precludes access, the right hepatic vein can be transected with a vascular stapler (McEntee and Nagorney) and the parenchymal side ligated with a running vascular silk suture before parenchymal transection (**Fig. 71–13**). Alternatively, the right hepatic vein may be ligated as the final step of a formal lobectomy after parenchymal transection.

During *left lobectomy*, ligation of the main left hepatic vein, which frequently joins the middle hepatic vein, is deferred until parenchymal transection is complete because extrahepatic exposure is generally not feasible. Short, direct, hepatic veins between the inferior vena cava and segment 1 (caudate lobe) are ligated initially from the right of the hepatoduodenal ligament until segment 1 is mobilized inferiorly (**Fig. 71–14**). As the veins are ligated and divided, segment 1 can be retracted anteriorly and the remainder of the hepatic veins between the inferior vena cava and caudate lobe can be divided safely. Division of the retrocaval ligament from the

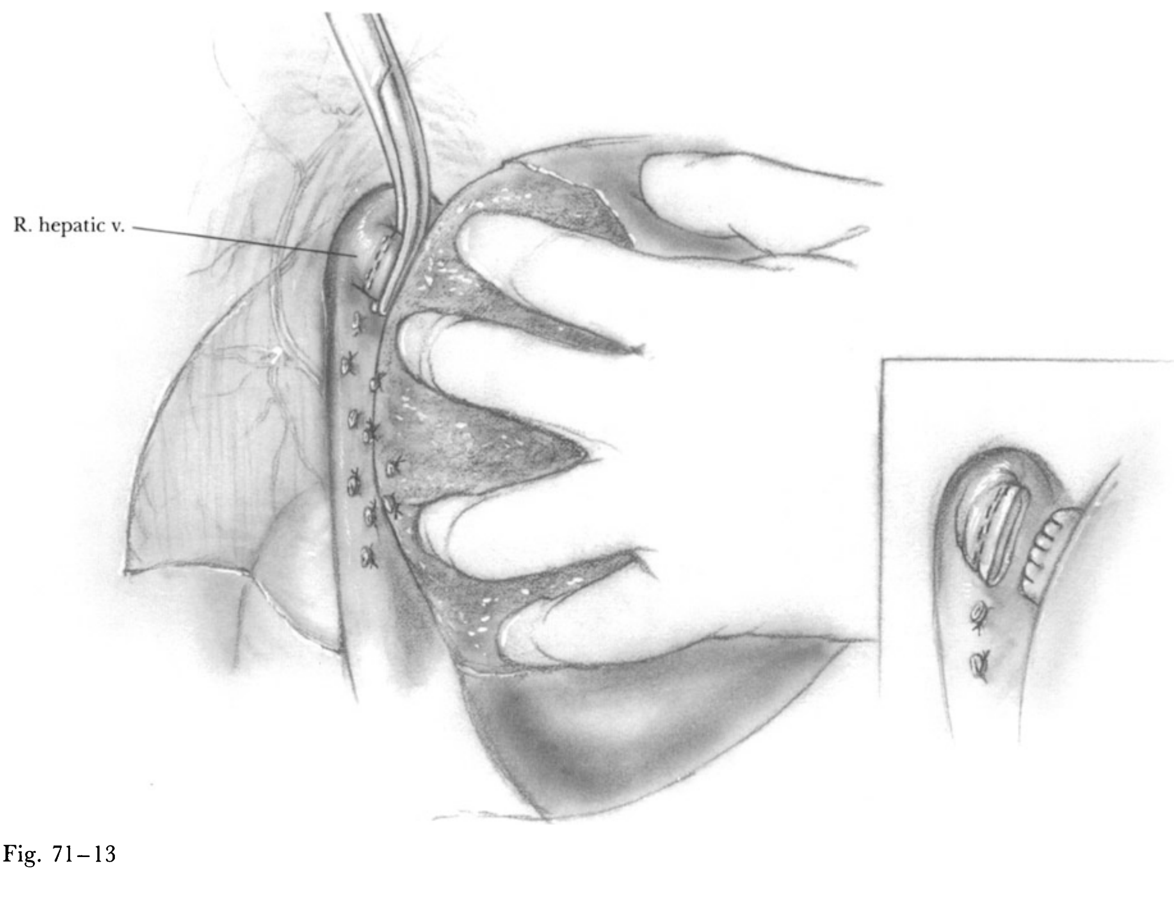


Fig. 71–13

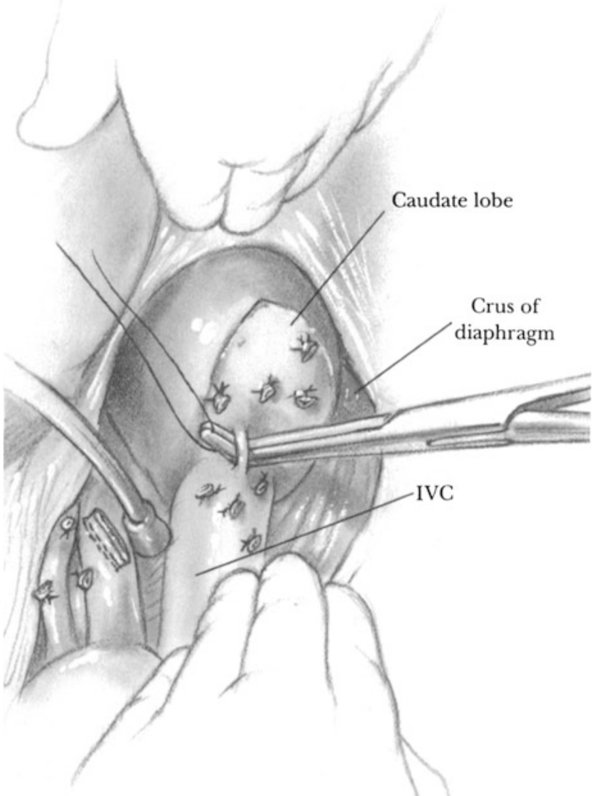


Fig. 71–14

left side of the inferior vena cava allows complete mobilization of segment 1.

The parenchyma is transected on the line of vascular demarcation along the principal plane by finger fracture, cautery, or ultrasound aspirator (**Fig. 71–15**). Bile ducts or vessels that require ligature are clipped on the resection side of the liver and are ligated on the remnant side to reduce artifact image distortion on postoperative follow-up CT scans. The middle hepatic vein is ligated during the parenchymal phase as encountered. As the hilus is approached, the bile ducts to the lobe being resected are exposed. Again, ligation is performed only when patency of the remaining lobar duct can be assured. Smaller ducts to segment 1 should be sought posterior to the main ductal confluence and ligated if encountered. Next, the parenchyma of the caudate process, or that liver substance between the posterior aspect of the portal vein and the inferior vena cava, is transected to expose the anterior surface of the inferior vena cava. Parenchymal transection along the principal plane continues until the main hepatic veins are encountered. If the major hepatic vein has been ligated, the lobe is simply removed (**Fig.**

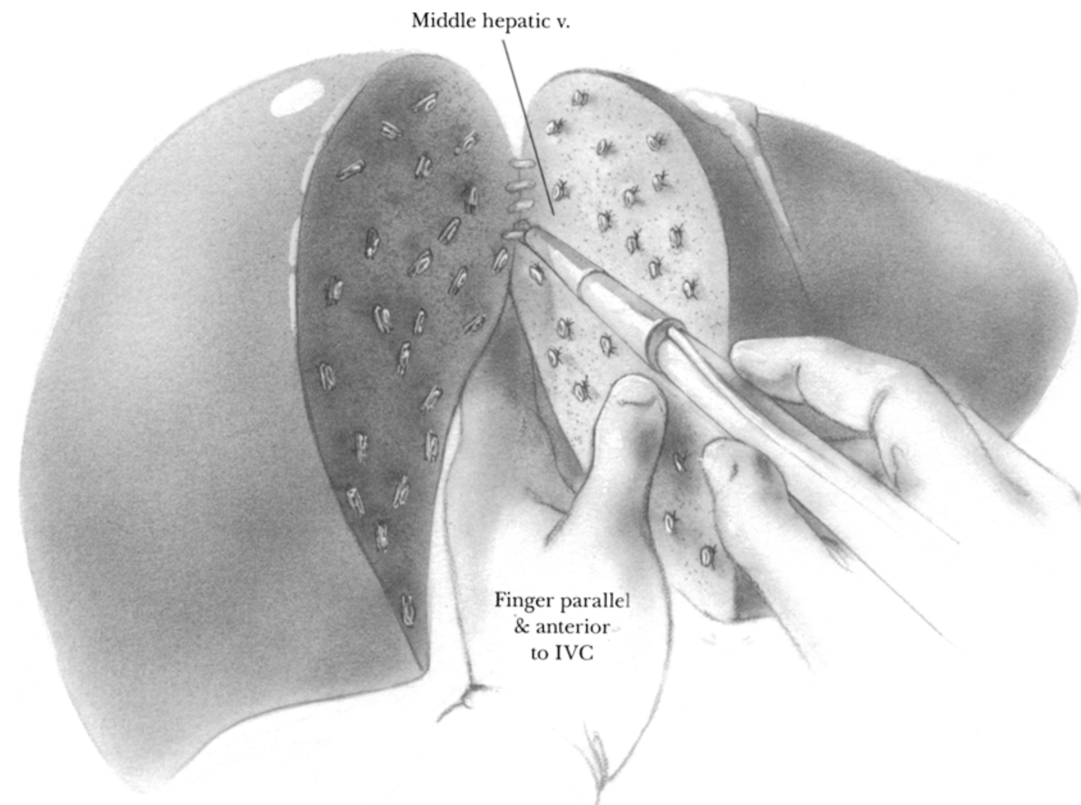


Fig. 71–15

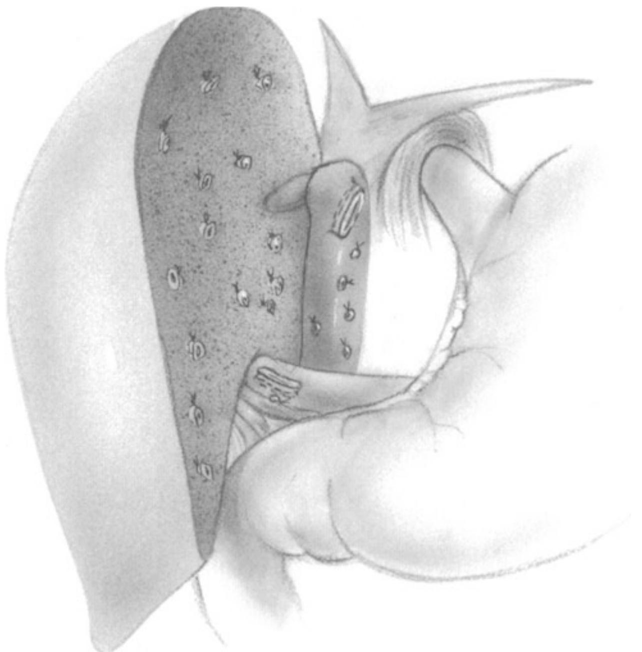


Fig. 71–16A

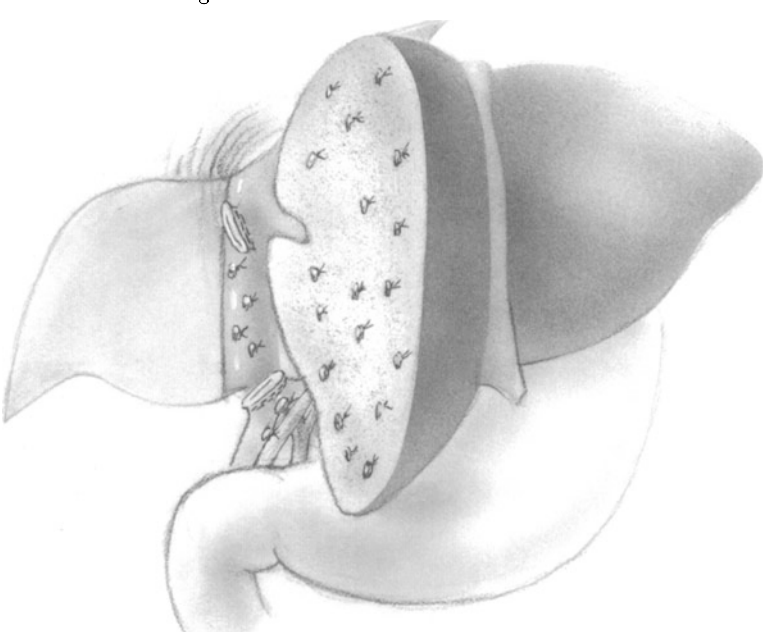


Fig. 71–16B

71–16a). If not, the hepatic veins are clamped or divided with a vascular stapler. *Inflow vascular occlusion is frequently employed during parenchymal transection to reduce intraoperative hemorrhage.* Hemostasis and bile stasis are obtained. Large interlocking parenchymal liver sutures are avoided. **Fig. 71–16b** illustrates the appearance of the hepatic remnant after right hepatic lobectomy. A suction drain is placed adjacent to the transected liver surface and bought out dependently through the abdominal wall. Occasionally the divided falciform is reapproximated to prevent torsion of the liver remnant and postoperative vascular compromise. The omentum is not attached to the parenchyma. The abdomen is closed in a standard fashion.

Postoperative Care

Postoperative care generally involves appropriate fluid administration. The addition of albumin to standard crystalloid solutions will reduce postoperative weight gain and maintain adequate urine output. Most major liver resections are associated with mild acidosis and coagulation abnormalities. Neither acid-base abnormalities nor coagulation deficits are treated postoperatively unless they cause clinically significant symptoms. Nasogastric intubation is continued overnight to prevent risk of aspiration. Epidural analgesia postoperatively markedly improves pulmonary function and pain control and is employed frequently.

Postoperative Complications

The major complications of hepatic resection are hemorrhage, biliary fistula, intra-abdominal infection, and liver failure. All complications are best treated by careful intraoperative prophylaxis. Hemostasis is secured meticulously, as is bile stasis. Hepatic insufficiency is treated as clinically indicated. Hepatic failure may require orthotopic liver transplantation.

References

Adson MA, Beart RW Jr. Elective hepatic resections. Surg Clin North Am 1977;57:339.

Couinaud C. Surgical anatomy of the liver revisited. Paris: C. Couinaud; 1989.

Delva E, Camus Y, Nordlinger B et al. Vascular occlusions for liver resections. Ann Surg 1989;209:211.

McEntee GP, Nagorney DM. Use of vascular staplers in major hepatic resections. Br J Surg 1991;40:78.

Putnam CW. The surgeon at work. Techniques of ultrasonic dissection in resection of the liver. Surg Gynecol Obstet 1983;157:475.

Schroder T, Hasselgren P-O, Brackett K et al. Techniques of liver resection. Comparison of suction, knife, ultrasonic dissector, and contact neodymium-YAG laser. Arch Surg 1987;122:1166.

Starzl TE, Koep LJ, Weil R III et al. Right trisegmentectomy for hepatic neoplasms. Surg Gynecol Obstet 1980;150:208.

Starzl TE, Shaw BW Jr, Waterman PM et al. Left hepatic trisegmentectomy. Surg Gynecol Obstet 1982;21:155.

Tranberg K-G, Rigotti P, Brackett KA et al. Liver resection. A comparison using the Nd-YAG laser, an ultrasonic surgical aspirator, or blunt dissection. Am J Surg 1986;151:368.

Pancreas

72 Concept: Which Operations for Pancreatic Cancer?

Resection versus Bypass

In past decades the mortality rate of pancreatic resection ranged between 20% and 40%. Since the mortality rate far exceeded the incidence of 5-year survival, it could reasonably be argued that the results of bypass procedures were superior to resection. For the period 1952–1973, Aston and Longmire lost 13.8% of 65 patients undergoing a Whipple resection. But those patients undergoing surgery from 1963 to 1973 had a mortality rate of only 5.1%. van Heerden et al. experienced a 4.3% mortality in a series of total pancreatectomies. Barton and Copeland reported a 2.3% mortality for 44 Whipple operations for ampullary carcinoma.

Reports of the mortality after partial pancreatoduodenectomy in the past few years have demonstrated a dramatic decline. Trede, Shwall, and Saeger encountered no hospital deaths in 118 pancreatic resections performed between 1985 and 1990. Crist et al. noted a 24% mortality in patients operated upon from 1969 to 1980, while those undergoing surgery between 1981 and 1986 experienced a 2% mortality rate. Miedema and associates at the Mayo Clinic operated upon 279 patients between 1980 and 1989 with a 4% postoperative death rate.

Patient survival following pancreatoduodenectomy has also shown a distinct improvement in the past decade. Cameron et al. in 1991 reported an actuarial 5-year survival of 19% following resection of carcinoma of the pancreatic head in 89 cases. Trede and associates reported a 24% 5-year actuarial survival among 130 patients following resections for ductal adenocarcinoma of the pancreas.

Since the average mortality rate for a palliative bypass procedure in pancreatic carcinoma is 10%–20% (Brooks, 1983), which far exceeds that of pancreatic resection when the latter is performed by an experienced team, we believe that any patient whose tumor can be encompassed by surgical means should undergo resection. We have noted, together with Child, Hinerman, and Kauffman, with Wilson and Block, and with others, that even in patients who are not cured by resection, pancreatectomy provides a considerably greater degree of palliation, especially of pain, than does a bypass operation.

Contraindications to resection include distant metastases, peritoneal seeding, invasion of the root of the mesentery and metastases to distant lymph nodes (e.g., at the celiac axis). A minor degree of invasion of the portal vein or the middle colic vessels does not contraindicate resection.

Which Bypass Operation?

Because patients with inoperable pancreatic cancer are usually in the poor-risk category and cannot withstand any serious postoperative complication, the bypass procedure must be selected with care. Operations involving anastomoses to the duodenum are contraindicated because a leak is often fatal in these patients. Using the gallbladder to bypass a malignant obstruction may be short-lived because the tumor may grow up the CBD and occlude the cystic duct. Our preference in this category of patients is an anastomosis between the end of a Roux-en-Y segment of jejunum and the side of the dilated hepatic duct.

Because the Roux-en-Y jejunojejunostomy is accomplished by a stapling technique that takes only 1–2 minutes of operating time, the Roux-en-Y technique can be accomplished expeditiously. It has the additional advantage that leakage of bile from this type of anastomosis is not a serious complication if a drain has been inserted at the time of surgery (see Chap. 68).

Because 15%–30% of patients with inoperable carcinoma of the head of the pancreas will experience obstruction of the duodenum before they die of cancer, we routinely perform a gastrojejunostomy to the Roux-en-Y loop in order to prevent this late complication. The gastrojejunostomy, too, is performed by a stapling technique to the greater curvature side of the gastric antrum. The gastrojejunostomy should be located 50–60 cm from the hepaticojejunostomy. Our mortality rate from this procedure has been one death in 64 Roux-en-Y hepaticojejunostomies.

Total versus Partial Pancreatoduodenectomy (Whipple)

There are several reasons why one would feel that total pancreatectomy is a safer operation than is a Whipple. Removing the entire pancreas avoids the possibility of postoperative acute pancreatitis as well as the possibility that the patient will develop a leaking pancreaticojejunal anastomosis. The latter complication is responsible for many of the lethal results following pancreatoduodenectomy. Unfortunately the operative mortality following total pancreatectomy has not been lower than that which follows partial pancreatoduodenectomy.

Also, the diabetes that follows total pancreatectomy tends to be "brittle" and difficult to manage in about 25% of patients. Death from hypoglycemia has been reported as long as 4 years following operation when the patients do not exhibit continued alertness to diabetic control.

In addition to the difficulties that patients experience with diabetes following total pancreatectomy, there is also the problem of dealing with the complete absence of the exocrine secretions of the pancreas. Although there are good substitutes for the pancreatic enzymes available, they require daily lifelong medication and are expensive.

Recent studies have, in fact, failed to demonstrate any better results following total pancreatectomy than the Whipple pancreatoduodenectomy (Warshaw and Castillo; van Heerden and associates). For this reason, most pancreatic surgeons have abandoned the total pancreatectomy except for special cases. The hypothesis that a more extensive operation would result in improved survival is not supported by data. It also appears that patients with a soft pancreatic remnant and a small pancreatic duct do not require a total pancreatectomy in any significant number of cases for the purpose of preventing leakage from the pancreatojejunal anastomosis. Invaginating the pancreatic remnant into the lumen of the jejunum appears to be effective without requiring total pancreatectomy.

Fortner, Kim, Cubilla, and associates have described a very radical total pancreatectomy that includes the resection and reanastomosis of the superior mesenteric artery and vein. As yet, there are inadequate data to support the use of this procedure.

Distal Pancreatectomy

Distal pancreatectomy is indicated and may be curative in cases of localized cystadenocarcinoma and malignant insulinoma. On the other hand, for duct cell carcinoma of the pancreatic tail, distal pancreatectomy has resulted in no known 5-year survivors. However, in some cases resection may produce excellent palliation.

Is Biopsy Necessary?

When a Whipple pancreatoduodenostomy is inadvertently performed for chronic pancreatitis, the mortality rate is low because the thickened pancreas and pancreatic duct take sutures quite well and thus minimize the incidence of postoperative anastomotic leakage. Also, the postoperative disability is minimal because removing the head of the pancreas does not produce diabetes in patients who do not already suffer from this condition. On the other hand, if total pancreatectomy is done in error, the resulting disability may be a brittle form of diabetes. In any case, we believe that prior to pancreatectomy, a serious attempt should be made to confirm the diagnosis of malignancy. Needle aspiration of the tumor during laparotomy should be carried out. Staining of this aspirate for cytological study is a safe means of obtaining a histological diagnosis. When these procedures fail, a scalpel or Travenol needle biopsy may be successful.

In some cases an experienced pancreatic surgeon may make the diagnosis of carcinoma on the basis of marked enlargement of the pancreatic duct accompanied by a thin-walled dilated CBD and gallbladder.

Pancreatectomy as a Palliative Procedure

Although pancreatectomy for cancer is generally performed only when there are prospects for cure, this operation does in fact provide better palliation than any other. In agreement with Child and associates, "we are convinced that death from metastatic disease is more humane than death with a painful cancer in place which infiltrates the aorta and regional nerves." A number of patients following pancreatectomy for cancer have survived from 2–5 years without suffering the unrelenting back pain characteristic of this disease. Death generally ensues from liver metastases. Consequently, a surgical team, whose mortality rate is at or below 5%, should be aggressive in performing pancreatectomy whenever the lesion is technically resectable and if there are no distant metastases.

References

Aston SJ, Longmire WP Jr. Pancreaticoduodenal resection. Arch Surg 1973;106:813.

Barton RM, Copeland EM III. Carcinoma of the ampulla of Vater. Surg Gynecol Obstet 1983;156:297.

Brooks JR. Surgery of the pancreas. Philadelphia: Saunders; 1983.

Cameron JL, Crist DW, Sitzmann JV et al. Factors influencing survival after pancreaticoduodenectomy for pancreatic cancer. Am J Surg 1991;161:120–125.

Child III CG, Hinerman DL, Kauffman GL. Pancreatoduodenectomy. Surg Gynecol Obstet 1978;147:529.

Collins JJ, Craighead JE, Brooks JR. Rationale for total pancreatectomy for carcinoma of the pancreatic head. N Engl J Med 1966;274:599.

Crist DW, Sitzmann JV, Cameron JL. Improved hospital morbidity, mortality, and survival after the Whipple procedure. Ann Surg 1987;206:358–365.

Fortner JG, Kim DK, Cubilla A et al. Regional pancreatectomy: en bloc pancreatic, portal vein and lymph node resection. Ann Surg 1977;186:42.

Miedema BW, Sarr MG, van Heerden JA et al. Complications following pancreaticoduodenectomy: current management. Arch Surg 1992;127:945–950.

Trede M, Schwall G, Saeger H. Survival after pancreatoduodenectomy. Ann Surg 1990;211:447–458.

van Heerden J, ReMine WH, Weiland LH et al. Total pancreatectomy for ductal adenocarcinoma of the pancreas. Am J Surg 1981;142:308–311.

Warshaw AL, Castillo CF. Pancreatic carcinoma. N Engl J Med 1992;326:455–465.

Wilson SM, Block GE. Periampullary carcinoma. Arch Surg 1974;108:539.

73 Partial Pancreatoduodenectomy (Whipple)

Indications

Carcinoma of ampulla

Periampullary and duodenal carcinoma

Carcinoma of the distal common bile duct (CBD)

Islet cell carcinoma of pancreatic head

Duct cell carcinoma of pancreatic head

Chronic pancreatitis with intractable pain

Contraindications

Distant metastases (liver)

Distant lymph node metastases (celiac axis)

More than minimal invasion of portal vein, superior mesenteric vessels, or root of small bowel mesentery

In the absence of a surgical team experienced in pancreatoduodenectomy, when a patient suffering from obstructive jaundice has been found to have operable ampullary or pancreatic cancer, refer the patient elsewhere.

Preoperative Care

Correct hypoprothrombinemia with vitamin K.

Accomplish nutritional rehabilitation, if necessary.

If the patient's serum bilirubin exceeds 20 mg/dl, the operative mortality rate will be increased. In these cases, preoperative decompression of the biliary tract is advocated by some surgeons. One method of accomplishing this is to have an experienced radiologist insert into the dilated hepatic ductal system a percutaneous drainage catheter (Denning, Ellison, and Carey). This catheter is attached to a drainage bag for a period of 3–6 weeks, during which the bilirubin level will recede. Alternatively, a stent can usually be inserted into the CBD and through the obstruction after endoscopic papillotomy. Norlander, Kalin, and Sunblad, after establishing preoperative percutaneous transhepatic drainage in 58 patients with jaundice due to cancer, doubted that this procedure benefited these patients. There is no evidence that preoperative biliary drainage should be performed in patients whose serum bilirubin is markedly elevated.

Perform diagnostic procedures as described below.

Prescribe perioperative antibiotics.

Pass nasogastric tube.

Special Diagnostic Procedures in Obstructive Jaundice

After determining the liver chemistry profile in patients suspected of having obstructive jaundice, order a sonogram or CT scan of the pancreas and bile ducts. Sonography will generally reveal whether the bile ducts are dilated, whether there are calculi in the gallbladder, and whether the head of the pancreas is enlarged.

Patients who present with a clinical picture of cholangitis (chills, fever, jaundice, and pain) and whose sonogram reveals gallbladder calculi together with an enlarged common bile duct are eligible for cholecystectomy and choledocholithotomy without further study. Alternatively, endoscopic papillotomy with extraction of the common bile duct stones followed 2 days later by laparoscopic cholecystectomy will also alleviate this pathology.

If the sonogram reveals dilatation of the intrahepatic ducts with no visualization of the common hepatic duct or common bile duct, the indicated diagnosis is a Klatskin cholangiocarcinoma at the bifurcation of the hepatic ducts. Confirmation should be obtained by a percutaneous transhepatic cholangiogram (PTC) in order to identify the proximal extent of this tumor.

If the sonogram reveals dilatation of the intrahepatic and extrahepatic ducts down to the duodenum, in the absence of biliary calculi, the indicated diagnosis is a periampullary carcinoma or a carcinoma of the head of the pancreas. Obtain a computed tomographic (CT) scan, which will reveal a tumor of the head of the pancreas in about 80% of patients suffering from this condition. Dilatation of the pancreatic duct constitutes additional evidence in favor of this diagnosis. No further diagnostic studies are necessary prior to definitive treatment when the combination of a pancreatic mass and dilated pancreatic ducts is seen on the CT scan.

If the CT scan shows no mass in the head of the pancreas, but the pancreatic duct is dilated, one may suspect a carcinoma of the ampulla. Endoscopy in these patients may be helpful because an endoscopic biopsy may provide histological confirmation of the diagnosis of ampullary carcinoma. Obtaining this information preoperatively can be helpful to the surgeon. The preoperative CT scan may on occasion demonstrate evidence of metastatic disease in the celiac lymph nodes or in the liver. We prefer to explore most patients with periampullary or pancreatic head carcinoma for several reasons. First, the hepaticojejunostomy Roux-en-Y operation eliminates the problem of obstructive jaundice in patients with inoperable pathology, generally for the remainder of their lifespan. Second, our operative mortality for this operation is less than 2%. Third, it provides an opportunity to perform a pancreatoduodenectomy for possible cure of the malignancy in those patients who are resectable. Five-year survival rates for ampullary carcinoma have been reported to approach 40%, and in cases of carcinoma of the pancreatic head, Cameron and also Trede reported survival rates approaching 20%. Also, if the surgeon's mortality rate for pancreatoduodenectomy can be kept below 5%, this provides the best mode available for palliative management of pancreatic carcinoma. Finally, the palliative efficacy of intraoperative insertion of radioactive palladium seeds (brachytherapy) into moderate size inoperable cancers of the pancreas has been impressive to us in early studies. We reserve the insertion of biliary stents by the percutaneous transhepatic route or via endoscopic papillotomy for patients with periampullary and pancreatic carcinoma whose life expectancy is a matter of several months.

Assuming the availability of a surgeon experienced in radical pancreatic surgery, Tompkins, Aizen, Saunders et al. suggest that "if ultrasound shows a dilated ductal system in a jaundiced patient who is a satisfactory operative risk, the patient be taken to surgery where definitive diagnosis and treatment may be carried out."

Preoperative angiography is often performed prior to pancreatectomy, since it is helpful for the surgeon to know in advance if his patient has an anomalous hepatic artery that originates at the superior mesenteric artery. Lacking this information, the surgeon runs an increased risk of damaging the anomalous artery during the pancreatic dissection. Angiography of the celiac axis may reveal that the portal vein or the splenic artery or vein are completely occluded by tumor, in which case it is very likely that the lesion is inoperable. In cases of this type, it may be desirable to biopsy the pancreas under radiographic control with a percutaneous needle. Cytological study of the needle aspirate is often diagnostic of cancer. This may obviate the need for surgery.

Pitfalls and Danger Points

Intraoperative hemorrhage
Trauma to or inadvertent ligation of superior mesenteric artery or vein, an anomalous hepatic artery, or the portal vein
Failure of pancreaticojejunal anastomosis with leakage
Failure of choledochojejunal anastomosis with leakage (rare)
Postoperative hemorrhage
Postoperative sepsis
Postoperative acute pancreatitis
Postoperative marginal ulcer with gastric bleeding

Operative Strategy

Avoiding and Managing Intraoperative Hemorrhage

The greatest risk of major intraoperative hemorrhage occurs when the surgeon is dissecting the portal vein away from the neck of the pancreas. This is especially true when an inexperienced pancreatic surgeon has misjudged the resectability of a carcinoma of the pancreas. In this case, while injudiciously trying to separate the portal vein from an invading carcinoma, he can produce a major laceration at a time when he has not yet achieved adequate exposure of the portal vein. Freeing the portal vein is the most dangerous step in this operation. Temporary control of hemorrhage is generally possible in this situation if the surgeon will compress the portal and superior mesenteric veins against the tumor by passing his left hand behind the head of the pancreas.

Next, an experienced assistant will have to divide the neck of the pancreas anterior and just to the left of the portal vein. In some cases, it will be necessary to isolate and temporarily occlude the splenic, the inferior mesenteric, the superior mesenteric, the coronary, and the portal veins in order to achieve proximal and distal control. If tumor has indeed invaded the portal vein, then a patch or a segment of vein may have to be excised, to be replaced by a saphenous vein patch or, in some cases, a vein graft. An end-to-end anastomosis of the portal to the superior mesenteric vein is possible when the segment to be resected is short. To replace longer segments of resected portal vein, interpose a saphenous vein graft. Ligating the portal vein is often fatal unless the superior mesenteric vein is preserved and is free to drain *into the intact splenic, and then into the short gastric veins*. We know of no 5-year survivals in patients whose tumor has invaded the portal vein.

Avoiding Postoperative Hemorrhage

Braasch and Gray (1977) in a review of 279 Whipple operations noted that postoperative hemorrhage, either from the operative site or the gastrointestinal tract, occurred in 11% of their patients. Among patients who developed postoperative hemorrhage, 58% died. This complication must be regarded as preventable. Postoperative hemorrhage stems from one of the four following causes: (1) stress ulcer; (2) gastrointestinal marginal ulcer; (3) digestion of the retroperitoneal blood vessels by combined leakage of both bile and pancreatic juice; or (4) inadequate ligature of the innumerable blood vessels divided during surgery.

With respect to stress bleeding, it is important to treat the postoperative pancreatectomy patient with an H_2 blocker, so that the intragastric pH will not go below the level of 5.0. Frequent determinations of the gastric pH by aspirating the nasogastric tube will determine the dosage of therapy required in each case. This is identical with the routine followed in an Intensive Care Unit for surgical patients who are at risk of developing stress bleeding. This therapy is very effective in preventing bleeding from stress ulcers.

To prevent a postoperative marginal ulcer, which follows the Whipple operation in 6% of cases (Grant and Van Heerden), either perform a vagotomy plus antrectomy or remove at least 65%–75% of the stomach. Of these two methods, Scott, Dean, Parker et al. demonstrated the superiority of vagotomy in these cases. Preservation of the pylorus may itself reduce the incidence of postoperative ulcers.

Hemorrhage secondary to the digestion of retroperitoneal tissues by activated pancreatic juice is best prevented by observing the operative strategy (outlined below) aimed at preventing leakage from the pancreatic anastomosis.

Hemorrhage that results from a ligature slipping off the gastroduodenal or right gastric artery is a result of careless operative technique. During pancreatectomy, carefully *skeletonize* each of these two arteries prior to ligating them. Nonabsorbable ligature material should be used and an *adequate stump of vessel must be left distal to the ligature* to prevent slipping. The same principles apply to the branches of the portal and superior mesenteric veins.

Avoiding Leakage from the Pancreaticojejunal Anastomosis

Failure of the pancreaticojejunal anastomosis has in our experience been the most common serious technical complication of pancreatoduodenectomy. As noted by Braasch and Gray (1977), failure of the anastomosis is more common (25%) in patients who have carcinoma of the distal portion of the CBD or of the duodenum because many of these patients do not develop obstruction of the pancreatic duct, which is frequently accompanied by some degree of pancreatitis. Both obstruction and pancreatitis produce thickening of the pancreatic duct and the pancreatic parenchyma. In the absence of this thickening, sewing a small thin-walled duct to the jejunum produces a high failure rate. Some authors (Child, Hinerman, and Kauffman) feel that invagination of the pancreatic stump into the end of jejunum is superior to the mucosa-to-mucosa anastomosis. When a small duct and a soft pancreatic parenchyma are encountered, some surgeons consider that total pancreatectomy might be the safest alterantive, even though it will produce postoperative diabetes. This option is rarely needed. If the patient has a soft pancreas and a pancreatic duct that is not markedly enlarged, do not try to construct a duct-to-mucosa anastomosis. Rather, invaginate the pancreatic remnant into the lumen of the jejunum for a depth of at least 2 cm with two layers of sutures, as described later in this chapter. This will minimize the number of leaks from the pancreaticojejunal anastomosis, according to Rossi and Braasch. When the remaining pancreas is thickened with fibrosis and the duct has been markedly enlarged by the chronic obstruction, careful construction of an anastomosis between the pancreatic duct and the jejunal mucosa has a high likelihood of success. Rossi and Braasch insert a small catheter into the pancreatic duct in most patients and then lead the catheter through a puncture wound in the wall of the jejunum, and then out through the abdominal wall in order to drain the pancreatic secretions away from the healing anastomosis into a drainage bag. When we use this type of drainage, we leave the catheter in at least 2 weeks.

If a leak of pancreatic juice does occur, it is important to have in place an adequate number of drains in the area of the anastomosis. Leakage of pure pancreatic juice, which has not been activated, will not damage the surrounding tissues, and the pancreatocutaneous fistula will generally close spontaneously without damaging the patient. On the other hand, if leakage from the pancreaticojejunostomy is accompanied by simultaneous seepage of bile into the same region, the pancreatic tryptic ferments become activated and begin to digest the surrounding retroperitoneal tissues. This produces sepsis and hemorrhage, complications that constitute the chief causes of death following pancreatoduodenectomy. Consequently, every attempt should be made to divert the flow of bile from the area of the pancreaticojejunostomy. This may help prevent the bile from refluxing up into the pancreaticojejunal anastomosis.

Treating a Pancreatic Fistula by Removing the Pancreatic Stump

When a patient suffers a pancreatocutaneous fistula that leaks clear pancreatic juice, only expectant therapy is necessary. If after a few days the clear, watery secretion turns green, indicating the admixture of bile with the pancreatic juice, the situation is much more serious. A major leak of bile and pancreatic juice carries with it a high mortality rate. If the patient's condition begins to deteriorate despite adequate drainage, serious consideration should be given to exploring the patient and removing the remnant of pancreas together with the spleen. Although Braasch and Gray (1977) state that such a procedure is extremely hazardous, we performed this procedure successfully on one occasion without much difficulty. Under certain conditions converting the Whipple operation into a total pancreatectomy can constitute a lifesaving operation. Trede and Schwall reported success with this reoperation.

Avoiding Postoperative Marginal Ulcer

As mentioned above, preventing a marginal ulcer following pancreatectomy requires the excision of 65%–75% of the stomach or the combination of vagotomy with antrectomy in order to reduce the gastric acid output. We prefer vagotomy and antrectomy, as do Scott and associates. Alternatively, preserving the antrum and the pylorus as described by Traverso and Longmire does not cause a significant number of postoperative ulcers.

Avoiding Trauma to an Anomalous Hepatic Artery Arising from the Superior Mesenteric Artery

Braasch and Gray (1976) point out that in 20% of 200 cadaveric dissections performed by Michels, the superior mesenteric artery gave rise either to the common hepatic artery or to the right hepatic artery. In most cases, these anomalous hepatic arteries follow a course from the superior mesenteric artery posterior to the pancreas into the hepatoduodenal ligament. Proper anatomical dissection of the superior mesenteric vessels away from the superior uncinate process *with alert palpation of the posterior pancreas* by the surgeon will avoid traumatizing the anomalous hepatic artery. In 1% of the cases in the anatomical study, the common hepatic artery arose from the superior mesenteric and passed *through* the head of the pancreas on its way to the liver. In the 1% of patients in whom this anatomical condition exists, Braasch and Gray (1976) consider pancreatectomy contraindicated. Preoperative angiography to delineate the hepatic arterial supply will help the surgeon avoid injuring these anomalous vessels.

Operative Technique

Incision

Make a midline incision from the xiphoid to a point 10 cm below the umbilicus.

Evaluation of Pathology

If tissue has not been obtained preoperatively by gastroduodenoscopy for the positive histological diagnosis of cancer, then an attempt may be made to biopsy the tumor at operation prior to proceeding with pancreatectomy. Divide the omentum between hemostats to expose the anterior surface of the pancreatic head (**Fig. 73–1**). If a stony-hard area of tumor is visible on either the anterior or the posterior surface of the pancreas, shave the surface of the tumor with a scalpel or remove a wedge of tissue. If the tumor appears to be deep, insert into the tumor a No. 22 needle on a 10-ml syringe containing 4–5 ml

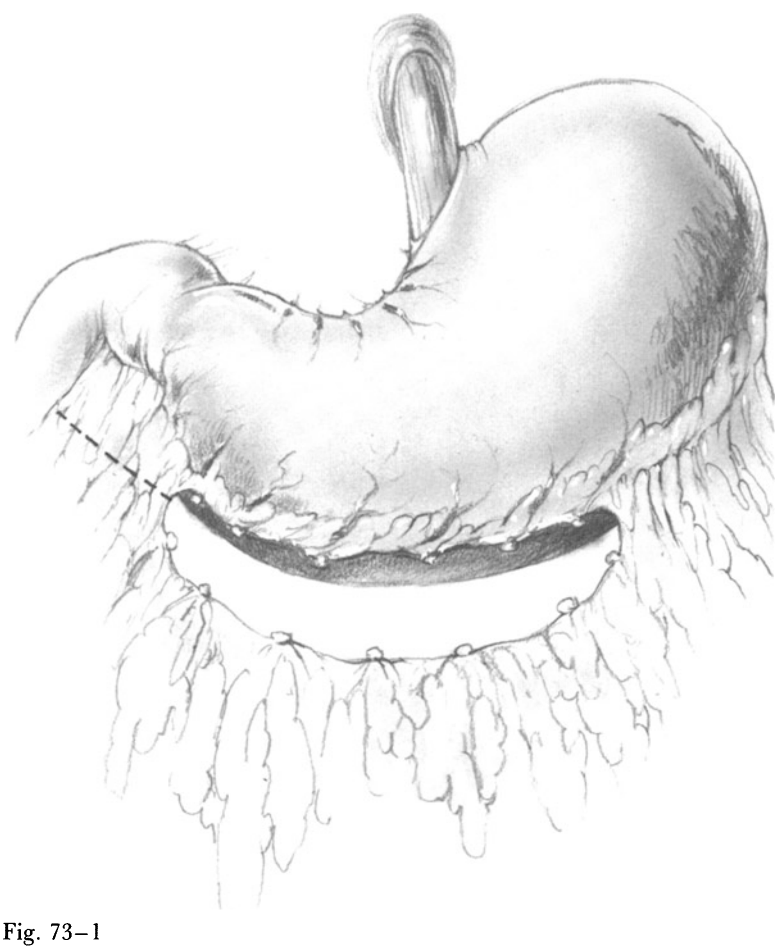


Fig. 73–1

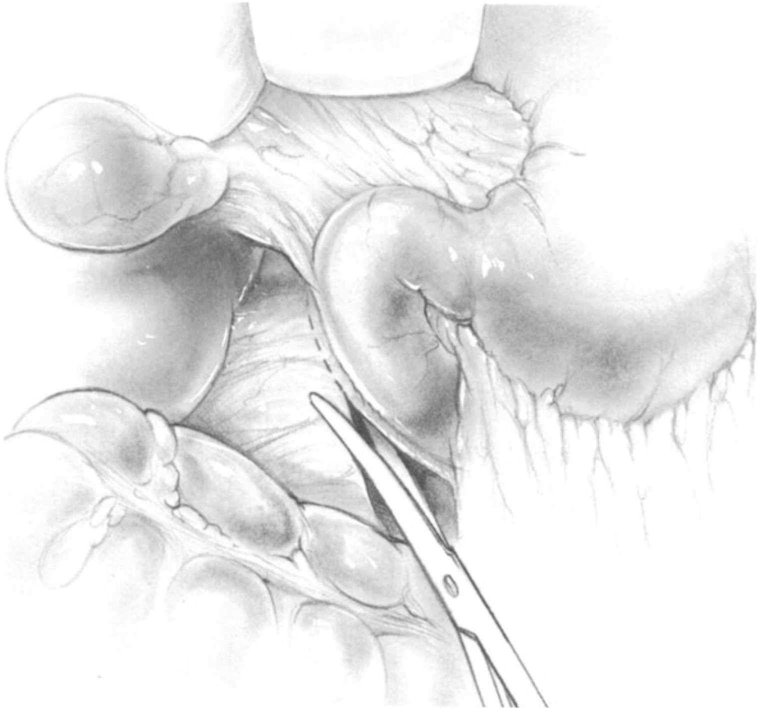


Fig. 73–2

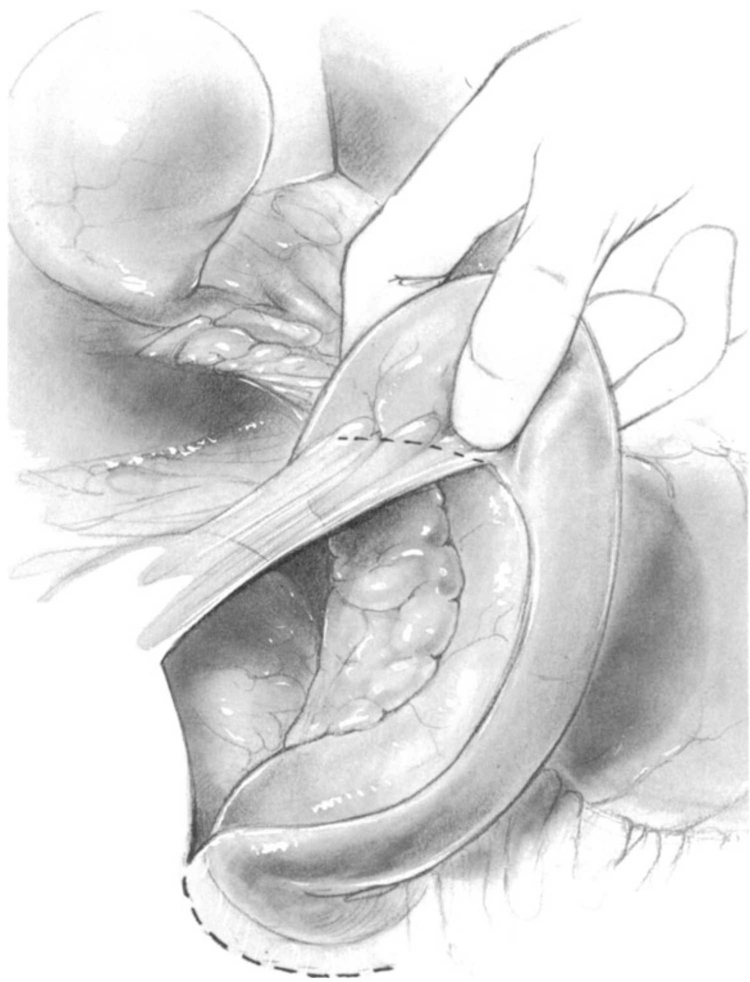


Fig. 73–3

of air; aspirate; expel the sample on a sterile slide; spray the slide *promptly* with a fixation solution and submit the slide for immediate cytological study. In most cases we have found cytological examination of smears prepared after thin needle aspiration to be both safe and accurate. Earnhardt reported a 90% sensitivity on a 0% false positive experience with fine needle cytology used intraoperatively to diagnose pancreatic cancer. If this is not confirmatory for cancer, perform the biopsy with a Travenol Tru-cut needle. If possible, pass a Travenol needle through both walls of the duodenum on its way to the pancreas. This technique helps avoid a postoperative pancreatic fistula. When lesions of the distal common duct are suspected, obtain a tissue sample by passing a small curette through a cholodochotomy incision and scrape the region of the suspected malignancy. Choledochoscopy is an excellent means of obtaining a biopsy of common duct tumors. If a tumor is palpable in the region of the ampulla, make a longitudinal or oblique duodenotomy incision over the mass and excise a sample under direct vision. Close the duodenotomy. Discard all instruments that have come into contact with the tumor during the biopsy and redrape the field.

If preoperative X-ray visualization of the CBD has not been accomplished by transhepatic cholangiography or ERCP, a cholangiogram or choledochoscopy may be indicated to rule out an impacted common duct stone as the cause of the patient's jaundice.

Next, evaluate the lesion for operability. Check for metastatic involvement of the liver, of the root of the small bowel mesentery, and of the lymph nodes at the celiac axis. Metastasis to a lymph node along the gastrohepatic or the gastroduodenal artery adjacent to the malignancy does not contraindicate resection.

Invasion of the superior mesenteric or the portal vein is the most common contraindication to resection. Although it is possible to resect a small segment of these veins, and to replace it with a vein patch or a vein graft, the finding that the tumor invades these structures is a contraindication to pancreatectomy.

Determination of Resectability; Dissection of Portal and Superior Mesenteric Veins

Perform an extensive Kocher maneuver by incising the peritoneal attachment (**Fig. 73–2**) along the lateral portion of the descending duodenum. It is not always necessary to liberate the hepatic flexure of the colon to accomplish this maneuver. Insert the left index finger behind a lateral duodenal ligament which attaches the descending duodenum to the fascia of Gerota. Divide this ligament over the index finger and continue this line of dissection toward the third portion of the duodenum as far as the point where the superior mesenteric vein crosses the transverse duodenum (**Fig. 73–3**). Excessive upward traction on the duodenum and pancreas may tear the superior mesenteric vein; so caution is indicated. Continue liberating the duodenum superiorly as far as the foramen of Winslow.

If the head of the pancreas is replaced by a relatively bulky tumor, it would be difficult to expose the superior mesenteric vein. In such cases, after dividing the omentum to expose the anterior surface of the pancreas, identify the middle colic vein and trace it to its junction with the superior mesenteric vein (**Fig. 73–4**). Although this junction may be hidden from view by the neck of the pancreas, one can generally identify the superior mesenteric vein without difficulty by following the middle colic vein. Gentle dissection is important in this area as there are often large fragile branches joining both the middle colic and the superior mesenteric veins with the inferior pancreaticoduodenal vein. If these branches are torn, control of bleeding behind the neck of the pancreas will be difficult.

In the course of this dissection, one can decide whether there is gross invasion of the vena cava or of the superior mesenteric vein, either of which contraindicates resection.

Identify the hepatic artery medial to the lesser curvature of the stomach after incising the filmy avascular portion of the gastrohepatic omentum. Incise the peritoneum overlying the common hepatic artery and sweep the lymph nodes toward the specimen. Continuing this dissection toward the patient's right will reveal the origin of the gastroduodenal artery. Dissect this artery free using a Mixter clamp

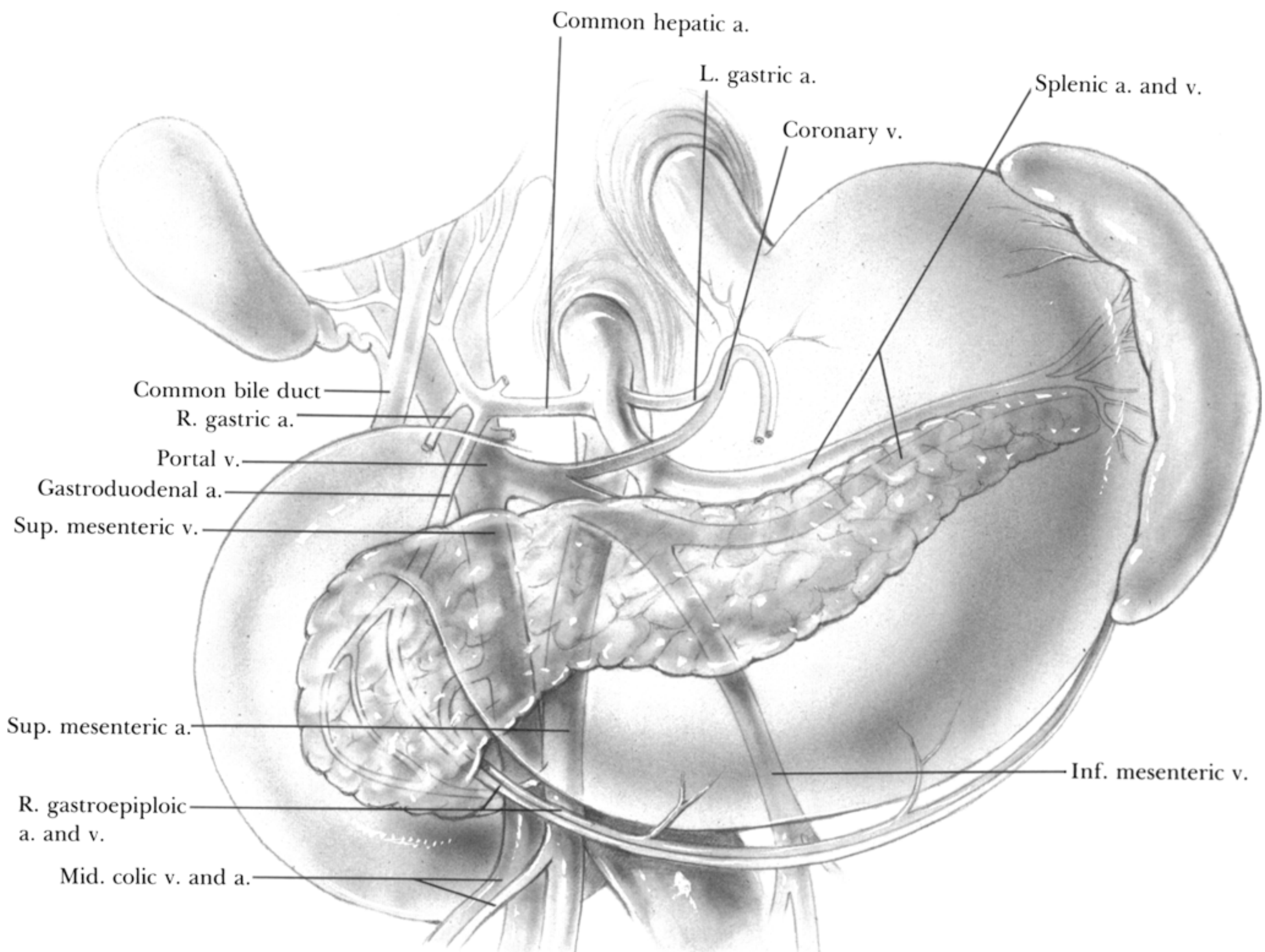


Fig. 73–4

Fig. 73–5

(**Fig. 73–5**) and divide the vessel between two ligatures of 2–0 silk, leaving about 1 cm beyond the proximal tie to prevent the possibility of the ligature slipping off. Continue the dissection just deep and slightly medial to the divided gastroduodenal artery and identify the anterior aspect of the portal vein (**Fig. 73–6**). In the presence of carcinoma near the head of the pancreas there are often numerous small veins superficial to the portal vein. *Do not use Hemoclips in this area* because they will inadvertently be wiped away during the subsequent dissection and manipulation. Each vessel should be divided and ligated with 3–0 or 4–0 ligatures.

After identifying the shiny surface of the portal vein, gently free this vein from the overlying pancreas, using a peanut sponge dissector. If there is no invasion of the portal vein by tumor, there will be no attachment between the anterior wall of the portal vein and the overlying pancreas; thus a finger can be passed between this vein and the neck of the pancreas (**Fig. 73–7**). Occasionally, this is easier to accomplish by inserting the finger from below the pancreas, between the superior mesenteric vein and the overlying gland. With one finger inserted between the neck of the pancreas and the superior mesenteric vein, pass the other hand behind the head of the pancreas and try to determine if the tumor has invaded the uncinate process, the posterior side of

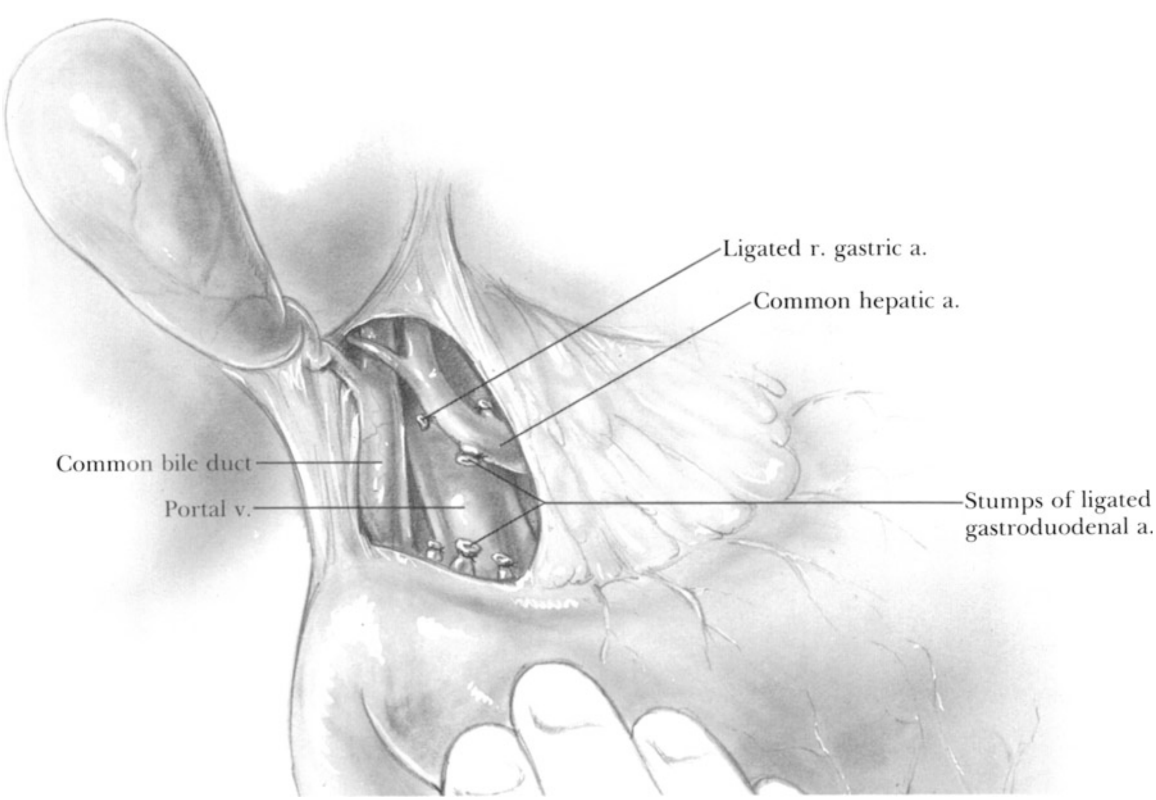


Fig. 73–6

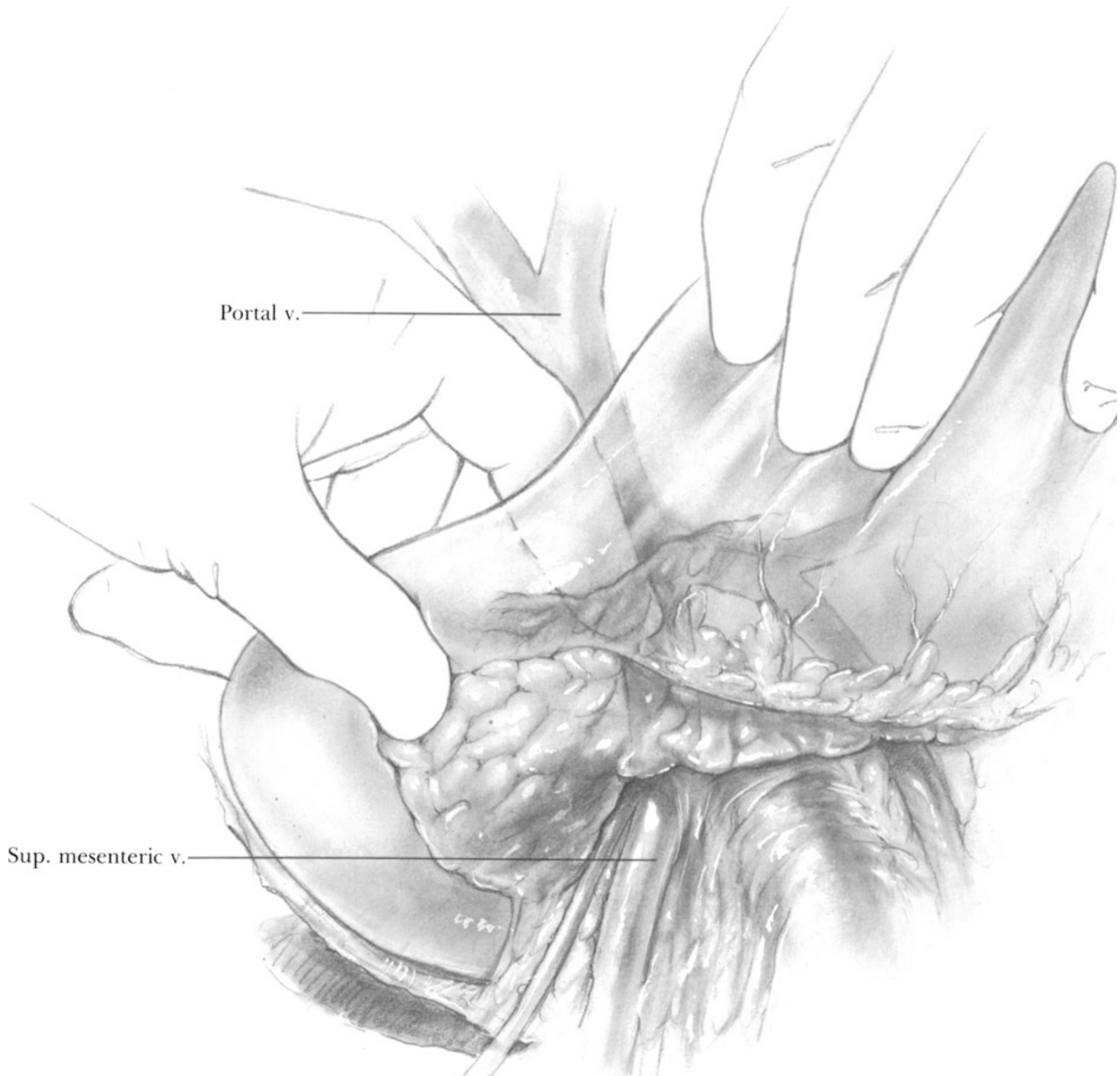


Fig. 73–7

the portal vein, or the superior mesenteric vessels. If all of the above conditions have been fulfilled, the tumor is probably resectable, and one may proceed now with the pancreatectomy. Execute this dissection carefully since it is the most hazardous in the entire procedure. If the tumor has invaded the portal vein and the finger dissection produces a laceration of the vein, control of the hemorrhage will be extremely difficult. (See discussion above, in the section on Operative Strategy.)

Continue the dissection of the hepatic artery by dividing and ligating the right gastric artery. Incise the peritoneum over the common hepatic artery as far as the porta hepatis. Unroof and expose the CBD and sweep the lymphatic tissue from the porta hepatis down to the specimen, thereby skeletonizing the hepatic artery and CBD.

Cholecystectomy

(See Chap. 60.)

Identify the junction between the cystic and common bile ducts in preparation for a cholecystectomy. Identify, ligate, and divide the cystic artery. Then dissect the gallbladder from its attachment to the liver from above down. When the gallbladder is free and is attached only by the cystic duct, apply a 3–0 suture-ligature to the cystic duct and remove the gallbladder.

Encircle the common hepatic duct just proximal to the point where it is joined by the cystic duct. Apply an occluding temporary ligature or clamp to the hepatic duct and divide it distal to the ligature or clamp, sweeeping lymphatic tissue toward the specimen.

Vagotomy and Gastrectomy

(See Chaps. 19 and 24.)

With the lower portion of the sternum retracted upward and in a cephalad direction by means of either a Thompson or an Upper Hand retractor, expose the anterior surface of the abdominal esophagus. Using a Harrington or Weinberg retractor to elevate the left lobe of the liver, incise the peritoneum overlying the abdominal esophagus. With a peanut sponge dissector separate the esophagus from the crura of the diaphragm. When this has been accomplished, encircle the abdominal esophagus with the index finger. Resect the anterior and posterior vagal trunks plus any other vagal branches that can be identified.

Palpate the left gastric artery along the lesser curvature of the stomach. Identify a point about halfway between the esophagus and pylorus. Insert a large hemostat between the vascular pedicle and the lesser curvature of the stomach. Doubly ligate the left gastric pedicle by using 2–0 silk ligatures and divide these vessels, freeing the lesser curvature of the stomach. Now identify the gastroepiploic arcade on the greater curvature at a point approximately opposite the point of division of the left gastric vessels. Ligate and divide this arcade vessel. This will accomplish approximately a 50% gastrectomy. Divide the omentum outside the arcade toward the head of the pancreas.

Now apply the TA-90 stapling device across the body of the stomach and fire the staples (see Fig. 24–45). Use the 4.8-mm staples. Reapply the TA-90 device about 1 cm cephalad to this line of staples and fire again (see Fig. 24–46). Then transect the stomach flush with the stapling device and remove the TA-90. Observe the staple line for bleeding points. These can generally be controlled by electrocoagulation. Apply a sterile rubber glove over the antrum of the stomach in order to avoid contamination from the everted gastric mucosa. Fix the glove in place with an umbilical-tape ligature.

Division of Pancreas

In patients with periampullary or distal CBD tumors there may be no obstruction of the pancreatic duct. Place the line of division of the pancreas 3 cm to the left of the superior mesenteric vessels. This will leave a remnant of pancreatic tail, which is suitable for implanting into the open end of the jejunum when the pancreatic duct is too small for a good anastomosis. If this method is elected, carefully free the neck and the body of the pancreas from the underlying splenic vein by working from above and from below. A few small branches from the pancreas to the splenic vein may require division.

After the neck and body of the pancreas have been elevated, apply a TA-55 stapler across the pancreas (**Fig. 73–8a**). Use 3.5-mm staples in most cases. Fire the stapling device and divide the pancreas *to the left* of the stapling device (**Fig. 73–8b**). Identify the pancreatic duct and insert a plastic catheter into the duct to prevent its being occluded by sutures (**Fig. 73–9**).

In patients who have an ampullary carcinoma that obstructs the pancreatic duct, the thickened and dilated duct, together with the secondary pancreatitis produced by this obstruction, makes both the duct and the pancreas suitable for accurate suturing. The same technique of division is used. Generally, a suture-ligature will be necessary for a superior and for an inferior pancreatic artery in the pancreatic stump.

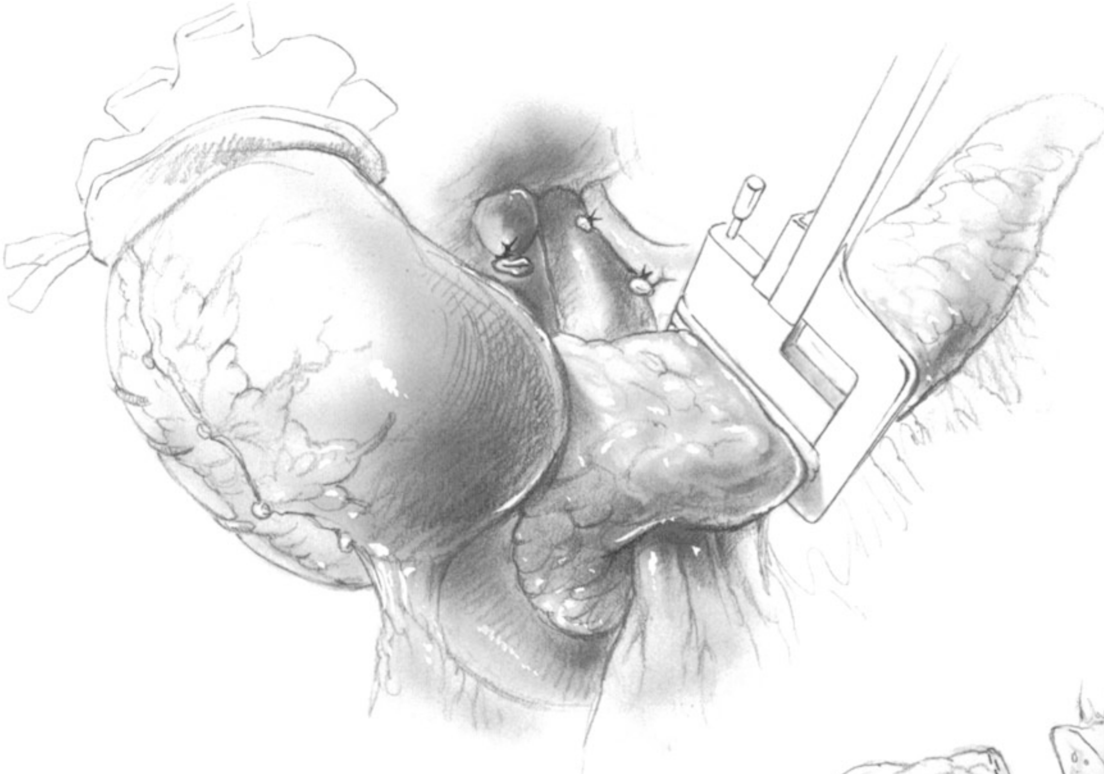


Fig. 73–8a

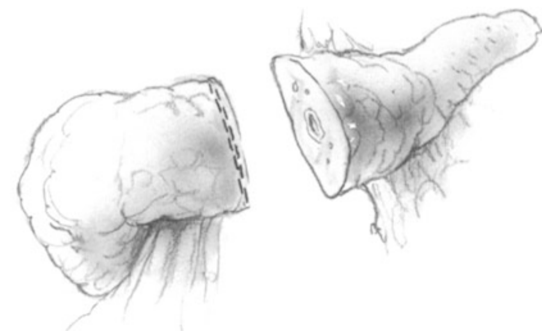


Fig. 73–8b

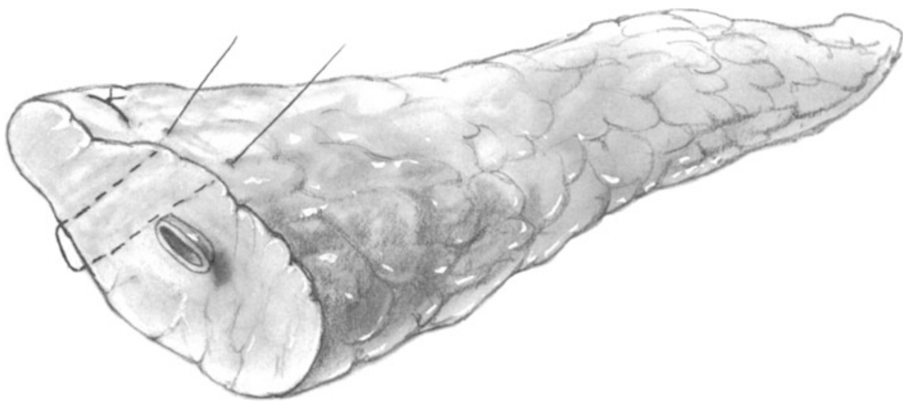


Fig. 73–9

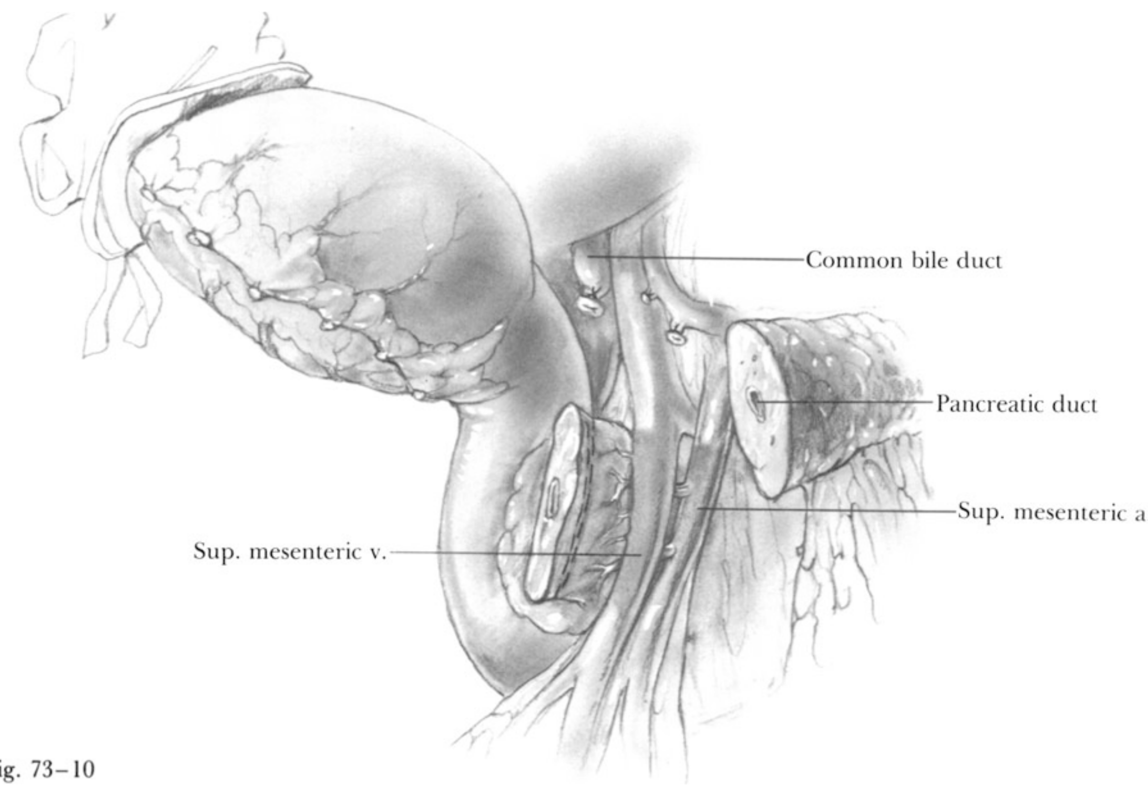


Fig. 73–10

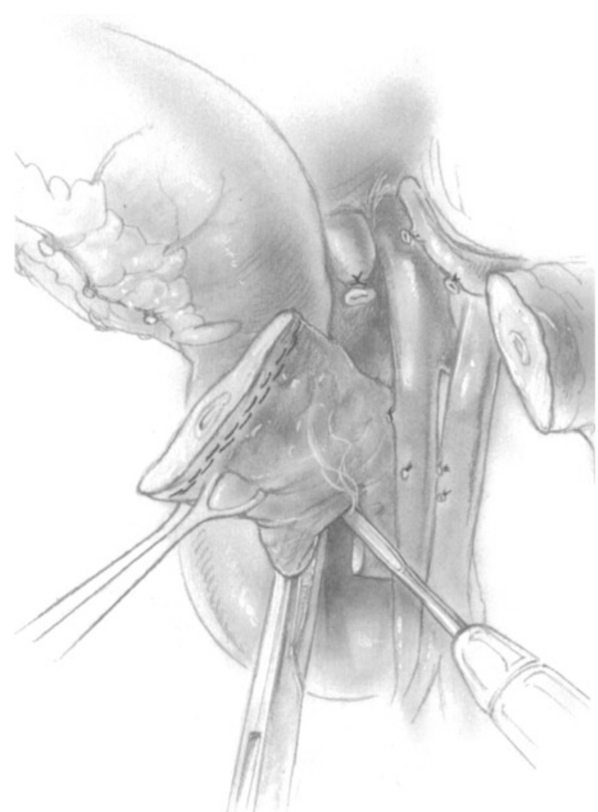


Fig. 73–11

Dissection of Uncinate Process

Now retract the cut, stapled end of pancreas as well as the divided stomach towards the patient's right. This will expose the anterior surface of the superior mesenteric and portal veins (**Fig. 73–10**). Two or three arterial branches of the superior mesenteric artery pass deep to the superior mesenteric vein and into the head of the pancreas. These are generally easy to identify. Divide and ligate each of them with 3–0 silk. Several branches from the pancreas drain into the superior mesenteric vein from the patient's right. These are also divided and ligated. Thereupon the superior mesenteric vein may be gently retracted to the patient's left, revealing the superior mesenteric artery. The uncinate process may terminate at this point in some fibroareolar tissue, in which case this may be divided under direct vision. More often, a tongue of uncinate process is attached to the posterior surface of the superior mesenteric artery. First pass the left hand behind the uncinate process *to check again that there is no major anomalous hepatic artery* coming from the superior mesenteric. Use the electrocoagulator to divide the uncinate process (**Figs. 73–11 and 73–12**). Another convenient method is to apply a TA-55 stapler across the uncinate process prior to dividing it; this will achieve hemostasis if 3.5-mm staples are used. Be certain to avoid injuring the

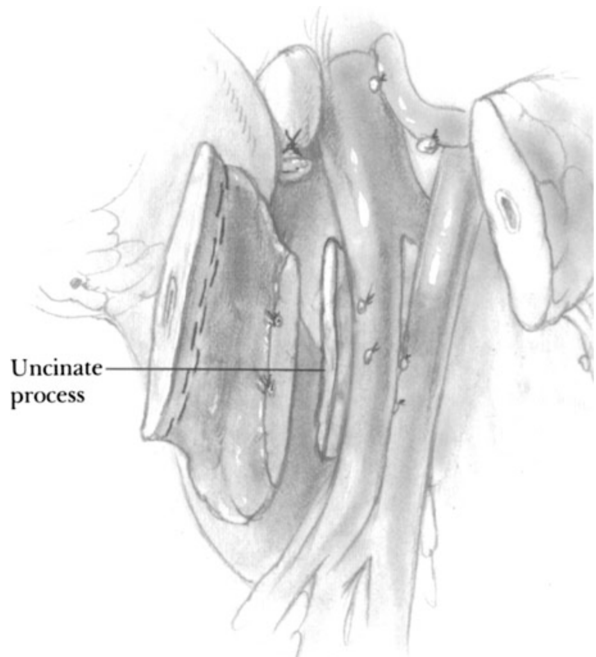


Fig. 73–12

superior mesenteric vein and artery. At the end of this dissection the gastric antrum, the duodenum, and the head of the pancreas will be attached only at the duodenojejunal junction (**Fig. 73–13**).

It is possible to save 10–12 minutes of operating time by applying a GIA stapler across the fourth portion of duodenum and by dividing the duodenum, thereby releasing the specimen from all of its attachments. This will leave both the proximal and distal segments of divided duodenum closed by means of staples. This method avoids the necessity of dividing the proximal jejunal mesentery and of freeing the duodenojejunal junction from the ligament of Treitz. The stomach, hepatic duct, and pancreas can each then be anastomosed end-to-side to the jejunum. Most surgeons do free the duodenojejunal junction from the ligament of Treitz, divide the mesentery in this region, and divide the jejunum a few centimeters beyond the ligament of Treitz. This procedure is described in the next paragraph.

Dissection and Division of Proximal Jejunum

Expose the ligament of Treitz under the transverse mesocolon and divide it so that the duodenojejunal junction is completely free. Pass the proximal 6–8 cm of jejunum behind the superior mesenteric artery and vein into the supramesocolic space. Then serially clamp, divide, and ligate each of the mesenteric branches from the superior mesenteric vessel to the proximal 6–8 cm of the jejunum. This will release the

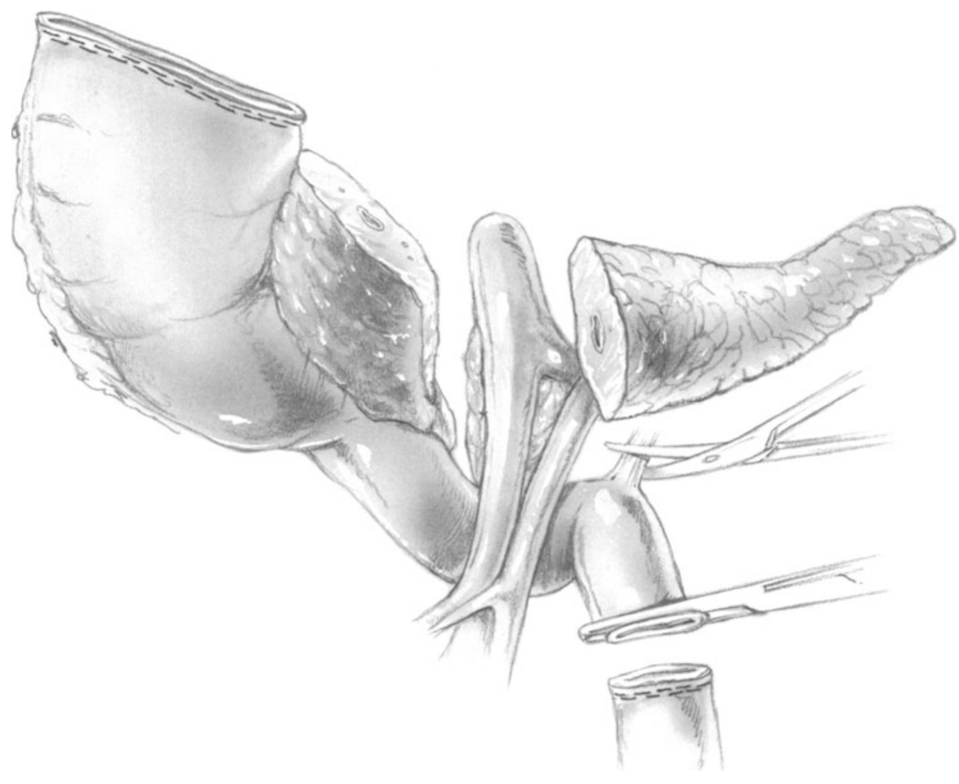


Fig. 73–13

proximal jejunum. Unless it is planned to implant the pancreatic tail into the open end of jejunum, apply a TA-55 stapling device across the proximal jejunum and fire the staples (3.5 mm). Then, using a scalpel, divide the jejunum flush with the stapler. Lightly electrocoagulate the everted mucosa and remove the stapling device. It is not necessary to invert this staple line with a row of sutures. Remove the specimen.

Pancreaticojejunal Duct-to-Mucosa Anastomosis

Pass 12–15 cm of proximal jejunum through the aperture in the transverse mesocolon. Construct an end-to-side pancreaticojejunostomy along the antimesenteric aspect of the jejunum, beginning at a point about 3 cm from the staple line. Use interrupted 4–0 Prolene to suture the posterior capsule of the pancreas to the seromuscular layer of jejunum (**Fig. 73–14**). Then make a small incision slightly larger than the diameter of the pancreatic duct (**Fig. 73–15**). Approximate the pancreatic duct to the full thickness of the jejunal wall using interrupted 6–0 Prolene sutures (**Fig. 73–16**). Wearing telescopic lenses with a 2½ × magnification is helpful in assuring an accurate anastomosis. After the posterior half of this anastomosis has been completed, insert an 8–10F catheter into the pancreatic duct. Cut several side holes near the tip of the catheter. Thread the long end of the catheter into the jejunum. Make no holes in the catheter on the jejunal side of the anastomosis. The catheter will be brought out from the jejunum about 10 cm beyond this anastomosis and passed through a stab wound in the abdominal wall for drainage to the outside. Insert a 4–0 silk purse-string suture around the hole in the jejunum through which the catheter exits. Then complete the duct-to-jejunum anastomosis with 6–0 Prolene sutures (**Fig. 73–17**). Carefully buttress the remainder of the pancreas into the anterior wall of jejunum with additional 4–0 sutures (**Fig. 73–18**). It is important to suture the catheter to the pancreas by means of a single 5–0 PG stitch; otherwise it is easily dislodged during subsequent steps of the operation. Also suture the jejunostomy site to the stab wound of the abdominal wall if possible.

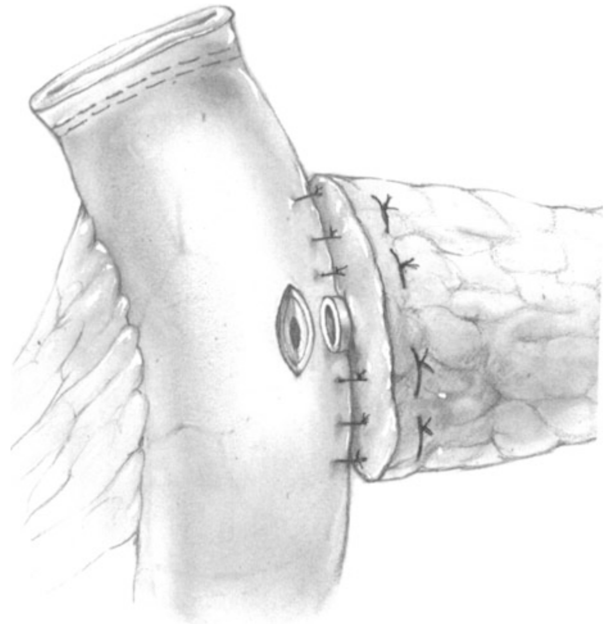


Fig. 73–15

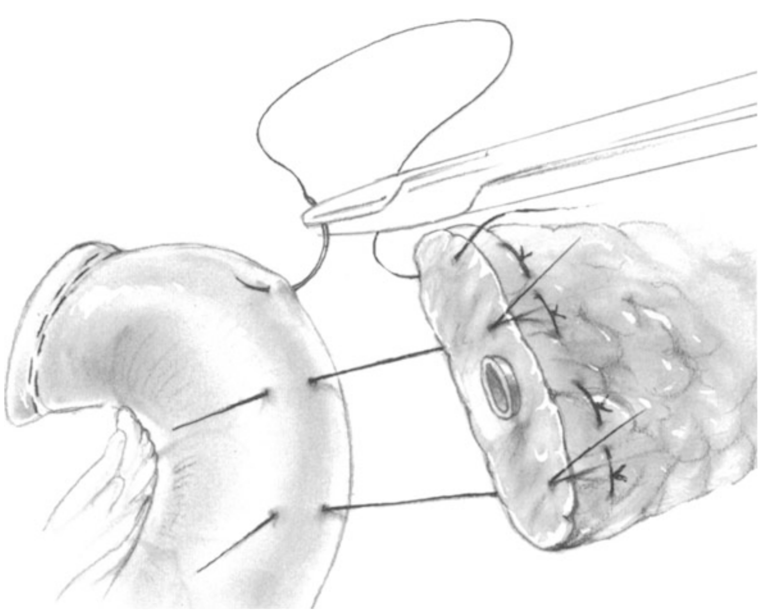


Fig. 73–14

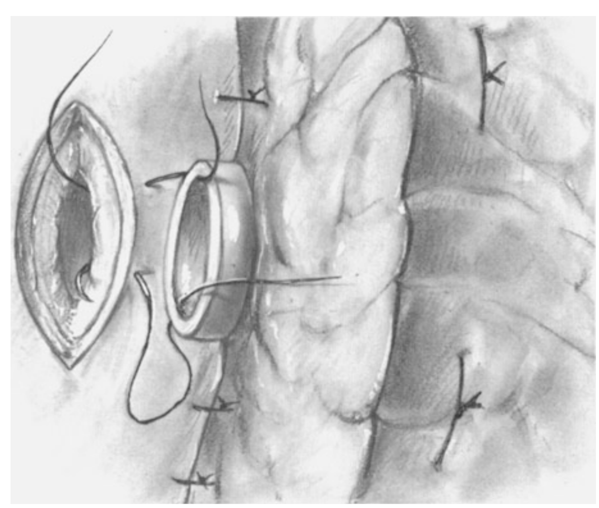


Fig. 73–16

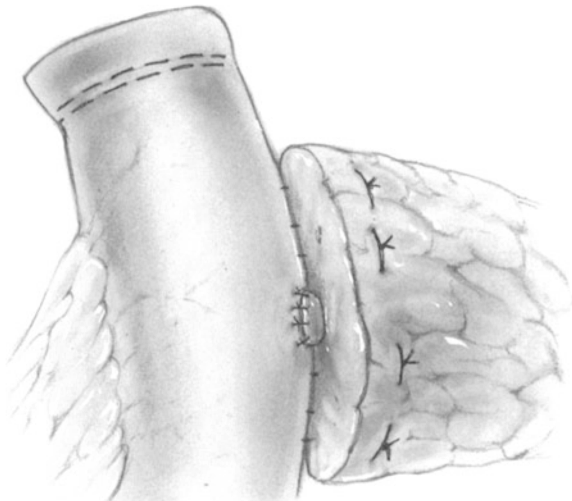


Fig. 73–17

Pancreaticojejunal Anastomosis by Invagination

An alternative method of anastomosing pancreas to jejunum is to pass 2–3 cm of the pancreatic stump into the lumen. First insert a catheter into the pancreatic duct as described above. Suture the catheter into the duct with fine Vicryl. Pass 3 cm of the pancreatic stump into the open proximal end of the jejunum. This is easily accomplished by inserting guide sutures at the superior and inferior margins of the anastomosis. Use 4–0 Prolene and insert the needle into the superior aspect of the jejunum 3 cm away from its proximal margin (**Fig. 73–19a**).

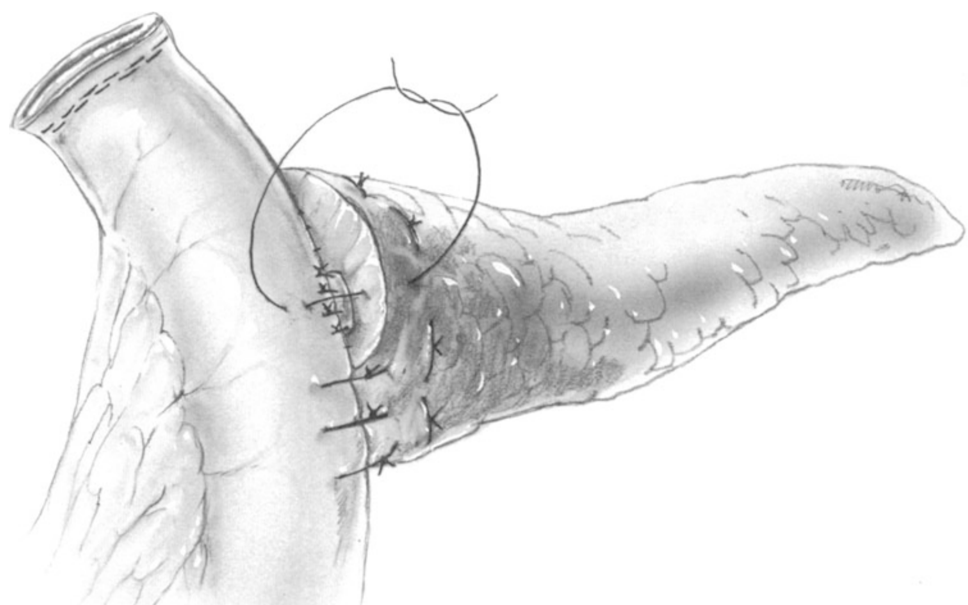


Fig. 73–18

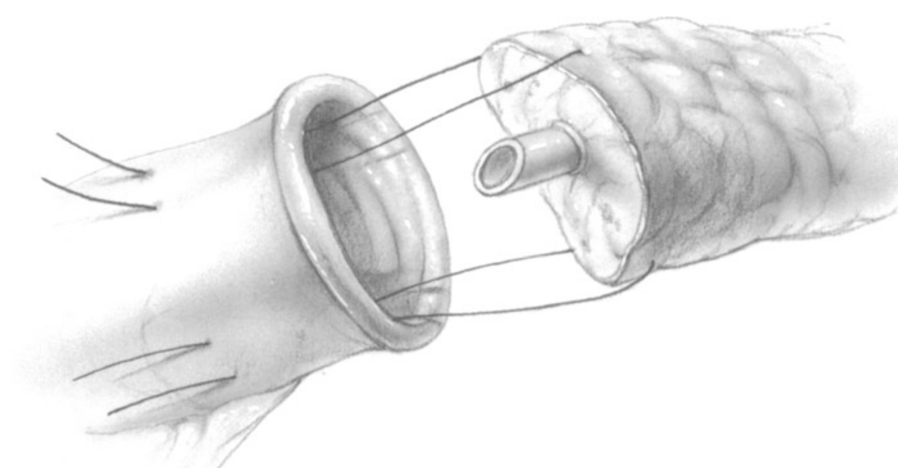


Fig. 73–19a

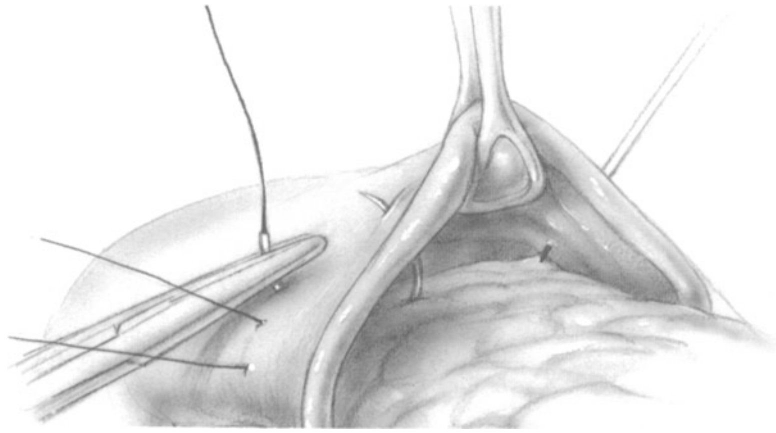


Fig. 73–19b

Using the same needle, take a bite of the superior margin of the pancreas. Then return the same suture inside-out of the open end of the jejunum, emerging 3 cm from the cut edge. Place an identical suture at the inferior margin of the jejunum and pancreas. By putting traction on these two sutures, the pancreas can be brought into the open end of the jejunum. If the jejunum will not accommodate the pancreas because the pancreatic stump is too large, inject glucagon (1 mg) intravenously to relax the jejunum. If the jejunum still cannot accommodate the pancreatic stump after injection of glucagon, utilize the techniques described below where the pancreatic stump is invaginated into the jejunum through an incision in the jejunum along its antimesenteric margin. Now insert a catheter of appropriate width into the pancreatic duct and bring the cathether out of the jejunum through a small stab wound 6–8 cm distal to the pancreaticojejunal anastomosis. If a catheter is not used, then insert a 4-cm plastic tube into the pancreatic duct. About 1–2 cm should project beyond the cut edge of the duct. This will help prevent some of the sutures that will be used in creating the anastomosis from encompassing the duct and thereby occluding it. This tube will be ejected into the intestinal stream spontaneously at a later date. Now insert additional 4–0 Prolene sutures to fix the cut edge of the pancreas to the circumference of the jejunum (**Fig. 73–19b**). If the sutures are all inserted but not tied, this step can be accomplished under direct vision to avoid damage to the pancreatic duct. When the sutures have all been inserted, the pancreas is readjusted in its new location inside the jejunal lumen and each of the sutures is tied. A second layer of Lembert sutures is inserted from the proximal cut edge of the jejunum to the periphery of the pancreas in such fashion that the jejunal mucosa will be inverted (**Fig. 73–20**).

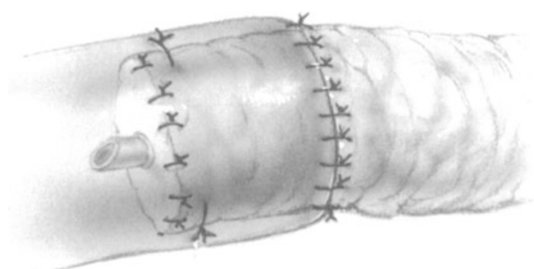


Fig. 73–20

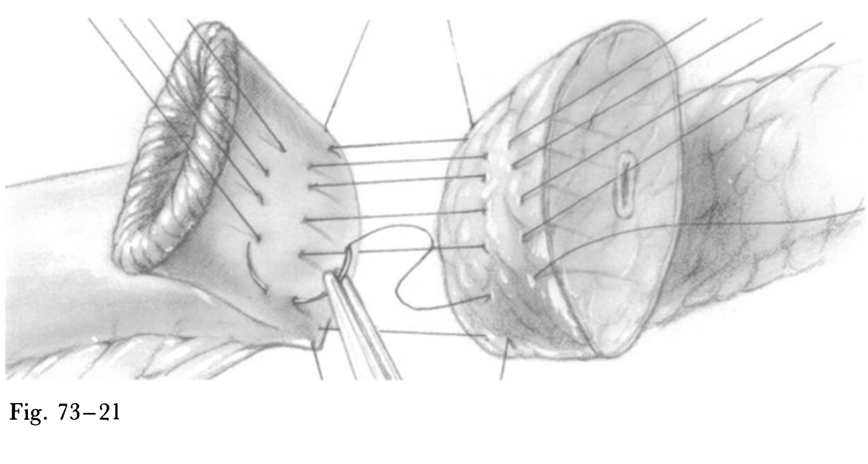


Fig. 73–21

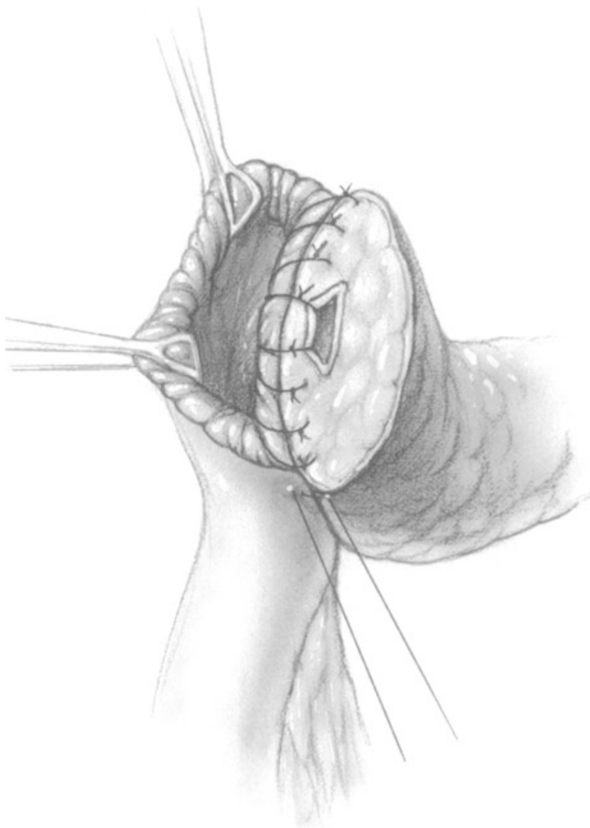


Fig. 73–22

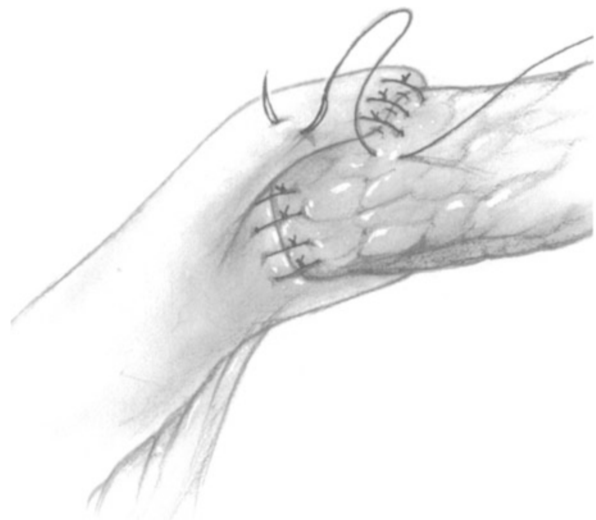


Fig. 73–24

Another method of intussuscepting the pancreatic stump into the jejunum is described beginning with **Fig. 73–21**. Using interrupted 4–0 Prolene or silk, insert stitches of the Lembert type approximating the pancreas to the jejunum at a point 2.5 cm from their proximal margins, as shown. After completing this seromuscular layer of sutures, insert a second layer approximating the proximal margin of the pancreas to full thickness of jejunum, as demonstrated in **Fig. 73–22**. If the pancreatic duct is large enough, include the posterior wall of the pancreatic duct in the suture line as shown. The first layer in the anterior suture line is demonstrated in **Fig. 73–23**. Use Lembert sutures to invert the mucosa of the jejunum into the parenchyma of the pancreas. The final anterior row of sutures between the seromuscular coat of jejunum to the pancreas will complete the intussusception of the pancreas into the jejunum, as shown in **Figs. 73–24** and **73–25**.

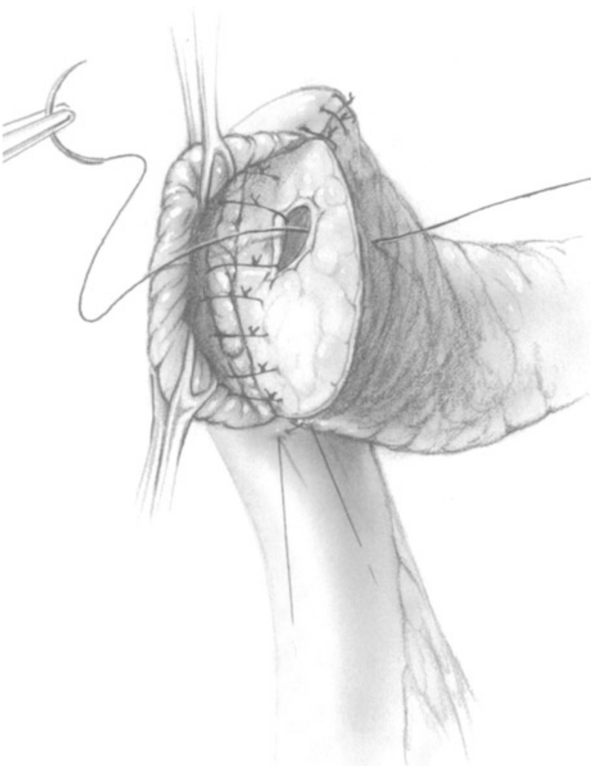


Fig. 73–23

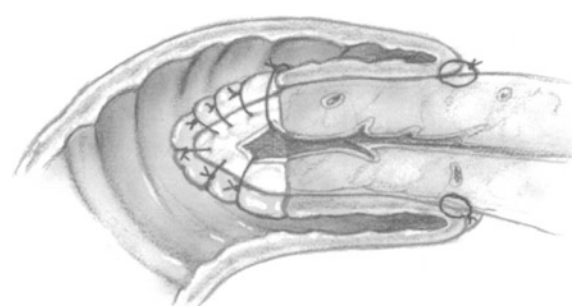


Fig. 73–25

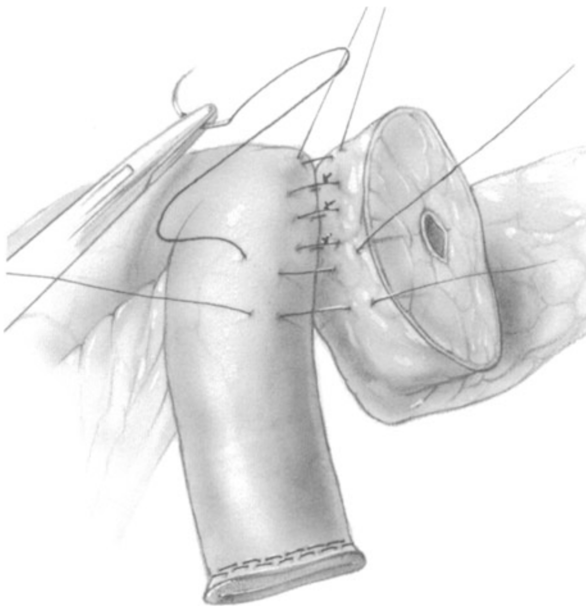


Fig. 73–26

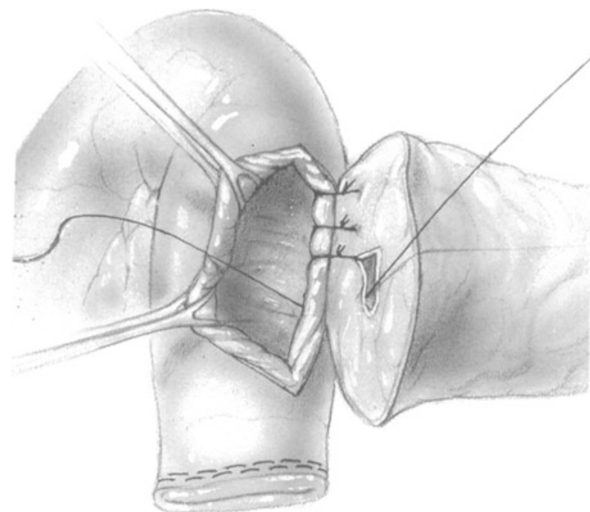


Fig. 73–28

When the stump of the pancreas is too large to be invaginated into the lumen of the jejunum even after the administration of glucagon, another method may be employed. As shown in **Fig. 73–26**, close the cut end of the jejunum with a TA-55 stapling device, generally using 3.8-mm staples. This need not be inverted by a layer of sutures. Approximate the cut edge of the pancreas to the antimesenteric border of the jejunum so as to complete an end-to-side anastomosis leaving 1–2 cm of jejunum hanging freely beyond the anastomosis. Insert 4–0 sutures of the Lembert type, approximating the seromuscular

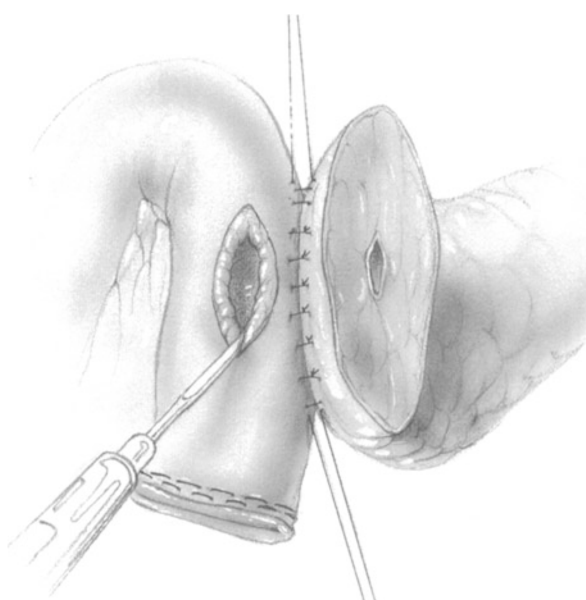


Fig. 73–27

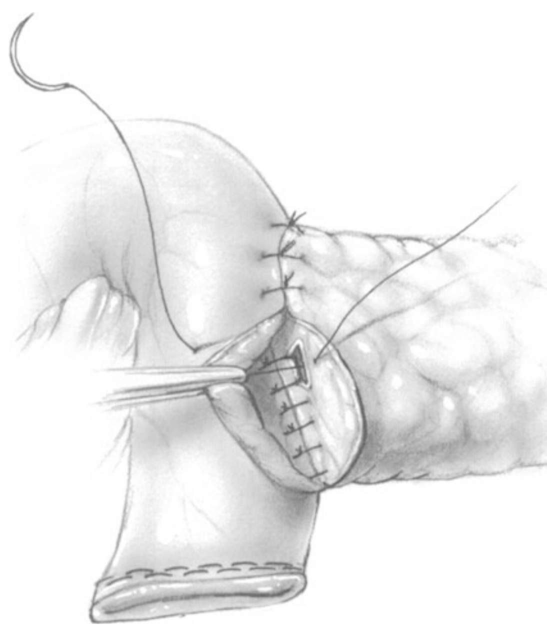


Fig. 73–29

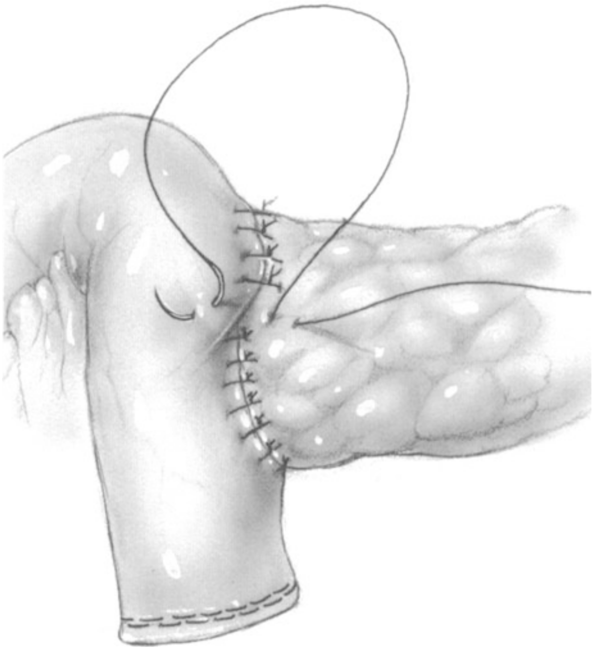


Fig. 73–30

Fig. 73–31

coat of the jejunum to the pancreas. The pancreatic sutures should be inserted about 1.5 cm away from its cut edge. When this layer is complete, make an incision along the antimesenteric border of the jejunum slightly shorter than the diameter of the pancreas, as seen in **Fig. 73–27**. Then insert sutures between the posterior edge of the pancreas, taking the full thickness of the jejunum in interrupted fashion to constitute the second posterior layer. If the pancreatic duct is large enough, include the posterior wall of the pancreatic duct in the sutures (**Fig. 73–28**). Again, use interrupted 4–0 sutures to approximate the anterior edge of the pancreas to the full thickness of the jejunum, as in **Fig. 73–29**. The final anterior layer of sutures will complete the invagination of the pancreas by approximating the anterior wall of the pancreas to the seromuscular coat of the jejunum, as in **Fig. 73–30**.

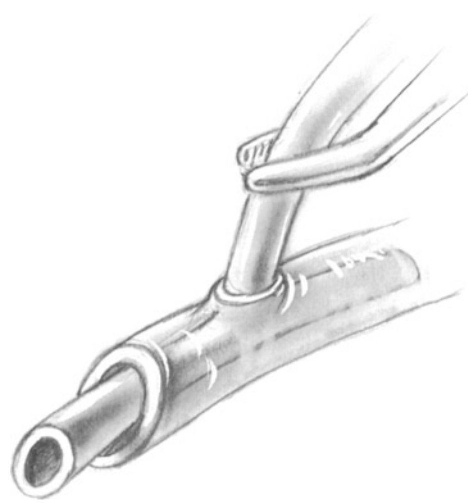


Fig. 73–32

Hepaticojejunal Anastomosis

Before anastomosing the hepatic duct to jejunum, make a tiny stab wound in the anterior wall of the hepatic duct about 3 cm proximal to its cut end. Insert a Mixter clamp into the hepatic duct through the stab wound. Grasp the *long arm* of a 16F or 18F T-tube (**Fig. 73–31**) and draw it through the stab wound (**Fig. 73–32**). The purpose of this T-tube is to drain bile to the outside until the pancreaticojejunostomy has healed completely.

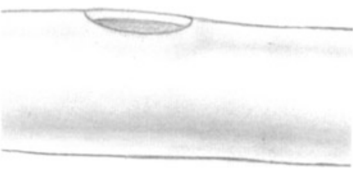


Fig. 73–33

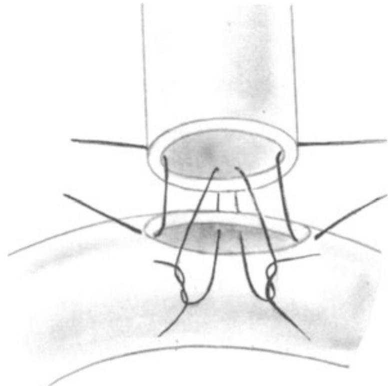
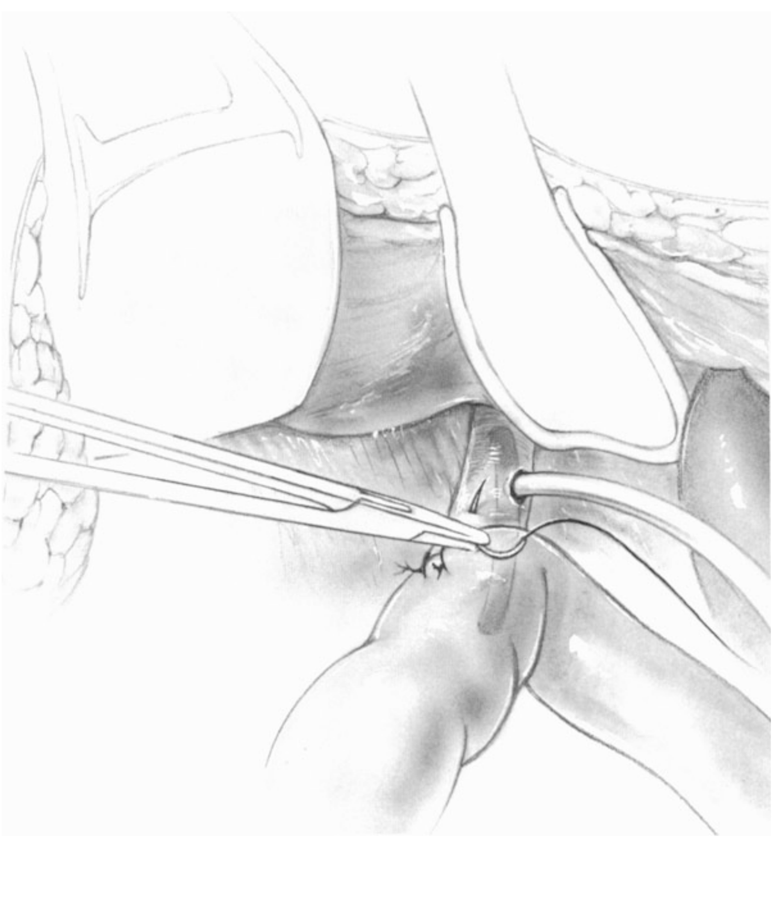


Fig. 73–34

Then make an incision on the antimesenteric border of the jejunum (**Fig. 73–33**) about 15–20 cm distal to the pancreaticojejunostomy. The jejunal incision should be approximately equal to the diameter of the hepatic duct. Use one layer of interrupted 5–0 Vicryl sutures to approximate the full thickness of hepatic duct to the full thickness of jejunum (**Fig. 73–34**). Tie the knots of the posterior layer of sutures in the lumen. The anterior knots are placed on the serosal surface of the hepaticojejunal anastomosis. On the jejunal side of the anterior layer a "seromucosal" type of stitch (see appendix, Fig. B–16) may be used. Leave only 3–4 mm of space between sutures (**Fig. 73–35**). We have not found it necessary to insert two layers of sutures. If the diameter of the hepatic duct is small, enlarge the ductal orifice by making a small Cheatle incision in the anterior wall of the duct.



Gastrojejunostomy

Identify the proximal jejunum, and bring it to the gastric pouch in an antecolonic fashion. Place the antimesenteric border of jejunum in apposition with the posterior wall of the residual gastric pouch for the gastrojejunal anastomosis. Leave 10–20 cm between the hepaticojejunostomy and the gastric anastomosis. Insert a guy stitch approximating the antimesenteric wall of the jejunum to the greater curvature of the stomach at a point about 3 cm proximal to the previously placed TA-90 staple line. Then, with the electrocautery make small stab wounds in the posterior wall of the stomach and in the jejunum. Now insert the GIA device, one fork into the gastric lumen and one into the jejunum (see Fig. 24–47). Be certain that there is no extraneous tissue between the walls of the stomach and jejunum. After locking the GIA stapling device, insert a single Lembert stitch to approximate stomach and jejunum at the tip of the GIA. Then, fire the GIA and remove it. Carefully inspect the staple line for bleeding which should be corrected either by cautious electrocoagulation or the insertion of 4–0 PG sutures. Apply Allis clamps to the anterior and posterior terminations of the staple line. Use additional Allis clamps to close the remaining aperture in the gastrojejunal anastomosis.

Apply a TA-55 stapler deep to the line of Allis clamps and fire the staples. (The details of this technique are described in Chap. 24.)

Close the defect in the mesocolon at the region of Treitz's ligament by means of continuous and interrupted sutures of 4–0 PG around the jejunum and its mesentery. Try to isolate the hepaticojejunal anastomosis from the pancreatic anastomosis by suturing the free edge of the omentum to the remaining hepatoduodenal ligament overlying the hepatic duct.

Intermittently during the entire operation, a dilute antibiotic solution is used for irrigating the operative field. **Fig. 73–36** illustrates the completed operation.

Insertion of Drains

Insert a latex drain through a stab wound in the right upper quadrant down to the vicinity of the hepaticojejunostomy. Allow the T-tube to exit through the same stab wound in the right upper quadrant.

Next, bring the pancreatic catheter through a tiny stab wound in the antimesenteric wall of the jejunum about 10 cm distal to the pancreatic anastomosis. Place a 4–0 silk purse-string suture around this tiny stab wound. Then make a stab wound in the appropriate portion of the abdominal wall, generally in the right upper quadrant; bring the catheter through this stab wound. If feasible, fix the jejunum to the abdominal wall around the catheter's exit point, using four sutures of interrupted 3–0 PG, one suture to each quadrant. This will prevent intraperitoneal leakage of jejunal content. Connect this catheter to a plastic collecting bag. Alternatively, bring the catheter through a stab wound in the *proximal* jejunum as depicted in Fig. 73–39.

Through a stab wound in the left upper quadrant, insert a latex and a Jackson-Pratt closed-suction drain to the posterior abdominal cavity in the vicinity of the pancreaticojejunostomy and subhepatic spaces.

Closure

Close the abdominal wall using 1 PDS sutures in the fashion described in Chap. 5.

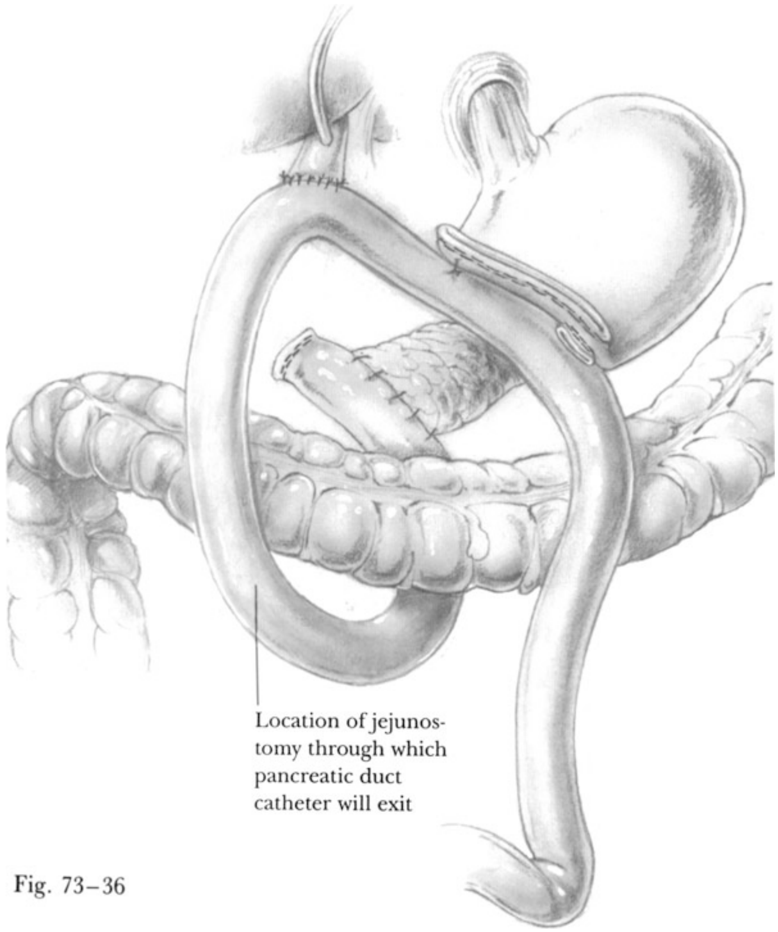


Fig. 73–36

Operative Technique: Partial Pancreatoduodenectomy with Preservation of Stomach and Pylorus

Concept: When to Preserve the Pylorus

Traverso and Longmire introduced the concept of preserving the pylorus following pancreatoduodenectomy, especially for benign conditions like chronic pancreatitis. We and others (Newman, Braasch, Rossi et al.) have used this modification of the pancreatoduodenectomy for patients with cancers *localized* to the pancreas, the ampulla, periampullary duodenum, and the distal CBD. If preservation of the pylorus with its intact vagal innervation is successful, it will avoid the necessity for gastric resection and vagotomy, maintain normal gastric emptying, and eliminate the gamut of postgastrectomy malfunctions.

Following the usual partial or total pancreatoduodenectomy, marginal ulcer may occur unless vagotomy and gastric resection are performed (Scott and associates). By removing the head and neck of the pancreas, a portion of the alkaline pancreatic secretion is eliminated from the intestinal tract. This reduces the buffering capacity of the secretions in the upper intestinal tract and lessens its resistance to peptic ulceration. Nevertheless, pylorus preservation has become a widely accepted modification of the Whipple operation. In a nonrandomized study, Klinkenbijl and associates compared 45 patients who underwent a standard Whipple operation with 46 patients who had the pylorus preservation modification. The mean duration of follow-up was 25 months. There was no difference in the incidence of peptic ulcer, hospital mortality, the number of days of postoperative gastric suction, the time that diet was initiated following operation, complications, recurrence of disease, or survival. Hospital stay was significantly shorter after pylorus preservation. Operating time was less by an average of 45 minutes per case, and median blood loss was 700 ml less. Weight changes after surgery were significantly more favorable after pylorus preservation.

Grace, Pitt, and Longmire reported lower morbidity and mortality rates in patients with benign and malignant periampullary disease following pylorus preservation. We believe that this modification is applicable in most cases of pancreatic resection unless the proximal duodenum is involved with tumor. Preserving the proximal 2 cm of duodenum and the left gastroepiploic arcade along the greater curvature of the antrum does not limit resection of the lymph nodes that drain tumors of the ampullary region.

Pitfalls and Danger Points

Same as those mentioned above for the Whipple pancreatoduodenectomy, plus the possibility of inadequate blood supply to the duodenum.

Operative Strategy

The important parts of this operation are identical with the Whipple pancreatoduodenectomy except that the pylorus and 2 cm of duodenum as well as all of the vagus nerve branches are preserved. In the hope of reducing the risk of marginal ulceration, we place the duodenojejunal anastomosis closer to the biliary and pancreaticojejunal anastomoses than is the case with the Whipple operation.

Also illustrated in this operative description is a method of bringing the pancreatic catheter to the abdominal wall through a tiny stab wound near the closed proximal end of the jejunal segment (Fig. 73–39). This has the important advantage that the length of the catheter between the pancreatic duct and the abdominal wall is much less than that described under the technique of the Whipple operation (above).

Technique: Modifications for Preserving the Pylorus with Partial Pancreatoduodenectomy

The operative technique used in partial pancreatoduodenectomy with preservation of the pylorus is the same as that described above for the Whipple operation, with the following exceptions:

Do not perform a vagotomy.

Dissect the posterior wall of the duodenum off the head of the pancreas for a distance of 2.5 cm after dividing and ligating the gastroduodenal and the right gastric arteries as described above.

Apply the GIA stapling device to the duodenum at a point about 2.5 cm distal to the pylorus. Fire the stapling device. This will transect the duodenum and apply a stapled closure to both the proximal and distal ends of the divided duodenum.

Be careful to avoid injuring the gastroepiploic arcade in the greater omentum along the greater curvature of the stomach, since much of the blood supply to the proximal duodenum will be coming from the intact left gastroepiploic artery down to the pylorus. Beyond this point the duodenum will be fed by the intramural circulation. Additional blood supply comes from the left gastric artery along the lesser curve of the stomach.

Anastomose the end of the duodenum to the antimesenteric side of the jejunum at a point about 20 cm distal to the hepaticojejunal anastomosis. The jejunum should be brought directly from the hepaticojejunostomy to the duodenum for an end-to-side

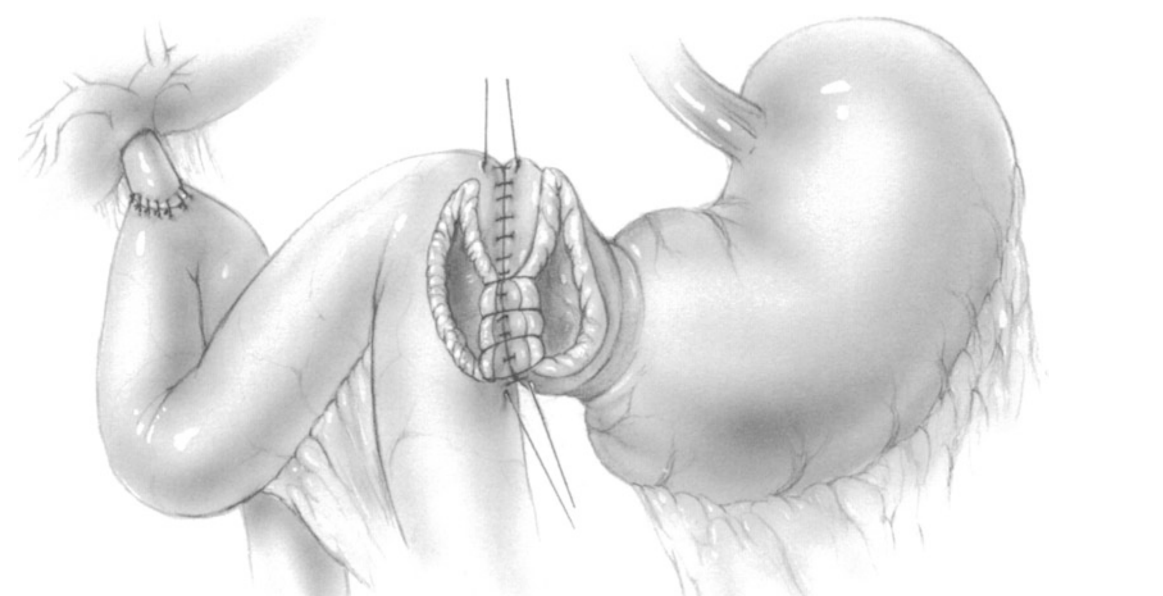


Fig. 73–37

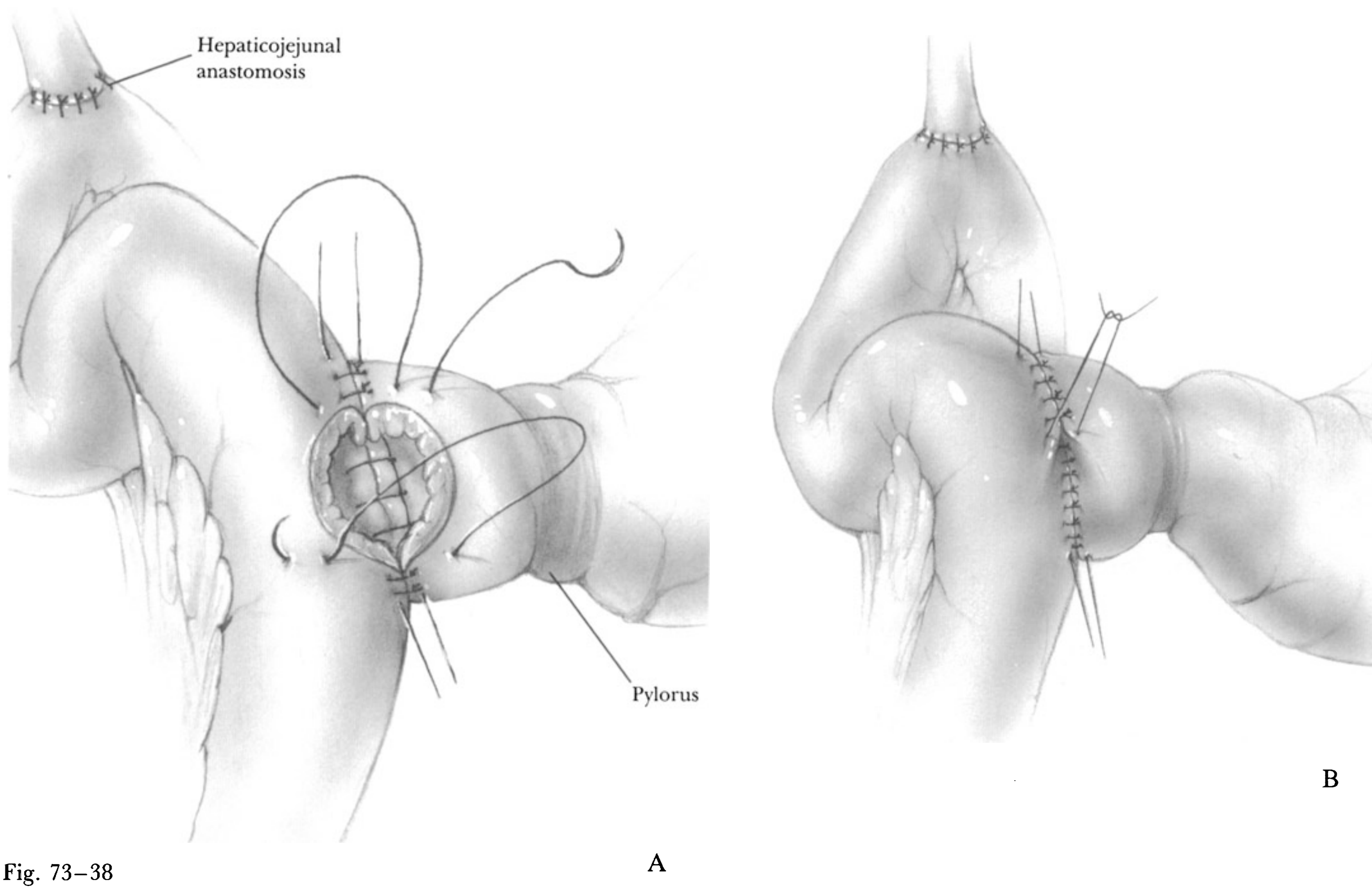


Fig. 73–38

duodenojejunal anastomosis in the supramesocolic space.

The first step in preparing for the anastomosis is to apply several Allis clamps to the line of staples closing the duodenum. Then excise the staple line with a scissors, leaving the duodenum wide open. Observe the cut duodenum for adequacy of bleeding. Although pulsatile flow is not generally seen and the duodenum may be somewhat cyanotic, a fairly brisk ooze of red blood is an indication of satisfactory circulation.

Do not place the anastomosis too close to the pylorus because the close proximity of the suture line to the pylorus will interfere with pyloric function and result in gastric retention. Insert a layer of 4–0 interrupted silk Lembert sutures to approximate the posterior seromuscular coat of the duodenum to the antimesenteric border of the jejunum. After this has been done, make an incision in the antimesenteric border of the jejunum. Obtain hemostasis with absorbable sutures or electrocoagulation. Then begin the mucosal layer. Use 5–0 atraumatic Vicryl suture material and place the first stitch in the middle of the posterior layer of the anastomosis. Run a continuous locked stitch from this point to the left-hand termination of the posterior layer. Take relatively small bites through the full thickness of duodenum and jejunum. If the bites are small, the continuous suture will not act as a purse string to narrow the anastomosis.

Insert a second 5–0 Vicryl suture adjacent to the first one at the midpoint of the posterior layer. Run this stitch in a continuous locked fashion towards the patient's right. Accomplish closure of the first anterior layer of the anastomosis by using the same 5–0 Vicryl stitch either as a Connell, a Cushing, or a "seromucosal" stitch (**Fig. 73–37**). Terminate this layer by tying the ends of the two continuous Vicryl sutures to each other in the middle of the anterior layer. Complete the anterior layer of the anastomosis by inserting interrupted 4–0 silk Lembert seromuscular sutures (**Fig. 73–38a and b**).

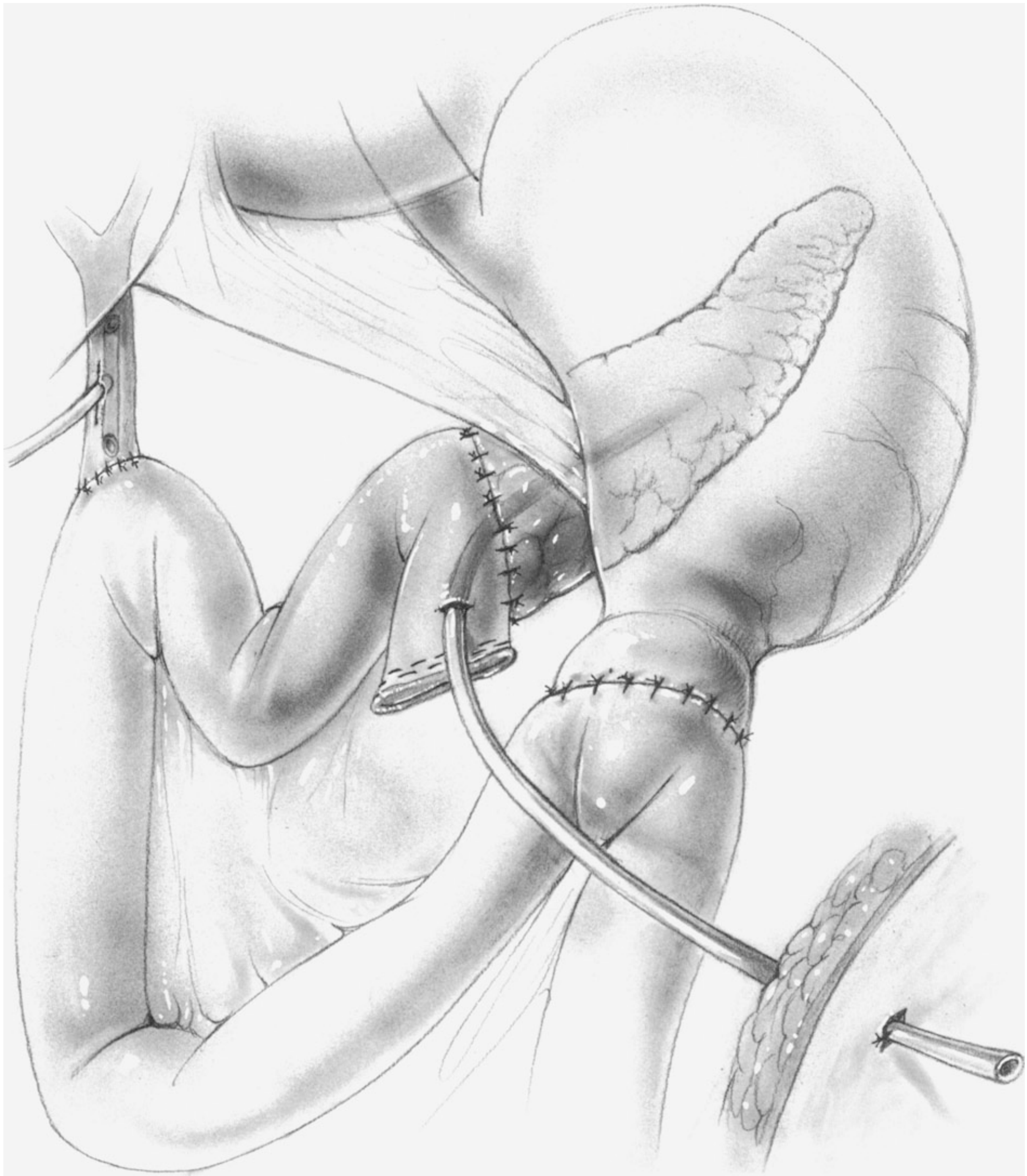


Fig. 73–39

Fig. 73–39 illustrates the method of draining the pancreatic duct. Insert the Silastic catheter (e.g., the small round Jackson-Pratt catheter) into the pancreatic duct after completing the posterior layers of the pancreaticojejunostomy. Suture the catheter to the pancreas with a 5–0 PG stitch. Then bring it through a puncture wound in the proximal jejunum. Close the jejunal puncture wound around the catheter with a 4–0 silk purse-string suture. Then bring the catheter through a puncture wound of the abdominal wall to the left of the midline incision. Transfix the catheter to the skin with a suture. In most cases it will be possible to suture the jejunum to the parietal peritoneum around the puncture wound through which the catheter exits.

Fig. 73–40 illustrates the end result of this operation without a catheter in the pancreatic duct but with the pancreatic stump invaginated into the jejunal lumen.

Insert a closed-section drainage catheter near the pancreatic anastomosis. Bring the catheter out through a puncture wound in the upper abdominal wall.

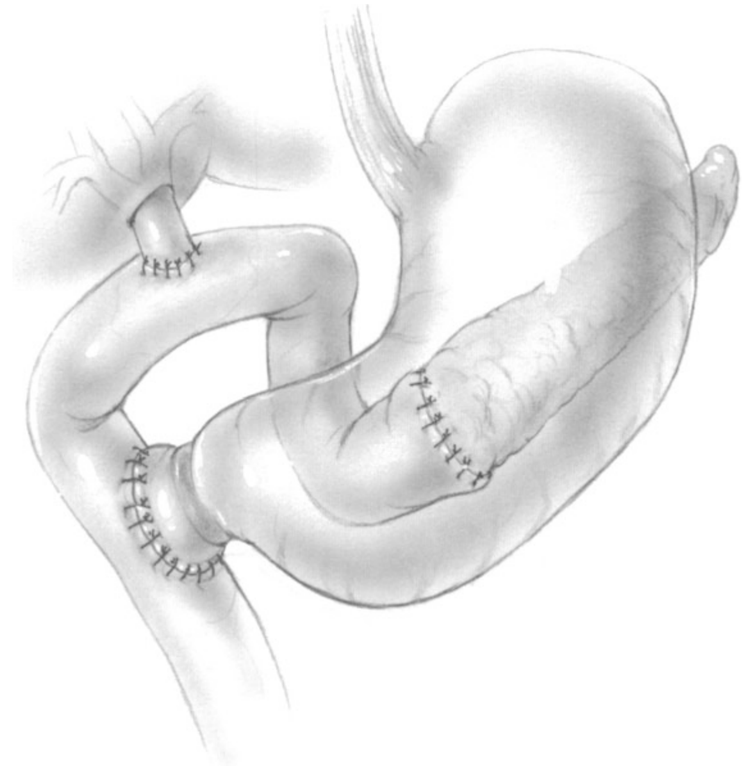


Fig. 73–40

Needle-Catheter Jejunostomy

Perform a needle-catheter jejunostomy in all pancreatoduodenectomies. If the patient should suffer from delayed gastrointestinal function due to leakage of one of the anastomoses, jejunal feedings are superior to total parenteral nutrition.

Complications of Pancreatectomy with Stomach and Pylorus Preservation

Delayed Gastric Emptying

This complication will occur if the duodenojejunal suture line abuts the pyloric sphincter muscle and thus interferes with the sphincter's proper functioning. Most cases of delayed gastric emptying subsequent to a pancreatoduodenectomy are due to leakage from the pancreaticojejunal or hepaticojejunal anastomoses or intraperitoneal sepsis rather than some intrinsic disorder of gastric function. Evacuation of intraperitoneal collections or abscesses accelerates the return to normal gastric emptying. Most of these abscesses can be evacuated by percutaneous CT-guided insertion of drainage catheters.

Pyloroduodenal Ulcer

Superficial ulceration may follow impairment of the duodenal blood supply.

Peptic ulcer of the duodenum or jejunum may occur if the gastric pH following the operation is permitted to fall below 4–5. With the bile diverted into the T-tube and all the pancreatic juice draining to the outside via the pancreatic duct catheter, one of our patients developed a gastric pH of 1 postoperatively while receiving cimetidine 100 mg per hour intravenously. The patient bled from a superficial pyloroduodenal ulcer that healed when the pancreatic secretions were injected into the nasogastric tube together with antacids. In the early postoperative period it is important to administer enough H_2 blockers to raise gastric pH to 5.0.

Postoperative Care

Perioperative antibiotics, which were initiated prior to the operation, are repeated by the intravenous route every 4 hours during the procedure and then every 6 hours for four doses postoperatively. If the bile was infected prior to surgery, administer antibiotics until the infection is suppressed.

Administer H_2 blockers parenterally. Test the intragastric pH on the sample of gastric juice aspirated through the nasogastric tube every 2 hours. Administer additional antacid, if necessary, in doses sufficient to keep the pH at or above the level of 5.0.

Intravenous fluids should be administered in sufficient quantities to assure normal urine output. In older cardiac patients it is extremely helpful to have the guidance of pulmonary artery wedge pressures and sometimes of cardiac output determinations. Some of our patients have required 8 or more liters of isotonic fluid on the day of operation to maintain cardiovascular homeostasis even in the absence of significant blood loss. Since this is an extensive operation, one can expect considerable sequestration of fluids into the "third space." By the 3rd postoperative day there is frequently a brisk diuresis, at which time intravenous fluids should be limited in volume.

Initiate enteral feedings by way of the jejunostomy catheter after the operation is completed and continue these feedings until the patient is able to take a full diet by mouth.

Both the T-tube and the pancreatic catheter are left in place for 21 days. If there has been no drainage of pancreatic juice or bile by the 7th or 8th day, the latex drains may be mobilized and gradually removed. Remove the Jackson-Pratt drain on day 8–10 unless significant amounts of fluid are being aspirated.

If a clear, watery secretion drains from the operative site, this represents a pancreatocutaneous fistula, which will probably heal with the passage of time. If this leak of pancreatic juice becomes complicated by the admixture of bile and pus, the tryptic enzymes become activated and start digesting the tissues in the vicinity of the anastomosis. This complication can be serious and even fatal. Initially, attempt conservative therapy by continuous irrigation of the anastomotic site through the catheter using sterile saline containing appropriate dilute antibiotics. A dosage of 1–2 liters per day seems appropriate. If, despite this management, the patient's condition continues to deteriorate, relaparotomy for removal of the remaining tail of pancreas together with the spleen may prove lifesaving.

Postoperative Complications

Leakage from pancreatic anastomosis

Leakage from biliary anastomosis

Postoperative sepsis

Acute pancreatitis

Postoperative hemorrhage. In our experience both sepsis and hemorrhage are most often the result of leakage from the pancreaticojejunal anastomosis. In some cases this may be due to the development of acute pancreatitis in the pancreatic tail. As discussed above, the only solution to this vicious cycle, in some cases, is surgical removal of the residual pancreas.

Postoperative gastric bleeding. If the gastric pH is kept elevated by antacid therapy, bleeding from gastric ulceration is rare.

Thrombosis of the superior mesenteric artery or vein. Although we have never encountered this complication, thrombosis can occur. It can be prevented by dissecting these two vital structures with care and precision.

Hepatic failure

Gastric bezoar. We have had two patients who developed gastric phytobezoars following pancreatoduodenectomy with vagotomy. Both were treated with gastric lavage and with medication, which included papain and cellulase, with satisfactory results.

Discussion of the reduced morbidity and mortality rates after pancreatoduodenectomy in the 1990s. The reduction in the hospital mortality rates for pancreatoduodenectomy in the past decade has been striking. Crist, Sitzmann, and Cameron reported a 24% mortality rate in patients operated upon between 1969 and 1980, while those patients having their surgery between 1981 and 1986 experienced a 2% rate. Pellegrini and associates had one death in 51 consecutive pancreatoduodenectomies done between 1979 and 1987. Trede, Schwall, and Saeger reported no operative deaths in 118 consecutive pancreatic resections from the Surgical University Clinic at Mannheim, West Germany, performed from 1985 to 1990. Miedema and associates from the Mayo Clinic operated on 279 patients between 1980 and 1989 with a 4% postoperative mortality.

The most common serious complication is leakage from the pancreaticojejunal anastomosis. This occurs in 5%–20% of patients. In the presence of well-placed drains, a pancreatic fistula may not require definitive treatment. Pellegrini et al. emphasized that intra-abdominal abscesses are well-handled by an interventional radiologist who inserts percutaneous drainage catheters. This was successful in 5 of their 7 patients with postoperative sepsis. In previous years, they noted that 15% of patients undergoing pancreatoduodenectomy required postoperative relaparotomy for this complication. They prefer to perform pancreatectomy with pylorus preservation. They experienced no postoperative gastric bleeding. Trede and Schwall reported 11 instances of pancreaticojejunal leakage (5% of their cases) and postoperative acute pancreatitis in an additional 5%. About one-quarter of patients with these complications died.

These authors emphasize early detection of these complications. They advocate prompt relaparotomy and excision of the residual pancreas in all patients who demonstrate manifestations of acute illness subsequent to leakage from the pancreaticojejunal anastomosis or acute pancreatitis. They reported that relaparotomy for completion pancreatectomy, was life-saving in 10 of the 12 patients who had this operation. The two remaining patients died of uncontrollable erosive hemorrhage. As part of their early detection program, these authors routinely perform an abdominal ultrasound and CT scan 1 week after operation.

The drainage of clear pancreatic juice following pancreatectomy is generally a benign complication that will correct itself. However, if bile is noted to be draining together with the pancreatic juice, the complication is the same as a lateral duodenal injury. The activated tryptic ferments cause extensive damage by eroding the peripancreatic tissues and blood vessels. This is the type of patient upon whom completion pancreatectomy should be performed promptly. Other patients with leakage from the pancreatic anastomosis may develop undrained collections in the upper abdomen that have a high potential for becoming infected. When these undrained collections are identified on the CT scan, ask the interventional radiologist to insert a CT-guided percutaneous drain. We agree with Pellegrini and associates that this maneuver constitutes a tremendous advance in postoperative care, especially for patients who have undergone pancreatoduodenectomy.

Another study that may reveal the extent of a pancreaticojejunal leak is the injection of contrast material into the T-tube. With the patient turned towards his left side, the contrast material may be visualized leaking from the pancreatic anastomosis.

Ten years ago, a 5-year survivor following pancreatoduodenectomy for carcinoma of the head of the pancreas was a rare event. In 1991 Cameron and associates reported on 89 patients with carcinoma of the head of the pancreas undergoing pancreatic resection. Their actuarial 5-year survival was 19%. Patients with negative lymph nodes had a median survival of 56 months. It is interesting that patients who received two or fewer units of blood transfusion during the operation had a 5-year survival of 25%, while those who had greater than two units transfused had a 10% 5-year survival. Of course, for ampullary and periampullary carcinoma, the 5-year survival in some series approaches 40%.

The reduction in mortality and morbidity after pancreatoduodenectomy applies also to the elderly patient. Spencer, Sarr, and Nagorney studied patients 70 years and older who underwent this operation. The overall operative mortality was 9%. They conclude that healthy patients older than 70 years can tolerate properly performed pancreatoduodenectomy with mortality and morbidity rates only slightly greater than that for younger patients.

References

Braasch JW, Gray BN. Technique of radical pancreatoduodenectomy. Surg Clin North Am 1976;56:631.

Braasch JW, Gray BN. Considerations that lower pancreatoduodenectómy mortality. Am J Surg 1977;133:480.

Cameron JL, Crist DW, Sitzman JV et al. Factors influencing survival after pancreaticoduodenectomy for pancreatic cancer. Am J Surg 1991;161:120–125.

Child CG III, Hinerman DL, Kauffman GL. Pancreatoduoenectomy. Surg Gynecol Obstet 1978;147:529.

Crist DW, Sitzmann JV, Cameron JL. Improved hospital morbidity, mortality, and survival after the Whipple procedure. Ann Surg 1987;206:358–365.

Denning D, Ellison C, Carey L. Postoperative percutaneous transhepatic biliary decompression lowers operative morbidity in patients with obstructive jaundice. Am J Surg 1981;141:61.

Earnhardt RC, McQuone SJ, Minasi JS. Intraoperative fine needle aspiration of pancreatic and extrahepatic biliary masses. Surg Gynecol Obstet 1993;177:147–152.

Grace PA, Pitt HA, Longmire WP. Pylorus preserving pancreatoduodenectomy: an overview. Br J Surg 1990; 77:969–974.

Grant CS, Van Heerdon JA. Anastomotic ulceration following subtotal and total pancreatectomy. Ann Surg 1979;190:1.

Klinkenbijl JHG, van der Schelling GP, Hop WCJ et al. The advantages of pylorus-preserving pancreatoduodenectomy in malignant disease of the pancreas and periampullary region. Ann Surg 1992;216:142–145.

Miedema BW, Sarr MG, van Heerden JA et al. Complications following pancreaticoduodenectomy: current management. Arch Surg 1992;127:945–950.

Newman KD, Braasch JW, Rossi RL et al. Pyloric and gastric preservation with pancreatoduodenectomy. Am J Surg 1983;145:152.

Norlander A, Kalin B, Sunblad R. Effect of percutaneous transhepatic drainage upon liver function and postoperative mortality. Surg Gynecol Obstet 1982;155:161.

Pellegrini CA, Heck CF, Raper S. An analysis of the reduced morbidity and mortality rates after pancreatoduodenectomy. Arch Surg 1989;124:778–781.

Rossi RL, Braasch JW. Techniques of pancreaticojejunostomy in pancreatoduodenectomy. Probl Gen Surg 1985;2:506–513.

Scott HW Jr, Dean RH, Parker T et al. The role of vagotomy in pancreaticoduodenectomy. Ann Surg 1980;191:688.

Spencer MP, Sarr MG, Nagorney DM. Radical pancreatectomy for pancreatic cancer in the elderly. Ann Surg 1990;212:140–143.

Tompkins RK, Aizen BM, Saunders KD. Carcinoma of the ductus choledochus. Am J Surg 1991;161:235–238.

Traverso LW, Longmire WP Jr. Preservation of the pylorus in pancreaticoduodenectomy: a follow-up evaluation. Ann Surg 1980;192:306.

Trede M, Schwall G. The complications of pancreatectomy. Ann Surg 1988;207:39–47.

Trede M, Schwall G, Saeger H. Survival after pancreatoduodenectomy. Ann Surg 1990;211:447–458.

74 Total Pancreatoduodenectomy

Indications

Some surgeons believe that all duct cell carcinomas of pancreas should be treated by total pancreatectomy.

Contraindications

Distant metastases

Absence of an experienced surgical team

Patient who lacks alertness and intelligence to manage diabetes

Invasion of portal or superior mesenteric vein

Preoperative Care

(See Chap. 73.)

Pitfalls and Danger Points

Operative or postoperative hemorrhage

Trauma to superior mesenteric artery and vein, or to anomalous right hepatic artery

Devascularization of omentum and possibly stomach

Operative Strategy

In addition to the points discussed concerning the operative strategy of the Whipple operation (Chap. 73), remember that division of both the gastroduodenal and the splenic arteries results in complete devascularization of the omentum unless special effort is exerted to preserve the left gastroepiploic ar-

Fig. 74–1

tery. Complete omentectomy is generally performed as part of a total pancreatectomy.

Also remember that division of the splenic artery, the short gastric, the right gastric, and the gastroduodenal arteries leaves the gastric pouch dependent on the left gastric artery for its blood supply. For this reason, do not divide the left gastric artery at its point of origin from the celiac axis. Rather, it should be divided along the lesser curvature distal to the point where the branches to the proximal stomach and esophagus arise.

Operative Technique

Incision

Except for very stocky patients, we use a long midline incision from the xiphoid to a point 10 cm below the umbilicus.

Evaluation of Pathology; Kocher Maneuver

The technique followed here is identical with that shown in Figs. 73–2 and 73–3.

Determination of Resectability; Dissection of Portal and Superior Mesenteric Veins

This technique is identical with that described in Figs. 73–4 to 73–7, except that instead of dividing the omentum between clamps, detach the omentum from the transverse colon so that it may be removed with the specimen (**Figs. 74–1 and 74–2**).

Fig. 74–2

Splenectomy and Truncal Vagotomy

With the stomach and omentum retracted in a cephalad direction, identify the splenic artery along the superior surface of the pancreas. Open the peritoneum over the splenic artery at a point 1–2 cm distal to its origin at the celiac axis. With a right-angled Mixter clamp, free the posterior surface of the artery and apply a 2–0 silk ligature (**Fig. 74–3**). Ligate the vessel but do not divide it at this point in the operation.

Then apply a Thompson retractor to the left costal margin in order to improve the exposure of the spleen. Make an incision in the avascular lienophrenic fold of the peritoneum (**Figs. 74–4a and 74–4b**). Electrocoagulate any bleeding vessels. Elevate the tail of the pancreas together with the spleen. Divide the attachments between the lower pole of the spleen and the colon. Expose the posterior surface of the spleen and identify the splenic artery and veins at this point. If there is any bleeding, ligate these vessels.

Insert moist gauze pads into the bed of the elevated spleen.

At this time remove the Thompson retractor from the left costal margin and place it in the region of the

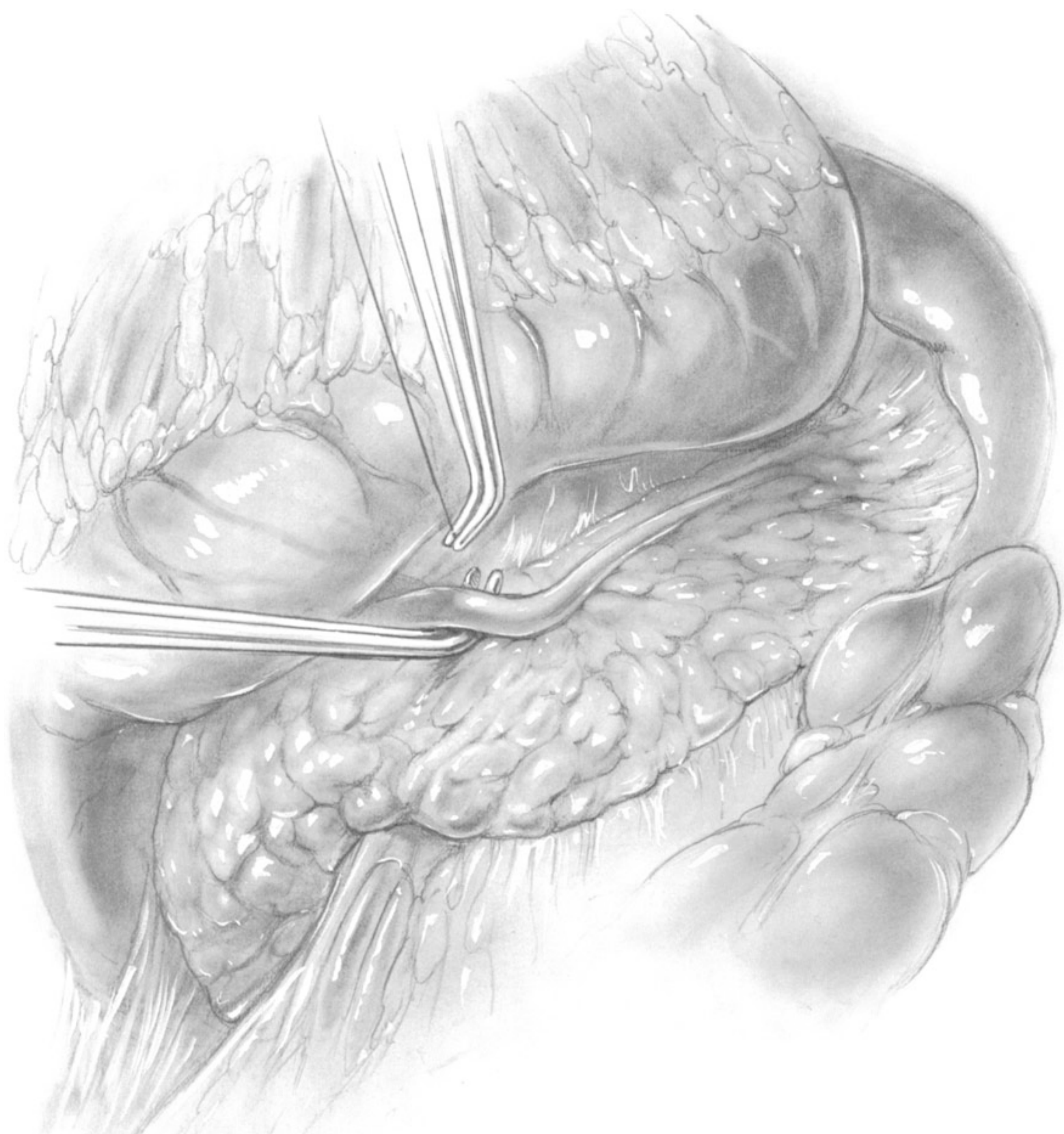


Fig. 74–3

Fig. 74–4a

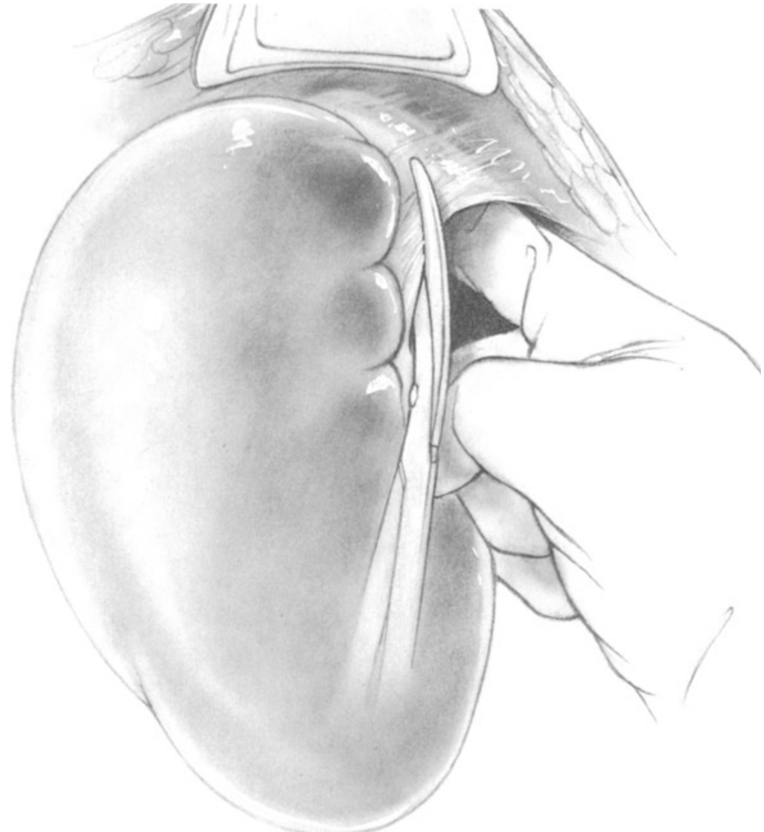


Fig. 74–4b

sternum. Apply traction in a cephalad and anterior direction, exposing the abdominal esophagus. Incise the peritoneum over the abdominal esophagus. Use a peanut-gauze dissector to separate the crus of the diaphragm from the esophagus (**Fig. 74–5**) and perform a truncal vagotomy as described in Chap. 19.

Mobilizing the Distal Pancreas

Now identify the proximal short gastric vessel. Insert the left index finger beneath the gastrophrenic ligament. Apply a Hemoclip to the distal portion of the vessel. Ligate the gastric side of the vessel with 2–0 or 3–0 silk and divide it (**Fig. 74–6**). Continue the

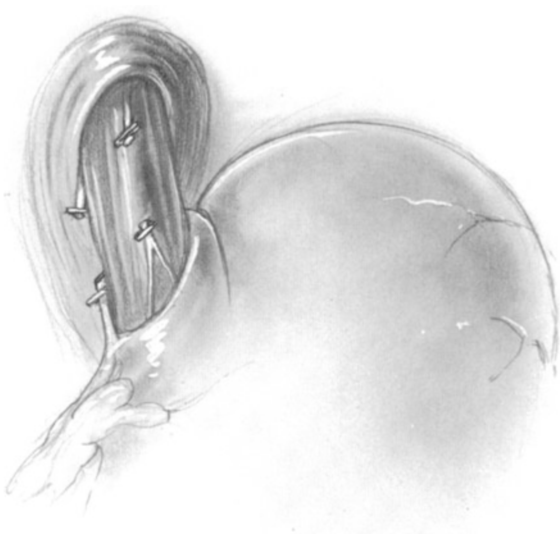


Fig. 74–5

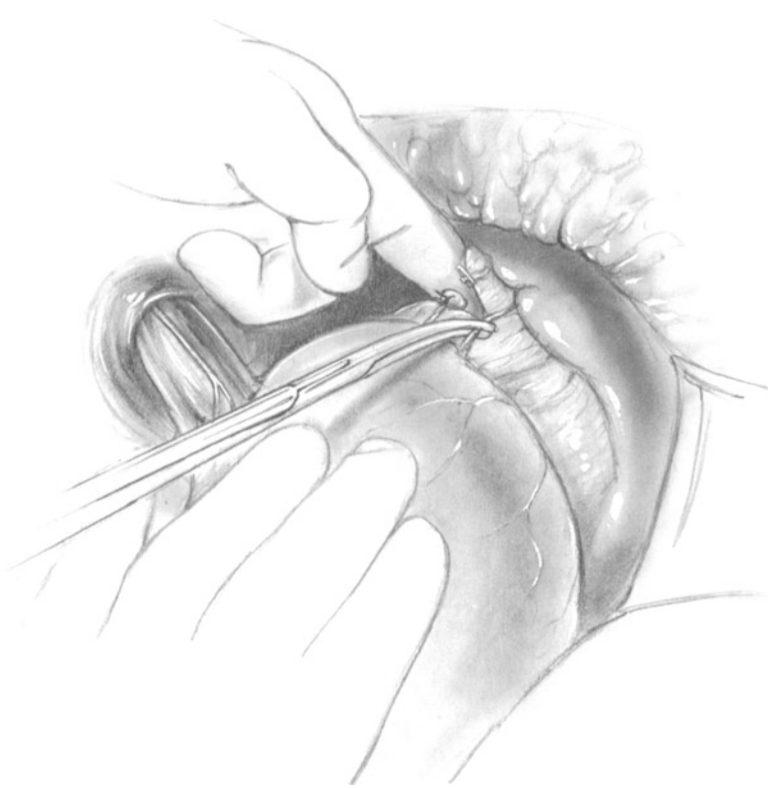


Fig. 74–6

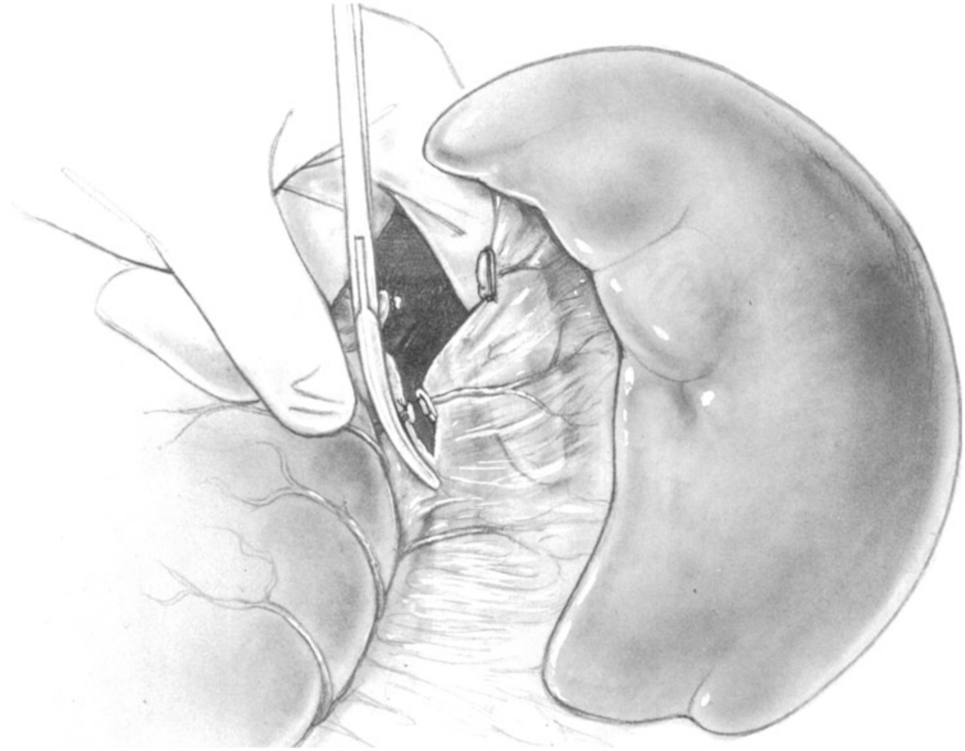


Fig. 74–7

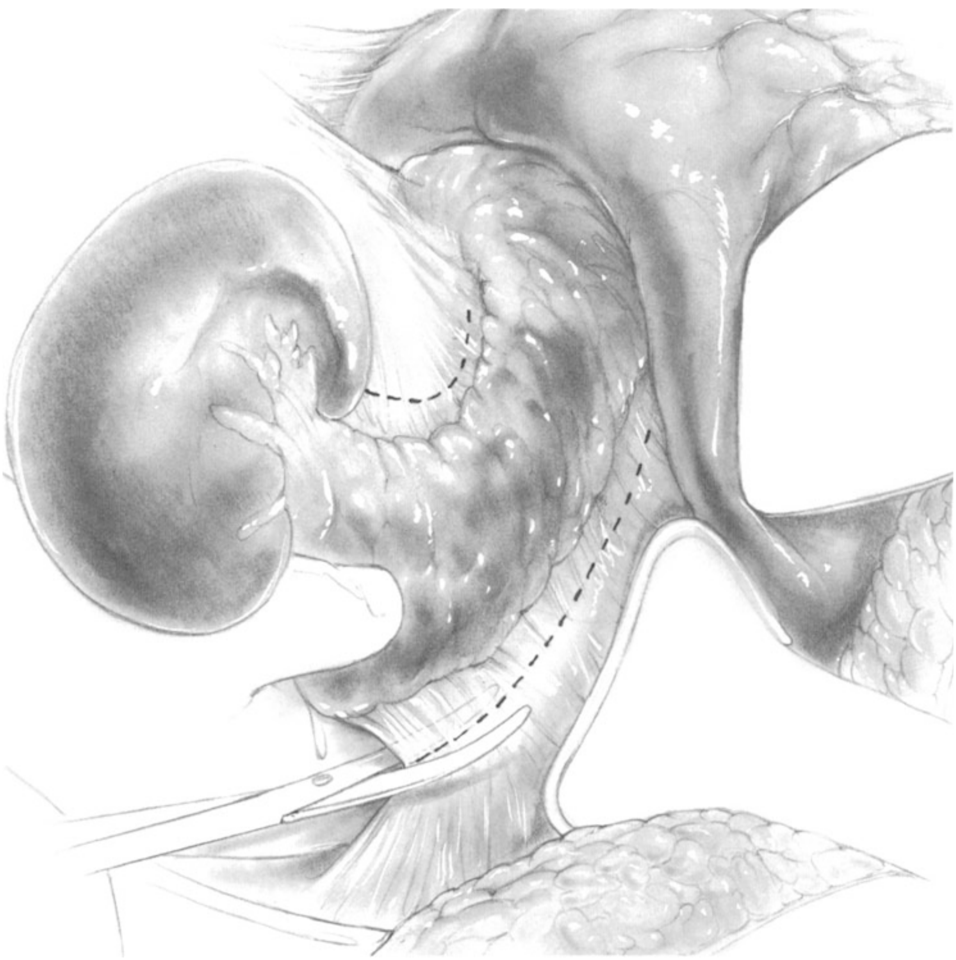


Fig. 74–8

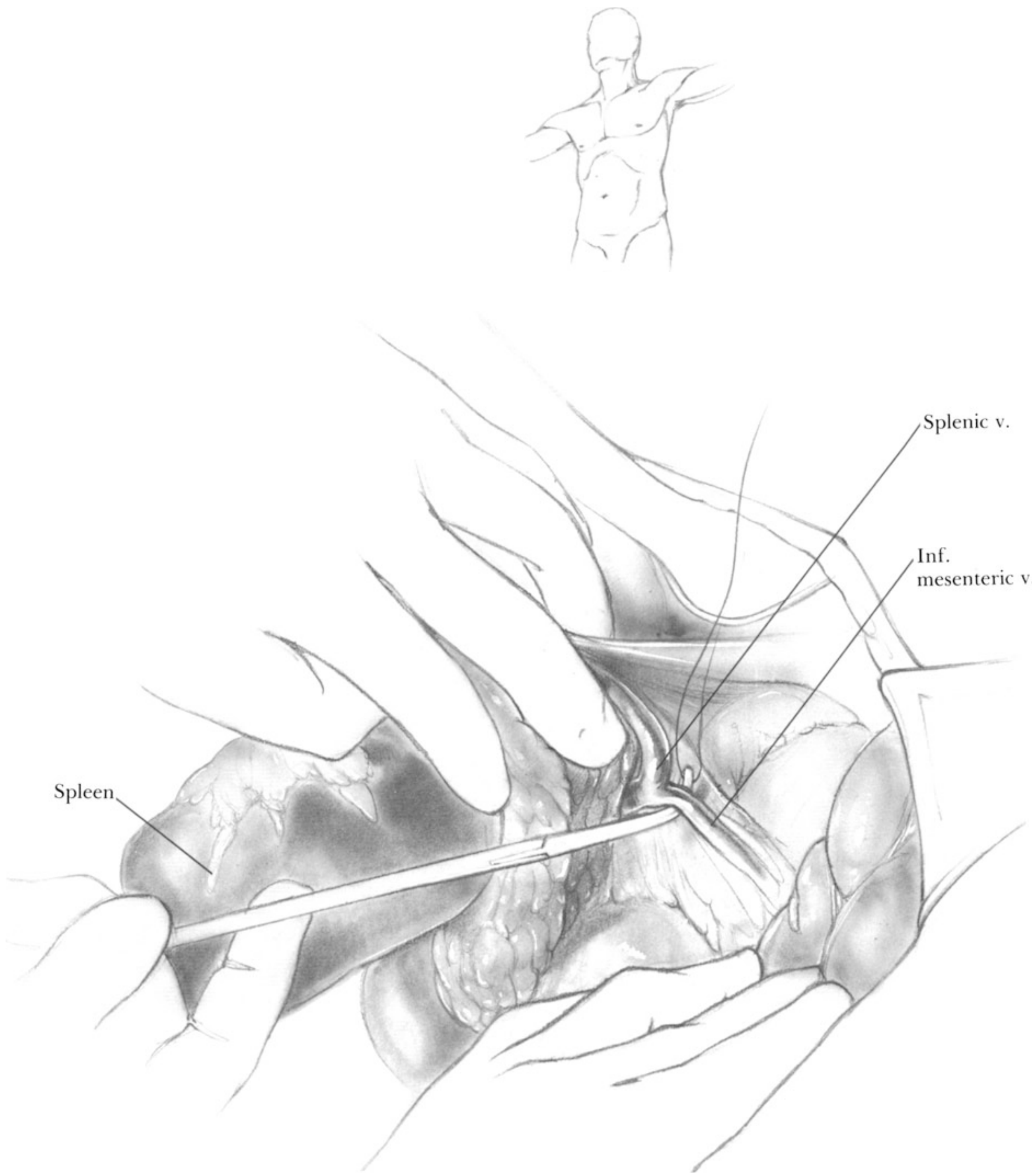


Fig. 74–9

dissection in this manner until all of the short gastric vessels have been divided (**Fig. 74–7**).

Now redirect attention to the tail and body of the pancreas. It will be seen that this organ is covered by a layer of posterior parietal peritoneum. This is avascular and should be incised first along the superior border of the pancreas and then again along the inferior border of the pancreas after elevating the tissue with the index finger (**Fig. 74–8**). As the pancreas is elevated from the posterior abdominal wall, follow the posterior surface of the splenic vein to the point where the inferior mesenteric vein enters. Then divide this vessel between 2–0 silk ligatures (**Fig. 74–9**). Follow the splenic artery to its point of origin where the previous ligature will be seen. Doubly ligate the proximal stump of the splenic artery and apply a similar ligature to the distal portion of the splenic artery. Divide between these ties. Then carefully dissect the junction of the splenic and portal veins away from the posterior wall of the

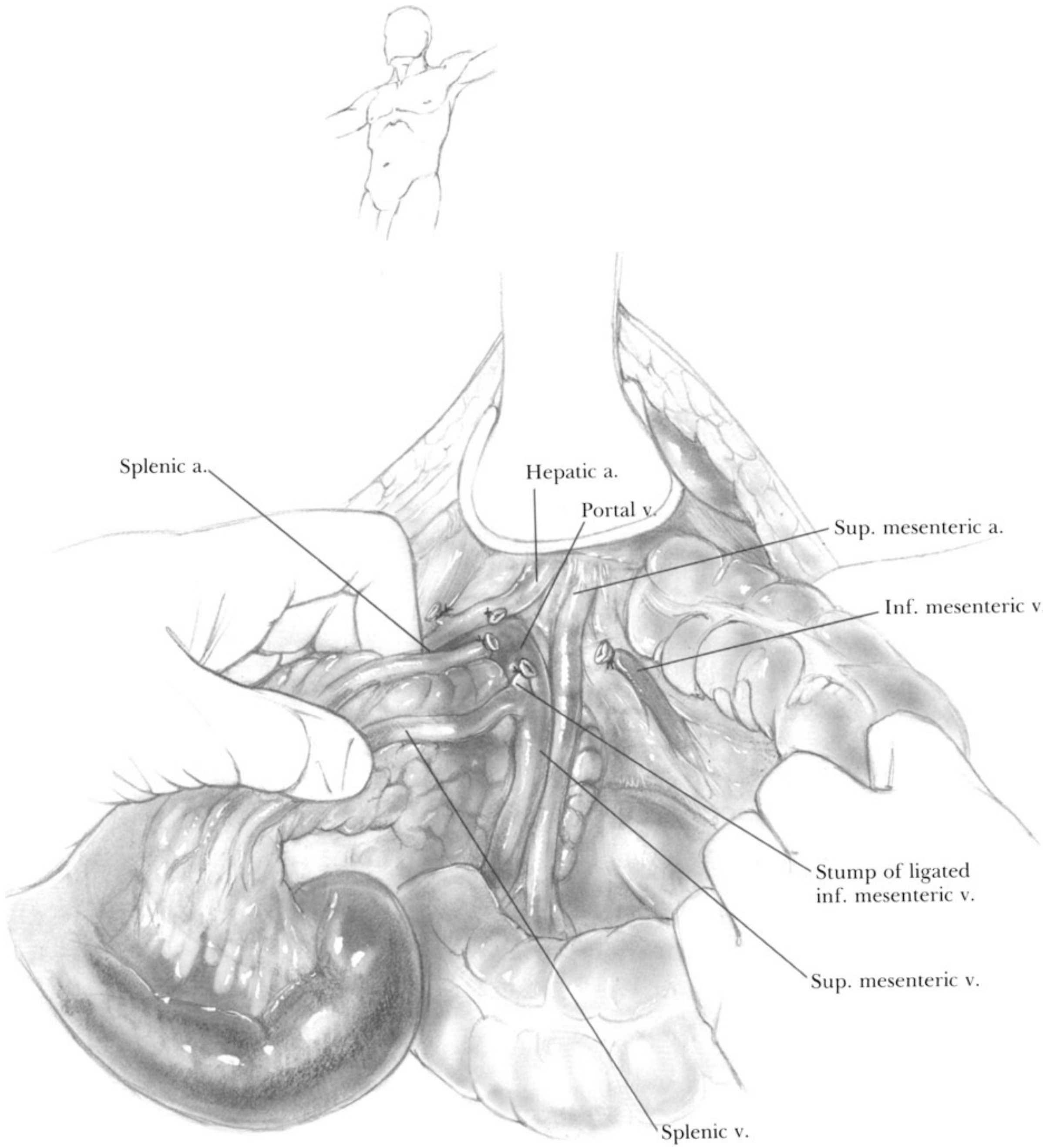


Fig. 74–10

pancreas. After 2 cm of the terminal portion of the splenic vein has been cleared (**Fig. 74–10**), divide the splenic vein between 2–0 silk ligatures.

Hemigastrectomy

Select a point on the lesser curvature of the stomach about halfway between the pylorus and the esophagogastric junction. Divide and ligate the left gastric vessels at this point. Clear the omentum from the greater curvature of the stomach so that a hemigastrectomy can be accomplished. Then divide the stomach between two applications of the TA-90 stapling device (**Fig. 74–11**). Lightly coagulate the everted mucosa of the gastric stump. Apply a sterile rubber glove to the specimen side of the divided stomach and fix it in place with an umbilical tape ligature.

Cholecystectomy and Division of the Hepatic Duct

The hepatic duct, portal vein, and hepatic artery have already been stripped of overlying peritoneum and lymph nodes. At this time, divide and ligate the cystic artery. Remove the gallbladder by dissecting it out of the liver bed from above down (**Fig. 74–12**).

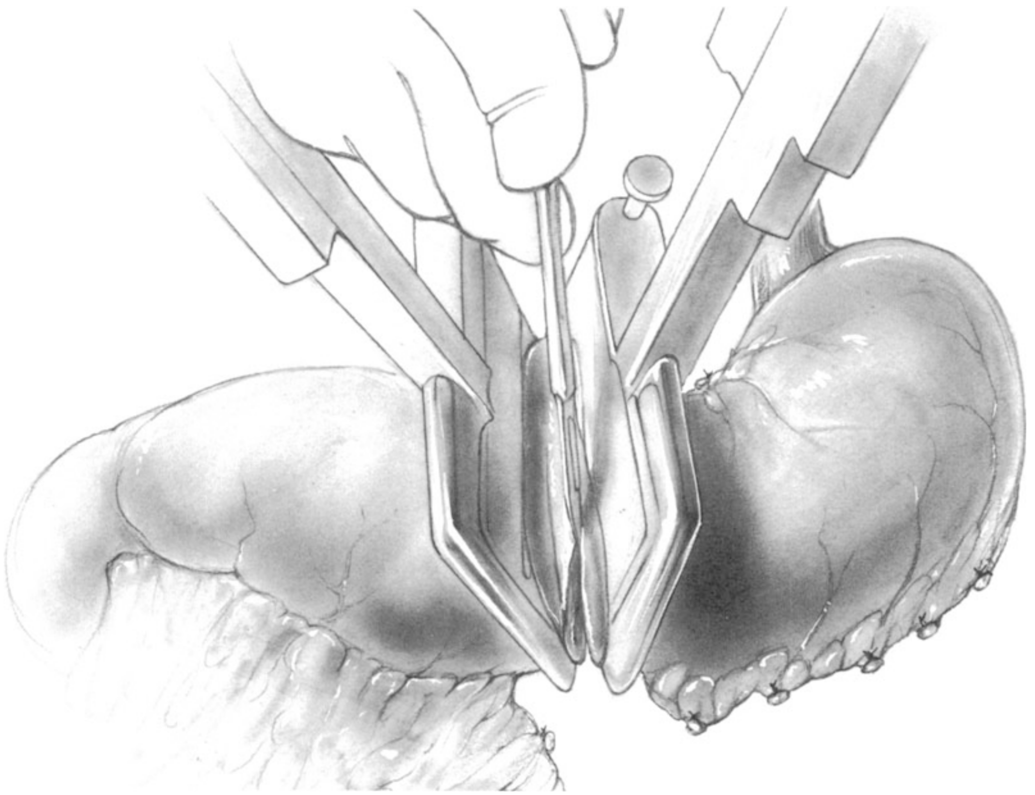


Fig. 74–11

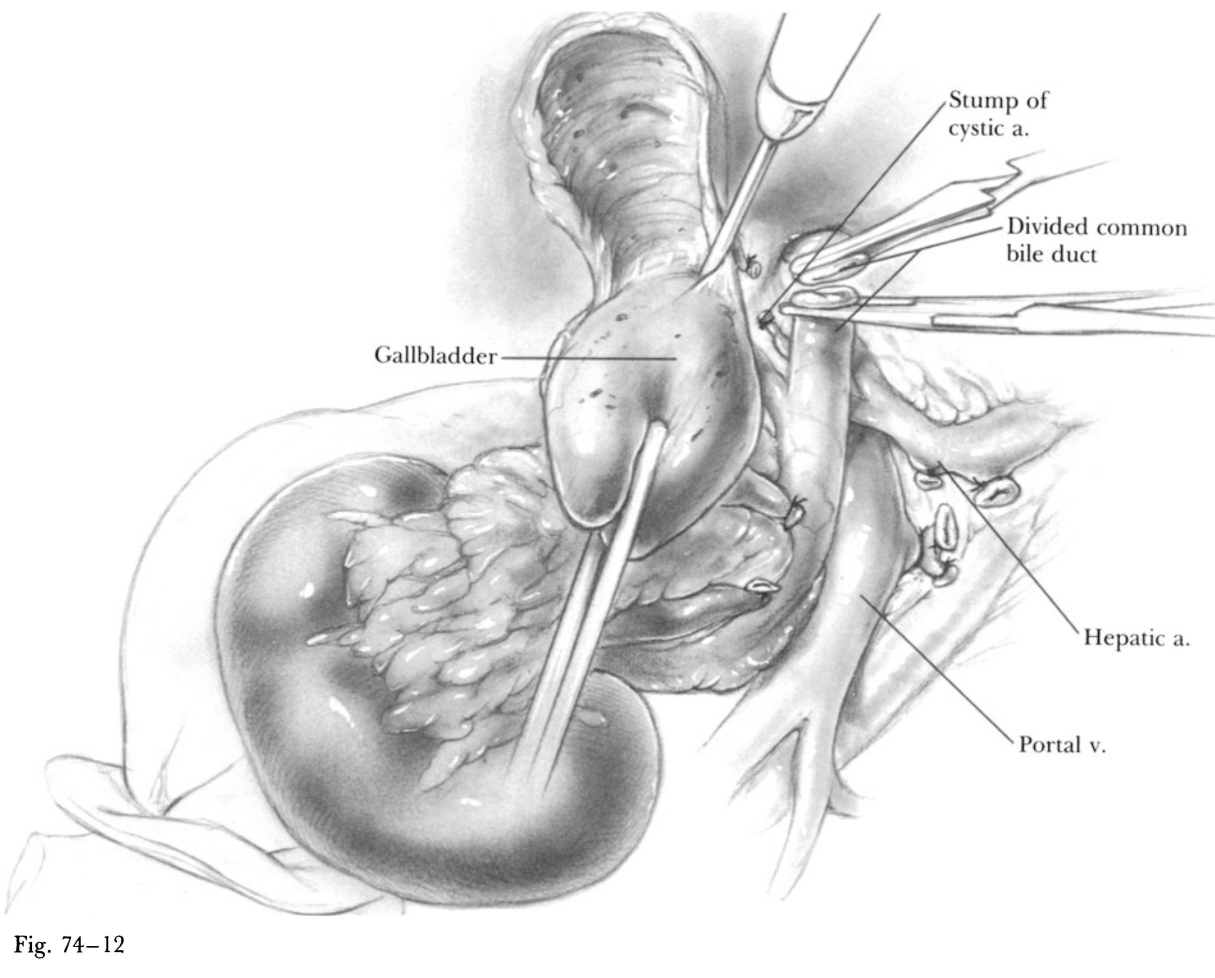


Fig. 74–12

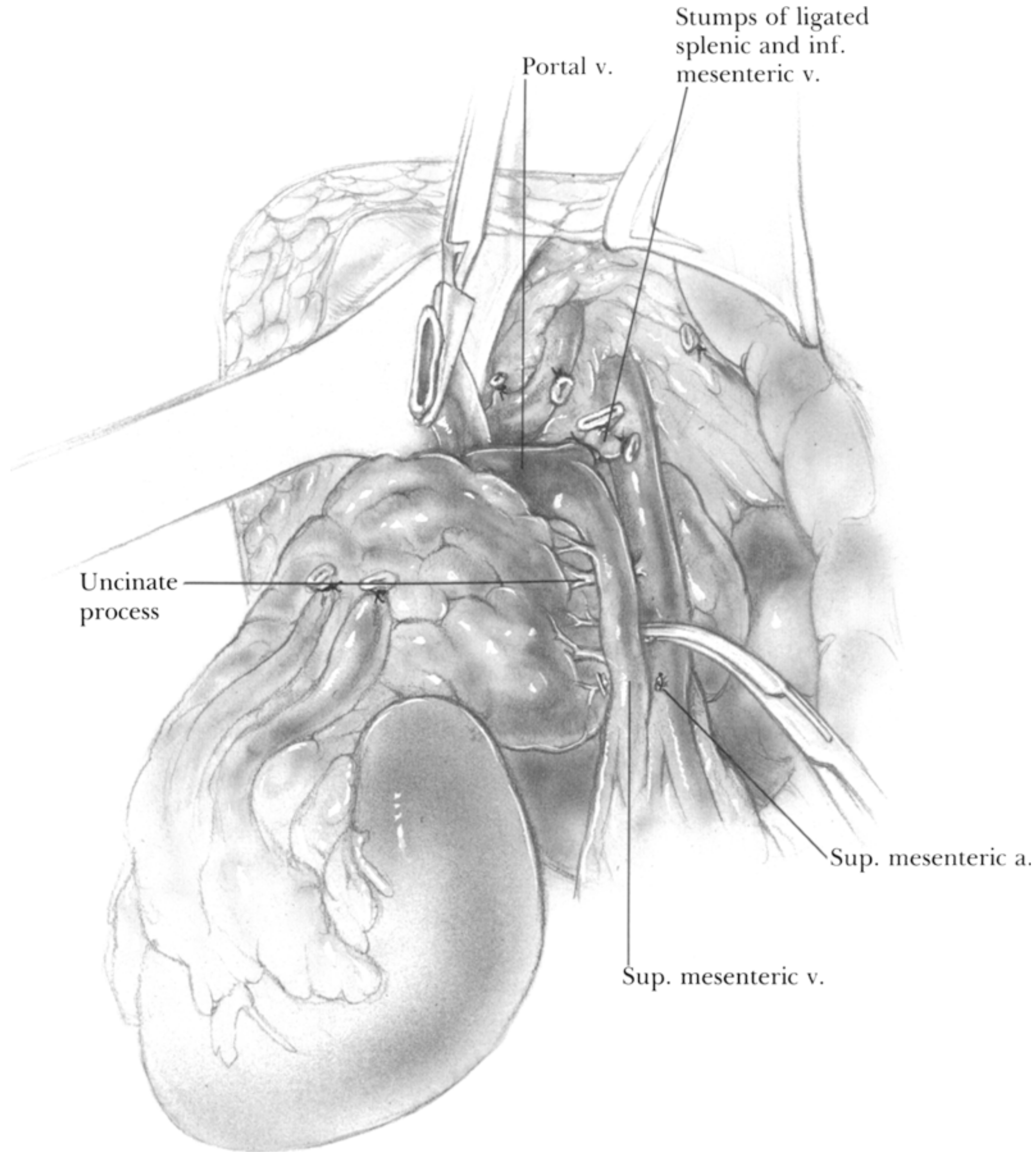


Fig. 74–13

Obtain complete hemostasis in the liver bed with electrocautery. Ligate the cystic duct. Divide it and remove the gallbladder.

Dissect the hepatic duct free from the portal vein at a point just above its junction with the cystic duct. Free about 1.5 cm of hepatic duct. Apply a ligature to the distal end and an atraumatic bulldog clamp to the proximal end and divide the duct.

Freeing the Uncinate Process

Retract the spleen, pancreas, and duodenum to the patient's right. Gentle dissection will disclose 3–4 venous branches between the posterior surface of the pancreatic head and the portal-superior mesenteric veins (**Fig. 74–13**). Ligate each of these vessels with 3–0 silk and divide them. Then it will be possible gently to retract the portal vein to the right. At this point the superior mesenteric artery can generally be clearly identified. In some cases it is easy to identify several arterial branches that can be dissected free, divided, and individually ligated (**Fig. 74–14**). More commonly, a fibrotic segment of uncinate process goes posterior to the superior mesenteric artery. This is difficult to dissect free. In these cases, the uncinate process may either be divided with the electrocoagulator, or divided between straight Crile hemostats, always keeping the superior mesenteric artery in view (see Figs. 73–11 and 73–12). Alternatively apply a TA-55 stapler to the uncinate process and divide the process flush with the stapling device. Before dividing the uncinate process, always

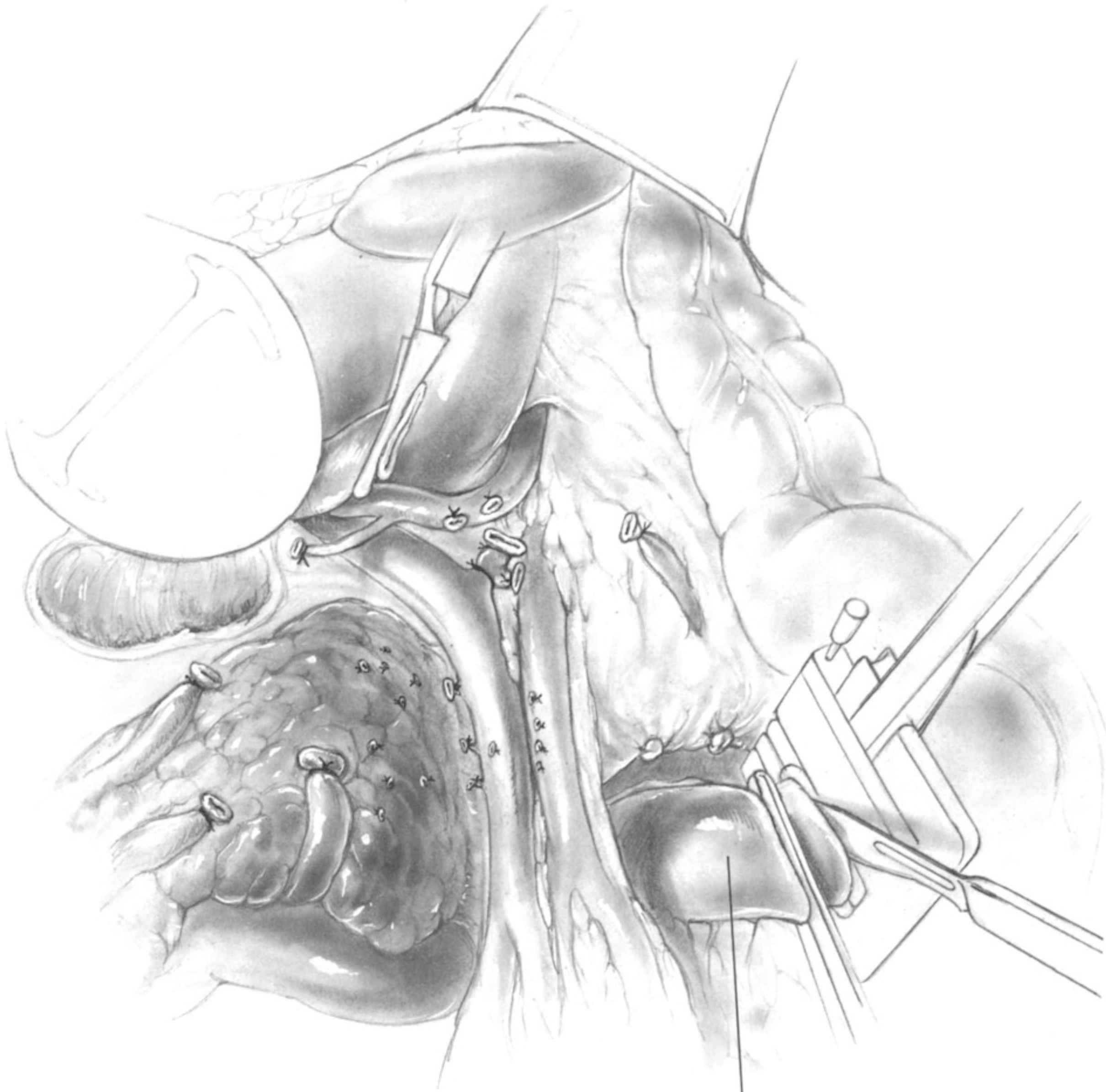


Fig. 74–14

remember to palpate along its posterior surface to be sure that an anomalous hepatic artery does not arise from the superior mesenteric artery and pass through this uncinate process, thus making it vulnerable to injury at this point in the operation.

Mobilizing the Duodenojejunal Junction

Expose the ligament of Treitz by elevating the transverse colon. Divide all of the attachments between the terminal duodenum and the ligament of Treitz by sharp dissection. Next divide the first 3–4 blood vessels to the jejunum after drawing the jejunum behind the superior mesenteric vessels to the patient's right. After this segment of mesentery has been freed, apply a TA-55 stapling device with 3.5-mm staples across the jejunum. Fire the staples. Apply an Allen clamp to the specimen side of the jejunum. Divide the specimen with a scalpel, flush with the stapler (Fig. 74–14). After removing the stapling

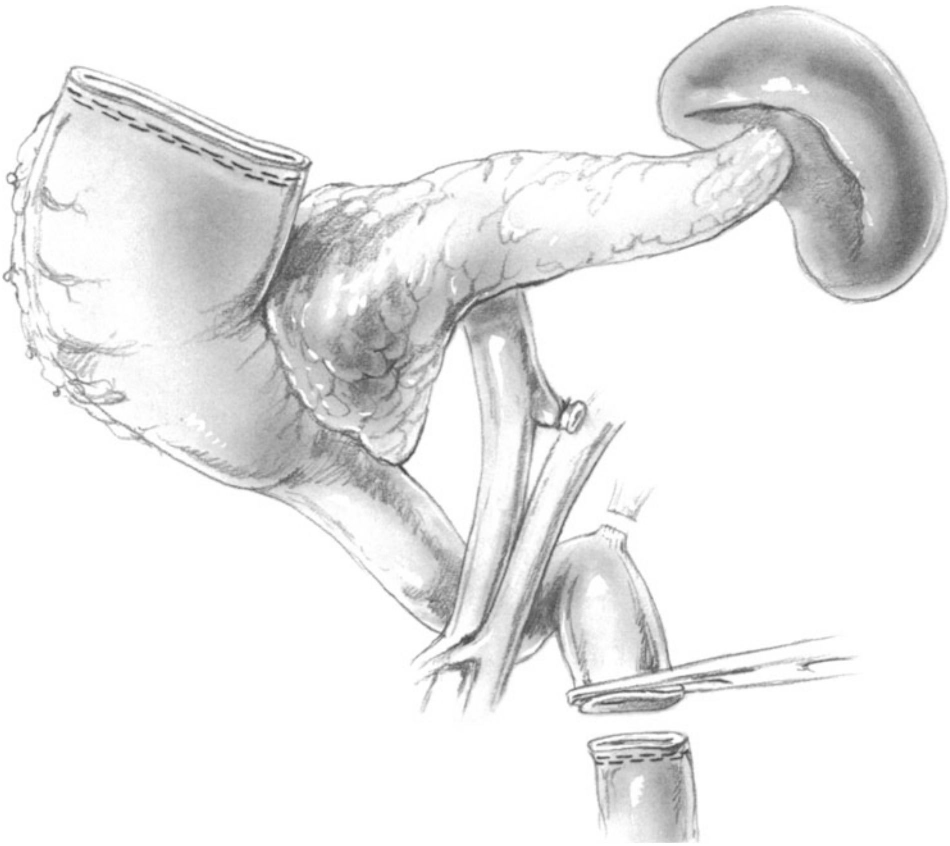


Fig. 74–15

device, lightly electrocoagulate the everted mucosa and remove the specimen (**Fig. 74–15**).

Hepaticojejunostomy

If the diameter of the hepatic duct is small, enlarge it by making a small Cheatle incision along its anterior aspect.

In order to insert a T-tube across the anastomosis, make a 3-mm incision on the anterior wall of the hepatic duct at a point about 2–3 cm proximal to its cut end. Then insert a right-angled hemostat through this incision into the lumen of the hepatic duct. Grasp the long limb of a No. 16 T-tube and draw it through the lumen and out through the small puncture wound (see Figs. 73–31 and 73–32).

Bring the proximal jejunum in an antecolonic fashion up to the hepatic duct. Make an incision along the antimesenteric border of the jejunum about equal to the diameter of the hepatic duct. Excise any redundant jejunal mucosa by electrocautery. We use one layer of 5–0 Vicryl sutures for this anastomosis. Since this material is absorbable, it does not matter whether the knots are tied inside or outside the lumen of the anastomosis.

Insert the first suture through the full thickness of the jejunum and then through the hepatic duct at the left lateral border of the anastomosis. Insert the second suture in the same fashion at the right lateral margin of the anastomosis. Before tying these sutures bisect the posterior anastomosis by placing the next suture at the midpoint between the first two and tie it (see Fig. 73–34). Insert the remaining sutures of the posterior layer so as to invert the jejunal mucosa.

Now complete the anterior layer of the anastomosis with a single row of interrupted through-and-through sutures of 5–0 Vicryl. If there is any difficulty about inverting the jejunal mucosa, use a Lembert or a seromucosal suture on the jejunal side and a full-thickness stitch on the hepatic duct side.

Gastrojejunostomy

At a point about 50 cm downstream from the hepaticojejunal anastomosis, construct a stapled gastrojejunostomy (**Figs. 74–16 and 74–17**) by the technique described in Chap. 24 (Figs. 24–47 to 24–50). Bring the T-tube out through a stab wound in the right upper quadrant. Irrigate the entire operative field with a dilute antibiotic solution. Be certain that hemostasis is complete. Insert a large

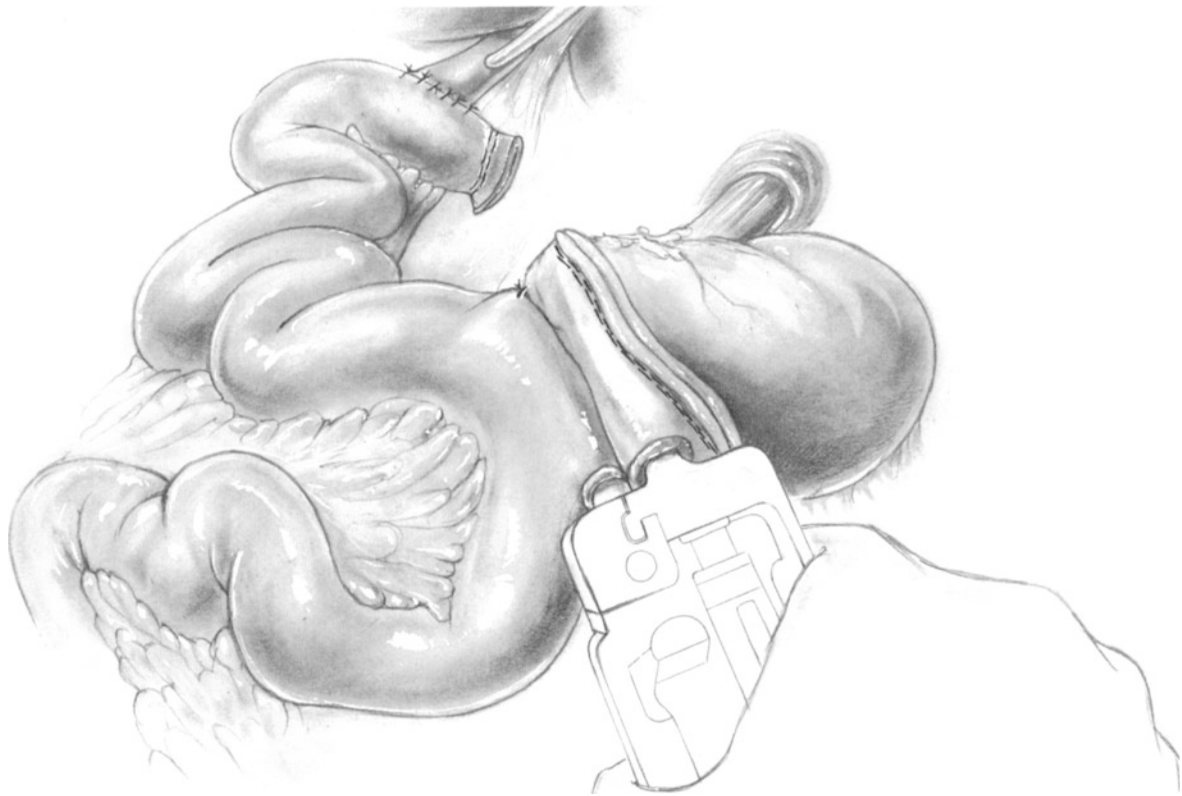


Fig. 74–16

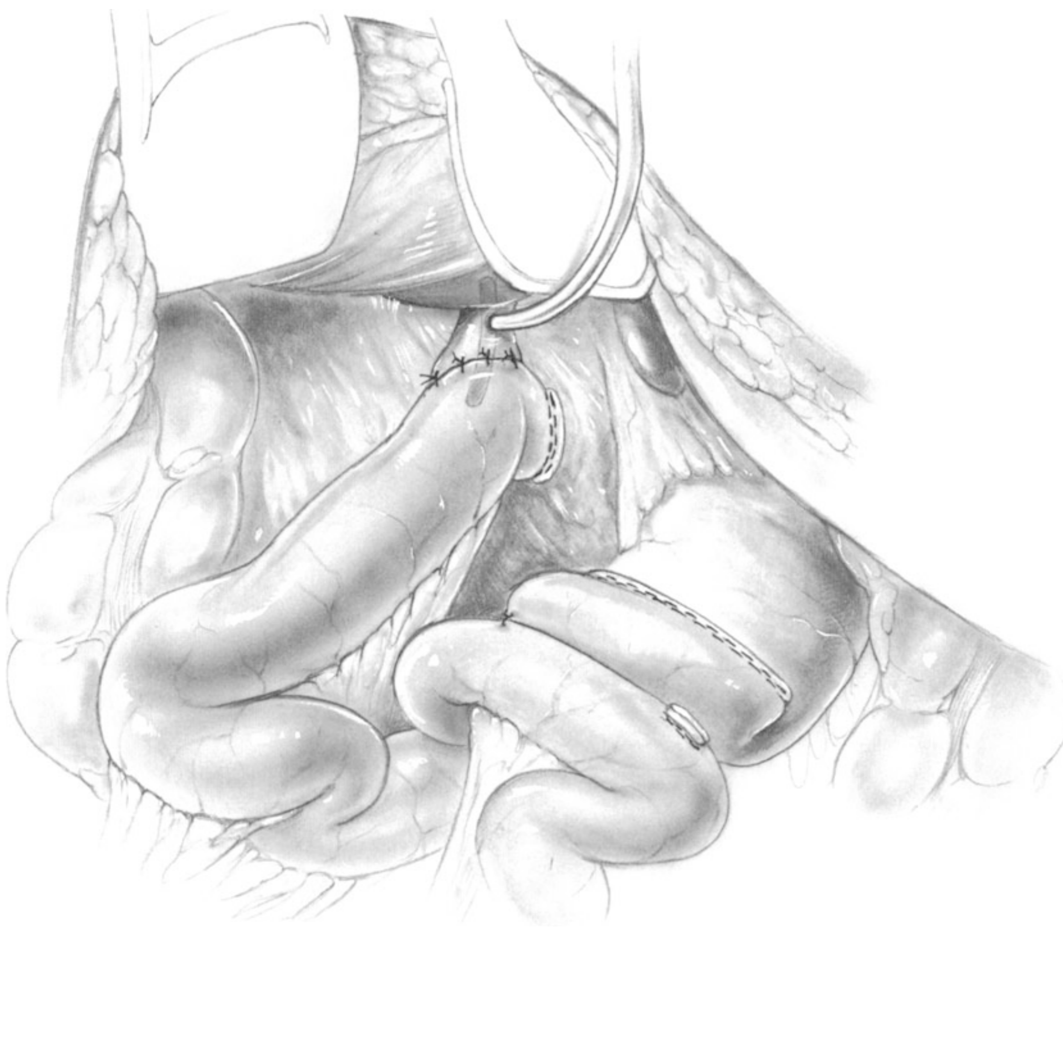


Fig. 74–17

Jackson-Pratt suction-drainage catheter in the right upper quadrant of the operative field and bring it out through a stab wound in the abdominal wall.

Close the midline incision in routine fashion. Close the skin with interrupted nylon sutures or staples.

Postoperative Care

Those principles of postoperative care described in Chap. 73 apply to total pancreatectomy except that there is no possibility of a pancreatic fistula. The suction-drainage catheter is removed sometime after the 4th postoperative day unless a significant amount of drainage persists. The T-tube is left in place for 21 days.

The most important element of postoperative care following total pancreatectomy is the regulation of the resulting diabetes. The greatest danger is the hypoglycemia that develops from administering too much insulin. Perform blood sugar determinations every 3–4 hours for the first few days. Do not try to keep the blood sugar level below 200 mg/dl. Especially during the early postoperative period, the diabetes is quite brittle and an overdose of only a few units of insulin may produce hypoglycemic shock. There is much more danger from hypoglycemia than from diabetic acidosis. Administer regular insulin in doses of 2–5 units every few hours as necessary. Frequently no more than 10–20 units are required per day.

After the patient begins to eat, he may be switched to one of the longer-acting insulin products. The patients and his relatives should be carefully instructed in the symptoms of hypoglycemia.

Repeated measurements of the gastric pH are vital to prevent postoperative gastric hemorrhage. Use intravenous H_2 blockers to keep the gastric pH at 5 or above.

A sufficient dose of pancreatic enzymes must be given to prevent steatorrhea. This may require three tablets of Pancrease before each meal.

Postoperative Complications

Insulin shock

Postoperative gastric bleeding due to stress ulceration or marginal ulcer

Postoperative hemorrhage

Postoperative sepsis

Leakage from biliary anastomosis

Mesenteric venous thrombosis

Hepatic failure

75 Distal Pancreatectomy

Indications

Malignant tumors of body or tail: cystadenocarcinoma; malignant insulinoma or gastrinoma; duct cell carcinoma (rarely resectable)

Benign tumors that cannot be locally excised (e.g., insulinoma)

Pseudocysts of tail (selected)

Chronic pancreatitis localized to body and tail

Preoperative Care

Angiography occasionally localizes a tumor (e.g., insulinoma).

Operations for insulinoma require careful monitoring of the blood sugar at frequent intervals prior to and during operation.

Patients suspected of having a gastrinoma should have this diagnosis confirmed by serial serum gastrin levels before and after administration of intravenous secretin.

Pitfalls and Danger Points

Lacerating splenic or portal vein

Operative Strategy

Avoiding Damage to Blood Vessels

Once the decision has been made that the lesion in the pancreas should be resected, locate the splenic artery at a point a few centimeters beyond its origin at the celiac axis. Ligate the vessel in continuity to reduce the size of the spleen and to reduce the volume of blood loss if the splenic capsule is ruptured during the dissection.

The greatest danger in resecting the body and tail of the pancreas arises when a malignancy in the body obscures the junction between the splenic and portal veins. Invasion by tumor of the portal vein is an indication of inoperability. If elevation of the tail and body of the pancreas together with the tumor should result in a tear at the junction of the splenic and portal veins, and this accident occurs before the tumor has been completely liberated, it may be extremely difficult to repair the lacerated portal vein. If an accident of this type should occur, it may be necessary to find the plane between the neck of the pancreas and the portal vein, and then to divide the pancreas across its neck while manually occluding the lacerated vein. With the portal and superior mesenteric veins exposed after the neck of the pancreas has been divided, occluding vascular clamps may be applied and the laceration repaired. This complication can generally be avoided by careful inspection of the tumor after elevating the tail of the pancreas and by observing the area where the splenic vein joins the portal. If the tumor extends beyond this junction, it is probably inoperable.

Avoiding Pancreatic Fistula

We have used the TA-55 stapling device for many years to accomplish closure of the cut end of the remaining pancreas after resecting the body and tail of this organ (Pachter, Pennington, Chassin et al.). When the stapler is used across the neck of a pancreas of average thickness, the staples seem to occlude the cut end of the pancreatic duct successfully; no supplementary sutures are needed to prevent a fistula.

If the stapler is not used, be certain to occlude the cut pancreatic duct by inserting a nonabsorbable mattress suture.

Operative Technique

Incision and Exposure

In the average patient a long midline incision from the xiphoid to a point about 6–10 cm beyond the umbilicus provides adequate exposure for mobilizing the spleen and the tail of the pancreas. In an obese or a very muscular individual with a wide costal angle, a long transverse or left subcostal incision is a suitable alternative.

Exploration; Liberating the Omentum

After exploring the abdomen for possible metastatic deposits, expose the body and tail of the pancreas by liberating the omentum from its attachments to the

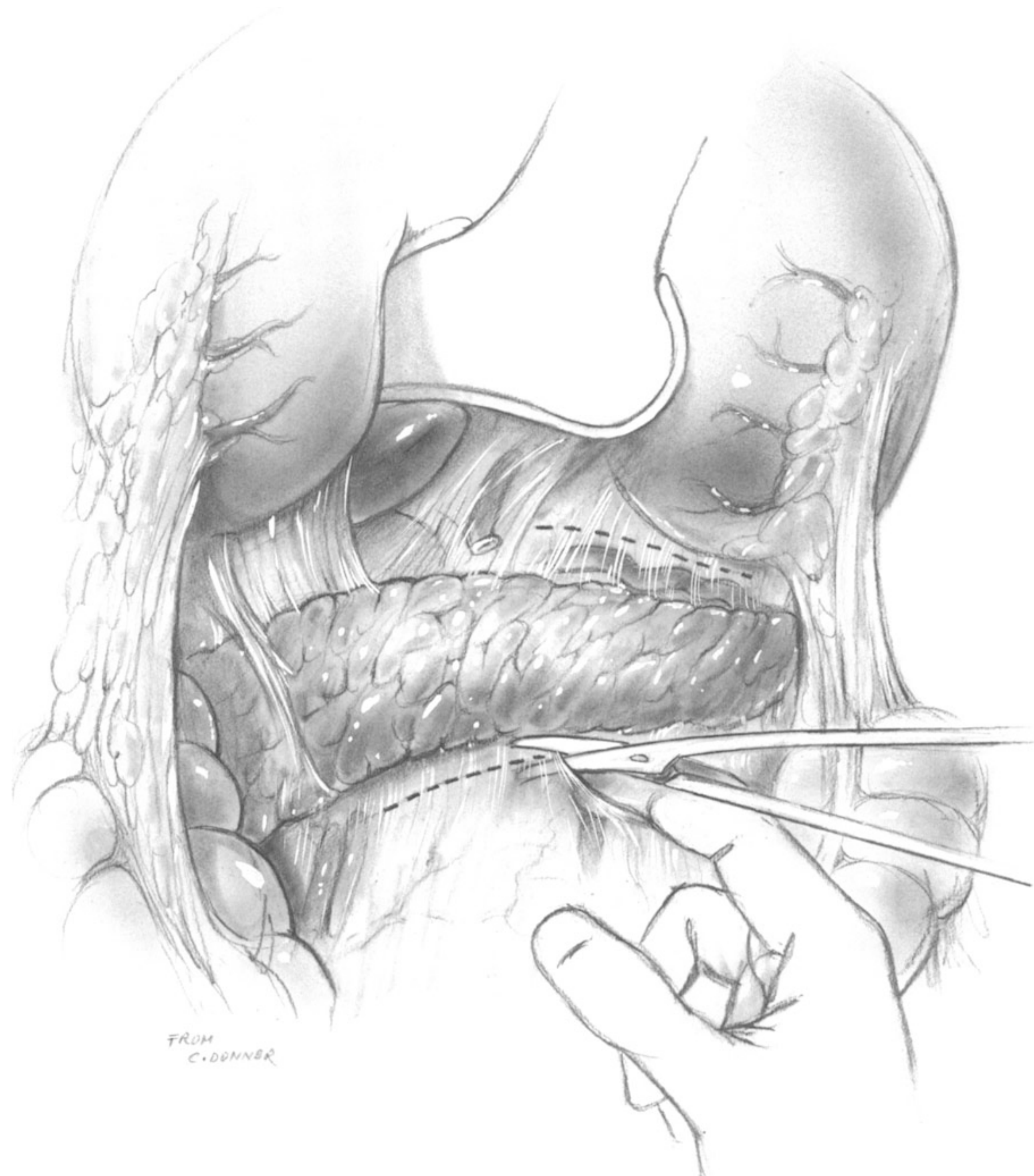


Fig. 75–1

transverse colon. An alternative method is to divide the omentum between hemostats. This will expose the anterior surface of the pancreas. In order to palpate the posterior surface of the pancreas, it will be necessary to incise the layer of peritoneum that covers the pancreas and then continues down to the transverse colon forming one leaflet of the transverse mesocolon. Incise this layer along the inferior border of the tail of the pancreas (**Fig. 75–1**). The only major blood vessel deep to this layer of peritoneum is the inferior mesenteric vein that travels from the transverse mesocolon to join the inferior border of the splenic vein just before the splenic vein joins the portal. After completing this incision, insert the index finger behind the pancreas and use the fingertip to elevate the peritoneum along the superior margin of the pancreas (**Fig. 75–2**). Then incise this layer of peritoneum with a scissors, avoiding the sometimes convoluted splenic artery that runs along the superior border of the pancreas deep to the layer of peritoneum. After these two peritoneal incisions have been made, palpate the tail and body of the

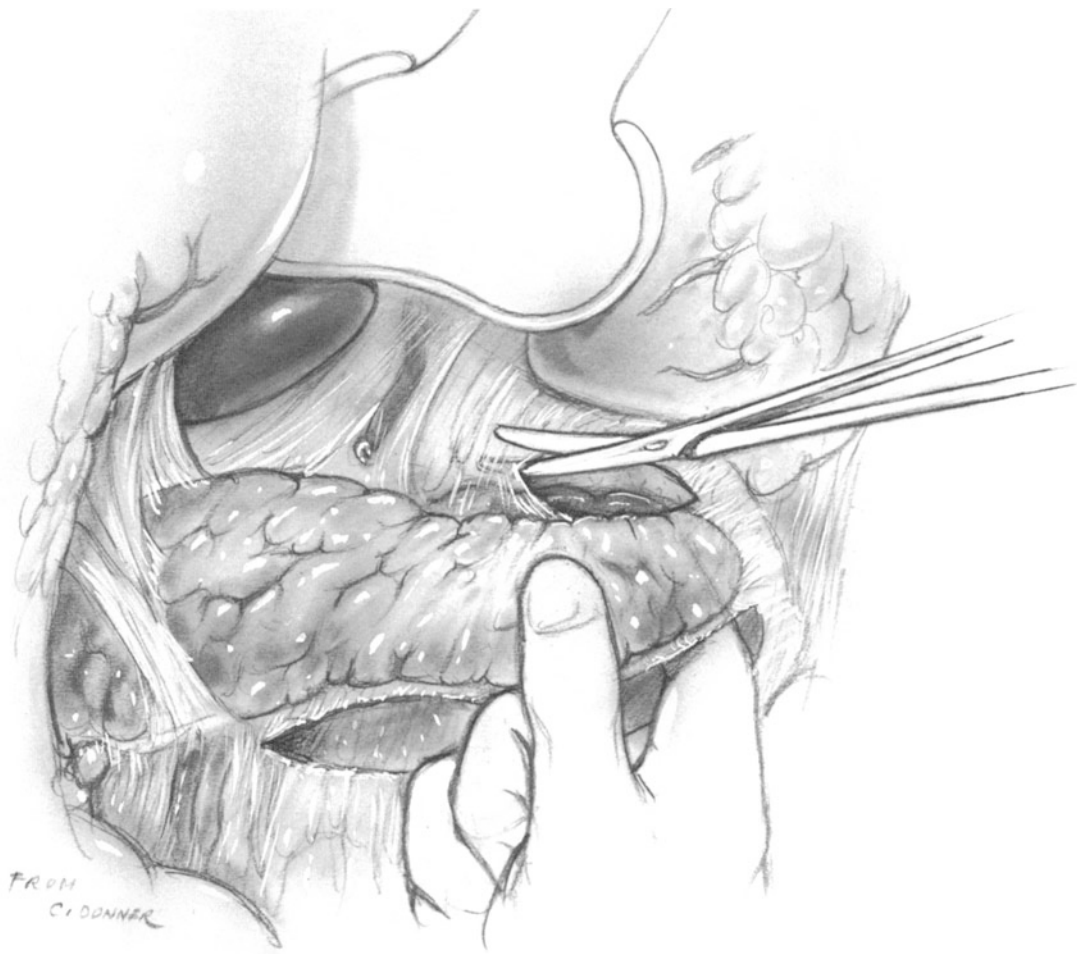


Fig. 75–2

pancreas between the thumb and forefinger to evaluate the pathology.

If the surgeon is searching for a gastrinoma, he should also perform a Kocher maneuver and palpate the descending duodenum and the head of the pancreas. Some non-beta cell tumors of the pancreas can be palpated as small projections from the pancreas into the posterior wall of the descending duodenum. Many of the benign tumors can be excised locally or may be shelled out by gentle dissection.

Identifying Splenic Artery

Palpate the splenic artery along the upper border of the neck of the pancreas at a point a few centimeters from its origin. If there is some confusion as to the identity of the artery, occlude it with the fingertip and palpate the hepatoduodenal ligament to determine whether it is the hepatic artery that has been occluded. If the hepatic artery pulsation is normal, then open the peritoneum overlying the splenic artery. Encircle it with a right-angle clamp and ligate it in continuity with 2–0 silk (see Figs. 78–3).

Mobilizing Spleen and Pancreas

Retract the spleen to the patient's right, placing the splenorenal ligament on stretch. Incise this ligament (see Fig. 79–1) with a Metzenbaum scissors or electrocoagulator. Continue this incision up to the diaphragm and down to include the splenocolic ligament. Now elevate the spleen and the tail of the pancreas by fingertip dissection from the renal capsule. The greater omentum may be attached to the lower portion of the spleen. Dissect this away from the spleen. It should now be possible to elevate the spleen and the tail and body of the pancreas up into the incision leaving the kidney and adrenal gland behind. Cover these structures with a large moist gauze pad.

The spleen remains attached to the greater curvature of the stomach by means of the intact left gastroepiploic and short gastric vessels. Divide each of these structures individually between hemostats and then ligate each with 2–0 silk (see Fig. 78–2 and 78–4). Inspection of the posterior surface of the pancreas will reveal the splenic vein. Dissecting along the inferior border of the pancreas will unroof the inferior mesenteric vein on its way to join the splenic vein. Identify, encircle, and divide the inferior mesenteric vein between 2–0 silk ligatures.

Dividing the Splenic Artery and Vein

Gently elevate the splenic vein by sweeping the areolar tissue away from this vessel with a peanut dissector until the junction between the splenic and portal veins is identified. At this point encircle the splenic vein with a right-angle clamp at a point about 2 cm proximal to its junction with the portal vein. Pass two ligatures of 2–0 silk around the splenic vein and tie these two ligatures about 1.5 cm apart. Divide the vein between the two ligatures (**Fig. 75–3**).

Then identify the previously ligated splenic artery. Tie a second ligature around this artery and

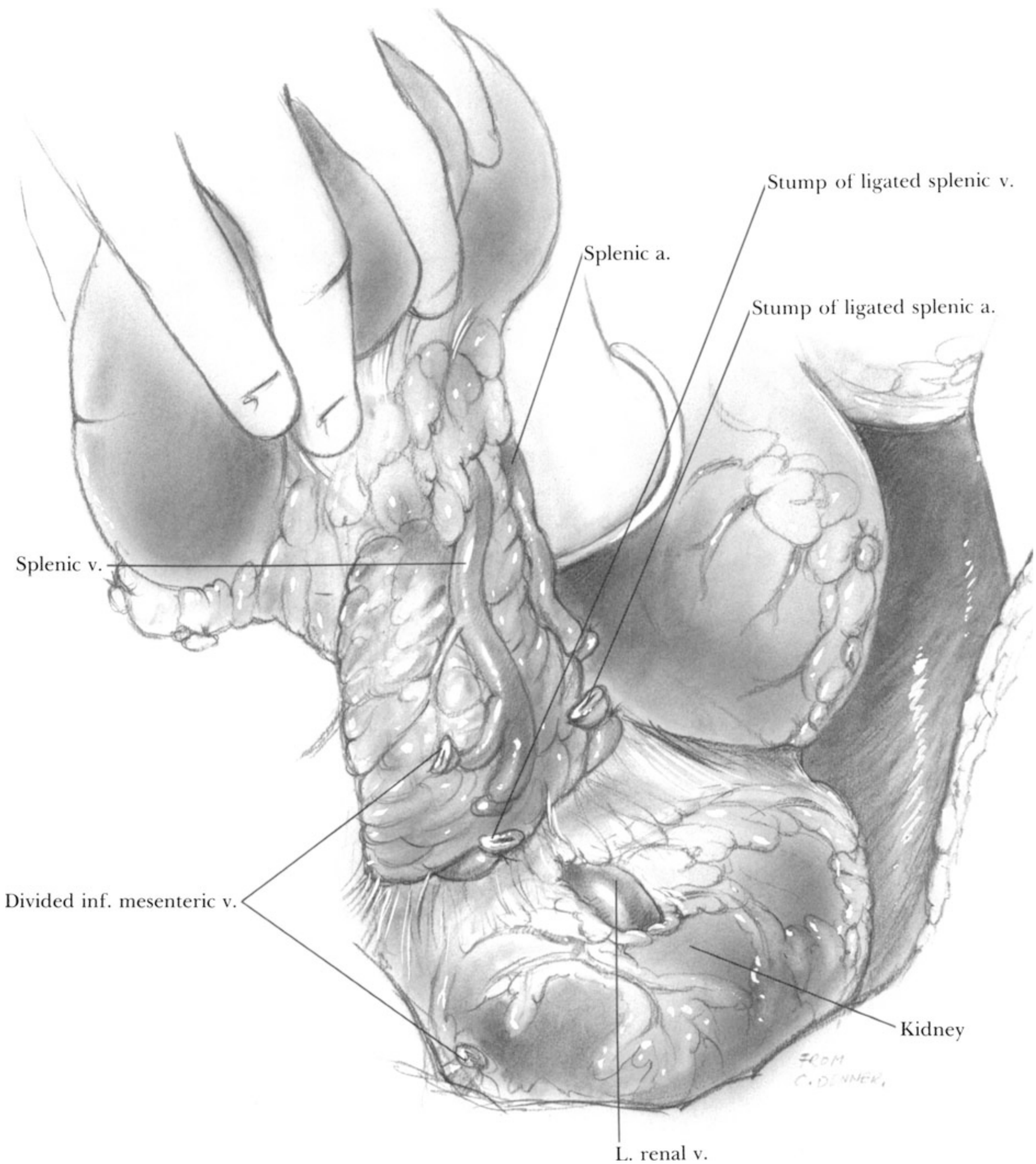


Fig. 75–3

Fig. 75–4

divide the vessel distal to the two ligatures. This will leave the specimen attached only by the neck of the pancreas in the region of the portal vein.

Dividing the Pancreas

If the pancreas is average in thickness, it is a simple matter to apply a TA-55 stapler across the neck of the pancreas. Use 3.5-mm staples in most cases. Fire the staples and divide the pancreas flush with the stapler using a scalpel. Remove the specimen. Then remove the stapling device and inspect the cut edge of the pancreas carefully for bleeding points (**Fig. 75–4**). It is frequently necessary to suture-ligate a superior pancreatic artery near the upper border of the remaining pancreas. We have not found it necessary to identify or to suture the pancreatic duct when using a stapled closure of the transected pancreas.

Alternatively, one may occlude the transected pancreas with interlocking interrupted mattress sutures of 3–0 nonabsorbable suture material. If the pancreatic duct is identified, occlude this duct with a separate mattress suture.

Closure and Drainage

Place a flat Jackson-Pratt multiperforated closed-suction drainage catheter down to the site of the divided pancreas and bring the catheter out through a puncture wound in the abdominal wall.

Close the incision in routine fashion after ascertaining that complete hemostasis in the pancreatic and splenic beds has been achieved.

Postoperative Care

Attach the drainage catheter to a closed-suction system. Leave the drain in place 4–6 days. If a pancreatic duct fistula is suspected, leave the drain in place for a longer period of time.

Perform occasional checks of the serum amylase and the blood sugar to detect postoperative pancreatitis and diabetes.

Postoperative Complications

Pancreatic fistula. If this complication develops, it will generally recede spontaneously in 1–4 weeks. If it does not recede in that period of time, perform an X-ray sinogram with an aqueous contrast medium.

Acute pancreatitis in the residual pancreas is a possible but uncommon complication.

Diabetes mellitus of mild degree sometimes occurs after an extensive distal pancreatectomy.

Reference

Pachter HL, Pennington R, Chassin JL et al. Simplified distal pancreatectomy with the autosuture stapler; preliminary clinical observations. Surgery 1979;85:166.

76 Operations for Pancreatic Cyst

Concept: When to Operate and Which Operation to Do

Cystadenoma versus Pseudocyst

The proper operation for cystadenoma, a neoplasm that has the potential of containing malignancy, is a resection. On the other hand, most pseudocysts may be cured by drainage. Therefore it is important to make an accurate diagnosis before selecting the operation for a pancreatic cyst. A pseudocyst, which is often preceded by one or more attacks of acute pancreatitis, frequently produces upper abdominal pain, occasionally nausea and vomiting, mild leukocytosis, and an elevated serum amylase. The cystadenoma, on the other hand, produces few symptoms. In any case, during the course of performing a drainage operation on a suspected pseudocyst, always excise a segment of the cyst wall for immediate frozen-section histopathology to rule out cystadenoma or cystadenocarcinoma. This is particularly important because resecting a cystadenocarcinoma results in a highly satisfactory 5-year survival rate (over 50%). If the cyst is lined by epithelium, it is *not* a pseudocyst and should be resected, not drained.

Operation or Percutaneous Catheter Drainage of Pancreatic Pseudocyst

In the past decade invasive radiologists have successfully inserted percutaneous catheters into various sites of the abdomen for purposes of draining abscesses. Percutaneous catheter drainage of a pancreatic pseudocyst is identical to external drainage, a procedure that surgeons still use when the cyst wall is too thin to suture or when the cyst is grossly infected. The drawback has always been that when the cyst was in communication with one of the pancreatic ducts, a persistent pancreatocutaneous fistula developed. It is still not clear whether avoiding an operation by percutaneous catheter drainage will produce annoying complications that will outweigh the advantage of avoiding surgery. The report of Adams, Harvey, and Anderson sheds considerable light upon this issue. They studied 28 patients suffering from pancreatic pseudocysts. Six had pancreatic ascites associated with pseudocysts. Successful pseudocyst resolution was achieved in 26 patients, with failure of eradication in 2 patients. The mean length of time required for cathether drainage before cyst eradication was 48 days, with a range of 7–210, with complications such as one myocardial infarction, one pneumothorax, and 6 infections of cysts, primarily by *Staphylococcus aureus*. There did not appear to be any serious late complications relating to the drainage procedure.

Criado, De Stefano, and Weiner performed percutaneous catheter drainage of pancreatic pseudocysts in 42 patients. One drainage procedure was sufficient in 22 patients, but 15 patients required two, and five underwent three procedures. The mean follow-up evaluation time was 10 months. Of the 42 patients, there were 33 treatment failures. Eventually 25 patients required surgery.

These authors feel that percutaneous drainage is useful as initial treatment in patients at high surgical risk and perhaps for infected cysts, but "in elective situations where long term success is the goal, internal drainage probably continues to be the most valuable option." A randomized prospective study comparing surgery with catheter drainage would be exceedingly useful.

Timing of Operation

In the case of *cystadenoma*, perform a resection as soon as the patient is properly prepared.

The pancreatic *pseudocyst* begins its existence as nothing more than an accumulation of secretion and exudate surrounding the pancreas in the lesser sac after an episode of acute pancreatitis. These cysts may be detected sometimes by no other means than sonography or computerized tomography.

After a period of time the wall of the pseudocyst develops a fibrotic lining, which makes a cystogastric or cystojejunal anastomosis feasible. Prior to the development of this fibrotic wall, suturing the cyst to a portion of the gastrointestinal tract may be dangerous. Consequently, operation is not indicated during the first 6 weeks following the initial formation of the pseudocyst unless serial sonography shows rapid growth or unless some complication occurs. Abscess, rupture of the cyst with peritonitis, and hemorrhage have been reported during this initial 6-week period of observation by Bradley, Clements, and Gonzales. Immediate operation is, of course, indicated for these complications. On the other hand, these authors found that at least 40% of their patients showed complete resolution of the pseudocyst *during* this 6-week period. *After* the passage of 6 weeks, they noted only one case of spontaneous resolution in 33 patients studied in contrast with 17 serious complications, which included intraperitoneal rupture (with two deaths), cystenteric fistula, common bile duct obstruction, and hemorrhage.

Frey emphasized that hemorrhage in patients with pancreatic pseudocysts is most often due to rupture of a pseudoaneurysm. This type of aneurysm occurred most frequently in the splenic artery and ruptured into the pseudocyst, but pseudoaneurysms were also found in the gastroduodenal and the inferior pancreaticoduodenal arteries. In patients who have formed cystenteric fistulas, rupture of a pseudoaneurysm produces hemorrhage into the gastrointestinal tract and occasionally hemobilia.

Because of the high incidence of serious complications occurring in patients with conservatively managed pseudocysts, all such cysts require operation unless they resolve themselves in 6 weeks, or unless the cyst is less than 5 cm in diameter as measured on the sonogram (Bradley et al.; Frey; Martin et al.; Shatney and Lillehei).

Choice of Operation

External Drainage by Laparotomy or Percutaneous Catheter

External drainage is the operation of choice in all pseudocysts that have not yet developed a wall fibrotic enough to withstand suturing and in the unusual case of the pseudocyst that is in fact a large abscess cavity containing frank pus. We rarely encounter a patient who is "too sick" to withstand a cystojejunostomy or a cystogastrostomy, although Martin, Catalano, Cooperman et al. feel that external drainage is not such a poor second choice. In their series, the longest period of continuous drainage from the cystocutaneous fistula was 4 months, although most fistulas stopped draining within 6 weeks. Other authors report a high incidence of persistent fistulas, recurrent cysts, and other complications following external drainage (Frey; Sandy, Taylor, Christensen et al.).

Marsupialization, or suturing the wall of the cyst to the skin, is rarely indicated. If the cyst wall is thick enough to suture to the skin, it is thick enough to undergo a cystenteric anastomosis.

Another method of instituting external drainage is to pass a needle and then a catheter into the pseudocyst by a transcutaneous route under the control of computed tomography (Karlson, Martin, Frankuchen, and associates). This technique of draining a pancreatic pseudocyst must be judged an experimental procedure until more data become available concerning its merits and its complications.

Cystogastrostomy

This operation is indicated only when the anterior wall of the cyst is firmly attached to the posterior wall of the stomach. Under these conditions it is an excellent operation. Otherwise, suturing the free wall of a cyst to the free wall of the stomach assumes the risk of a postoperative gastric fistula, which is indeed a disastrous complication. Because the wall of a pseudocyst is primarily fibrous and contains no discrete blood supply, there is always some risk that an anastomosis to this structure will fail. And because most large pseudocysts are indeed firmly attached to the posterior wall of the stomach, cystogastrostomy is probably the most commonly performed operation for pancreatic pseudocyst.

Cystoduodenostomy

The warning stated above applies with even greater force to cystoduodenostomy. If the cyst wall is not densely attached to the wall of the duodenum, do not perform cystoduodenostomy because a duodenal leak in this situation will often be fatal, as it was in the case of two patients reported by Frey.

Roux-en-Y Cystojejunostomy

This operation is indicated whenever an anastomosis must be performed to the anterior wall of a cyst that is not firmly attached to either stomach or duodenum. If a defunctionalized limb is used, one that is over 50 cm long, the dehiscence of a cystojejunal anastomosis will not be a life-threatening complication because the fluid leaking from this type of anastomosis will not contain the powerful digestive ferments that flow from leaking gastric or duodenal anastomoses.

Distal Pancreatectomy

When a patient with a pancreatic pseudocyst suffers also from a pseudoaneurysm in the back wall of the cyst, simply performing a drainage procedure, whether internal or external, will not prevent postoperative hemorrhage (Frey). While the older literature concerning postoperative hemorrhage following cystogastrostomy attributed the bleeding to some technical error in the anastomosis (Huston, Zeppa, and Warren), it is highly likely that the bleeding resulted from the rupture into a cyst of a pseudoaneurysm. Frey noted that 10.8% of his operative cases were found to have pseudoaneurysms on preoperative angiography. "Since hemorrhage . . . was a significant factor in the majority of deaths of patients with pseudocysts," Frey states that "all pseudocysts having an associated pseudoaneurysm should, whenever possible, be treated by excision." Three patients in Frey's series, none of whom had bled preoperatively or had any evidence of blood in the cysts at operation, underwent a simple drainage procedure, and all three exsanguinated postoperatively. A pseudoaneurysm in the wall of the cyst was the source of the hemorrhage in each case.

When a pseudoaneurysm is actively bleeding, local control by ligating the artery in the wall of a chronically inflamed cyst may not be effective since the suture will often cut through the artery postoperatively, with consequent rebleeding. Resection of the cyst together with adjacent pancreas and division of the artery in an uninflamed area proximal to the pseudoaneurysm will eliminate the threat of hemorrhage.

When an arteriogram does not demonstrate a pseudoaneurysm, it is probably not necessary to excise a pseudocyst, even if it contains blood at the time of operation (Frey; Grace and Jordan).

The only other indication for resecting a pancreatic pseudocyst occurs when a patient suffers such severe pain from irreversible chronic pancreatitis that distal pancreatectomy is indicated for this purpose alone.

Whipple Pancreatoduodenectomy

When arteriography demonstrates a pseudoaneurysm of the pancreaticoduodenal artery in the head of the pancreas, Frey believes that a Whipple pancreatoduodenectomy is indicated to remove the serious threat of exsanguinating hemorrhage. Otherwise, most pseudocysts in the head of the pancreas or in the uncinate process can be treated by internal drainage. Even though the mortality rate of pancreatoduodenectomy for pancreatitis is lower than that after cancer, this radical procedure is not often indicated for pancreatic pseudocysts except in patients who have a pseudoaneurysm in the head of the pancreas.

Indications

Any pseudocyst that measures over 5 cm in diameter by sonography or CT scan requires operation if it persists for more than 6 weeks.

Preoperative Care

Visualize the cyst by sonogram or CT scan.

Complete an upper GI X-ray series.

Rule out the presence of gallstones or bile duct obstruction by sonography, oral cholecystography, or endoscopic radiographic cholangiopancreatography (ERCP).

Perform angiography of the splenic artery and pancreas in all chronic pseudocysts prior to surgery.

Administer perioperative antibiotics.

Insert a nasogastric tube preoperatively.

Pitfalls and Danger Points

Anastomotic leak

Postoperative hemorrhage

Mistaken diagnosis (abdominal aortic aneurysm, cystadenocarcinoma)

Overlooking a pseudoaneurysm in the wall of a cyst

Operative Strategy

Avoiding Anastomotic Leakage

As discussed above, do not perform either a cystogastrostomy or a cystoduodenostomy unless the wall of the cyst is firmly attached to the wall of the stomach or duodenum. In the latter case make the anastomosis through the area of attachment. Otherwise, perform a Roux-en-Y cystojejunostomy because leakage from this anastomosis is far less dangerous to the patient than is leakage from either stomach or duodenum.

Also, be certain that the wall of the pseudocyst is thick enough to make the anastomosis safe. Although this degree of thickening is generally presumed to require the passage of 6 weeks, a thick wall may occasionally be noted as soon as 3 weeks after the onset of the cyst (Grace and Jordan). If there is doubt about the adequacy of the cyst wall, perform an external drainage operation.

Avoiding Diagnostic Errors

Although preoperative angiography is helpful in ruling out the presence of an abdominal aortic aneurysm that may resemble a pancreatic pseudocyst, always inspect the pancreatic cyst carefully with the tentative hypothesis that it may, in fact, be an aortic aneurysm. Also, insert a needle into the suspected cyst and aspirate to see if it contains blood. When the cyst is pulsatile, proceed with great caution, as the cyst may contain a free rupture of a pseudoaneurysm of the splenic artery.

Also, perform a biopsy of the cyst wall to rule out cystadenocarcinoma.

Pseudoaneurysm

When arteriography has demonstrated a leaking pseudoaneurysm of the splenic artery in a large pseudocyst, it is wise to ask the angiographer to pass a balloon catheter into the proximal splenic artery in order to occlude the artery preoperatively. Sometimes the area of inflammation extends close to the origin of the splenic artery, making proximal control in the operating room, under emergency conditions, quite difficult.

It is preferable to resect a cyst containing a pseudoaneurysm to prevent postoperative rupture and hemorrhage, rather than to drain it.

The Jaundiced Patient

While jaundice in the presence of a pseudocyst may well be the result of extrinsic pressure by the cyst against the distal common bile duct, it is also important to rule out the presence of calculi or periductal pancreatic fibrosis as the cause of bile duct obstruction. Preoperative ERCP is helpful, but performing an operative cholangiogram after the cyst has been drained will determine whether further surgery of the bile duct is necessary. If the jaundice is due to chronic fibrosis in the head of the pancreas, a bypass operation will be required. It may be necessary to perform a side-to-side choledochojejunostomy to the defunctionalized limb of the Roux-en-Y distal to the cystojejunostomy.

Operative Technique

External Drainage

Make a long midline incision. Explore the abdomen. Identify the pseudocyst. After making an incision in the greater omentum to expose the anterior wall of the cyst, insert a needle into the cyst to rule out the presence of fresh blood. Then incise the cyst wall and evacuate all of the cyst contents. Take a sample for bacteriological analysis. If the cyst wall is too thin for anastomosis, insert a soft Silastic catheter and bring it out through an adequate stab wound in the left upper quadrant.

If the cyst wall is thick enough to permit suturing to the skin for marsupialization, the wall is adequate for cystojejunostomy.

If the cyst wall is thick enough to permit suturing, but the contents of the cyst appear to consist of pus and to resemble a large abscess, make a Gram stain. Sometimes what appears to be pus is only grumous detritus. If the Gram stain does not show a large number of bacteria, it is possible to perform an internal drainage operation. Otherwise, marsupialize a 4–5 cm window in the anterior cyst wall by suturing it to the anterior fascia of a large 5-cm stab wound in the abdominal wall.

Close the abdominal incision in the usual fashion after lavaging the abdominal cavity with a dilute antibiotic solution.

Cystogastrostomy

Make a midline incision from the xiphoid to the umbilicus. Explore the abdomen. If the gallbladder contains stones, perform a cholecystectomy and a cholangiogram. Explore the lesser sac by exposing the posterior wall of the stomach from its lesser curvature aspect. If the cyst is densely adherent to the posterior wall of the stomach, a cystogastrostomy is the operation of choice. If the retrogastric mass is pulsatile, consider seriously whether the mass represents an aortic aneurysm. Expose the aorta at the hiatus of the diaphragm and prepare a suitable large vascular clamp for emergency occlusion of this vessel, should this be necessary. If the surgeon has had no previous experience with this maneuver, he should request the presence of a vascular surgeon. A preoperative CT scan should be accurate in identifying the nature of the mass.

Make a 6–8 cm incision in the anterior wall of the stomach (**Fig. 76–1**) opposite the most prominent portion of the retrogastric cyst. Obtain hemostasis with an electrocautery or ligatures. Then insert an 18-gauge needle through the back wall of the stomach into the cyst and aspirate. If no blood is obtained, make an incision about 5–6 cm in length through the posterior wall of the stomach and carry it through the anterior wall of the cyst. Excise an adequate ellipse of tissue from the anterior wall of the cyst for frozen-section histopathology to rule out the presence of a cystadenoma or cystadenocarcinoma (**Fig. 76–2**).

Then approximate the cut edges of the stomach and cyst by means of continuous or interrupted 3–0 PG sutures (**Fig. 76–3**). Close the defect in the anterior wall of the stomach by applying 4–5 Allis clamps and then perform a stapled closure by using the TA-90 stapler. If the gastric wall is not thickened, use the 3.5-mm staples. Lightly electrocoagulate the everted gastric mucosa. Suture-ligate any arterial bleeders with 4–0 PG.

Roux-en-Y Cystojejunostomy

Make a long midline incision. Explore the abdomen. Check the gallbladder for stones. Expose the anterior wall of the cyst by dividing the omentum overlying it. Prepare a segment of jejunum at a point about 15 cm beyond the ligament of Treitz. Divide the

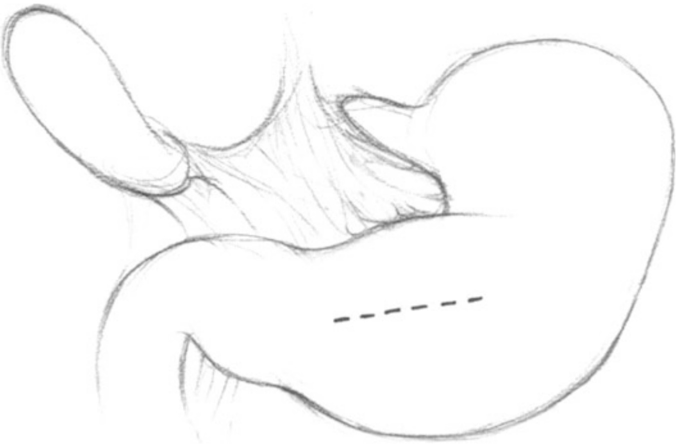


Fig. 76–1

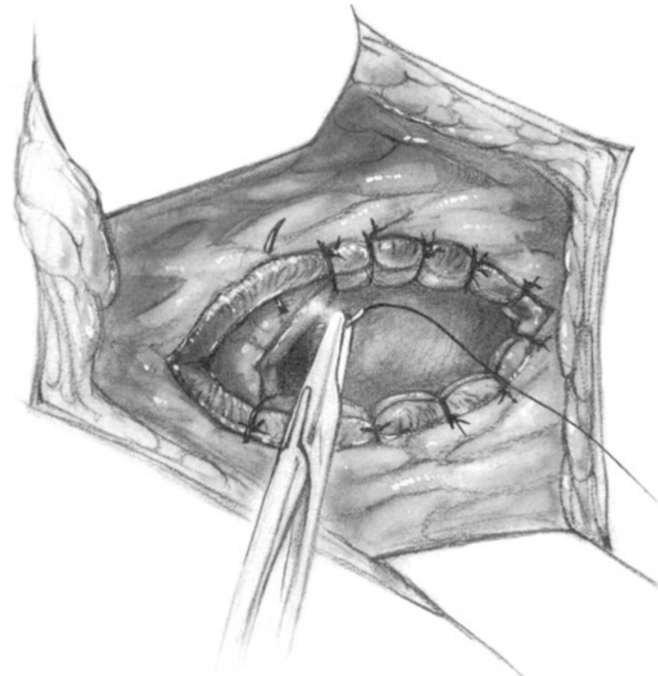


Fig. 76–3

Fig. 76–2

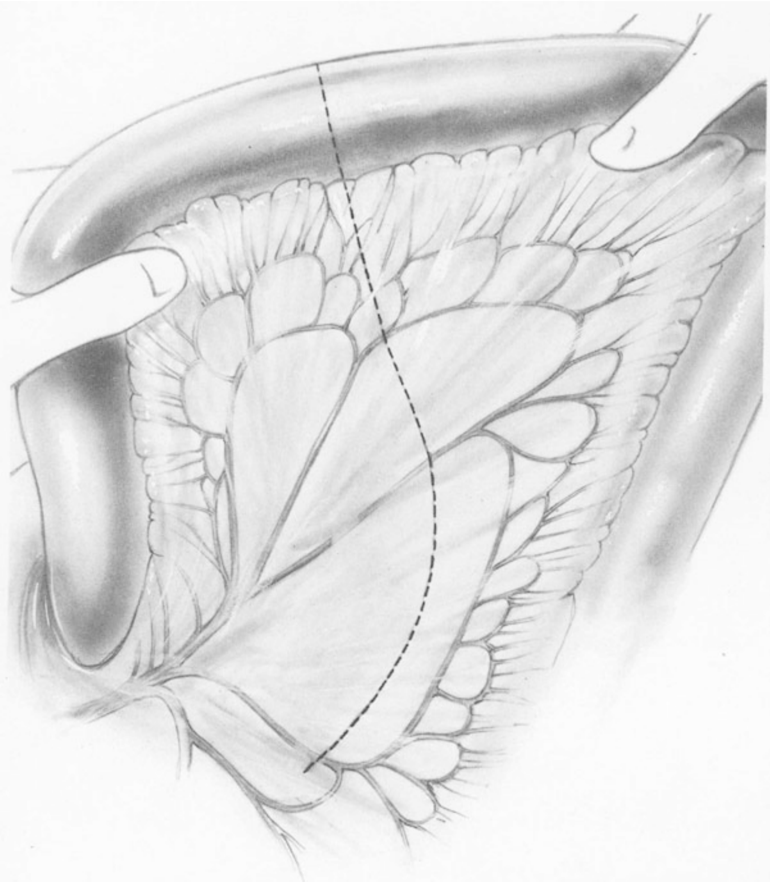


Fig. 76–4

jejunal mesentery as illustrated in **Fig. 76–4**. Then divide the jejunum between two Allen clamps. Liberate enough of the mesentery of the distal jejunal segment to permit the jejunum to reach the cyst without any tension.

Make a small window in an avascular portion of the transverse mesocolon and deliver the distal jejunal segment into the supramesocolic space. Excise a window of anterior cyst wall, about 3–4 cm in diameter. Send it for frozen-section histopathological examination. Perform a one-layer anastomosis between the open end of jejunum and the window in the anterior wall. Insert interrupted Lembert 3–0 or 4–0 Vicryl sutures. Then use 4–0 Vicryl sutures to attach the mesocolon to the jejunum at the point where it passes through the mesocolon.

Anastomose the divided proximal end of the jejunum to the antimesenteric border of the descending limb of the jejunum at a point 60 cm beyond the cystojejunal anastomosis. Align the open proximal end of jejunum so that its opening points in a cephalad direction. Make a 1.5-cm incision in the antimesenteric border of the descending jejunum using electrocautery (see Fig. 68–7). Insert the forks of the GIA stapling device into both limbs of jejunum so that the GIA will grasp the antimesenteric borders. Then fire the GIA device making a side-to-side anastomosis (Fig. 68–9).

Apply an Allis clamp to the anterior termination of the GIA staple line and another Allis clamp to the posterior termination of the GIA staple line and draw these two points apart. Then insert a guy suture to approximate the midpoints of the cephalad and caudal lips of jejunum (see Fig. 68–10). Complete the anastomosis by triangulation. Apply Allis clamps to the tissue between the guy suture and the anterior termination of the GIA staple line. Apply a TA-55 device with 3.5-mm staples deep to the guy suture and the Allis clamps. Close the TA-55 and fire, creating an everting closure (see Fig. 68–11). Excise the redundant mucosa with a heavy scissors, but be careful not to detach the guy suture. Lightly electrocoagulate the mucosa. Then apply Allis clamps to approximate the jejunum between the guy suture and the posterior termination of the GIA staple line. Apply a TA-55 device just deep to the guy suture and the Allis clamps. Fire the TA-55. Excise the redundant tissue and lightly electrocoagulate the everted mucosa. Remove the TA-55 (see Fig. 68–12). Be sure that the ends of the GIA staple line have been included in each of the two applications of the TA-55. This method will create a large end-to-side anastomosis, completing the Roux-en-Y procedure.

Use 4–0 PG sutures to close the defect in the jejunal mesentery.

The completed cystojejunostomy is illustrated in **Fig. 76–5**.

If the cyst wall is of adequate quality, no drains need be used. Close the incision in the usual fashion.

Distal Pancreatectomy

The technique of distal pancreatectomy is described in Chap. 75.

Whipple Pancreatoduodenectomy

The technique for the pancreatoduodenectomy is described in Chap. 73.

Postoperative Care

Nasogastric suction for 1–3 days.

Perioperative antibiotics are indicated. If the culture report of the cyst contents comes back positive, administer the appropriate antibiotics for 7 days.

In cases of external drainage, administer antibiotics depending on the culture reports. Leave the drain in place until the amount of fluid obtained is minimal and also a radiographic study with aqueous contrast material shows that the cyst has contracted down to

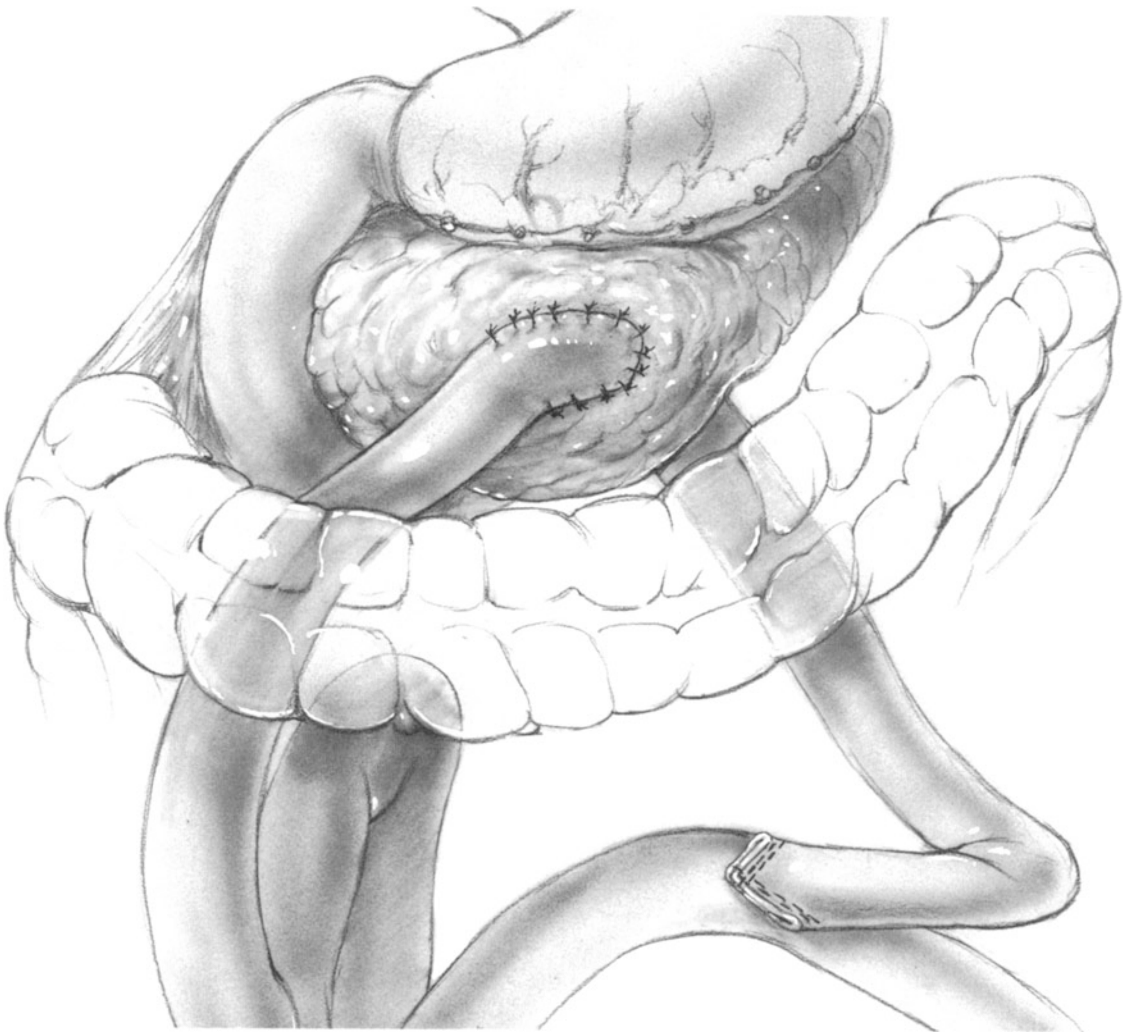


Fig. 76–5

the size of the drain. It may be helpful to instill a dilute antibiotic solution at intervals into the drain if the cyst is infected.

Postoperative Complications

Acute pancreatitis

Persistent fistula following external drainage

Abscess

Postoperative bleeding into gastrointestinal tract (rare if pseudoaneurysms have been excised)

References

Adams DB, Harvey TS, Anderson MC. Percutaneous catheter drainage of pancreatic pseudocysts. Am Surg 1991;57:29–33.

Bradley II EL, Clements Jr JL, Gonzalez AC. The natural history of pancreatic pseudocysts: a unified concept of management. Am J Surg 1979;137:135.

Criado E, De Stefano AA, Weiner TM. Long term results of percutaneous catheter drainage of pancreatic pseudocysts. Surg Gynecol Obstet 1992;175:293–298.

Frey CF. Pancreatic pseudocyst-operative strategy. Ann Surg 1978;188:652.

Grace RR, Jordan Jr PH. Unresolved problems of pancreatic pseudocysts. Ann Surg 1976;184:16.

Huston DG, Zeppa R, Warren DW. Postoperative hemorrhage after pancreatic cystogastrostomy. Ann Surg 1976;177:689.

Karlson KB, Martin EC, Fankuchen EI et al. Percutaneous drainage of pancreatic pseudocysts and abscesses. Radiology 1982;142:619.

Martin Jr EW, Catalano P, Cooperman M et al. Surgical decision-making in the treatment of pancreatic pseudocysts: internal versus external drainage. Am J Surg 1979;138:821.

Sandy JT, Taylor RH, Christensen RM, Scudamore C et al. Pancreatic pseudocyst: changing concepts in management. Am J Surg 1981;141:574.

Shatney CH, Lillehei RC. Surgical treatment of pancreatic pseudocysts: analysis of 119 cases. Ann Surg 1979; 189:386.

77 Pancreaticojejunostomy (Puestow) for Chronic Pancreatitis

Concept: Which Therapy for Chronic Pancreatitis?

Pathogenesis

Chronic pancreatitis of the type severe enough to require surgery generally follows chronic alcohol abuse. It is rare after an attack of biliary pancreatitis if the biliary calculi are removed. Occasionally trauma to the pancreas or congenital abnormalities of the pancreatic ducts may produce chronic pancreatitis.

Objectives of Surgery

It is unlikely that any type of operation will significantly preserve pancreatic function. The only objective that surgery can be expected to accomplish is relief of pain. This can be achieved in some patients by an extensive pancreaticojejunostomy, an operation that presumably relieves the patient's pain by decompressing the partially obstructed pancreatic ducts. Another method of alleviating intractable pain in chronic pancreatitis is resection of part or all of the diseased pancreas. The drawback to resection operations is that they may produce diabetes, which can be very difficult for the alcoholic patient to manage. A number of alcoholic patients, following extensive pancreatic resection, will die late in the postoperative course due to a complication of diabetes control.

Although another objective of pancreatic surgery is to preserve the exocrine function of the pancreas, there are no convincing data that pancreaticojejunostomy accomplishes this aim.

Choice of Operation

Sphincteroplasty

Even when sphincteroplasty is accompanied by a septotomy that enlarges the orifice of Wirsung's duct, it is not an effective operation for the usual type of chronic pancreatitis seen in the alcoholic patient. Theoretically, if there is a localized obstruction at the orifice of Wirsung's duct, sphincteroplasty combined with ductoplasty is a logical procedure to relieve this obstruction. Because an isolated obstruction of this type is quite rare, however, there is, in our opinion, scant indication for sphincteroplasty in chronic pancreatitis.

Pancreaticojejunostomy, Roux-en-Y

Pancreaticojejunostomy is the operation of choice in patients with intractable pain from chronic pancreatitis *only if the pancreatic duct is dilated* to a diameter over 5 mm. Since there are multiple points of ductal obstruction in most patients with this disease, the pancreatic ductogram in the typical case will resemble a "chain of lakes." When the indications for pancreaticojejunostomy are restricted to patients who have large ducts, 80% will experience satisfactory relief of pain following this operation according to Prinz and Greenlee. When the pancreatic duct is not enlarged, pancreaticojejunostomy is contraindicated. The diameter of the pancreatic duct can generally be determined preoperatively by endoscopic radiographic cholangiopancreatography (ERCP). Otherwise, it will be necessary to obtain a pancreatic ductogram in the operating room prior to performing a pancreaticojejunostomy.

Pancreatic Resection

(See Chaps. 73–75.)

Whipple Pancreatoduodenectomy

When the chronic pancreatitis appears to be located primarily in the head of the pancreas or the uncinate process, or when these areas are the site of a pseudoaneurysm, a resection of the head of the pancreas may be necessary. In this case the usual Whipple operation is modified by preserving the stomach and pylorus, as illustrated in Chap. 73. In performing this operation for chronic pancreatitis, it may be somewhat more difficult to free the portal vein from the pancreas than when one does a Whipple operation for ampullary carcinoma. However, anastomosing the cut end of the pancreatic duct to the jejunum will be more secure because the duct in chronic pancreatitis is fibrotic and holds sutures quite well with a low rate of postoperative pancreatic fistula. The mortality rate following pancreatoduodenectomy for chronic pancreatitis is probably no more than 3%, a figure lower than that which follows the same operation in patients with carcinoma. When the tail and body of the pancreas are preserved, the incidence of postoperative diabetes will be low.

Distal Pancreatectomy
When the primary location of the chronic pancreatitis appears to be localized in the body and tail of the pancreas, and when the pancreatic duct is too small for a successful side-to-side pancreaticojejunostomy, then resecting the distal portion of the pancreas may be indicated if the patient suffers intractable pain. If it is possible to dissect the fibrotic pancreas away from the splenic vein, it may occasionally be possible to perform a distal pancreatectomy with preservation of the spleen. Otherwise, this operation is done by the technique described in Chap. 75. Distal pancreatectomy for pancreatitis in the alcoholic patient is not generally effective in relieving pain according to White and Hart.

Subtotal and Total Pancreatectomy
Frey and Child performed an 80%–95% pancreatectomy with preservation of the duodenum. A 2-cm remnant of the pancreatic head was left on the duodenum and the pancreatoduodenal blood vessels were preserved to guarantee adequacy of the duodenal blood supply. Special attention must be devoted to avoiding trauma to the distal common bile duct. If the uncinate process is diseased, it must be resected or the patient's pain may not be relieved. Although the technical details can be mastered, this has not proved to be a very satisfactory operation for a chronic alcoholic because of the difficulty that the alcoholic patient will experience in controlling the resulting diabetes. The same objection applies to a total pancreatoduodenectomy for intractable chronic pancreatitis in the alcoholic patient.

Nonsurgical Treatment

Some internists believe that if they persist in conservative management of patients with intractable pain from chronic pancreatitis, the disease will "burn out" and pain will eventually be relieved. There is no evidence that this concept is valid. On the other hand, long-term survival of the alcoholic patient with chronic pancreatitis is not likely, whether or not he has undergone a successful operation for the pancreatitis. This is because most of the patients do not discontinue their consumption of alcohol, and the cause of death is generally some complication of alcoholism. Aside from encouraging the patient to change his drinking habits, medical management requires medication for pain and enzyme replacement therapy for malabsorption secondary to exocrine insufficiency.

A positive indication for continuing nonsurgical management of chronic pancreatitis is the presence of severe hepatic cirrhosis, especially with portal hypertension.

Indications

Chronic pancreatitis producing *intractable* pain not responsive to medical treatment. If the pancreatic duct is dilated (diameter of 5–7 mm), perform pancreaticojejunostomy. Otherwise, pancreatic resection of some type may be required.

Preoperative Care

Evaluate hepatic function.

Rule out portal hypertension.

Establish nutritional rehabilitation if necessary.

Order ERCP.

Complete an upper GI X-ray series to rule out duodenal obstruction.

Rule out biliary calculi by X-ray or sonography.

Pitfalls and Danger Points

Failure to rule out portal hypertension

Overlooking pancreatic carcinoma (In any large series of operations for chronic pancreatitis, there will be a few cases of pancreatic carcinoma. It is possible that chronic pancreatitis does indeed predispose the patient to pancreatic cancer. Before deciding on an operative procedure, biopsy suspicious areas. Aspiration cytology in the operating room may be helpful in this situation.)

Operative Strategy

Since the dilated pancreatic ducts are thick walled and fibrotic the pancreaticojejunal anastomosis is a safe procedure in these cases. One layer of sutures generally suffices.

Operative Technique

Exposure

Make a midline incision from the xiphoid to a point 4–5 cm below the umbilicus. Separate the greater omentum from the middle of the transverse colon for a sufficient distance to expose the pancreas. Divide the peritoneal attachments between the pancreas and the posterior wall of the stomach.

Incising the Pancreatic Duct

The main pancreatic duct is generally located about one-third of the distance from the cephalad to the caudal margin of the pancreas. If the duct cannot be

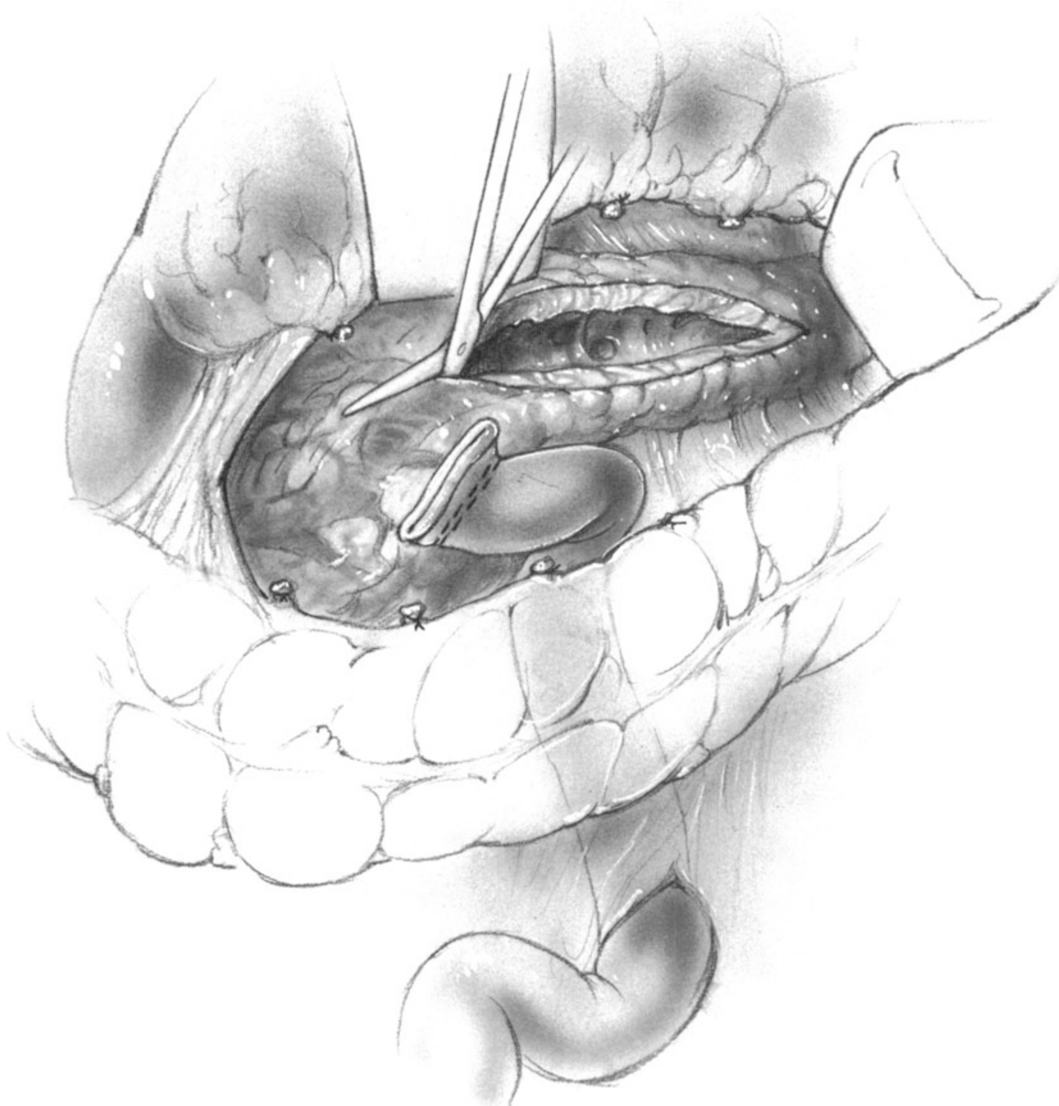


Fig. 77–1

palpated, inserting a 22-gauge needle and attempting to aspirate pancreatic juice may serve to locate the pancreatic duct. If the duct has not been successfully visualized by a preoperative ERCP, perform a ductogram in the operating room by aspirating 2 ml of pancreatic juice with a 22-gauge needle; inject an equal amount of dilute Hypaque into the duct. If there is suspicion that the common duct is obstructed by the chronic pancreatitis, perform a cholangiogram in the operating room.

Once the pancreatic duct has been identified, it should be opened by making an incision along its anterior wall. The incision should open the entire duct from the head to the tail of the pancreas. This may be done with a Potts scissors or with a scalpel (**Fig. 77–1**). Continue the duct incision further into the head of the pancreas than is shown in the illustrations. Secure hemostasis with an electrocautery. Occasional bleeding points may require a fine PG suture-ligature. If a stricture of the pancreatic duct is encountered, insert a probe through the strictured area and incise the anterior wall of the duct with a scalpel over the probe. Remove any calculi or debris that may have collected in the ductal system.

Constructing the Roux-en-Y Jejunostomy

Prepare the proximal jejunum for a Roux-en-Y as illustrated in Fig. 68–1. Select a suitable point about 12–15 cm beyond the ligament of Treitz. After a sufficient amount of mesentery has been divided, apply the TA-55 stapling device to the jejunum and fire the 3.5-mm staples. Apply an Allen clamp just proximal to the stapling device. Divide the jejunum flush with the cephalad side of the stapler with a scalpel. Lightly electrocoagulate the everted mucosa and remove the stapler.

Make a 3-cm incision in an avascular area of the transverse mesocolon. Pass the limb of jejunum through this incision and position it side-to-side to the open pancreatic duct. The stapled cut end of the jejunum should be approximated to the tail of the pancreas and the distal jejunum to the head. Now incise the antimesenteric border of jejunum over a length approximately equal to the incision in the pancreatic duct using a scalpel or electrocautery. Since the fibrotic pancreas accepts sutures nicely, one layer of sutures is sufficient. For the posterior layer of the anastomosis, approximate the full thickness of the jejunum to the incision in the pancreatic duct. Use 4–0 Vicryl interrupted sutures. Insert the needle through both the mucosal and seromuscular portions of the jejunal wall. Then pass the needle through the fibrotic parenchyma of pancreas and through the pancreatic duct. Tie the suture with the knot inside the lumen of the pancreatic duct (**Fig. 77–2**). For the anterior layer of the anastomosis use a seromucosal or Lembert stitch on the jejunum. Then pass the needle through the full thickness of

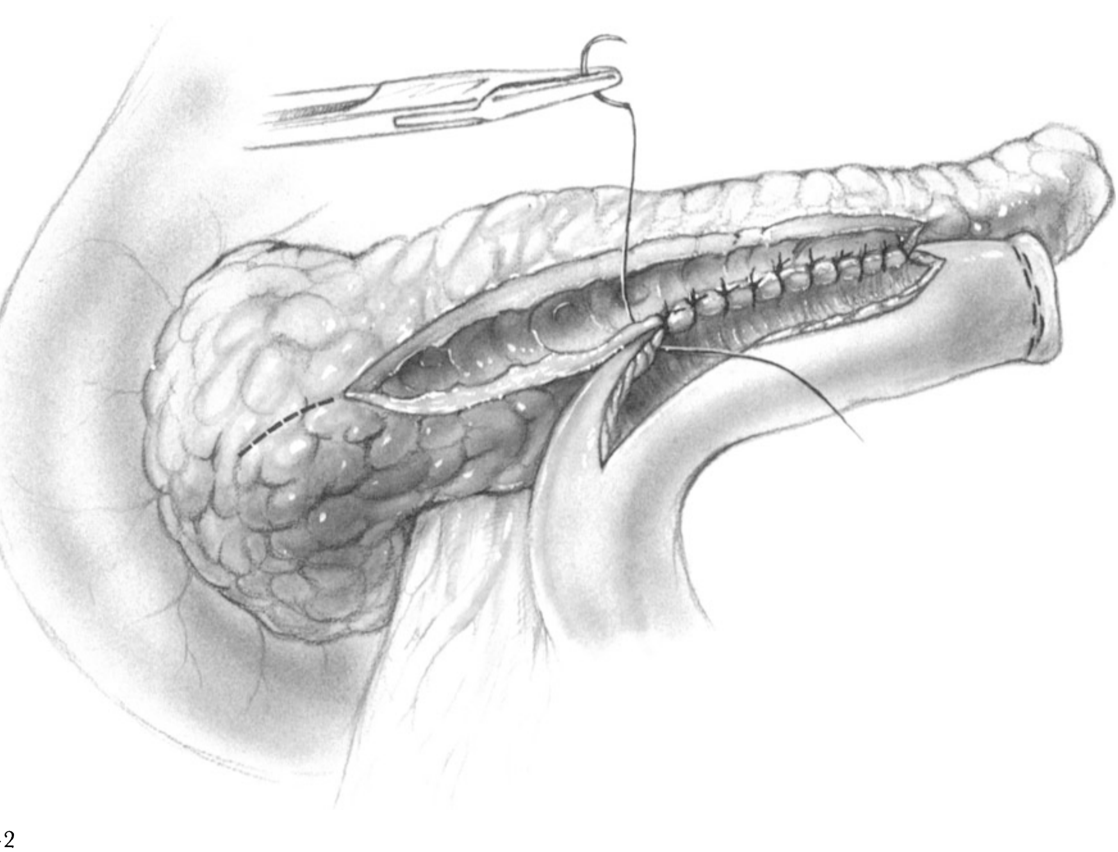


Fig. 77–2

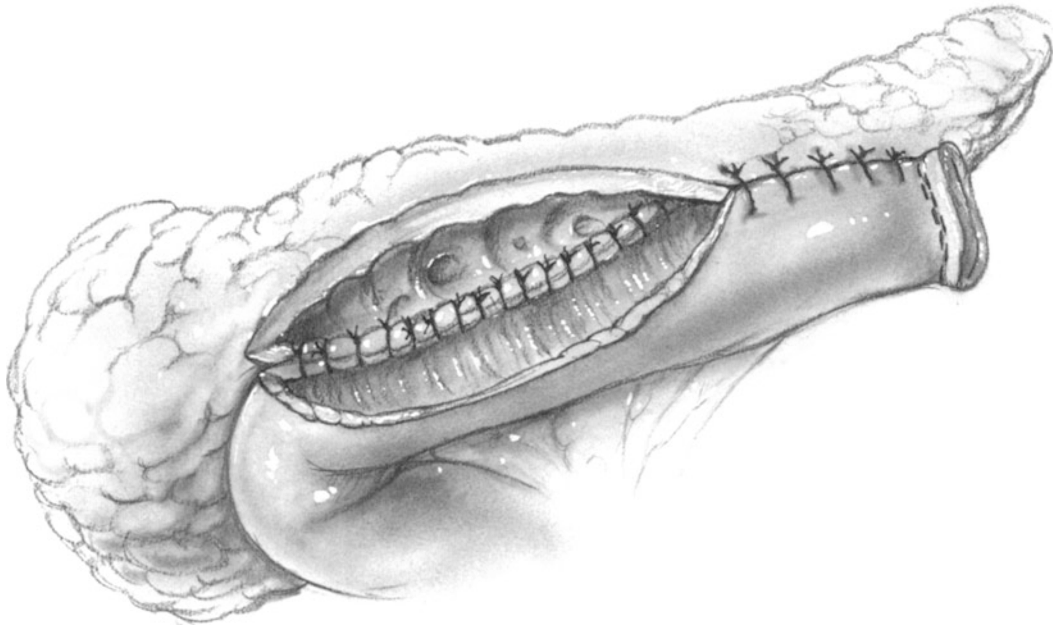


Fig. 77–3

Fig. 77–4a

Fig. 77–4b

the duct including some of the pancreatic parenchyma (**Figs. 77–3** and **77–4a** and **77–4b**).

Close the defect in the mesocolon by inserting fine interrupted sutures between the mesocolon and the serosa of the jejunum.

At a point at least 60 cm distal to the pancreaticojejunostomy, construct an end-to-side jejunojejunostomy to complete the Roux-en-Y anastomosis. We generally accomplish this anastomosis by stapling as described in Figs. 68–7 to 68–12.

If desired, make a puncture wound in the left upper quadrant and insert a Jackson-Pratt closed-suction silicone drainage catheter down to the region of the pancreaticojejunal anastomosis. Close the abdomen in routine fashion.

Postoperative Care

Discontinue nasogastric suction in 1–3 days.

Administer perioperative antibiotics for 24 hours.

Postoperative Complications

Pancreatic fistula

Abdominal or wound infection

References

Frey CF, Child GG III. Pancreatectomy for chronic pancreatitis. Ann Surg 1976;184:403.

Prinz RA, Greenlee HB. Pancreatic duct drainage in 100 patients with chronic pancreatitis. Ann Surg 1981; 194:313.

White TT, Hart HJ. Pancreaticojejunostomy versus resection in the treatment of chronic pancreatitis. Am J Surg 1979;138:129.

Spleen

78 Splenectomy for Disease

Indications

Since the specific therapy for the group of diseases that require splenectomy is often in a state of flux and since some of the conditions are complicated by problems of coagulation, it is important that the indications and timing for surgery be worked out in close cooperation with an experienced hematologist. Splenectomy may be indicated for patients with hereditary anemias (spherocytosis, elliptocytosis, nonspherocytic hemolytic anemia), primary hypersplenism, and chronic idiopathic thrombocytopenic purpura. Patients with autoimmune hemolytic anemia, secondary hypersplenism, thalassemia, myelofibrosis, chronic lymphatic leukemia, and lymphoma also may benefit from splenectomy in selected situations. Until recently splenectomy was a routine part of the staging procedure for patients with Hodgkin's disease, but this is no longer accepted.

Primary splenic tumor

Splenic abscess

Splenic cysts, parasitic and nonparasitic

Under unusual circumstances, a large number of other diseases may be benefited by splenectomy, such as Gaucher's disease, sarcoidosis, Felty's syndrome, Niemann-Pick's disease, and Fanconi's syndrome.

Preoperative Care

Consult with an experienced hematologist concerning blood coagulation factors in the patient and the careful cross-matching of an adequate quantity of blood. For patients with thrombocytopenia, preparations should be made to have platelets and other coagulation factors on reserve. Do not administer the platelets prior to ligating the splenic artery in patients with thrombocytopenia as the platelets will be promptly destroyed.

Insert nasogastric tube prior to operation.

Administer perioperative antibiotics.

Remember that in patients with giant splenomegaly, portal hypertension, and pancytopenia (as may occur in myelofibrosis), preoperative occlusion of the splenic artery by transcatheter infarction of the spleen may be accomplished in the angiography suite (Levy, Wasserman, and Pitha). Splenectomy should be performed promptly after completion of the splenic artery occlusion, as necrosis of the spleen and sepsis are otherwise likely to occur.

Pitfalls and Danger Points

Intraoperative hemorrhage

Postoperative hemorrhage

Injuring the greater curvature of the stomach

Injuring the pancreas

Postoperative sepsis, especially in immunologically impaired patients

Failure to remove accessory spleen

Operative Strategy

Avoiding Intraoperative Hemorrhage

Perhaps the single most important method of avoiding serious intraoperative bleeding is to be sure that the exposure is adequate for each step of the operation. For the large spleen, this requires a long incision, although it is rarely necessary to perform a thoracic extension. Frequently, the use of a Thompson retractor to elevate the left costal margin will greatly improve exposure.

A second important method of avoiding the laceration of a major vein is the meticulous dissection and individual ligation of each of the important vessels. When performing splenectomy for hematological disorders, we prefer to isolate the splenic artery as the first step in the splenectomy. The splenic artery may be approached from the lesser curvature portion of the stomach by entering the lesser sac at this point. An alternative approach is to divide the gastrocolic omentum, thereby exposing the upper border of the pancreas. When the splenic artery is ligated before manipulating the spleen, it will be noted that a large spleen frequently diminishes considerably in size and thus makes the dissection safer.

Patients with portal hypertension, as in myelofibrosis, also require clamping and ligating of the splenophrenic and splenorenal ligaments.

Preventing Postoperative Hemorrhage

At the conclusion of the splenectomy, it is important to achieve complete hemostasis in the bed of the spleen, especially along the tail of the pancreas, the left adrenal gland, and the posterior abdominal wall. Some of the bleeding points can be controlled by electrocoagulation; others require clamping. Bleeding from the tail of the pancreas almost always necessitates the insertion of fine suture-ligatures on atraumatic needles because the blood vessels tend to retract into the pancreatic tissue. If there is diffuse oozing due to inadequate platelets or other coagulation deficiencies, it may be necessary after the spleen is removed to administer platelets, fresh frozen plasma, and other coagulation factors. After administering these substances and testing the blood for various coagulation deficiencies, continue to observe the operative site until the bleeding stops. Do not simply insert a few drains and close the abdomen. The latter course will often lead to the development of a large hematoma in the left upper quadrant. Some of these hematomas may become infected and cause a subphrenic abscess.

Avoiding Pancreatic Injury

The greatest risk of injuring the tail of the pancreas occurs when the splenic blood supply is being ligated and divided at the hilus of the spleen. When carrying out this step, it is important clearly to identify the tail of the pancreas and to divide the blood vessels without injuring the pancreas. If each clamp contains only a blood vessel and not other tissue, then the pancreas will not be crushed by a large hemostat. Nor will it be transected inadvertently.

Avoiding Trauma to the Stomach

During the course of clamping and dividing the short gastric vessels it is easy—especially when a large spleen is being removed—to include the wall of the gastric greater curvature within a hemostat aimed at a short gastric vessel. In other situations, the serosa of the stomach may be denuded during the process of dissecting out these blood vessels. In either case, the injury may result in a gastric fistula, a serious and life-threatening complication. Consequently, take care to identify clearly each of the vessels and to achieve hemostasis and division of the short gastric vessels without damaging the stomach.

In addition, a postoperative gastric fistula may be avoided if the greater curvature is inverted with a continuous or interrupted layer of seromuscular Lembert sutures. In this way the ligated stumps of the short gastric vessels and any possibly traumatized gastric wall are inverted together. In cases where division of the short gastric vessels has been accomplished with great ease and under conditions of good visibility, one may be able to guarantee that the greater curvature has not been traumatized. In these cases, it may not be necessary to invert this region of the stomach.

Preventing Postoperative Sepsis

In the immunologically deficient patient, subphrenic sepsis in the bed of the excised spleen may occur, especially in those patients who have sustained a postoperative hematoma. Therefore, the first step in preventing this complication is to ascertain that good hemostasis has been achieved. Secondly, we believe that the use of prophylactic antibiotics administered intravenously at the induction of anesthesia and repeated at intervals for the next 24 hours, is an important means of helping to prevent this complication. This is especially true if there is any danger that the stomach or colon may be entered during a difficult dissection. Whether irrigating the field and the abdominal wound with a dilute antibiotic solution provides any *additional* protection is not statistically validated at this time; however, we choose to carry out this type of lavage during splenectomy.

We agree with Traetow, Fabri, and Carey that inserting a drain to the splenic bed appears to increase the incidence of postoperative subphrenic sepsis. This is especially true for the latex type of drain that permits the entrance of bacteria from the skin down the drain tract. If the pancreas has been injured, or if the hemostasis cannot be completely controlled despite intensive effort, then a drain is necessary. However, it is important to use a closed-suction type of drain, either one or two, passed through snug puncture wounds and sutured to the skin (see Chap. 3). Also, removing the drain within 5 days appears to lower the risk of infection.

Accessory Spleen

Occasionally, the presence of a residual accessory spleen will impair the therapeutic effect of a splenectomy. In some reported cases, performing a second laparotomy and removing an accessory spleen has resulted in considerable improvement. Consequently, it is important in patients splenectomized for hematological diseases to identify and remove accessory spleens. The most common locations of accessory spleens are in the hilus of the spleen as well as in the gastrosplenic, the splenocolic, and the splenorenal ligaments. Also search the perirenal area, the tail of the pancreas, the small bowel mesentery, and the presacral region for accessory spleens, although these locations are less commonly the site of an accessory spleen than is the area around the splenic hilus.

Operative Technique

Incision

In the patient who has a small spleen, as is often the case with idiopathic thrombocytopenic purpura, a long left subcostal incision, reaching at least to the anterior axillary line, provides excellent exposure. In some cases the subcostal incision may be improved by a Kehr extension up the middle to the xiphocostal junction, as illustrated **Fig. 78–1**. In patients with marked splenomegaly, a long midline incision may be preferable, especially if the patient has a narrow costal arch. Use an electrocoagulator to incise the abdominal wall. In order to provide adequate exposure, a midline incision must extend a considerable distance below the umbilicus. Then, apply a Thompson retractor to elevate the left costal margin and to draw it in a cephalad and lateral direction.

Ligating the Splenic Artery

Incise the avascular portion of the gastrohepatic ligament along the middle of the lesser curvature portion of the stomach and elevate the stomach to expose the upper border of the pancreas. Palpate the splenic artery as it courses along the upper border of the pancreas towards the spleen. If it appears that ligating the splenic artery near the pancreatic tail will be difficult, then identify the pancreas behind the lesser curvature of the stomach and incise the peritoneum over the splenic artery above the body of the pancreas. Carefully pass a blunt-tipped right-angle Mixter clamp around the splenic artery. Temporarily occlude this artery either with a vascular clamp or by doubly encircling it with a Vesseloop or a narrow umbilical tape fixed in place with a small hemostat.

In most cases, approach the splenic artery by opening the gastrocolic omentum outside the gastroepiploic arcade, applying clamps, dividing and ligating serially with 2–0 silk. Also divide and ligate the left gastroepiploic vessel (**Fig. 78–2**). After a window in the omentum has been achieved, identify the splenic artery by palpating along the superior border of the pancreatic body or tail. Open the peritoneum over the artery and encircle the artery

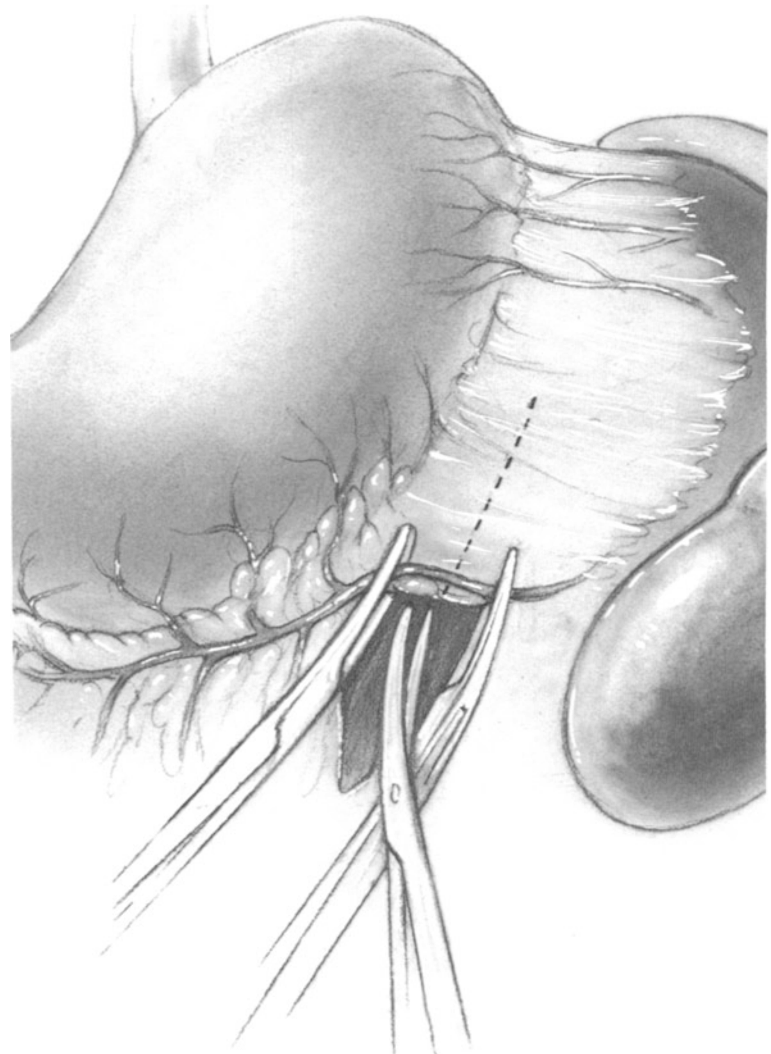


Fig. 78–2

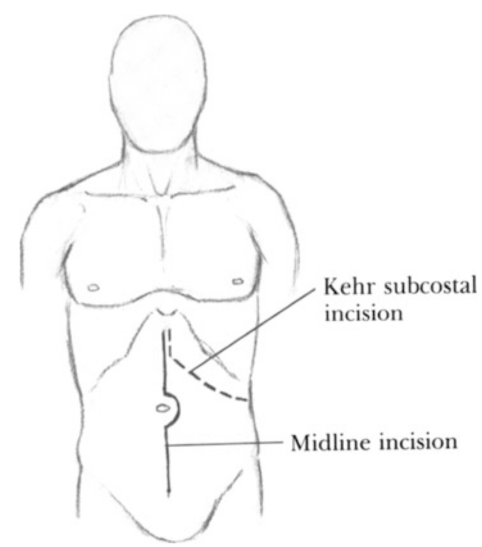


Fig. 78–1

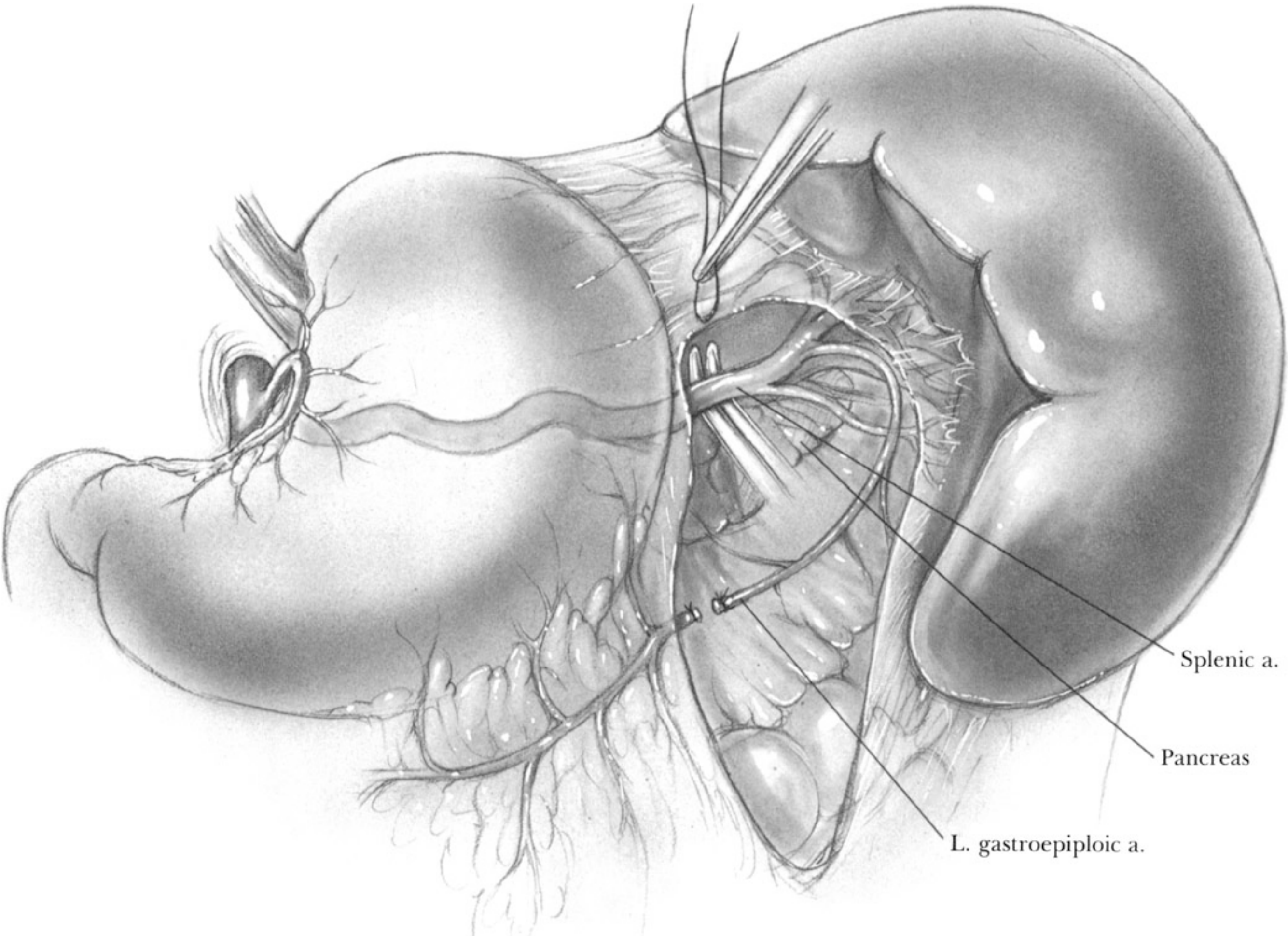


Fig. 78–3

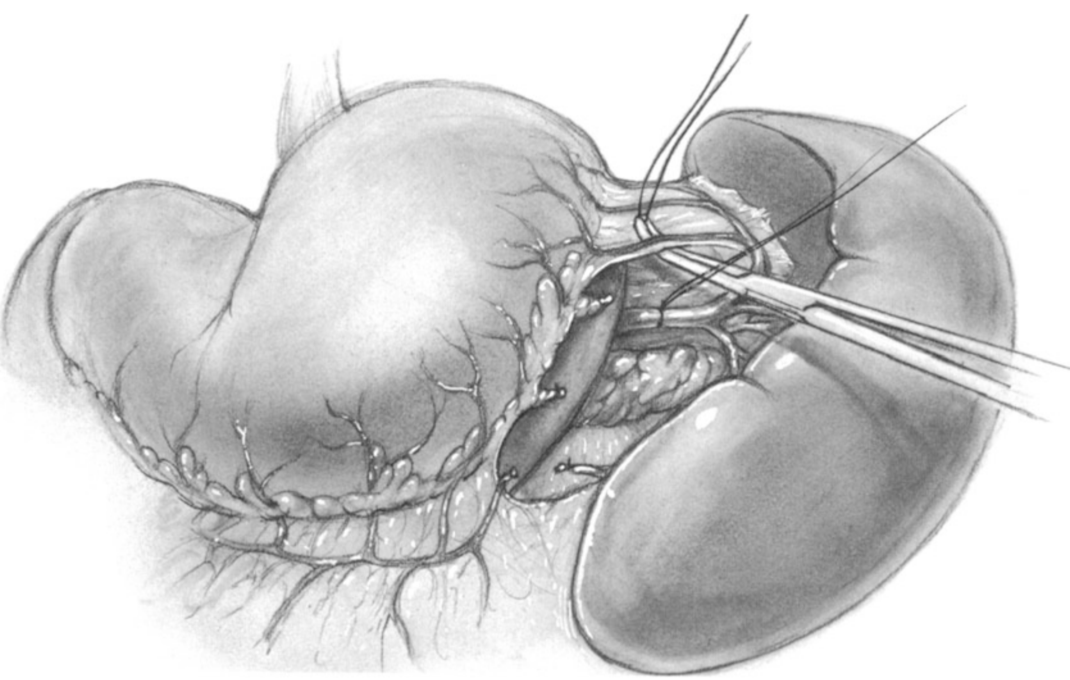


Fig. 78–4

with a 2–0 silk ligature (**Fig. 78–3**). Then tie this ligature.

Sometimes, accomplishing the identification of the splenic artery requires division of the lower short gastric vessels. If this step has not already been accomplished, then identify, clamp, divide, and ligate these structures with 2–0 silk (**Fig. 78–4**). Continue the division of the short gastric vessels in a cephalad direction as long as the exposure is satisfactory. If the upper short gastric vessel is not long enough to be divided easily at this time, delay this until the spleen has been completely mobilized.

Mobilizing the Spleen

With the left hand, retract the spleen in a medial direction to expose the splenophrenic and splenorenal ligaments. These are generally avascular. Divide the ligaments with a Metzenbaum scissors or an electrocautery. Only in the presence of portal hypertension will it be necessary to ligate a number of bleeding vessels in these ligaments. Insert the left index finger behind the incised splenorenal ligament and continue the incision both by sharp and blunt dissection until the spleen has been freed from the capsule of Gerota and the diaphragm (**Figs. 78–5** and **78–6**).

In the same plane, slide the hand behind the posterior surface of the pancreas and elevate both the tail of the pancreas and the attached spleen into the abdominal incision. Tearing the splenic capsule by rough maneuvering during this step will produce unnecessary bleeding and possible postoperative peritoneal splenosis. Apply a number of moist gauze pads to the bed of the spleen in the posterior abdominal wall.

Slide the index finger behind the splenocolic ligament and divide this ligament, releasing the colon and its attached omentum from the lower pole of the spleen. This dissection will leave the spleen attached only by the splenic artery and vein and perhaps one or two remaining short gastric vessels.

Ligating the Splenic Vessels

With the spleen elevated out of the abdominal cavity, search the posterior aspect of the splenic hilus for the tail of the pancreas. Gently separate the tail of the pancreas from the posterior wall of the splenic artery and vein. Carefully divide and ligate small branches of the splenic vessels entering the tail of the pancreas. Identify the previously ligated splenic artery. Ligate the artery again near the hilus. Leave sufficient stump of splenic artery (1 cm). Then divide the splenic artery. Further dissection will reveal the splenic vein. This may be a large structure, or it may have divided into several branches by the time it

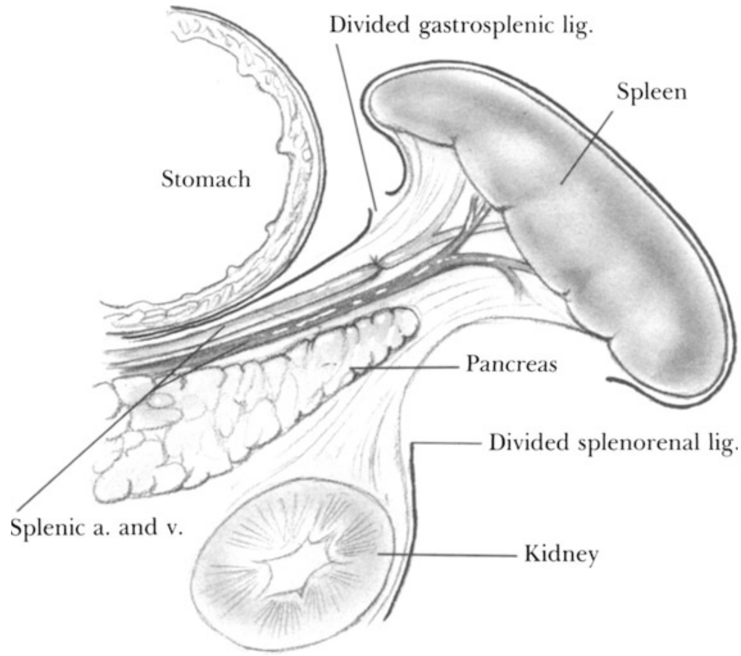


Fig. 78–5

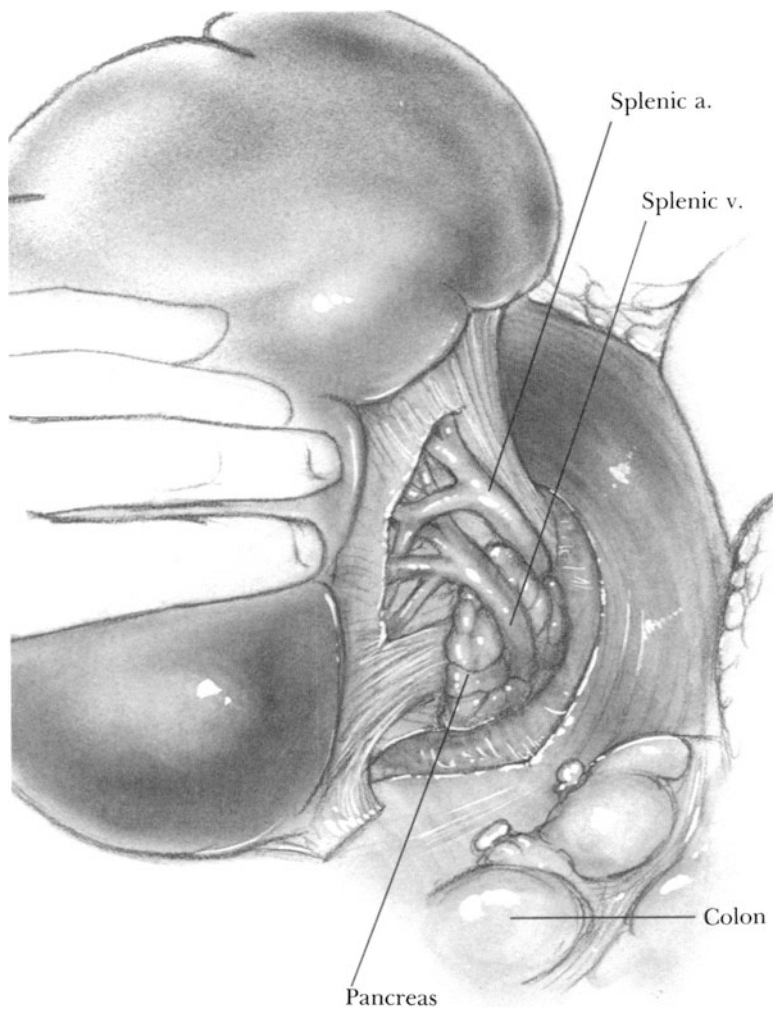


Fig. 78–6

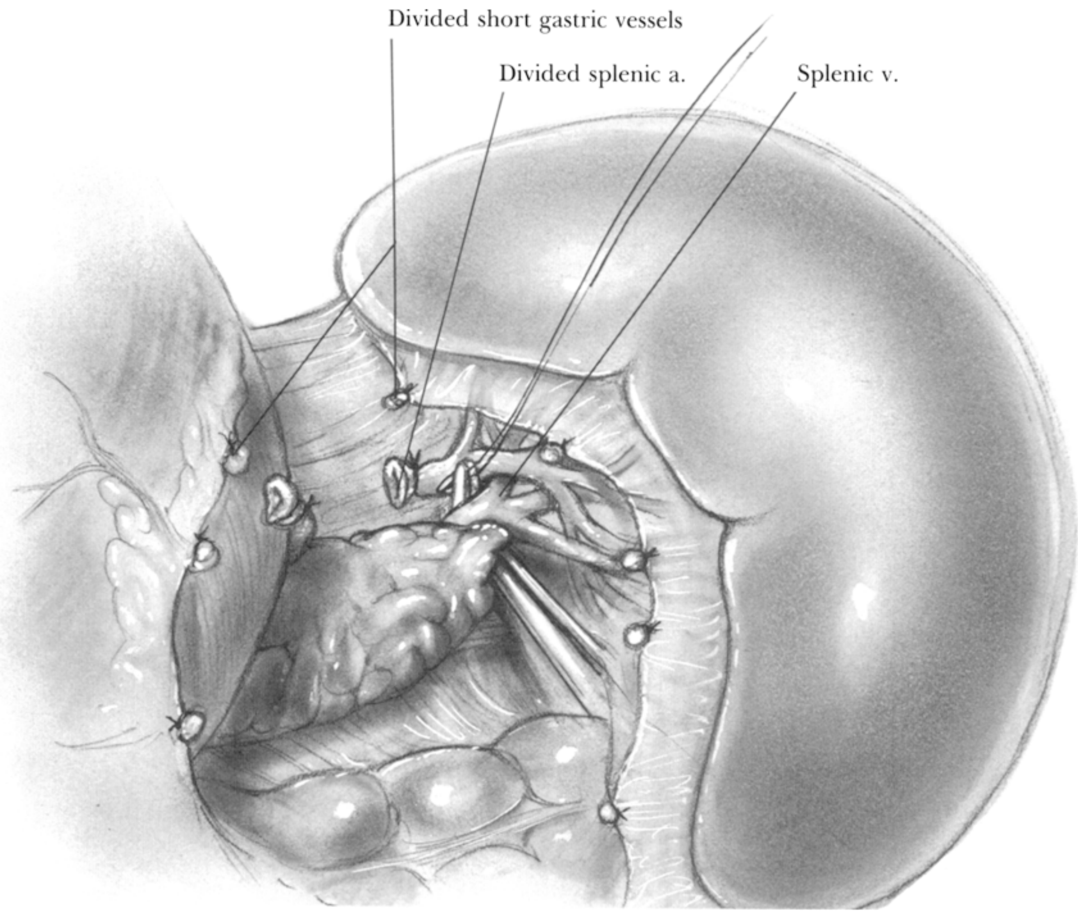


Fig. 78–7

reaches the splenic hilus. Carefully encircle either the main splenic vein or each of its branches with 2–0 silk ligatures (**Fig. 78–7**). Tie the ligatures and divide the veins between ligatures. Remove the spleen.

Search the area of the pancreatic tail, the kidney, the gastrosplenic ligament, the omentum, the small and large bowel mesentery, and the pelvis for accessory spleens. Remove the gauze pads from the splenic bed and accomplish complete hemostasis utilizing an electrocoagulator and ligatures.

Inverting the Greater Curvature of Stomach

Carefully inspect the greater curvature of the stomach. If there is the slightest suspicion of any damage

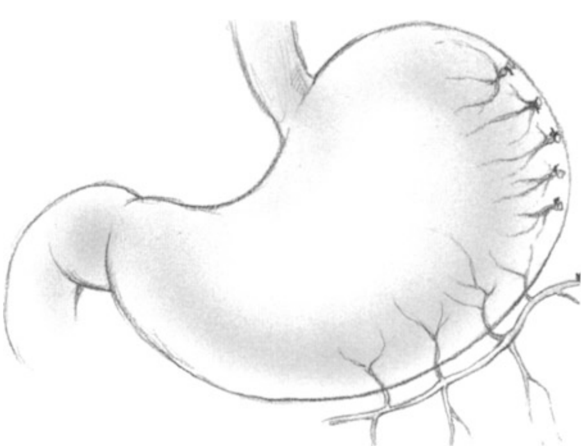


Fig. 78–8

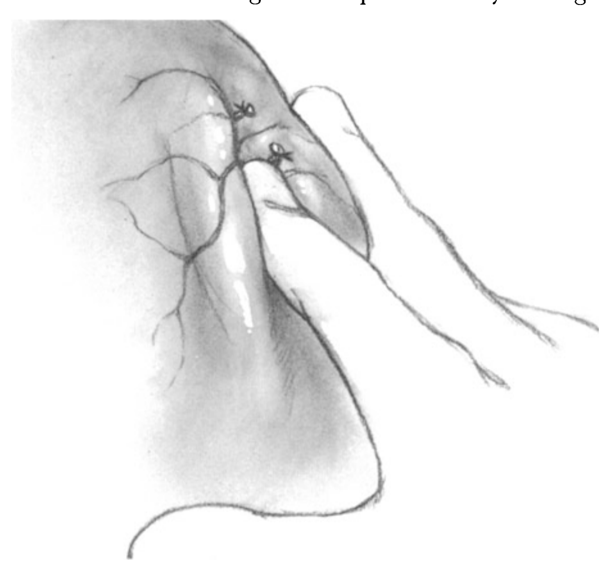


Fig. 78–9

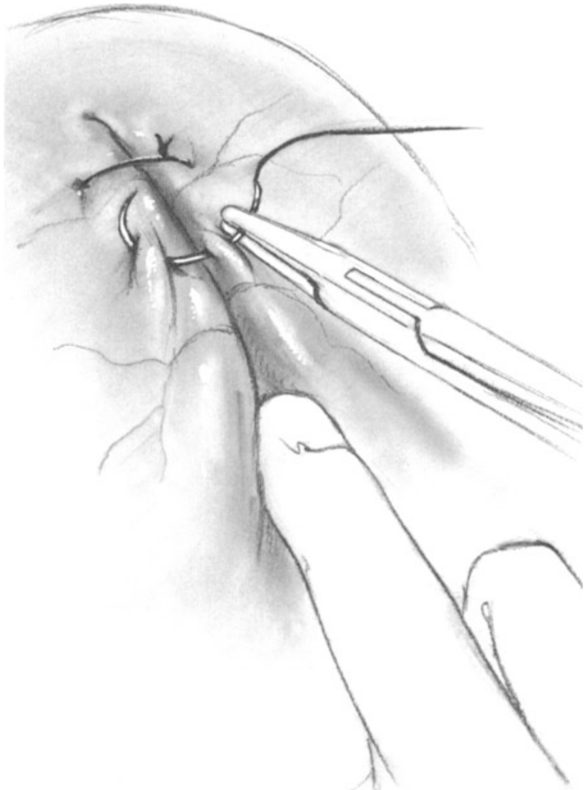


Fig. 78–10

to the tissue in this area, turn in the greater curvature together with the ligated stumps of the short gastric vessels. Use continuous or interrupted Lembert sutures of 4–0 atraumatic PG suture material to accomplish this step, which will avoid a possible gastric fistula (**Figs. 78–8** to **78–11**).

Abdominal Closure

Irrigate the upper abdomen with a dilute antibiotic solution. After aspirating this solution with a suction device, close the abdomen in routine fashion. Do not insert any drains unless there has been an injury to the pancreas or unless complete hemostasis has not been possible to achieve. In either of these cases, insert one or two medium-sized plastic closed-suction drains of the Hemovac or Jackson-Pratt types, through one or two puncture wounds in the area of the splenic bed and apply suction.

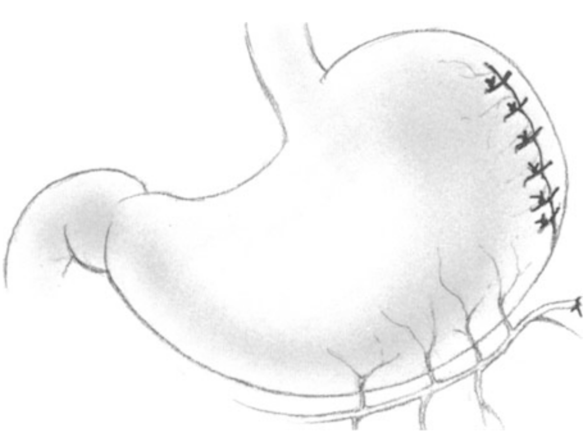


Fig. 78–11

Postoperative Care

Continue nasogastric suction for 1–2 days.

Continue perioperative antibiotics for 24 hours.

Continue steroid medication in those patients who were on this therapy prior to and during operation.

Monitor the patient's blood coagulation status and check for postoperative bleeding. Frequently, the platelet count will rise postoperatively. This does not generally require any treatment except in patients with myelofibrosis. Patients with this disease have been reported to suffer postoperative portal vein thrombosis. They should probably receive prophylactic treatment with aspirin and low-dose heparin (Gordon, Schaffner, Bennett et al.).

The leucocyte count may also rise markedly following splenectomy. This does not necessarily indicate sepsis.

If a patient has undergone a total splenectomy, be certain that the patient and his family are aware of the risks of overwhelming postsplenectomy sepsis. The patient should wear a Medic-Alert bracelet recording the fact that he has undergone splenectomy. Administer Pneumovax vaccine. This will protect against a majority of the types of pneumococcal infections. Young children should probably receive prophylactic treatment with penicillin throughout childhood. It is not clear that prophylactic antibiotics are indicated in adult life.

Postoperative Complications

Bleeding

Subphrenic abscess

Acute pancreatitis

Gastric fistula

Venous thrombosis

References

Gordon DH, Schaffner D, Bennett JM et al. Postsplenectomy thrombocytosis: its association with mesenteric, portal, and/or renal thrombosis in patients with myeloproliferative disorders. Arch Surg 1978;113:713.

Levy J, Wasserman P, Pitha N. Presplenectomy transcatheter occlusion of the splenic artery. Arch Surg 1979;114:198.

Traetow WD, Fabri PJ, Carey LC. Changing indications for splenectomy. Arch Surg 1980;115:447.

79 Operations for Splenic Trauma

Concept: Splenectomy or Splenorrhaphy?

Following splenectomy for trauma, children experience fatal sepsis at a rate 58 to 65 times greater than that experienced by the nonsplenectomized child. Sudden in onset, the sepsis is often fatal within 24 hours despite good medical treatment. It is generally caused by the encapsulated pneumococcus, meningococcus, *Haemophilus*, or sometimes *Escherichia coli*. Although the cases of fatal sepsis appear to be somewhat more common when a splenectomy is performed in a child under the age of 5 years, and although the fatal sepsis is likely to occur within 2 years of the splenectomy, there are many reports of fatal sepsis due to meningitis, pneumonia, and other causes, sometimes occurring many years after splenectomy. While it is difficult to determine exactly how much increase there is in the risk of fatal sepsis following splenectomy for trauma in the adult, there is general agreement that there is indeed some increase in this risk (Leonard, Giebink, Baesl et al.; Schwartz, Sterioff, Mucha et al.; Singer).

For all of the above reasons, it is imperative not to remove the traumatized spleen in children unless conservative management is not safe. In adults also the spleen should be salvaged unless it has been pulverized, separated from its blood supply, or unless the patient is unstable and preservation of the spleen would increase the risk of operative or postoperative fatality.

Children who have evidence of isolated trauma to the spleen can, in most cases, be successfully managed by nonoperative means (Ein, Shandling, Simpson et al.) unless they have lost more than 25%–30% of their blood volume. These children should be observed in an intensive care unit with frequent monitoring of vital signs for 2–3 days. After an additional 4–5 days of observation, including computed tomographic (CT) scanning, the child may be sent home. After an additional week of bed rest at home, and 3–4 weeks of restricted activity, the child may return to his normal way of life. Delayed splenic rupture during or after nonoperative management has been quite uncommon.

Whether conservative management is also indicated in the good-risk adult patient is a question that has not yet been answered. In the adult, where the injury is more likely to be an automobile accident rather than an athletic injury, there is a greater risk of overlooking serious injuries unrelated to the spleen if nonoperative management is pursued in a large number of cases. Nonoperative therapy is not at this time recommended for the usual splenic injury to the adult. The remainder of this chapter concerns itself with the management of splenic trauma in the adult patient, although the child in whom nonoperative management has failed can be managed by the same surgical principles.

Indications

Splenectomy is indicated for the traumatized spleen if the patient's condition is unstable, if he has suffered multiple injuries, if there is gross fecal contamination, if the spleen is fragmented beyond repair, or if the spleen has been separated from its blood supply. Do not risk the patient's life at any time in order to preserve an injured spleen, especially in patients over age 50.

Splenorrhaphy or partial splenectomy is indicated in good-risk patients who do not have the above indications for splenectomy.

Preoperative Care

Resuscitate the patient by means of adequate fluid and blood replacement.

Insert a nasogastric tube.

If the diagnosis is in doubt, perform a CT scan.

Pitfalls and Danger Points

Failure to control bleeding

Traumatizing the pancreas

Operative Strategy

Splenectomy

Unlike the technique described for the removal of the diseased spleen in Chap. 78, in removing the injured spleen initiate the dissection for removing the injured spleen by dividing the splenorenal and splenocolic ligaments as the first step in the operation. This will permit delivery of the spleen and the tail of the pancreas into the incision. Then hemostasis can be maintained by compressing the splenic artery between the thumb and index finger during the rest of the dissection. In the rare case where a giant spleen has been traumatized, it may be advantageous to identify the splenic artery (see Fig. 78–1) and to ligate it before delivering the enlarged spleen.

Iatrogenic Injuries

In past years, 20%–40% of all splenectomies have been performed as a result of iatrogenic injuries with an average mortality rate of 15% (Morgenstern, 1977). Most cases of iatrogenic splenic injuries result from avulsing a patch of the splenic capsule when the stomach or the transverse colon is retracted away from the spleen. Since the splenic pulp has not been damaged in most of these injuries, it is a simple matter to control the bleeding by applying a hemostatic agent, such as Surgicel or Avitene, and then by tamponading the area with a large gauze pad. Prior to closing the abdomen, remove the gauze pad carefully and inspect the area for bleeding. This technique is not effective if the injury occurs at the hilus of the spleen.

Splenic Fracture

The splenic artery and vein divide into 2–4 trunks prior to entering the spleen. The intrasplenic branches generally travel in a horizontal direction. Since most splenic fractures also travel in a transverse direction, often only one or two small blood vessels have been torn. To achieve hemostasis may require only that a hemostatic agent, Hemoclips, or suture-ligatures be applied; or that the laceration be sutured; or that a partial splenectomy be performed. Partial splenectomy is indicated if a portion of the spleen has been separated from its blood supply. This is suggested by a cyanotic discoloration of the devascularized segment compared to the remainder of the spleen.

Principles basic to all splenic suturing are adequate exposure combined with a *complete mobilization of the spleen* into the abdominal incision. This step is followed by temporary occlusion of the splenic artery by means of a Vesseloop and debridement of the devitalized tissue. Only by dividing the splenorenal and splenocolic ligaments and delivering the spleen together with the tail of the pancreas into the incision, can adequate repair of a ruptured spleen be undertaken. The best suture material appears to be 2–0 chromic catgut on an atraumatic straight or curved needle.

After replacing the repaired spleen into its natural bed, always wait 10–15 minutes and reinspect the spleen to be sure that the bleeding has indeed been completely controlled.

In some cases, a narrow pedicle of viable omentum may be placed into a fracture and sutured into place with chromic catgut.

After removing a portion of the spleen, it is not necessary to apply sutures to close the cut end of the spleen if good hemostasis can be achieved by means of Hemoclips and suture-ligatures in the splenic pulp. When sutures are inserted, they should penetrate the capsule and then be returned as a mattress stitch. In tying the sutures, take care not to tie them so tightly that they rupture the capsule. If the proper tension is applied to the knot, bolsters of Teflon, omentum, or Surgicel will not often be necessary.

Further discussions of surgical techniques for preserving the spleen can be found in papers by Morgenstern and Shapiro and by Buntain and Lynn.

Operative Technique

Incision

In the unstable patient, make a midline incision from the xiphoid to a point well below the umbilicus. In the stable patient, a midline incision is suitable for the patient with a narrow costal arch. For the wide-bodied patient, make a long left subcostal incision, dividing the muscular layers with the electrocoagulator to accelerate the operation. A Kehr extension, which extends up the midline from the medial tip of the subcostal incision and divides the linea alba to the xiphocostal junction, provides excellent exposure. In both the midline and the subcostal incisions, exposure is further enhanced by retracting the left costal margin anterolaterally and in a cephalad direction by means of the Thompson retractor.

Splenectomy

When the spleen is shattered, or when the hilus has sustained sufficient damage to separate the spleen from its blood supply, or when the patient's condition is unstable, emergency splenectomy is the operation of choice. In performing splenectomy for trauma, it is not necessary to isolate and ligate the splenic artery as a first step in the operation (as described in Chap. 78) unless the traumatized spleen is greatly enlarged due to a preexisting disease.

Take a position on the patient's right and retract the spleen in a medial direction with the left hand. Then divide the splenorenal, the splenophrenic, and the splenocolic ligaments (**Fig. 79–1**). In an emergency situation the experienced surgeon can often perform much of this dissection bluntly with his fingers. After the ligaments have been divided, slide the right hand behind the tail of the pancreas and elevate the tail of the pancreas together with the damaged spleen into the incision. Hemostasis can be achieved promptly by compressing the splenic artery and vein between the thumb and index finger in the space between the tip of the pancreas and the hilus of the spleen (**Fig. 79–2**). Pack the posterior abdominal wall with moist gauze pads. Expose the posterior aspect of the splenic hilus and identify the splenic artery and vein. It is generally simple to divide these structures between hemostats or ligatures (**Fig. 79–3**). This will control most of the bleeding. Now, deliberately dissect out each of the short gastric vessels. Next, divide each vessel between Adson hemostats and remove the spleen and then ligate each of the hemostats with 2–0 or 3–0 silk. Be sure to apply a second ligature to the splenic artery for added security and to control the minor bleeding points around the tail of the pancreas with fine suture-ligatures. Finally, remove the gauze pads from

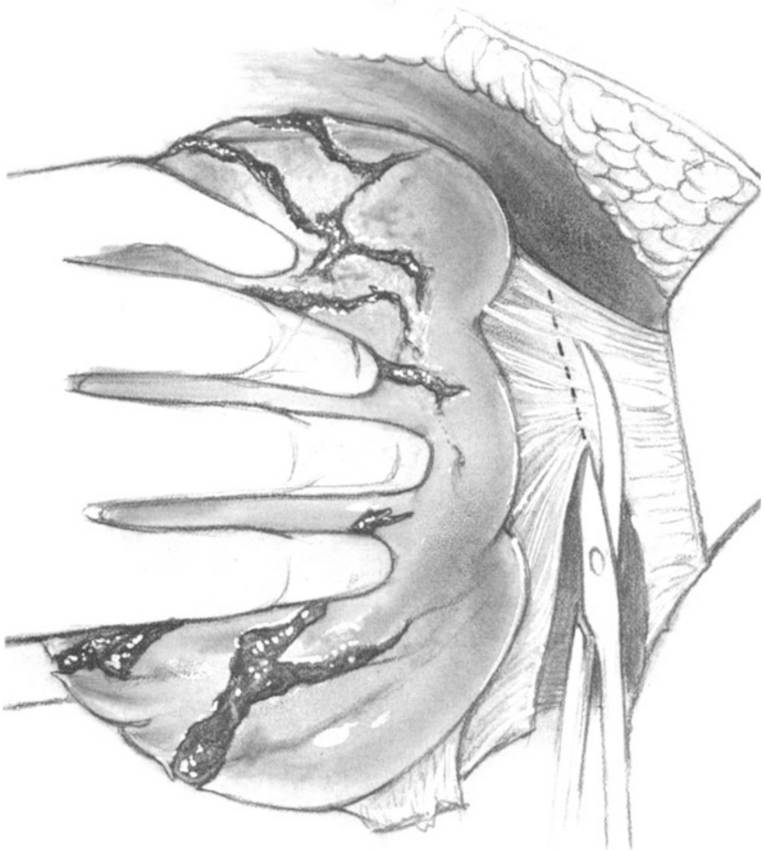


Fig. 79–1

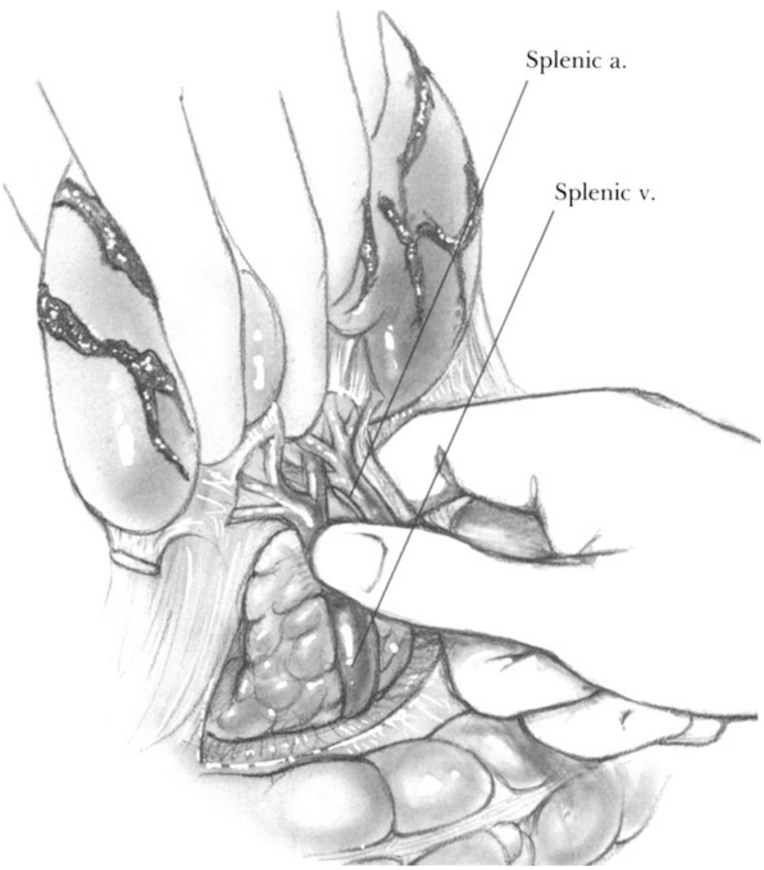


Fig. 79–2

Fig. 79–3

the splenic bed and achieve complete hemostasis with ligatures and electrocoagulation.

With this technique there need not be any haste to obtain hemostasis, because early in the operation the surgeon can control most of the bleeding by compressing the vessels at the hilus of the spleen with his fingers. Otherwise, hasty dissection may traumatize the tail of the pancreas.

Carefully inspect the greater curvature of the stomach. If there is any suspicion that the stomach wall has been injured during the dissection or the ligation of the short gastric vessels, insert Lembert sutures to invert this area of stomach as shown in Figs. 78–8 to 78–11.

Selecting the Optimal Technique for Splenic Preservation

Avulsion of Capsule; Superficial Injuries

Iatrogenic injury to the spleen, occurring during the course of vagotomy, hiatus hernia repair, or colon resection has constituted in many institutions the most common single indication for splenectomy in past years. Most of these injuries have involved the avulsion of a relatively small patch of splenic capsule. Superficial injuries of this type are best treated by the application of topical hemostatic agents (see below) rather than splenectomy. A large subcapsular hematoma, on the other hand, is best treated by incising the capsule, exposing the bleeding points, and then by applying topical hemostatic agents.

Partial Transverse Fracture

The transverse fracture that does not penetrate through the entire thickness of the spleen is a common injury because of the transverse distribution of the splenic blood supply. It is eminently suitable for repair by suturing after hemostasis has been obtained. A description of this technique is given in the section on splenorrhaphy below.

Complete Transverse Fracture

When a transverse fracture of the spleen has divided the organ into two or more segments, it is necessary to determine the viability of each segment. This is easily done because the nonviable spleen develops a purple discoloration. Remove the nonviable segments and retain the viable portion of the spleen after achieving hemostasis. Preserving from one-third to one-half of the normal spleen is very likely to prevent a significant diminution of the patient's immune response to infection. The technique for hemisplenectomy is given below. Be sure to identify and ligate the hilar artery that supplied the amputated segment of spleen.

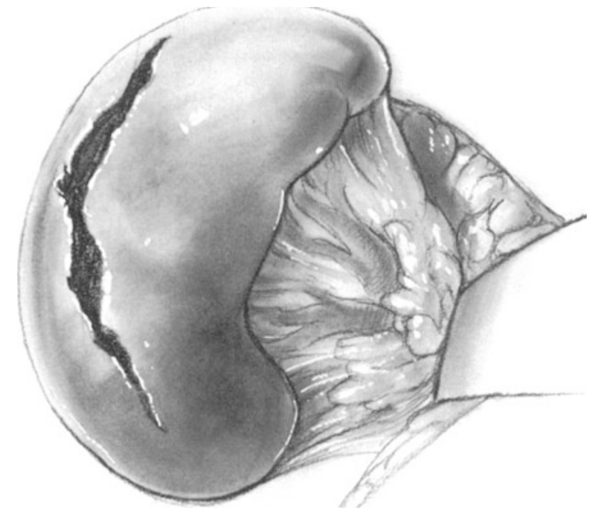


Fig. 79–4

Longitudinal Fracture

Severe blunt injuries may produce a longitudinal fracture in the long axis of the spleen (**Fig. 79–4**). Because this type of fracture may lacerate a large number of the transverse branches of the splenic artery and vein, hemostasis is more difficult than is the case with transverse injuries. After controlling the arterial bleeders with Hemoclips and suture-ligatures, the residual oozing can generally be managed by inserting a narrow pedicle of viable omentum and fixing it in place by means of a series of capsular sutures (**Fig. 79–5**).

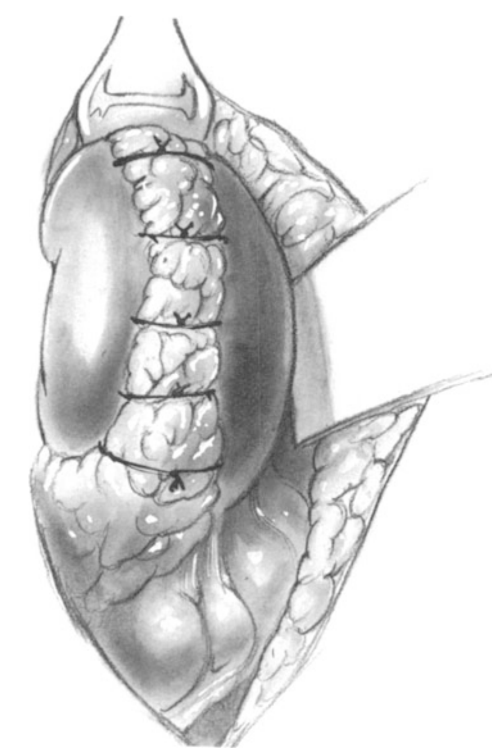


Fig. 79–5

Stellate Fracture

After exploring the depths of the fracture and removing clotted blood, treat the superficial fractures by suturing the capsule. Closing the capsule in this fashion will generally control bleeding from superficial fractures. Alternatively, applying Avitene to the stellate fracture may successfully control all but the arterial bleeders. The efficiency of this topical agent may be enhanced by also inserting capsular sutures.

Any splenic fracture, that significantly involves the hilus of the spleen, generally requires a partial splenectomy to control hilar bleeding, rather than capsular sutures.

Applying Topical Hemostatic Agents

Most of the topical hemostatic agents (Gelfoam, Oxycel, Surgicel, and Avitene) provide a framework for the deposition of platelets, which accelerates the formation of a blood clot. None of these agents will control rapid bleeding. Consequently, it is necessary to slow down the bleeding from the surface of a damaged spleen by local pressure for a few minutes. If the oozing surface is fairly smooth, apply a double sheet of Surgicel gauze. Cover this with a dry gauze pad. Apply even pressure with the gauze pad for 10 minutes. Then gently remove the gauze pad while taking care not to dislodge the sheet of Surgicel, which should now be adherent to the raw surface.

If the bleeding surface is irregular in nature, Avitene is a much better choice than Surgicel. It is very effective for oozing surfaces from traumatized capillaries and sinusoids. In applying Avitene, make certain to use only absolutely dry instruments. Use a forceps to apply enough Avitene to cover the entire bleeding surface for a thickness of 3–4 mm. Apply the Avitene quickly and cover it with a dry gauze pad. Apply constant pressure for at least 5 minutes. If bleeding breaks through one portion of the Avitene, apply an additional layer of dry Avitene. If bleeding continues to break through, remove the Avitene and pursue further efforts to reduce the rate of bleeding by applying Hemoclips or suture-ligatures. Rapid bleeding makes the Avitene gel prematurely, thus making it useless as a hemostatic agent.

Splenorrhaphy

Mobilizing the Spleen

Do not try to repair the spleen without completely mobilizing the spleen and the tail of the pancreas by the same technique described above (see Fig. 79–1). Be sure to free any attachments between the spleen and the omentum. Adequate exposure may also require the division of the lower short gastric vessels. Be very careful not to cause further injury to the spleen when dividing the splenic ligaments. Evacuate liquid and clotted blood from the area. Place a large gauze pad against the posterior abdominal wall in the area of the dissection and elevate the spleen and tail of the pancreas into the incision. If any of these maneuvers initiates brisk bleeding, compress the splenic artery and vein between the thumb and index finger at the hilus (see Fig. 79–2). Ligate any of the small vessels at the hilus that may have been lacerated by the trauma.

Suturing the Splenic Capsule

In the case of fractures that have not penetrated the full thickness of the spleen, remove devitalized tissue and blood clot from the traumatized areas. Use a narrow-tipped suction device to provide exposure and occlude bleeding arteries by accurately applying small or medium-sized Hemoclips. In the case of bleeding veins, or arteries that have retracted, use 4–0 or 5–0 vascular sutures. Residual oozing of blood from the sinusoids can be controlled by closing the capsule with interrupted sutures of 2–0 chromic catgut on a medium-sized gastrointestinal atraumatic needle, as illustrated in **Fig. 79–6**. If necessary, these sutures may be inserted in such fashion that they interlock. In other cases, a continuous suture of the same material may prove to be effective. In tying these sutures, take great care not to apply force sufficient to tear the delicate splenic capsule. Tie the sutures just tight enough to achieve hemostasis without tearing the spleen. If necessary, use strips or pledgets of Teflon felt or even Surgicel gauze; insert the sutures through these pledgets to protect the splenic capsule when the suture is being tied.

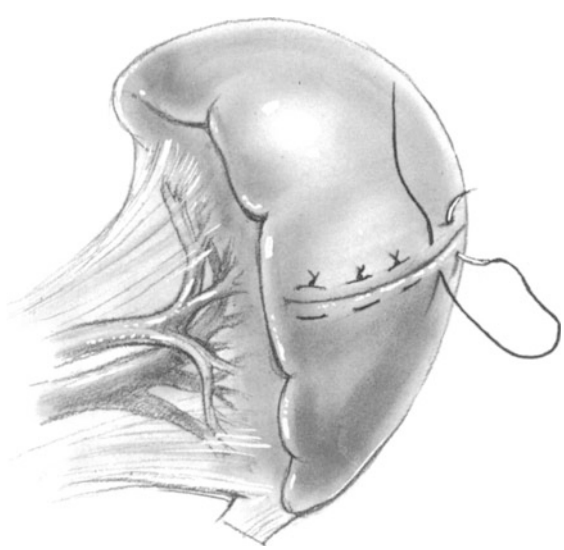


Fig. 79–6

Absorbable Mesh Wrap

When a spleen is the site of several fractures, wrapping it with a sheet of Vicryl or Dexon absorbable mesh after tailoring the mesh and suturing it so that the mesh provides even pressure to the damaged spleen may help achieve good hemostasis (Rogers et al.).

Partial Splenectomy

Dividing the Spleen

With a Vesseloop doubly looped around the splenic artery, occlude the splenic artery by applying tension to the Vesseloop with a small hemostat. Then, aspirate all blood clots from the area of injury, especially at the splenic hilus. Ligate the traumatized vessels at the hilus, preserving the blood supply to that portion of the spleen which will be retained. Use a narrow-tipped suction device to expose the bleeding points in the line of the fracture. Use the suction tip to develop a transverse division of the spleen. Apply small Hemoclips to bleeding vessels and continue the dissection until the traumatized section of the spleen has been entirely severed. Remove the specimen. Then release the Vesseloop encircling the splenic artery and observe the cut edge of the splenic remnant for hemostasis. Generally, some oozing will persist requiring suturing of the cut end of the spleen. Use 2–0 chromic catgut on a straight atraumatic needle (**Fig. 79–7**). Although their use should not often be necessary, it is possible to protect the delicate splenic capsule by applying a strip of Teflon felt on the anterior surface of the spleen and a second on the posterior surface. Then insert the sutures through the Teflon felt as shown on **Fig. 79–8**. Tie each of these mattress sutures.

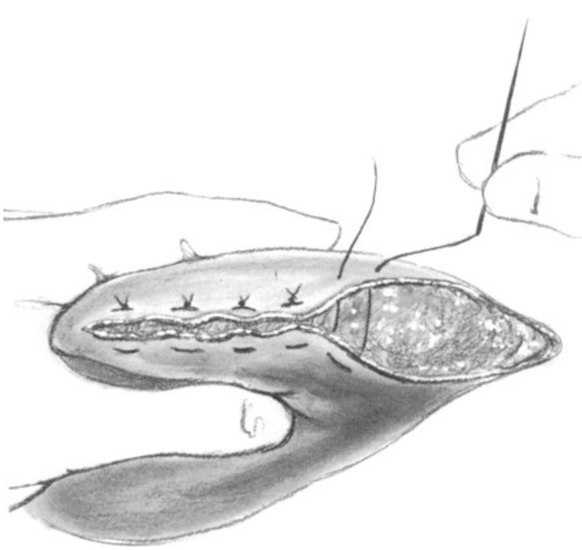


Fig. 79–7

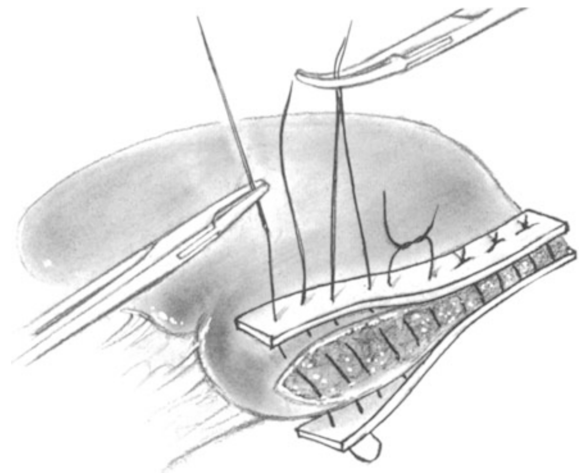


Fig. 79–8

This will achieve satisfactory hemostasis along the cut edge of the spleen.

Replace the splenic remnant in its natural position after making certain that hemostasis is complete in the posterior abdominal wall and in the splenic bed. Use electrocoagulation along the posterior abdominal wall, but if there are bleeding points in the tail of the pancreas, occlude these bleeding points by means of 4–0 or 5–0 suture-ligatures.

Do not close the abdominal incision for at least 10–15 minutes in order to inspect the splenic remnant after it has been replaced into the abdomen. If there is any bleeding, again deliver the remnant of spleen into the abdominal incision and control the bleeding.

Abdominal Closure and Drainage

Close the abdominal incision in the usual fashion after inserting a flat Silastic Jackson-Pratt closed-suction drainage tube through a puncture wound in the left upper quadrant down to the vicinity of the splenic bed.

Postoperative Care

Administer perioperative antibiotics for 12–24 hours.

Observe the patient in an intensive care unit or in another area where vital signs can be carefully observed for 2–3 days. Order hemoglobin and hematocrit determinations every 8 hours for the first 48 hours and then daily for the next 3–4 days.

If there is no significant bleeding or drainage, remove the drain by the 2nd postoperative day.

Keep the patient at bed rest for the first day or two. Thereafter cautiously resume ambulation. Patients who have had a splenorrhaphy or partial splenectomy should avoid vigorous athletics for a period of 4–6 weeks.

If a patient has undergone a total splenectomy, be certain that the patient and his family are aware of the risks of overwhelming postsplenectomy sepsis. The patient should wear a Medic-Alert bracelet recording the fact that he has undergone splenectomy. Administer Pneumovax vaccine. This will protect against a majority of the types of pneumococcal infections. Young children should probably receive prophylactic treatment with penicillin throughout childhood. It is not clear that prophylactic antibiotics are indicated in adult life.

Postoperative Complications

Postoperative bleeding. If proper hemostasis has been attained during the operation, this complication is rare.

Infarction of the splenic remnant.

References

Buntain WL, Lynn H. Splenorrhaphy: changing concepts for the traumatized spleen. Surgery 1979;86:748.

Ein SH, Shandling B, Simpson JS et al. Nonoperative management of traumatized spleen in children: how and why. Surgery 1978;13:117.

Leonard AS, Giebink GS, Baesl TJ et al. The overwhelming post-splenectomy sepsis problem. World J Surg 1980; 4:423.

Morgenstern L. The avoidable complications of splenectomy. Surg Gynecol Obstet 1977;145:525.

Morgenstern L, Shapiro SJ. Techniques of splenic conservation. Arch Surg 1979;114:449.

Pachter HL, Hoffstetter SR, Spencer FC. Evolving concepts in splenic surgery. Ann Surg 1981;194:262.

Rogers FB, Baumgartner NE, Robin AP. Absorbable mesh splenorrhaphy for severe splenic injuries: functional studies in an animal model and an additional patient series. J Trauma 1991;31:200–204.

Schwartz PL, Sterioff S, Mucha P et al. Postsplenectomy sepsis and mortality in adults. JAMA 1982;248:2279.

Singer DB. Postsplenectomy sepsis. In: Rosenberg HS, Bolande RP, eds. Perspectives in pediatric pathology, Chicago: Year Book Publishers; 1973;1:285.

Abdominal Wall

80 Concept: Which Operation for Inguinal Hernia?

Pathogenesis of Inguinal Hernia

Indirect inguinal hernia, even in adult life, is probably caused by the persistence of a patent processus vaginalis and can therefore be classified as a congenital lesion. A patient with this type of hernia is not born with a muscular or aponeurotic weakness; instead, as the neck of the indirect hernia enlarges over a period of years, pressure may produce weakness of the adjacent transversalis fascia. In the geographical area in which we practice, the ready availability of good pediatric care and pediatric surgeons has resulted in the detection and repair of many indirect inguinal hernias during infancy and childhood. Consequently, the majority of our adult hernias are direct in nature, their most probable cause being wear and tear. In the region of Hasselbach's triangle the only structures between the peritoneum and the skin are the transversalis fascia and the external oblique aponeurosis. Once the transversalis fascia becomes attenuated and stretched, a direct hernia will bulge through the external inguinal ring. The attenuated portion of the transversalis fascia is of no use in the repair. Along the superior and medial margins of the weak area, one may use the uninjured portion of the transversalis fascia together with the aponeurosis of the transversus abdominis muscle. On the inferolateral aspect of the weak area, a rim of transversalis fascia, called the iliopubic tract by Nyhus and Condon, is generally intact and useful in the repair. If this is not the case, either the shelving edge of the inguinal ligament or Cooper's ligament is available.

Indirect Hernia

In a child with an indirect inguinal hernia, where the neck of the sac is narrow and the diameter of the internal ring is normal, high ligation of the sac constitutes adequate surgery. Those patients, usually adults, whose internal ring has been forcibly dilated by the indirect hernia, have suffered a defect in the floor of the inguinal canal equivalent to a direct hernia. In this situation, after removing the sac, a procedure should be employed to repair the floor of Hasselbach's triangle. We prefer the Shouldice operation in most cases of this type.

Direct Hernia—Anterior Transversalis Repair (Shouldice)

With respect to the direct hernia, many surgical procedures have been proposed. The Halsted technique is simple, but positioning the new external ring directly over the internal ring results in a high incidence of recurrences at this site. McVay's repair utilizing Cooper's ligament is elegant in concept, but in the hands of many surgeons this repair leaves a weak area in the vicinity of the iliac vein at the medial margin of the new internal inguinal ring because the iliopubic tract or femoral sheath in this area may be attenuated. The preperitoneal repair popularized by Nyhus is valuable when repairing an incarcerated femoral hernia. When used to repair direct hernias, the Nyhus preperitoneal operation has been followed by an excessive recurrence rate (17%–35%, Nyhus and Condon p. 227). The Bassini operation has achieved worldwide popularity owing to its simplicity. The integrity of the Bassini repair depends on attaching the "conjoined tendon" to the shelving edge of the inguinal ligament with one layer of sutures. If any one of these sutures should break or cut through the tissue, recurrence would seem to be inevitable. The defect in the transversalis fascia itself and the internal inguinal ring are not specifically repaired. Follow-up studies by Berliner, Burson, Katz et al. have demonstrated a recurrence rate of 11.5% for this operation.

For the past 20 years at our institution, patients who have had direct or combined indirect-direct inguinal hernia and undergone the Shouldice repair have achieved excellent results. The Shouldice technique requires a complete dissection of Hasselbach's triangle with incision of the attenuated transversalis fascia from the internal inguinal ring to the pubic tubercle. All of the preperitoneal structures including the bladder and the deep inferior epigastric artery and vein are dissected away from the transversalis fascia prior to initiating any suturing.

Several layers of continuous suture material are utilized so that not only is the defect in the transversalis fascia repaired, but there is also successive attachment of the transversus abdominis arch and the internal oblique muscle to the iliopubic tract, the inguinal ligament, and the undersurface of the external oblique aponeurosis. The attenuated transversalis is *excised* and the healthy tissue is sutured. The effect of the succeeding layers of sutures is to weave into position a "roof patch" of external oblique aponeurosis over Hasselbach's triangle. The continuous nature of the suture permits tension to be equally distributed throughout the area, thus allowing the use of fine suture materials. At the same time the extensive dissection guarantees that the surgeon will see and evaluate each structure in the inguinal region.

In approximately 1%–2% of our patients with large direct or sliding hernias we have felt that the area of weakness was so extensive, or in some cases so infiltrated with adipose tissue, as to require a technique other than the Shouldice. In these situations we have inserted polypropylene mesh (Marlex). Although Lichtenstein reported good results with Marlex mesh in the *routine* repair of direct inguinal hernia, we have restricted its use to those cases where the Shouldice operation was not suitable and in cases of recurrent hernia (see Chap. 83).

Direct Hernia—Cooper's Ligament Repair (McVay)

In McVay's method of repairing the floor of the inguinal canal in a direct (or a large indirect) hernia, all the attenuated transversalis fascia is excised and the aponeurosis of the transversus abdominis muscle (transversus arch) is sutured down to Cooper's ligament and the anterior femoral sheath. This requires careful dissection so that the femoral sheath may be identified. The operation cannot be performed unless a long relaxing incision is made in the posterior leaflet of the anterior rectus sheath. When this operation has been properly executed, excellent results have been reported by Halverson and McVay and by Rutledge. The McVay operation resembles that of Shouldice in that all of the structures deep to the damaged inguinal floor are carefully dissected out and exposed. Both techniques use the transversus arch for the cephalad margin of the repair. Whereas the Shouldice repair uses the iliopubic tract, the femoral sheath, and the inguinal ligament for the lower sutures, McVay employs Cooper's ligament and the femoral sheath. Because we do not have a large experience with the Cooper's ligament repair, the operative technique described in Chap. 82 is that of McVay.

Inguinal Hernia Repair in Women—Modifications of Technique

In the absence of spermatic vessels and a vas, repairing an inguinal hernia in a woman is much simpler than in a man. The round ligament that is found in women in place of the spermatic cord is easily excised together with the sac, if a sac is present. If there is a weak area in the transversalis fascia, perform a standard Shouldice repair. If there is not a significant area of weakness, insert only the first two layers of a Shouldice repair. Then close the incision in the external oblique aponeurosis in the usual fashion. The recurrence rate following the repair in women is generally reported to be lower than in men.

In repairing a femoral hernia, the technique used is identical in both women and men.

Sliding Hernia—Shouldice or McVay Repair

Sliding inguinal hernias generally emerge lateral to the deep inferior epigastric artery and are therefore indirect in nature. Unlike other indirect hernias, the sliding hernia is not the result of a congenital sac. In a sliding hernia the sac is purely coincidental. The pathogenesis here is a large defect in the transversalis fascia that permits colon to slide through the abdominal wall, dragging some peritoneum along with it as an appendage. Consequently, excision of all or part of the sac *is not an essential part of the repair.* The sliding hernia should be treated as a direct hernia after the herniated colon and sac have been reduced. The sac may be opened to confirm the nature of the pathology, but amputation of the sac is not necessary unless the sac is very redundant. One then proceeds with either the typical Shouldice or McVay repair. Ryan reported a recurrence rate of only 1% after repairing 313 sliding hernias by these principles. Our observations confirm his findings.

Incarcerated and Strangulated Hernia—Modifications in Anesthesia and Incision

There is no significant variation in technique for these two complications of inguinal hernia, other than the use of general anesthesia in most cases. Do not hesitate to perform an additional midline laparotomy incision if it is necessary to achieve adequate exposure when resecting strangulated bowel.

When repairing a strangulated inguinal hernia contaminated by gangrenous bowel, we use monofilament steel wire or Prolene to repair the hernia in order to prevent the development of suture granulomata and sinuses postoperatively.

References

Berliner S, Burson L, Katz P, Wise L. An anterior transversalis fascia repair for adult inguinal hernias. Am J Surg 1978;135:633.

Halverson K, McVay CB. Inguinal and femoral hernioplasty: a 22-year study of the author's methods. Arch Surg 1970;101:127.

Lichtenstein IL. Hernia repair without disability. St. Louis: Mosby; 1970.

Nyhus LM, Condon RE (eds). Hernia, 2nd edn. Philadelphia: Lippincott; 1978.

Rutledge RH. Cooper's ligament repair for adult groin hernias. Surgery 1980;87:601.

Ryan EA. An analysis of 313 consecutive cases of indirect sliding hernias. Surg Gynecol Obstet 1956;102:45.

81 Anterior Transversalis Repair of Inguinal Hernia (Shouldice)

Indications

All indirect and sliding inguinal hernias should be repaired because of the significant incidence of strangulation.

With the use of local anesthesia, systemic disease is rarely so serious as to constitute a contraindication to operating. Small, nonsymptomatic direct inguinal hernias in elderly patients do not require surgery because they almost never produce strangulation. Direct hernias that produce symptoms, on the other hand, should be repaired.

Preoperative Care

Persuade obese patients to lose weight prior to surgery. Fat interposed between sutured layers of fascia impedes healing.

Pitfalls and Danger Points

Injury to femoral vessels during suturing
Injury to bladder (especially in sliding hernia)
Injury to colon (especially in sliding hernia)
Injury to deep inferior epigastric vessels with postoperative retroperitoneal bleeding
Injury to ilioinguinal nerve

Operative Strategy

Anesthesia

For inguinal hernia repair, local field block anesthesia is preferred. Patients are ambulatory the afternoon of operation and are able to resume a normal diet the same evening. Overdistention of the anesthetized bladder by intravenous fluids often follows the use of general anesthesia. This is a major cause of postoperative urinary retention. Relief of this complication requires bladder catheterization that may, in some cases of borderline prostatism, necessitate a prostatectomy after the hernia repair. Urinary retention is avoided with local anesthesia because it does not obtund the patient's sensation of a full bladder or his ability to urinate.

Local anesthesia does not mean that no attention is paid to the patient by anyone other than the operating team. We require that either an anesthesiologist or a nurse sit at the head of the table to monitor the vital signs.

Although local anesthesia allows us to manage most incarcerated hernias successfully, general anesthesia with endotracheal intubation is indicated whenever strangulation of bowel is suspected.

Avoiding Injury

The *iliac or femoral vein* may be injured by blindly inserting a suture too deep through the iliopubic tract or the inguinal ligament in the lateral portion of the repair. If this should occur, cut the needle off and remove the suture. Then apply pressure to the vein for 5–10 minutes. This maneuver will often avoid the need to expose the iliac vein and suture the bleeding point.

Occasionally, postoperative *preperitoneal hemorrhage* of serious nature has been produced by injuring one of the deep inferior epigastric vessels with a deep suture. In the Shouldice technique, this can be prevented by complete dissection of the transversalis fascia away from these structures after dividing the external spermatic vessels.

The *bladder* may be injured in attempting to amputate a sac in a sliding inguinal hernia. Overenthusiastic dissection on the medial aspect of an indirect sac, in the mistaken notion that the higher the ligation the better, may also traumatize the bladder. If a laceration of the bladder has been identified, close the defect by suturing the full thickness of the bladder wall with a continuous 3–0 PG atraumatic suture. Then invert this layer of stitches with a second continuous or interrupted layer of 3–0 PG Lembert-type sutures. Be sure that the bladder remains decompressed for the next 8–10 days by means of constant drainage with an adequate indwelling Foley catheter.

Colon as well as bladder may be injured if the sliding nature of an inguinal hernia is not diagnosed early in the course of operation. Whenever a bulky indirect inguinal hernia is not accompanied by

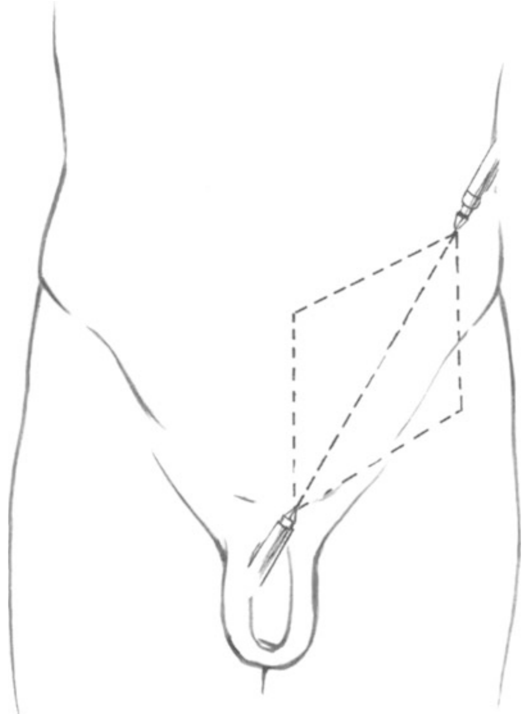


Fig. 81–1

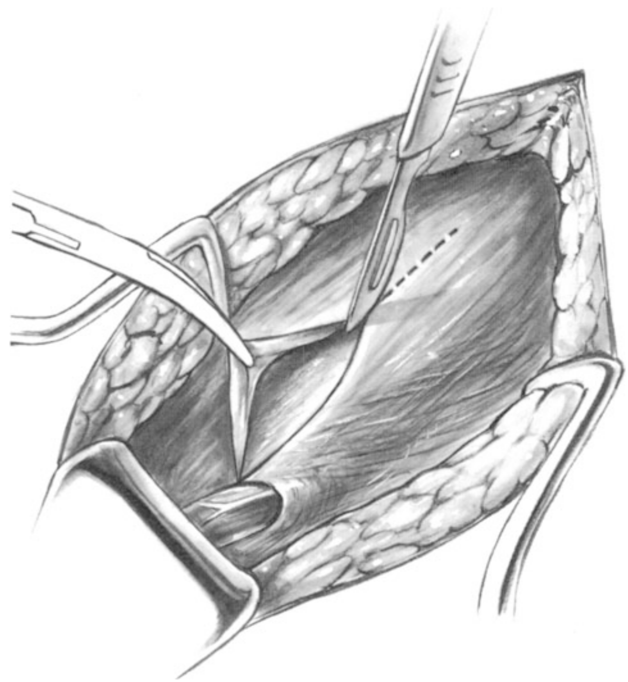


Fig. 81–2

a thin-walled, transparent sac, the presence of a sliding component should be suspected.

All of these inadvertent injuries can be avoided by taking advantage of the extensive exposure that may be attained by the long incision in the transversalis fascia when using the Shouldice method. The deep inferior epigastric vessels and their branches, the iliac vessels, the peritoneum, and, in case of a sliding hernia, the colon are all easily identified. Visualizing these structures is the best way to prevent damage.

Avoiding Postoperative Wound Infections

Of the patients who suffer a postoperative wound infection, 40%–50% will develop a recurrent hernia. Although the incidence of postoperative infection in all "clean" wounds in our institution has been about 1%, even this figure is excessive. The rate of infection can be minimized in hernia repair if the entire operation is performed with careful, sharp dissection. Also important is meticulous hemostasis, which is sometimes neglected in this area of surgery. Finally, the operative site should be irrigated with aliquots of 0.3% kanamycin solution containing 50,000 units of bacitracin in 300 ml of saline solution. This irrigation appears to have contributed to the complete elimination of postoperative infection in 1,200 consecutive herniorrhapy operations (Berliner).

Operative Technique

Local Anesthesia

Use a mixture of equal parts of 0.5% Marcaine and 2% Nesacaine. Create a field block by injecting into the subcutaneous tissues along the lines shown in **Fig. 81–1**. Inject also along the line of the incision. This will require a total of 40 ml of anesthetic solution.

After making the skin incision and exposing the external oblique aponeurosis, inject another 10 ml just beneath this layer. Also inject the abdominal musculature along a line 5 cm cephalad to the inguinal canal. This will improve muscle relaxation for the repair. Later, when the peritoneal sac is exposed, inject 5 ml into the sac. Not only will this technique of local block eliminate pain, but it also produces *surprisingly good muscle relaxation.*

Incision

Start the incision in the skin at a point 2.5 cm medial to the anterior superior spine of the ilium. Continue in an oblique fashion to the point where the external ring adjoins the pubic tubercle.

Exposure

By sharp scalpel dissection, clear the external oblique aponeurosis of fat and areolar tissue; continue inferiorly beyond the point where the external oblique aponeurosis becomes the inguinal ligament

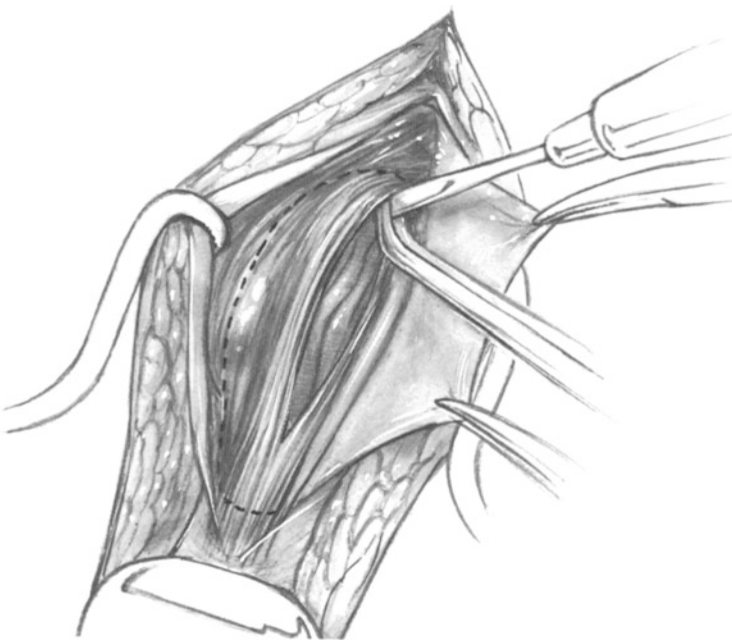


Fig. 81–3

and curves posteriorly in the upper thigh. Expose the external inguinal ring as well as the spermatic cord emerging from this ring. Occlude the bleeding points with 4–0 PG ligatures or electrocoagulation to obtain hemostasis. Incise the external oblique aponeurosis along the line of its fibers so that the incision will join the external inguinal ring at its *cephalad* margin (**Fig. 81–2**).

Identify the ilioinguinal nerve and dissect it free. Occasionally, the ilioinguinal nerve runs with the spermatic cord, closely approximated to the cremaster muscle. Retract the lateral leaflet of the external oblique in a caudal direction and expose its junction with the pubic tubercle. It is important now to elevate the medial leaflet of external oblique aponeurosis from the underlying transversus muscle for a distance of at least 3–4 cm. The medial leaflet is then retracted in a cephalad direction by inserting one fork of the self-retaining Farr retractor beneath this leaflet, while the other fork is inserted in the subcutaneous tissue of the lateral skin flap.

Excising Cremaster Muscle

Free the spermatic cord from surrounding attachments at a point medial to the pubic tubercle. An attempt to underrun the cord lateral to this point may result in traumatizing the structures enclosed in a direct hernia. In the medial location there is much less difficulty freeing the cord from surrounding structures. Remember that in patients with a direct hernia, the hernia sac remains behind when the spermatic cord is encircled. Use a latex tape for purposes of traction.

Transect attachments between the spermatic cord and the underlying tissues. This can be accomplished with the electrocautery. Resect lipomas and adipose tissue. In order to reduce the diameter of the cord, excise the *entire cremaster muscle* from that portion of the spermatic cord which will remain in the inguinal canal. This will permit you to minimize the diameter of the internal inguinal ring when it is

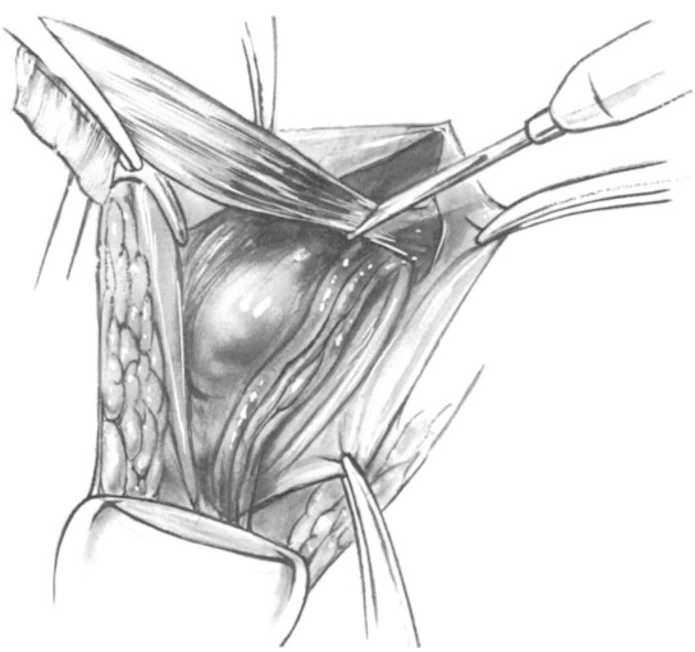


Fig. 81–4

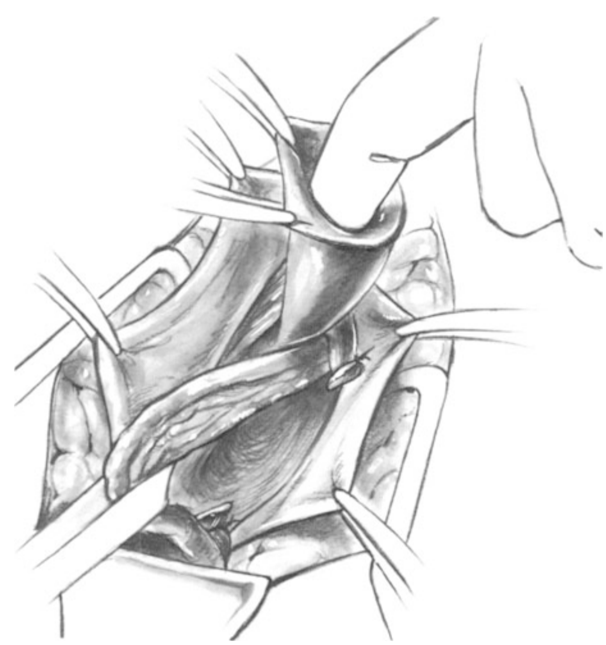


Fig. 81–5

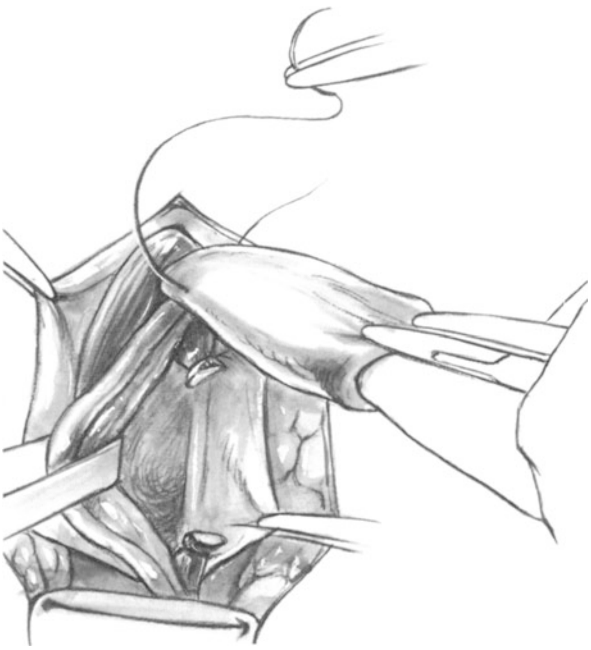


Fig. 81–6a

Fig. 81–6b

reconstructed. Be sure to remove all of the cremaster muscle fibers from their attachments to the iliopubic tract, the femoral sheath, and the transversalis fascia (**Figs. 81–3 and 81–4**). Only after accomplishing the removal of all these fibers will the visualization of these important structures be clear. Positive identification must be made of both the vas deferens and the internal spermatic vessels prior to resecting the cremaster.

Excising Indirect Sac

At this point, place the left index finger behind the cord near the internal ring and dissect out the cord structures in order positively to rule out the presence in the cord of an indirect sac. If an indirect sac is identified and the patient has a combined indirect and direct hernia, do not employ Hoguet's maneuver of attempting to convert the direct hernia into an indirect type as it is useless. Simply free the indirect sac to its neck; explore the sac (**Fig. 81–5**); transfix it with a single suture-ligature (**Fig. 81–6a**); and amputate the redundant portion (**Fig. 81–6b**). It is important to free the neck of the sac from surrounding structures so that the stump of ligated sac may retract into the abdomen. The hemostat retracting the lateral leaflet of the external oblique aponeurosis is now removed. This removal permits the cord to be placed lateral to this leaflet together with the ilioinguinal nerve, after which the hemostat is replaced as in **Fig. 81–7**.

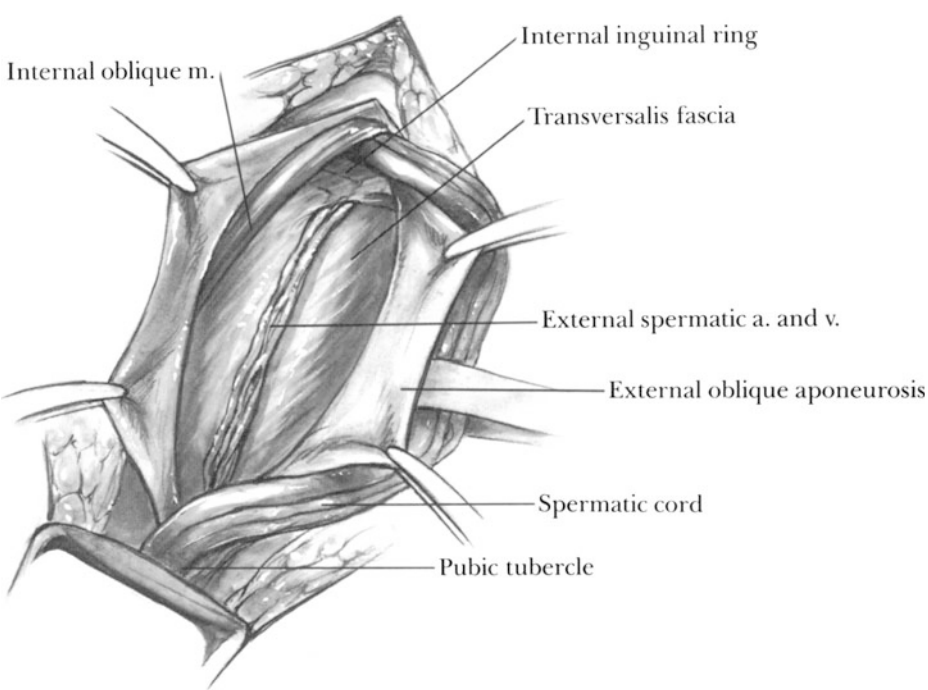


Fig. 81–7

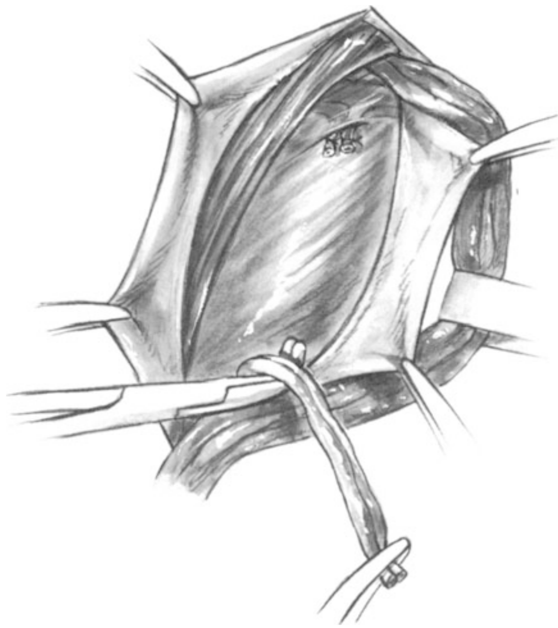


Fig. 81–8

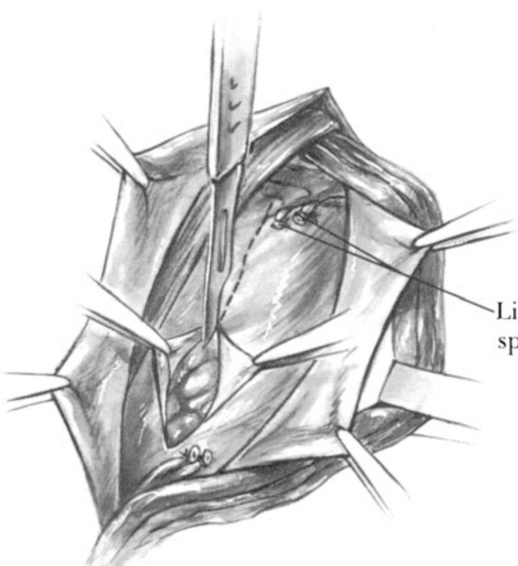


Fig. 81–9

Transversalis Dissection

Attention is directed to the bulge in Hasselbach's triangle, which constitutes the direct "sac." Identify the *external* spermatic vessels, which branch off the deep inferior epigastric artery and vein and lie superficial to the transversalis fascia (Fig. 81–7). Resect the external spermatic vessels between two ligatures of 2–0 PG, one at their junction with the deep inferior epigastric vessels and the other at the pubic tubercle (**Fig. 81–8**). Often a small branch of the genitofemoral nerve runs along the floor of the inguinal canal together with the external spermatic vessels. Excise this nerve together with the vessels. These steps will clear the entire floor of Hasselbach's triangle. Make a scalpel incision through the bulging attenuated transversalis fascia from the pubic tubercle to a point just medial to the deep inferior epigastric vessels (**Fig. 81–9**). When lobules of preperitoneal fat bulge through the scalpel incision, the remainder of the incision may be accomplished with a Metzenbaum scissors if preferred. If one is in the proper plane of dissection, the deep inferior epigastric vessels will have been entirely cleared of areolar tissue; Cooper's ligament will be clearly visible laterally, and the preperitoneal fat will be easily separated from the deep surface of the transversalis fascia in a cephalad direction (**Fig. 81–10**). If any branches of the deep inferior epigastric vessels join the deep surface of the transversalis fascia, carefully divide and ligate them so that the epigastric vessels can be pushed down away from the repair. Otherwise, retroperitoneal bleeding may be caused by inadvertently piercing these vessels with a needle while suturing the transversalis layer. Excise the attenuated portions of transversalis fascia and apply straight hemostats to the free cut edge of the medial leaflet of the transversalis fascia for purposes of traction. Apply a moist gauze sponge in a sponge-holder to the preperitoneal fat and bladder in order to push these structures posteriorly.

Shouldice Repair: Layer No. 1

Anchor the initial stitch (3–0 Tevdek on a C-5 atraumatic needle) by catching lacunar ligament and pubic periosteum in one bite and the undersurface of the medial flap of transversalis with overlying rectus fascia in the other. Tie this stitch. Apply upward traction on the straight clamps holding the medial leaflet of transversalis fascia; this will reveal a "white line" of fibrous tissue on the undersurface of the transversalis fascia. The "white line" represents the aponeurosis of the transversus muscle as seen

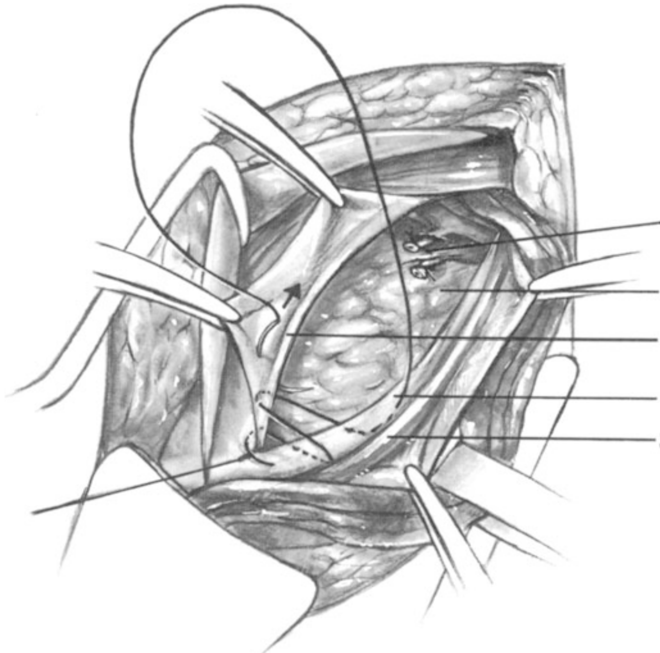


Fig. 81–10

through the transversalis fascia. This aponeurosis of the transversus abdominis muscle is thought by McVay and Halverson and by Nyhus and Condon to be the most important tissue involved in inguinal hernia repair. This arch of aponeurotic tissue becomes muscular as it approaches the internal inguinal ring. Include the "white line" in the continuous stitch that attaches the cut lateral edge of the transversalis fascia to the undersurface of the medial leaf of the transversalis (Fig. 81–10). Insert the needle into the lateral leaflet of transversalis fascia near the point where this layer appears to attach to the inguinal ligament (**Fig. 81–11**). This condensation of the caudal margin of the transversalis fascia is identical to what Nyhus and Condon call the iliopubic tract. Be sure to remove all the cremaster muscle fibers that cover the iliopubic tract and femoral sheath. Otherwise it is not possible to identify these structures accurately for proper suturing.

Each stitch should contain 4–6 mm of tissue. Continue the suture in a lateral direction until the newly constructed internal ring has been closed snugly around the spermatic cord so that only the tip of a Kelly hemostat will fit loosely between the cord and the internal ring.

Shouldice Repair: Layer No. 2

Excise the attenuated portion of the transversalis fascia. Then, use the same continuous strand of

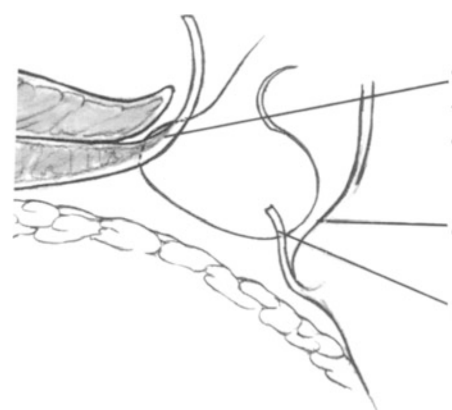


Fig. 81–11

suture material as in layer No. 1 and sew the free cut edge of the medial leaflet of transversalis fascia with adjacent internal oblique muscle to the anterior aspect of the iliopubic tract. Include 2–3 mm of the shelving edge of the inguinal ligament in the

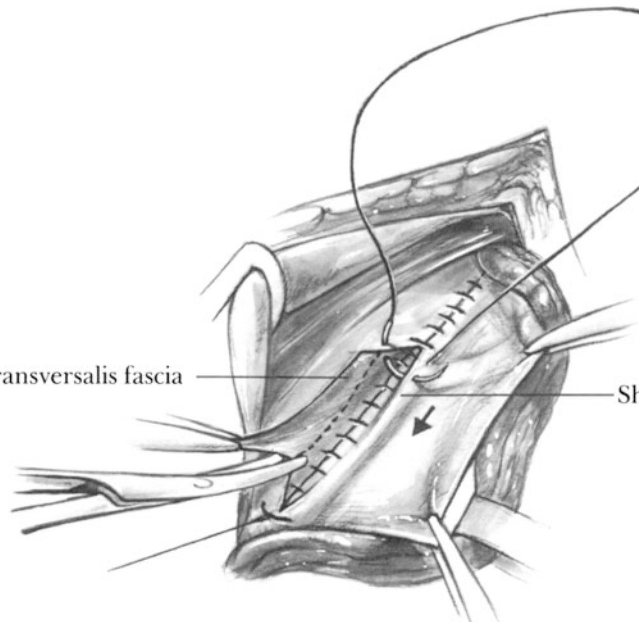


Fig. 81–12

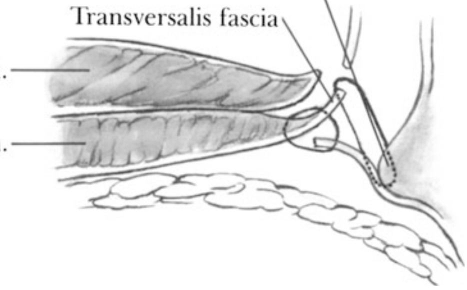


Fig. 81–13

continuous suture going medially (**Figs. 81–12 and 81–13**). Continue this suture to the pubic tubercle. Devote special attention to insert the last stitch into the pubic periosteum. At this point, terminate the suture by knotting it to its tail. Excise fatty tissue if present in the internal oblique muscle layer prior to suturing. A worthwhile modification of the Shouldice technique is to excise the lower 2 cm of the internal oblique muscle to expose the underlying aponeurosis of the transversus muscle. This step is, in fact, an integral part of McVay's method of hernia repair as shown in Fig. 82–1. After accomplishing this step, one can insert the sutures for Shouldice's layer No. 3 into the transversus aponeurosis instead of into the fleshy, internal oblique muscle.

Shouldice Repair: Layer No. 3

Use a new strand of 3–0 Tevdek to begin this layer. Take a bite of internal oblique muscle or "conjoined

Fig. 81–14

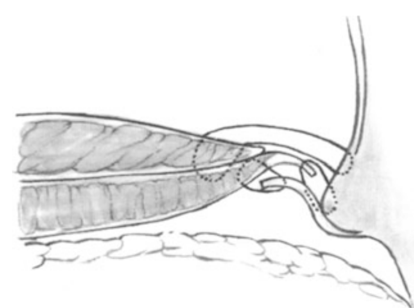


Fig. 81–15

tendon" and another of the shelving edge of the inguinal ligament and tie the suture, beginning this time at the medial margin of the newly constructed internal ring. If the internal oblique muscle is flimsy, resect the muscle and sew to the underlying aponeurosis of the transversus muscle. Insert this suture continuously in a medial direction (**Figs. 81–14 and 81–15**) as far as the pubic tubercle. Do not leave any gap in the suture line near the pubic tubercle as this oversight is a common cause of recurrent hernia adjacent to the pubis.

Shouldice Repair: Layer No. 4

Use the same continuous suture to create a fourth layer by taking first a bite of internal oblique muscle just cephalad to the previous layer and then a 4-mm bite of the undersurface of external oblique aponeurosis just anterior to the previously inserted layer (**Figs. 81–16 and 81–17**). Continue this suture until it approaches its point of origin at the internal ring, where the suture is terminated by being tied to its tail.

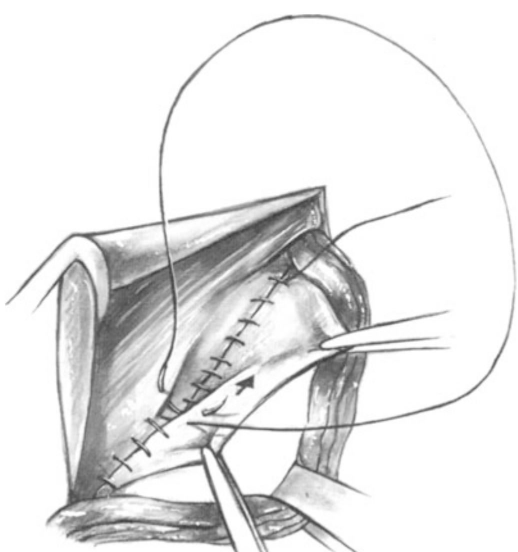


Fig. 81–16

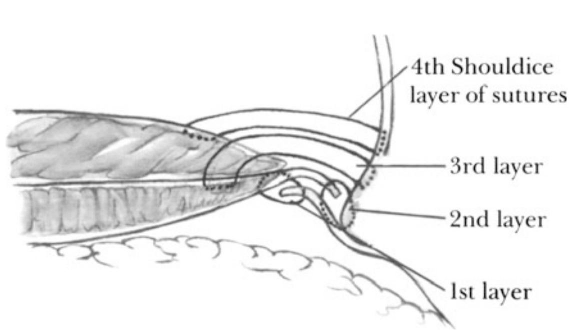


Fig. 81–17

Although the classical Shouldice repair calls for the four layers as described, we have generally found that the width of available external oblique aponeurosis was inadequate to construct the fourth layer. Most often we do three and occasionally two layers.

Berliner has studied the incidence of recurrent hernia, comparing the two-layer, the three-layer, and the four-layer Shouldice repairs. He found no significant differences among these three variations in technique.

This author reported on three-layer Shouldice primary hernia repairs in 1,084 men in 1983. After a follow-up period of 40 to 120 months, only 1.2% of these patients developed recurrent hernias.

Shouldice Repair: Closure of External Oblique Aponeurosis

Carry out a meticulous inspection of the cord and obtain complete hemostasis by a combination of fine ligatures and electrocoagulation. Replace the cord in the canal, which is now displaced somewhat in a cephalad direction. Elevate the medial portion of the external oblique aponeurosis to provide adequate space for the spermatic cord. Suture together the two leaflets of external oblique aponeurosis by utilizing a continuous atraumatic 2–0 PG suture (**Fig. 81–18**). At the new external inguinal ring include in the last bite of this suture the proximal cut edge of

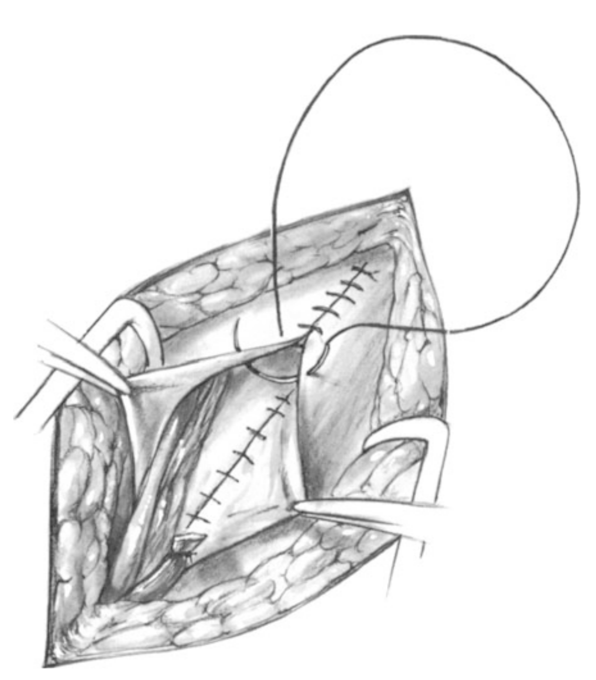


Fig. 81–18

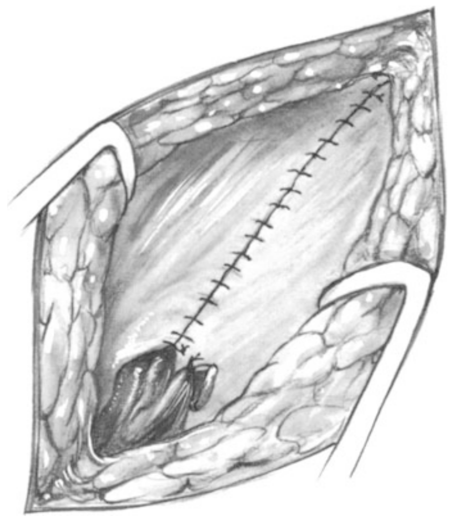


Fig. 81–19

cremaster muscle (**Fig. 81–19**). This will prevent the testis from descending to an abnormally low point in the scrotum as a consequence of resecting the cremaster muscle. There is no virtue in creating a tight external ring. Rather, allow a 2-cm opening for the spermatic cord.

At intervals during the operation, irrigate the field with an antibotic solution of 0.3% kanamycin and bacitracin, 50,000 units in 300 ml of saline solution.

Approximate Scarpa's fascia with several 4–0 PG sutures. Accomplish the skin closure by a continuous subcuticular suture of 4–0 PG, supplemented by strips of sterile adhesive to the skin (Steri-strip).

Postoperative Care

Begin active ambulation the afternoon of the operation. Analgesia will require Percocet for the next few days. Terminate the intravenous infusion in patients who have undergone local anesthesia when they leave the recovery room. Laxatives may be given on the night of the first postoperative day in order to avoid patient discomfort at defecation.

All of our patients undergoing repair of groin hernias have their operation under local anesthesia in our ambulatory surgery unit. With rare exceptions, all of the patients go home 2–4 hours after completion of their operations.

Postoperative Complications

Systemic complications of a pulmonary, cardiac, or urological nature are extremely rare.

Wound infections should be rare. Treat them promptly by opening the skin and subcutaneous tissues for adequate drainage and by ordering appropriate antibiotics.

Hematomas may occur in the wound and are generally treated expectantly. Some degree of superficial ecchymosis may be secondary to the injection of the agents for local anesthesia.

Testicular swelling is generally due to venous obstruction. Although this may sometimes be due to excessive constriction of the newly reconstructed internal ring, it is more often the result of trauma, or hematoma, or inadvertent ligature of the internal spermatic veins in the inguinal canal. Although this complication may lead to testicular atrophy or necrosis, in most cases satisfactory results may be anticipated from expectant therapy.

Persistent pain in the area innervated by the ilioinguinal or genitofemoral nerves is a rare but disturbing complication of inguinal hernia repair. Starling and Harms reported on 19 patients with ilioinguinal and 17 patients with genitofemoral neuralgia. Most of these followed inguinal hernia repair and were attributed to entrapment of the nerve in a stitch or scar tissue. These authors describe the diagnostic studies that they feel are necessary to diagnosis nerve entrapment. In most but not all of their cases, relief of pain was achieved by re-exploring the hernia incision and resecting the ilioinguinal nerve. In the case of the genitofemoral nerve, a retroperitoneal lumbar approach was used to transect the genital branch of the genitofemoral nerve.

For a discussion of the incidence, the causes, and the treatments of *recurrent inguinal hernia*, see Chap. 83.

References

Berliner SD. Personal communication.

Berliner SD. Adult inguinal/hernia: Pathophysiology and repair. In: Nyhus LM ed., Surgery Annual 1983;13: 307–329.

McVay CB, Halverson K. Inguinal and femoral hernias. In: Beahrs RW, Beart RW (eds) General surgery. Boston: Houghton Mifflin; 1980.

Nyhus LM, Condon RE (eds). Hernia, 2nd ed. Philadelphia: Lippincott; 1978.

Starling JR, Harms BA. Diagnosis and treatment of genitofemoral and ilioinguinal neuralgia. World J Surg 1989;13:586–591.

82 Cooper's Ligament Herniorrhapy (McVay)

Operative Technique for Direct or Large Indirect Inguinal Hernia

Incision and Exposure

Make a skin incision over the region of the external inguinal ring and continue laterally to a point about 2 cm medial to the anterior superior iliac spine. Open the external oblique aponeurosis with an incision along the line of its fibers from the external inguinal ring laterally for a distance of about 5–7 cm (see Fig. 81–2). Mobilize the spermatic cord. Excise the *entire* cremaster muscle from the area of the inguinal canal (see Fig. 81–3). Also remove any lipomas of the cord. Explore the cord carefully for the presence of the indirect sac. If a sac is present, dissect it from the cord. Open the sac, explore it, close the sac at its neck with a suture-ligature, amputate the sac, and permit the stump to retract into the abdominal cavity. Identify the *external* spermatic vessels at the point where they emerge from the transversalis fascia (see Fig. 81–7). Divide and ligate them at this point and remove about 4–5 cm of the vessels and ligate them again at the pubic tubercle (see Fig. 81–8).

In patients with an indirect inguinal hernia, identify the margins of the transversalis fascia around the internal inguinal ring. If the internal inguinal ring is only slightly enlarged, close the ring by means of several sutures between the healthy transversalis fascia along its cephalad margin and the anterior femoral sheath at its caudal margin. If the hernia has eroded more than 2 cm of posterior inguinal wall, a complete reconstruction will be necessary. In this case, incise the transversalis fascia with a scalpel beginning at a point just medial to the pubic tubercle (see Fig. 81–9). Carry the incision laterally with a scalpel or Metzenbaum scissors, taking care not to injure the underlying deep inferior epigastric vessels. The incision must be continued until the transversalis fascia has been incised all the way to the internal inguinal ring. Sweep the preperitoneal fat away from the undersurface of the transversalis fascia. Free the deep inferior epigastric vessels so that they may be retracted posteriorly together with the preperitoneal fat. A few small branches may have to be divided and ligated.

If you follow McVay's procedure, excise the iliopubic tract adjacent to Cooper's ligament. Then apply two identifying hemostats to the cephalad cut edge of the transversalis fascia and elevate. This will expose the aponeurosis of the transversus muscle. Excise the fleshy portion of the internal oblique

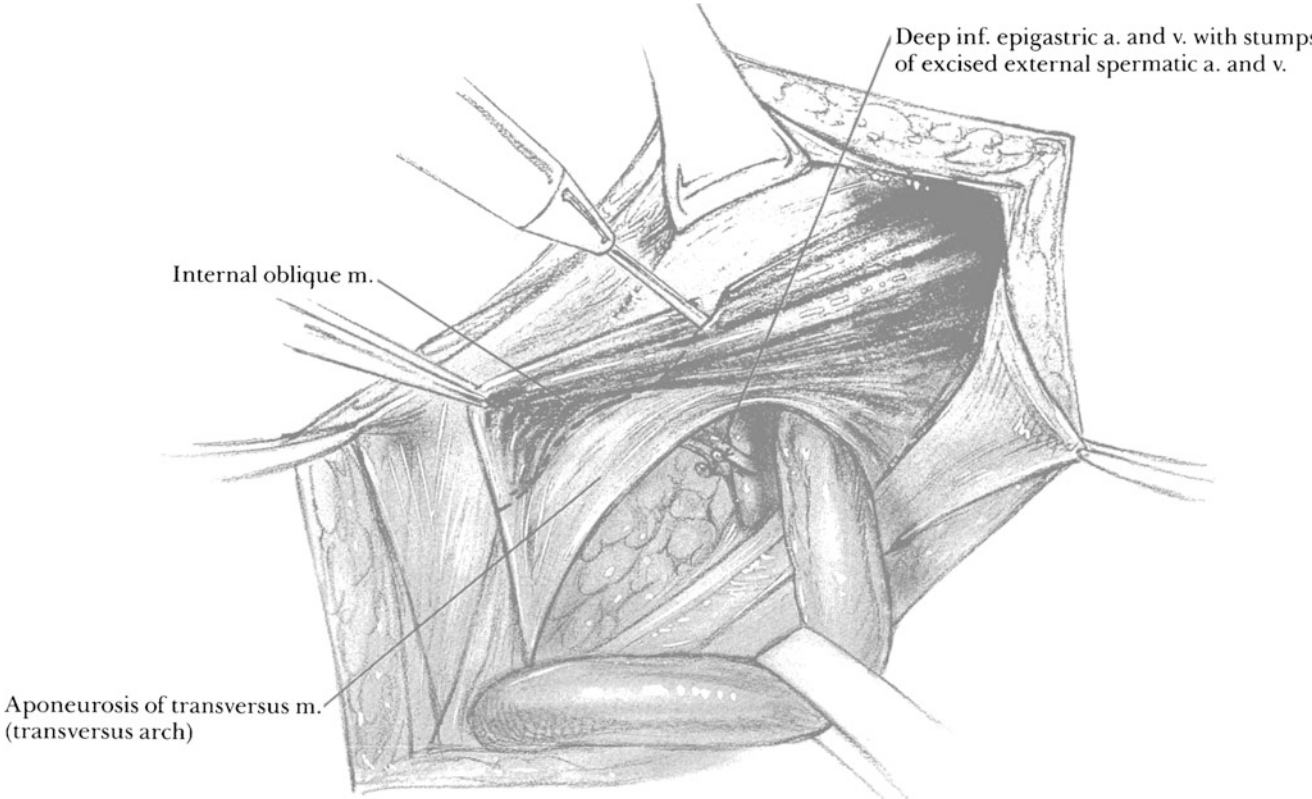


Fig. 82–1

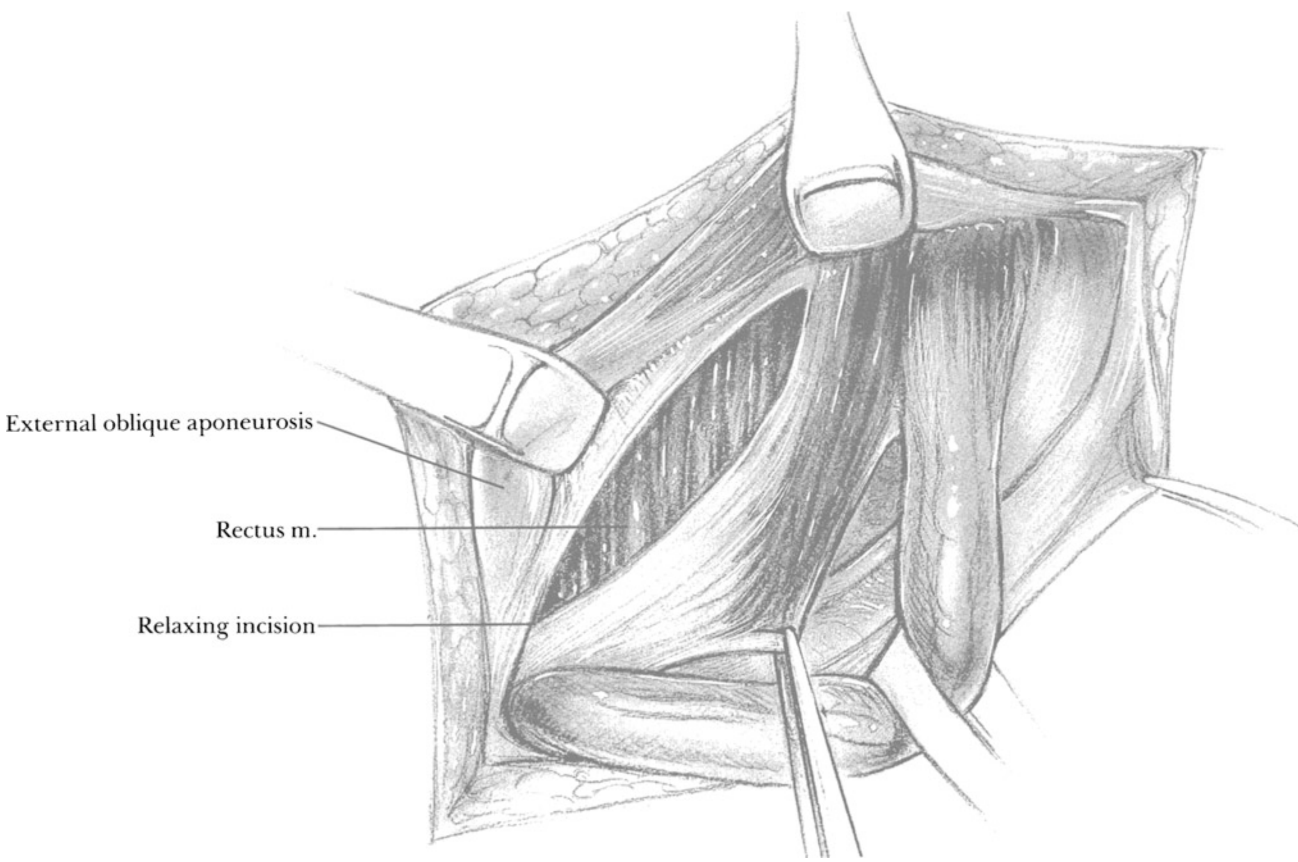


Fig. 82–2

muscle overlying the fibrous transversus arch to improve the exposure (**Fig. 82–1**).

Identify the anterior femoral sheath by gently inserting the back of a scalpel handle between the shelving edge of Poupart's ligament and the femoral sheath overlying the external iliac artery and vein. Then identify the anterior surface of the external iliac vein and artery and retract them gently in a posterior direction with a peanut sponge dissector. This will separate these vessels from the femoral sheath. In order to see the femoral sheath clearly, be certain to excise 100% of the overlying cremaster muscle fibers.

Making the Relaxing Incision

A relaxing incision is essential to prevent tension on the suture line. Elevate the medial portion of the external oblique aponeurosis and dissect it bluntly away from the internal oblique muscle and from the anterior rectus sheath. Make a 7–8 cm incision in the anterior rectus sheath beginning about 1.5 cm above the pubic tubercle and continue this incision in a cephalad fashion just medial to the point where the external oblique aponeurosis fuses with the anterior rectus sheath. This will constitute a vertical line that curves as it continues in a superior direction. The anterior belly of the rectus muscle will be exposed as downward traction is applied to the transversus arch (**Fig. 82–2**).

Inserting the Cooper's Ligament Sutures

Suture the transversus arch to Cooper's ligament using atraumatic 2–0 silk or other nonabsorbable suture material (**Fig. 82–3**). Take substantial bites of both the transversus arch and Cooper's ligament and place the sutures no more than 5 mm apart. Do not tie the sutures until all of them are in place.

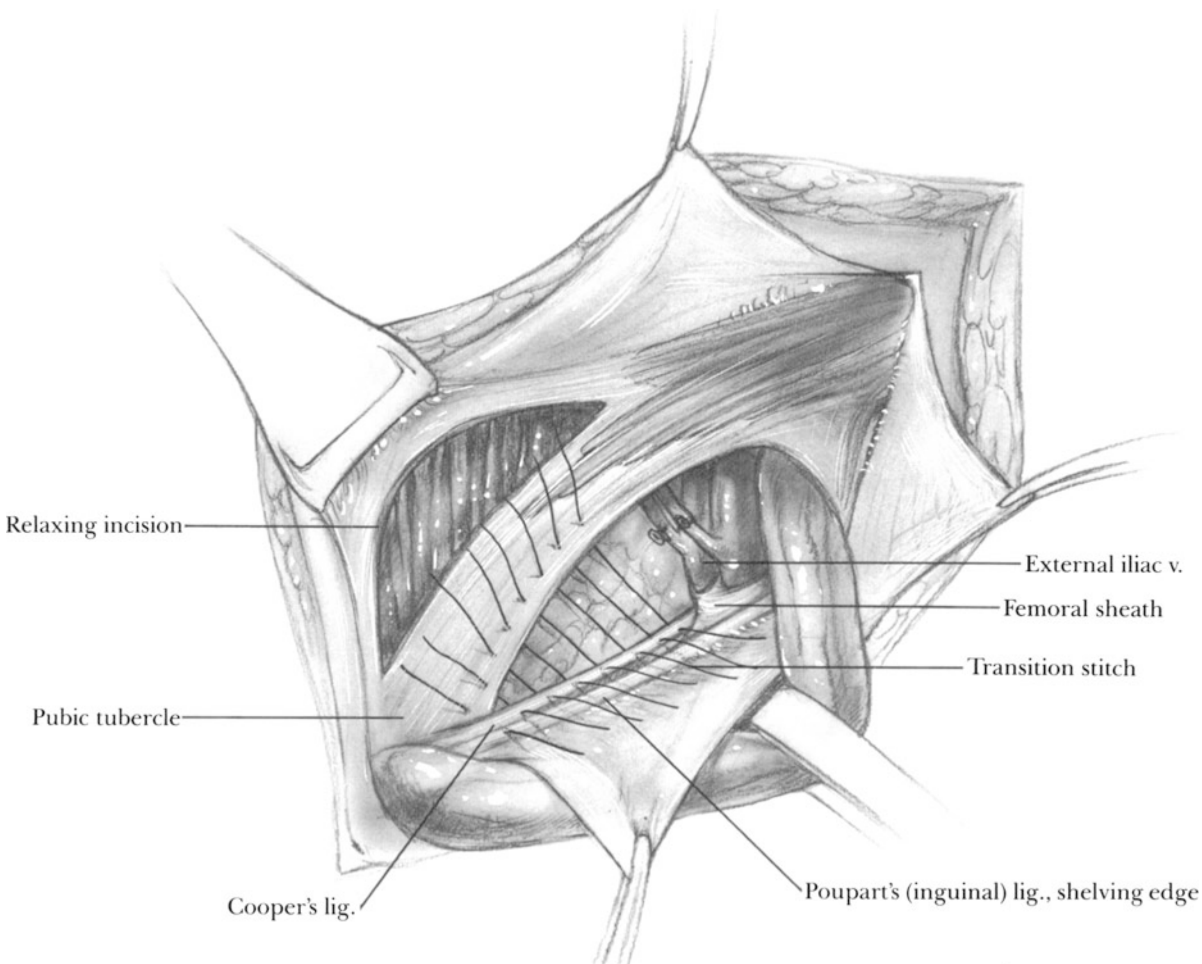


Fig. 82–3

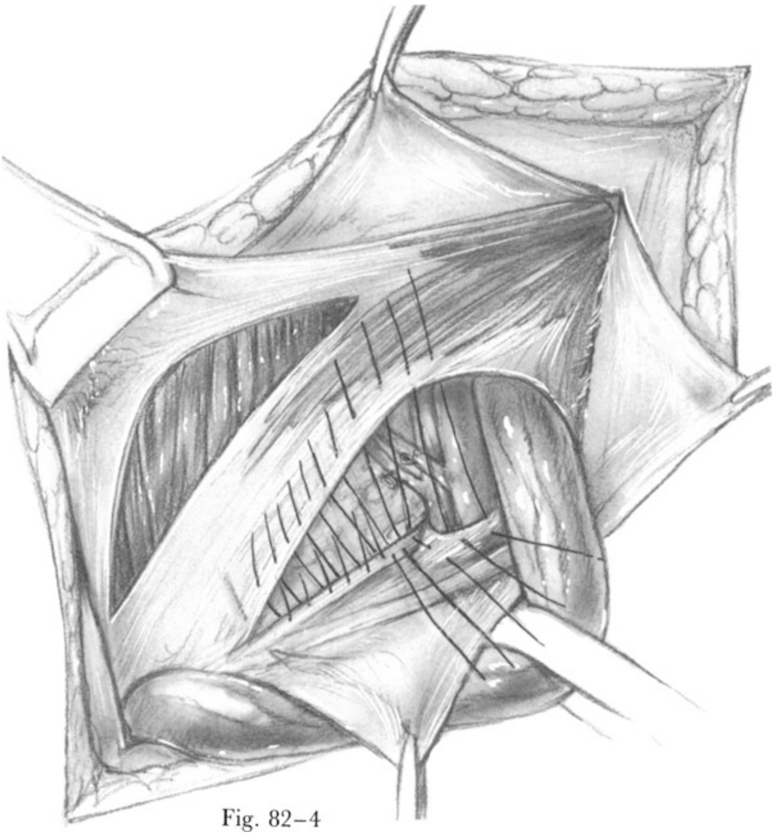


Fig. 82–4

As the suture line progresses laterally, the external iliac vein will be approached (**Fig. 82–4**). At this point insert a "transition suture" (**Fig. 82–5**) that penetrates the transversus arch, Cooper's ligament, and then the anterior femoral sheath. Lateral to this suture, sew the transversus arch to the femoral sheath. In his description of Cooper's ligament repair, Rutledge advocates including a bite of the shelving edge of the inguinal ligament together with the anterior femoral sheath. Continue to insert sutures until the internal ring is sufficiently narrowed to admit only a Kelly hemostat alongside the spermatic cord (**Fig. 82–6**). Do not insert any sutures lateral to the cord. After all the sutures have been inserted, tie each suture going from medial to lateral.

Suture the incised anterior rectus sheath down to underlying muscle along the lateral aspect of the relaxing incision with a few 3–0 interrupted silk sutures.

Closing the External Oblique Aponeurosis

Replace the cord in the inguinal canal. Check to assure complete hemostasis. Close the external oblique aponeurosis superficial to the cord by inserting inter-

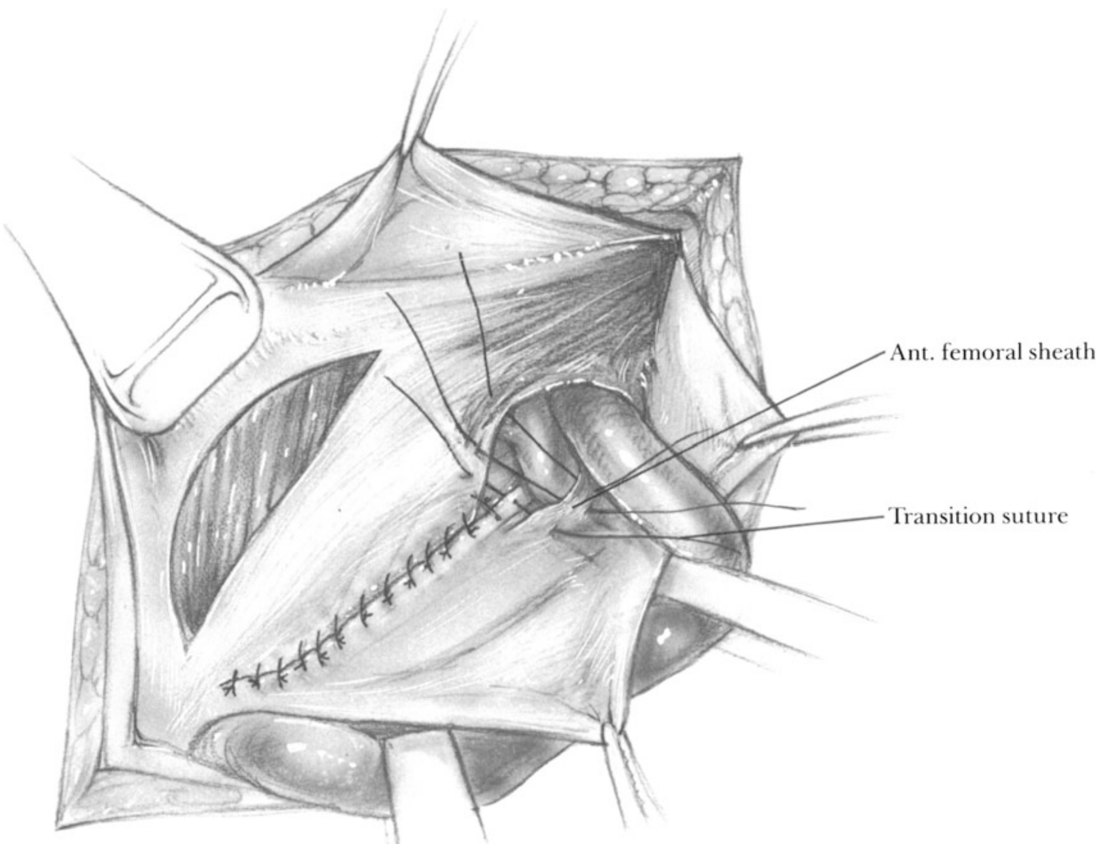


Fig. 82–5

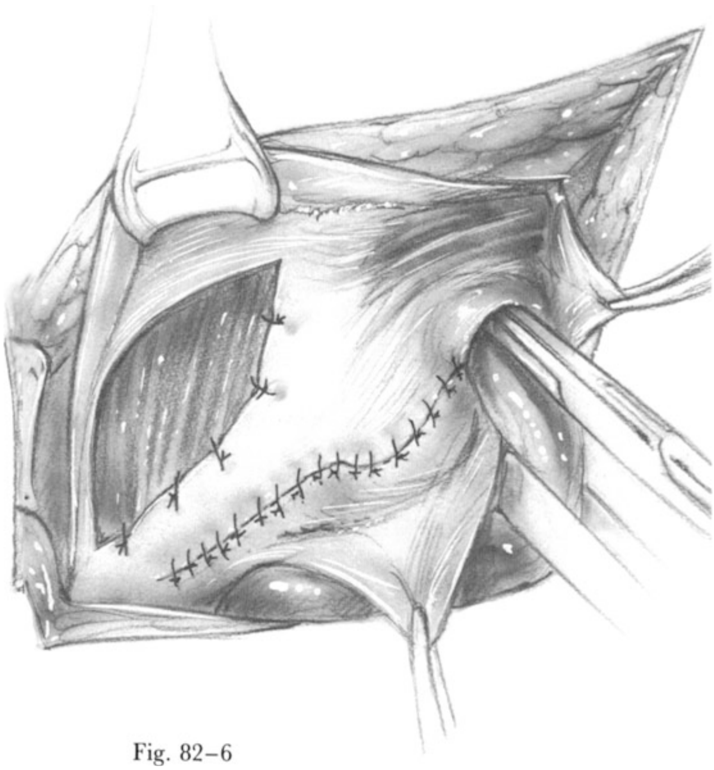


Fig. 82–6

rupted 3–0 silk sutures. Leave a 4–5 mm opening adjacent to the cord in reconstructing the external inguinal ring.

Close Scarpa's fascia with fine interrupted sutures and approximate the skin with a continuous 4–0 PG subcuticular suture.

Intermittently during the operation, irrigate the operative field with a dilute antibiotic solution of kanamycin and bacitracin.

Postoperative Care

(See Chap. 81.)

Postoperative Complications

(See Chap. 81.)

References

McVay CB, Halverson K. Inguinal and femoral hernias. In: Beahrs OH, Beart RW (eds) General surgery. Boston: Houghton Mifflin; 1980.

Rutledge RH. Cooper's ligament repair for adult groin hernias. Surgery 1980;87:601.

83 Operations for Recurrent Inguinal Hernia

Concept: Pathogenesis and Prevention of Recurrent Hernia

Scope of Problem

A number of experts with particular interest in the surgical technique of repairing an inguinal hernia have reported a very low postoperative recurrence rate. This is true of Glassow with respect to the Shouldice technique, Halverson and McVay and Rutledge for the Cooper's ligament technique, and Nyhus for the preperitoneal approach. Depending on the thoroughness and duration of the follow-up study, the above authors have reported recurrence rates between 0.25% and 3% for the repair of the direct inguinal hernia.

Unfortunately, as Berliner, Burson, Katz et al. state, a great proportion of the patients who are lost to a follow-up study are in fact suffering from a recurrent hernia. As time passes, more and more patients are lost to follow-up study. For instance, Halverson and McVay's study was able to follow only 76% of patients during the course of the 1–22 year follow-up. A study of long duration is necessary because only 57% of recurrent direct hernias are detected in the first 5 years, 78% after 10 years, and the remaining 22% between the 10th and 40th year in Postlethwait's report.

Berliner and associates noted an 11.5% failure rate in patients followed for 4–9 years after a Bassini or a Cooper's ligament repair. After devoting special study to the technique of hernia surgery, these authors adopted the Shouldice technique. During a 2–5 year study following 504 primary repairs by this technique, the recurrence rate was 1.8%. Following 1,084 cases Berliner noted a personal recurrence rate of 1.1%. Thieme and Quillinan reported recurrence rates of 9% and 10%, respectively, following the repair of groin hernias. With respect to the preperitoneal approach, it appears to be a good method for the repair of a femoral hernia. However, following the use of this approach for the repair of a direct hernia, Dyson and Pierce experienced a 35% recurrence rate, Gaspar and Casberg, 21%, and Ljungdahl, 17%.

On the other hand, repair of a simple indirect hernia with *no direct component* is followed by a low recurrence rate if the sac is completely excised. If there is no transversalis weakness, a complicated repair is not necessary to prevent a recurrence. This is especially true of hernias in children.

Pathogenesis of the Recurrent Groin Hernia

Internal Ring Left Too Large

If the internal ring is not reconstructed so that it admits the spermatic cord plus only 2–3 mm and no more, the risk of recurrence is increased. If the cremaster muscle and lipomata are not removed from the spermatic cord as it passes through the internal ring, then proper narrowing of this ring by suturing transversalis fascia and the transversus arch cannot be accomplished.

Inadequate closure of the internal ring often follows the repair of a large indirect hernia in the adult. Simply removing the sac and then performing a Bassini type of repair by suturing internal oblique muscle to the inguinal ligament are procedures that often fail to accomplish an adequate closure of the internal ring.

Defect at Pubic Tubercle

The second most common location of the hernial defect in a recurrent inguinal hernia is the most medial portion of Hasselbach's triangle adjacent to the pubic tubercle. This is often a localized defect measuring no more than 1–2 cm in diameter. The exact cause of this defect is not clear. It may result if the surgeon does not continue the suture line up to and including the pubic periosteum. Also, tying sutures with excessive tension may play a part in the etiology of this type of defect.

Failure to Suture Transversalis Fascia or Transversus Arch

Perhaps the most commonly utilized technique for repairing an inguinal hernia is some version of the Bassini repair. In the hands of many surgeons this consists of suturing the internal oblique muscle to the shelving edge of the inguinal ligament. Often these sutures fail to catch transversalis fascia or the aponeurosis of the transversus muscle (transversus arch), which are the structures that have the most strength in the region of inguinal hernial defects. In the traditional techniques of hernia repair, no attempt was made clearly to identify these structures prior to inserting sutures.

Failure to Excise Sac

Failure to remove the entire indirect sac has been reported to constitute an important cause of recurrent hernia. Obviously if the surgeon fails to remove the sac, recurrence of the hernia is probable. However, in recent years we have found that the presence of an indirect sac was rather uncommon in the recurrent hernias that we have encountered. Presumably a higher quality of surgery is being practiced, and the average surgeon is sophisticated enough to identify and remove the sac when one is present.

Use of Absorbable Sutures

It has long ago been demonstrated that the use of catgut in repairing an inguinal hernia is followed by an excessive rate of recurrence. Nevertheless, a few surgeons persist in using absorbable suture material, which loses most of its tensile strength within a week or two, a period of time inadequate for the solid healing of an inguinal hernia repair.

Subcutaneous Transplantation of Cord

A significant number of patients present themselves with recurrent inguinal hernias following a Halsted repair in which the spermatic cord is transplanted into the subcutaneous plane by fashioning a new external ring directly superficial to the internal ring. The superimposition, one ring over the other, results in a repair that is weaker than those that preserve the obliquity of the inguinal canal. Following the Halsted repair, a recurrent hernia presents at the point where the spermatic cord exits from the internal-external ring. Generally the two rings appear to have fused together, and the hernia protrudes from this common orifice alongside the cord. Although we are not aware of any statistical studies, it is our impression that the recurrence rate following the Halsted repair is more common than after the Shouldice or the McVay repairs.

Femoral Recurrence Following Inguinal Hernia Repair

Several authors (McVay and Halverson; Glassow) have emphasized that following the repair of an inguinal hernia, 1%–3% of patients will later develop a femoral hernia on the same side. When operating to repair an inguinal hernia, the surgeon should inspect and palpate the cephalad opening of the femoral canal in search for a small femoral hernia. The normal femoral canal will not admit the surgeon's fingertip. The only circumstances in which this step might be omitted is in the case of a young patient who presents a simple indirect hernia and no weakness of the floor of the inguinal canal.

If a femoral hernia is detected, it should be repaired simultaneously with the inguinal hernia repair. McVay's technique using Cooper's ligament automatically repairs any femoral defect by suturing the transversus arch to Cooper's ligament and the femoral sheath. Glassow recommends exposing the inferior opening of the femoral canal in the groin and repairing it with a few sutures from the lower approach. He then completes the inguinal repair by the Shouldice technique. A "plug" of Marlex mesh may be inserted into the femoral hernial ring from above or below to repair the femoral hernia.

Infection

Although this has not been discussed in a number of studies of recurrent hernia, our colleague, Dr. Stanley Berliner, noted 10 wound infections in 643 operations for inguinal hernia. Four of these 10 infected patients developed a recurrent hernia. After adopting the practice of irrigating the hernia incisions at intervals during the operation with a solution of kanamycin and bacitracin, he observed no wound infection in over 1,200 cases. Although a 1%–2% incidence of wound infection seems to be an insignificant number, the situation assumes more importance if 40% of the infected patients will develop recurrent hernias. We have been pleased with the results of antibiotic wound irrigation during hernia repairs over the past 10 years.

Prevention of Recurrence

Indirect Inguinal Hernia

In every repair of an indirect hernia free the sac above the internal ring after excising the entire cremaster muscle. Next remove it and carefully identify the margins of the internal ring. In order to do this, it will be necessary to delineate the transversalis fascia, which forms the medial margin of the internal ring. It is also important to differentiate weak from strong transversalis fascia. By identifying the lateral edge of the transversalis fascia as it joins the internal ring, one can then insert the index finger behind the transversalis layer and evaluate the strength of the inguinal canal's floor.

Although in infants and young children it is rarely necessary to reconstruct the internal ring following removal of the sac, in the adult the indirect hernia has often reached sufficient width to erode the adjacent transversalis fascia and to leave an internal ring with diameter of 2–4 cm. When this has occurred, we prefer to perform a Shouldice repair, similar to that which is done for the direct inguinal hernia.

In both indirect and direct hernia repairs for the adult patient, remove all of the cremaster muscle and adipose tissue surrounding the spermatic cord. If the diameter of the spermatic cord is narrowed, the aperture of the internal inguinal ring can also be made narrow. This will leave an insignificant defect in the floor of the inguinal canal for the potential recurrent hernia.

Direct Inguinal Hernia

A successful repair of a direct hernia requires meticulous dissection and exposure of the transversalis fascia, the aponeurosis of the transversus muscle, and the lateral condensation of the transversalis fascia near the inguinal ligament (iliopubic tract and femoral sheath) prior to suturing the transversus arch-transversalis fascia to the iliopubic tract and the inguinal ligament. Excellent results have been reported following both the Shouldice and the McVay types of repair of primary inguinal hernias (Glassow 1978; Berliner et al.; Halverson and McVay; Rutledge). In both operations, each of the above-mentioned anatomical structures must be carefully dissected. Each must be evaluated for attenuated portions that are not useful for the repair. The weakened areas must be excised and only strong tissues employed for suturing.

Indications

Strangulation

Incarceration or recent history of incarceration

Symptomatic hernia in good-risk patients

Preoperative Care

If the patient suffers from chronic pulmonary disease, make every effort to achieve optimal improvement. All patients should be encouraged to stop smoking for at least a week before the operation.

Encourage the obese patient to lose weight.

Evaluate elderly male patients for potential prostatic obstruction.

Administer perioperative antibiotics if the use of mesh is anticipated.

Pitfalls and Danger Points

Injuring internal spermatic artery and vein or iliac artery or vein

Injuring vas deferens

Injuring colon (rare)

Injuring bladder (rare)

Using weak tissues for repair

Operative Strategy

Anesthesia

Many operations for a recurrent inguinal hernia can be performed under local anesthesia without undue difficulty. Those patients who have had previous operations for recurrent hernia and have accumulated a great deal of scar tissue are preferably done with general anesthesia. Also, when the preperitoneal approach is used for hernia repair, general anesthesia is necessary.

Selecting the Optimal Technique for Repair of Recurrent Inguinal Hernia

Thieme followed 2,163 patients who underwent a primary inguinal hernia repair. He observed a recurrence rate of 8.8%. Of 166 patients operated on for recurrent inguinal hernia and subsequently followed for an average of 9 years, 33.1% experienced a second postoperative recurrence! Clear reported that 39.6% of 53 operations for recurrent hernia, followed for 10 years, had a second recurrence. On the other hand, Halverson and McVay as well as Glassow have reported recurrence rates of 3% or less following operations for recurrent inguinal hernia. These statistics indicate that the traditional approach of exposing the hernial defect and then simply suturing the defect closed is followed by a high incidence of failure.

In an elderly patient who has a recurrent hernia following a primary Halsted repair, it may be permissible to excise the sac and to narrow the fused internal-external ring aperture by suturing into the ring a plug of Marlex mesh (see Fig. 84–7), providing all of the surrounding tissues are strong. Also, after opening the external oblique aponeurosis and exposing the floor of the inguinal canal, one may encounter a small (1–2 cm) defect restricted to the medial portion of the floor. *Rarely*, a small defect of this type may be closed by a means of a few interrupted sutures. Often, this maneuver will require excessive tension. Here also an excellent alternative recommended by Lichtenstein is to insert a small Marlex plug into the defect and to fix it in place with one or two polypropylene sutures. In other cases the defect in the floor of Hasselbach's triangle will require that the entire transversalis fascia between the internal and external rings be incised and the repair be accomplished by the method of Shouldice. In many cases of recurrent hernia the primary operation did not include a dissection deep to the transversalis fascia. In these cases, once the transversalis layer is identified and incised, virgin tissues are encountered and a standard repair, similar to that for a direct hernia, may be accomplished.

However, in *most* cases it will not be possible to approximate strong transversalis fascia or transversus arch to the iliopubic tract or Cooper's ligament without excessive tension because too large a portion of these tissues has been destroyed by the previous operation and by the pressure of the enlarging hernia. In these cases there must be no hesitation to substitute, for the absent transversalis layer, one or two layers of prosthetic mesh. We agree with McVay and Halverson that inserting a small segment of mesh and suturing it to the outer margin of the hernial defect is not an adequate operation. These authors have stated, "a small patch of mesh cut to fit the defect and sutured circumferentially in place is an unsatisfactory solution to the problem. We have operated on patients in whom mesh has previously been used in this way and either we could not find the previously inserted mesh or it was rolled up in one portion of the wound." We prefer to use a piece of mesh that is 3.0 cm larger than the hernial defect along its entire perimeter. Also, we prefer to place the mesh between the peritoneum and the transversalis layer of the abdominal wall rather than to place it superficial to the abdominal musculature. This technique is illustrated below. When this technique is used, we generally make no attempt to suture the two edges of the hernial defect together. In other words, *the mesh replaces the defect* in the abdominal wall. A small opening is left for the spermatic cord. If possible, the cord is covered by the resutured external oblique aponeurosis. This leaves only the prosthetic mesh and the spermatic cord between the peritoneal and external oblique layers. Only in this fashion can tension be *completely* eliminated.

An alternative method of inserting the mesh is to use the preperitoneal approach of Nyhus and then to suture the mesh into place behind the abdominal wall. This technique is especially suitable in patients who have had two or more previous operations for recurring hernia. In these cases an anterior approach through the dense scar tissue carries with it a considerable risk of producing postoperative testicular atrophy by traumatizing the spermatic artery and veins. The preperitoneal approach markedly reduces the incidence of postoperative testicular complications. We do not believe that the preperitoneal approach is indicated for patients with primary direct inguinal hernias or for recurrent inguinal hernia unless prosthetic mesh is used to replace the defective transversalis layer of the floor of the inguinal canal.

Technique of Dissection

When the anterior inguinal approach has been selected, remember that the patient may have undergone his previous repair by the Halsted technique. This means that the surgeon should anticipate the possibility of encountering the spermatic cord in the subcutaneous layer of the dissection. Therefore, soon after the skin incision is made, elevate the cephalad skin flap and direct the dissection so that the anterior surface of the external oblique aponeurosis will be exposed at a point 3–5 cm above the inguinal canal. This will be virgin territory that has not been involved in previous surgery. Then carefully direct the dissection in a manner that will not expose the external oblique aponeurosis inferiorly until either subcutaneous spermatic cord or the reconstructed external ring has been exposed. In the absence of a previous Halsted repair, continue the dissection beyond the previous suture line of the external oblique aponeurosis until the junction of the inguinal ligament with the upper thigh has been exposed. If one does encounter the spermatic cord in a subcutaneous location, meticulous dissection is necessary to preserve the fragile spermatic veins.

In the absence of a previous Halsted repair, incise the aponeurosis of the external oblique with caution to avoid traumatizing the cord.

Avoiding Testicular Complications

In the elderly patient with a large recurrent hernia, the repair will be simplified if the patient is willing preoperatively to accept a simultaneous orchiectomy. In most series of recurrent hernia repairs, 10%–15% of cases undergo simultaneous orchiectomy. In younger patients and in those in whom the surgeon wishes to minimize the risk of having a testicular complication, the preperitoneal approach offers a sound alternative to dissecting in a previous operative field. Otherwise, take the time to perform a meticulous dissection of the spermatic vessels and vas. Sometimes the spermatic veins have been spread apart by a large hernia, increasing their vulnerability to operative trauma.

Some surgeons have advocated that the spermatic cord be deliberately divided at some point between the internal and external rings. They claim that if the testis has not been mobilized from its normal location in the scrotum, there will be sufficient collateral circulation for most testes to survive following division of the cord. Heifetz reported that 35% of 112 patients developed definite atrophy of the testis following division of the spermatic cord. Other patients experienced fever, testicular pain, and swelling secondary to interruption of the cord. The high complication rate following division of the cord without orchiectomy makes this an unacceptable procedure.

When the anterior inguinal approach through the previous incision has been elected for the repair of a recurrent hernia in a young male, it may occasionally appear that preserving the spermatic cord seems to be impossible. In this situation, it is advisable to abandon the anterior approach. In this case, extend the skin incision so that the medial skin flap can be elevated for a distance of 3–5 cm. Then continue the operation by an incision through the abdominal wall using the preperitoneal approach of Nyhus. After dissecting the peritoneum and the sac away from the posterior abdominal wall in the inguinal region, insert a prosthetic mesh. This approach will help avoid testicular complications.

Operative Technique—Inguinal Approach

Incision and Exposure

Enter the operative site by applying the scalpel along the previous operative scar. Alternatively, excise the previous scar. Then dissect the skin flap in a cephalad direction. Be aware of the possibility that at the previous operation the surgeon may have transplanted the spermatic cord into the subcutaneous location. Be careful not to injure the cord during this dissection. After the skin flap has been dissected for a distance of about 2–3 cm, carry the dissection down to the aponeurosis of the external oblique muscle. Accomplish this in an area that is superior to the region of the previous surgery.

Now dissect all of the subcutaneous fat off the anterior surface of the aponeurosis, proceeding in an inferior and lateral direction until the inguinal ligament and the subcutaneous inguinal ring have been cleared.

Repairing Recurrent Hernia Following Previous Halsted Operation without Opening the Inguinal Canal

When a patient has had his spermatic cord transplanted into the subcutaneous plane at the previous operation, the subcutaneous and the deep inguinal rings will be superimposed, one directly upon the other. In this case, the inguinal region is generally quite strong except for a single defect that represents an enlarged common external-internal ring, through which the spermatic cord will pass together with the hernial sac. In these patients it is often extremely difficult to separate the external oblique aponeurosis from the deeper structures, a step that is necessary before accomplishing either a Shouldice or a McVay repair. Instead of incising the external oblique aponeurosis in the region between the hernial defect and the pubic tubercle in these patients, it may be more prudent to remove the hernial sac and then to narrow the enlarged common ring with several heavy sutures.

In order to accomplish this, carefully identify and dissect the spermatic cord free from surrounding structures. Isolate the hernial sac. Then, open it and insert the index finger to verify that the floor of the inguinal canal is indeed strong. Dissect the sac away from any attachments at its neck. Close the sac with a single suture ligature of 2–0 PG. Alternatively, a purse-string stitch may be used. Amputate the sac and permit the stump to retract into the abdominal cavity. Dissect areolar tissue, fat, and cremaster from the margins of the hernial defect. Close the defect medial to the point of exit of the spermatic cord, using 2–0 Tevdek or Prolene on an atraumatic needle. In effect, the needle will penetrate, at the medial margin of the ring, 5–6 mm of the external oblique aponeurosis, underlying internal oblique, and transversalis fascia. At the lateral margin of the repair the needle will pierce the external oblique aponeurosis and the shelving edge of the inguinal ligament. Narrow the ring to the extent that a Kelly hemostat can be passed into the revised inguinal ring alongside the spermatic cord. Making the ring smaller than this will increase the risk of testicular complications.

Inevitably these sutures must be tied with some tension, which threatens the success of any hernia repair. Therefore, it is preferable whenever possible to insert an appropriately sized plug of Marlex mesh into the ring. Stabilize the plug with sutures as described in Fig. 84–7. This method will obliterate the defect *with no tension* on the tissues (Shulman et al.).

If the hernial defect is large (over 3 cm in diameter), then apply a patch consisting of a layer of Marlex or Prolene mesh to cover the defect. Suture the mesh to the edge of the hernial defect by using large bites of interrupted or continuous 2–0 atraumatic Prolene. Leave an opening for the exit of the spermatic cord along the medial margin of the repair.

Dissecting the Inguinal Canal

Most patients presenting with a recurrent inguinal hernia will have had their previous repair performed by some variety of the Bassini technique with the spermatic cord remaining in its normal location deep to the external oblique aponeurosis. In these cases, make an incision in the external oblique aponeurosis along the lines of its fibers, aimed at the cephalad margin of the external inguinal ring, as described above. Perform a patient, meticulous dissection of the spermatic cord in order to avoid traumatizing the delicate spermatic veins. After mobilizing the spermatic cord, identify the hernial sac. In our experience the most common location of a recurrence is in the floor of Hasselbach's triangle medial to the deep inferior epigastric vessels. The previous surgeon will probably not have identified the transversalis fascia and the aponeurosis of the transversus muscle. If this area is virgin territory, repair the recurrent hernia by the classical Shouldice technique described in Chap. 81. This repair is also suitable in patients who have a recurrence of an indirect nature since these patients will almost always also have considerable weakness of the inguinal canal. Of course, the indirect sac must be excised.

Repairing a Localized Defect in the Inguinal Floor

A number of patients with recurrent hernia suffer from a relatively small (2 cm or less) defect in the inguinal canal floor just medial to the public tubercle. Simple suturing of this defect will produce excessive tension. The standard repair calls for an incision through the floor of the inguinal canal followed by a definitive Shouldice or McVay reconstruction. In order to avoid this extensive dissection, Lichtenstein and Shulman et al. have recommended that this defect be repaired by inserting a plug of rolled-up Marlex mesh and suturing it in place with one or two stitches of 2–0 Prolene as described in the repair of a femoral hernia (see Fig. 84–7). We find this to be the best repair for this type of hernia.

Prosthetic Mesh Repair

In most cases of recurrent hernia, following the dissection of the inguinal canal, it will be found that the remaining tissues are simply not strong enough to assure a successful result in suturing the hernial defect. By far the most common error made by surgeons repairing a recurrent hernia is to misjudge the strength of the tissues being sutured. Attenuated scar tissue sutured under tension *will not produce a successful long-term repair*. Do not hesitate to excise these weakened tissues. Make no attempt to close the defect by sutures. Rather, insert prosthetic mesh. This can be inserted to replace the defect *without any tension at all*.

Complete the dissection of the inguinal canal through the layer of the transversalis fascia (see Figs. 81–2 to 81–10) so that the peritoneum, Cooper's ligament, and the aponeurosis of the transversus muscle have all been exposed. Separate the peritoneum from the transversalis fascia for a distance of at least 3 cm around the perimeter of the inguinal defect. Trim away attenuated tissues. Now take a layer of Marlex or Prolene mesh and cut a patch in the shape of an ellipse that is 3 cm–4 cm larger in diameter than is the defect. Place the mesh behind the abdominal wall between the peritoneum and the transversalis fascia. Suture the mesh in place by means of 2–0 atraumatic Prolene stitches *through the entire abdominal wall* in a mattress fashion as seen in

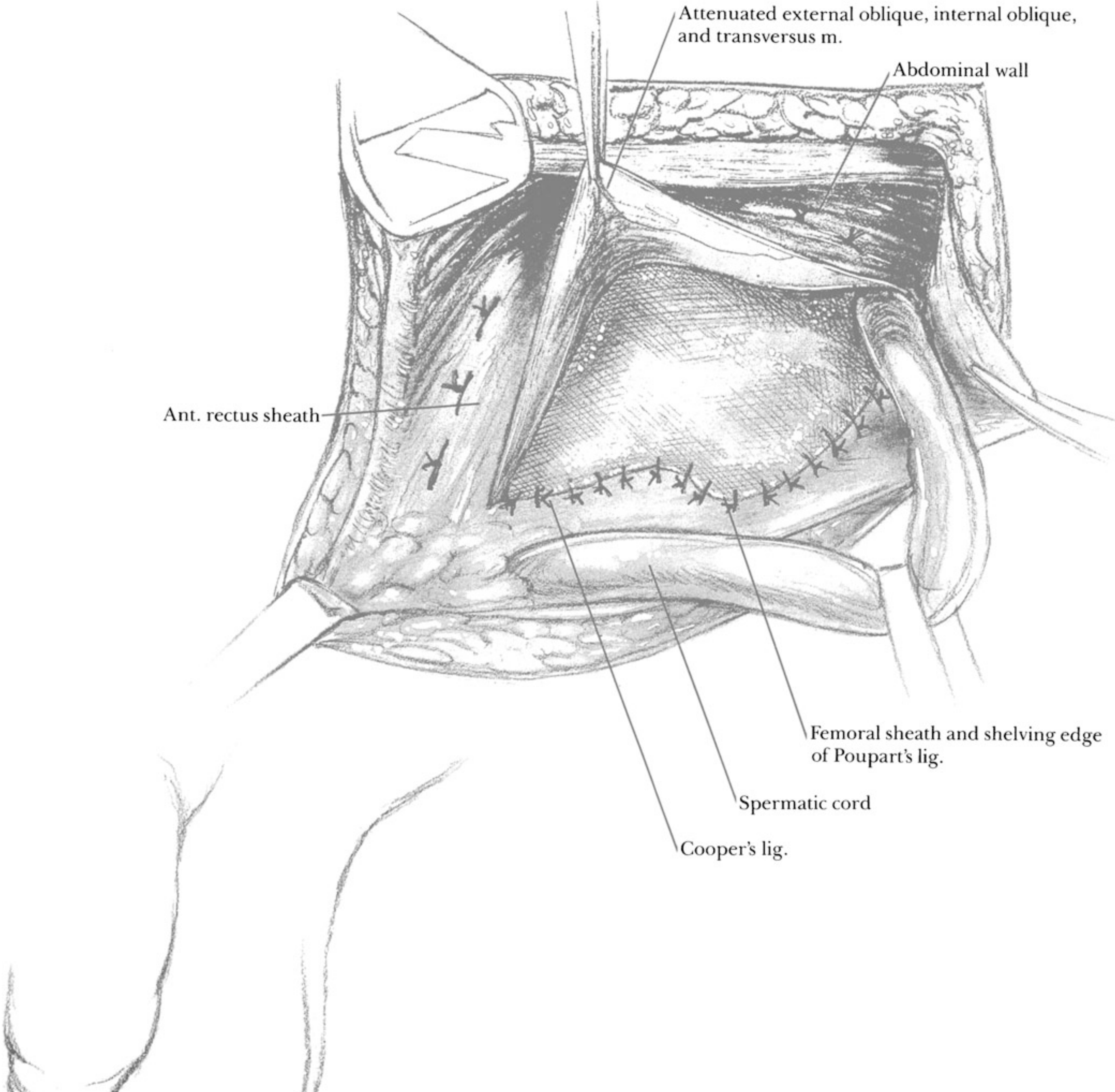


Fig. 83–1a

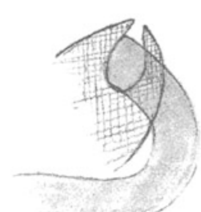


Fig. 83–1b

Fig. 83–1a. Continue to insert these interrupted mattress sutures around the perimeter of the defect and to penetrate external oblique, internal oblique, transversus muscles, and transversalis fascia. Along the medial aspects of the hernial defect, the sutures penetrate the anterior rectus sheath, the rectus muscle, and the transversalis fascia. Along the lateral margin of the defect, suture the mesh to Cooper's ligament with interrupted or continuous 2–0 Prolene stitches going from the pubic tubercle laterally to the region of the femoral canal. Lateral to this point, suture the mesh to the femoral sheath and the shelving edge of Poupart's ligament. Cut a small section out of the lateral portion of the mesh so as to avoid constricting the spermatic cord (**Fig. 83–1b**). *In most cases, it has not been possible to suture the layers of the abdominal wall together over the mesh without creating excessive tension.* After irrigating the operative area thoroughly with a dilute antibiotic solution, close Scarpa's fascia with 4–0 PG and close skin with a continuous 4–0 PG subcuticular suture.

A closed suction drain, such as the flat Jackson-Pratt, may be brought out from the area of the mesh through a puncture wound of the skin, but a drain is not necessary. If the mesh can be covered by external oblique aponeurosis, the drain can surely be omitted.

Abandoning the Anterior Approach

In rare cases of recurrent inguinal hernia, it may be apparent during the dissection of the spermatic cord that there is such dense fibrosis as to endanger preservation of the cord. When these conditions are encountered, especially in young patients, simply abandon the anterior approach. Elevate the cephalad skin flap and make an incision through the abdominal wall down to the peritoneum, as described below for the preperitoneal approach to the repair of a recurrent hernia. Dissecting peritoneum away from the posterior wall of the inguinal canal via the preperitoneal approach does not endanger the spermatic cord because this dissection is carried out in territory free of scar tissue.

Operative Technique—Preperitoneal Approach Using Mesh Prosthesis

The technique described below is derived in many aspects from the contributions of Nyhus, Notaras, Calne, McVay and Halverson, and Ponka. It is described for a larger right recurrent inguinal hernia.

Incision and Exposure

Enter the abdominal cavity by making a transverse incision in the lower quadrant, at a level that will be at least 3 cm above the upper margin of the hernial defect. Start the skin incision near the abdominal midline approximately two fingerbreadths above the pubic symphysis and proceed laterally for a distance of about 10 cm, aiming at a point just above the anterior superior spine of the ilium. Expose the external oblique aponeurosis and the anterior rectus sheath. Identify the external inguinal ring. Incise the anterior rectus sheath about 2–3 cm cephalad to the ring. Expose the rectus muscle. Continue the incision laterally along the line of the fibers of the external oblique aponeurosis, again ascertaining that the incision will be about 3 cm cephalad to the upper margin of the hernial defect (see Fig. 84–9). Incise the fibers of the internal oblique and transversus abdominis muscles and expose the underlying transversalis fascia. Carefully incise the transversalis fascia and identify the preperitoneal fat. The presence of this fat as well as the deep inferior epigastric vessels confirms the fact that the proper plane has been entered. Do not open the peritoneal layer. If this has been done inadvertently, suture the peritoneal laceration.

Apply a small Richardson retractor to the lower margin of the incision and sweep the peritoneum away from the lower abdominal wall using a moist gauze sponge in a sponge-holder.

Dissecting the Hernial Sac

In the process of sweeping the peritoneum away from the pelvic floor, the location of the sac will become apparent (see Fig. 84–10). If there is fibrosis in the region of the hernia due to multiple previous repairs, identify the deep inferior epigastric artery as it enters the posterior rectus sheath. Divide and ligate the epigastric vessels at this point. Grasp the distal cut edge of the epigastric vessels and trace the course of these vessels down to their point of origin from the external iliac artery and vein. The recurrent inguinal hernia will invariably be just medial to this junction point. If the hernial sac comes away from the cord without difficulty, then sweep it in a cephalad fashion together with the peritoneal envelope. If the sac remains adherent to the cord, make no attempt to dissect it free. Rather, identify the neck of the sac and incise the peritoneum at this point. Free the peritoneum from the circumference of the sac and then close the defect in the pelvic peritoneum with a continuous atraumatic 3–0 PG suture. Avoid damaging the bladder, which may be adherent to the medial margin of the hernial sac.

At the conclusion of this dissection, the entire posterior wall of the pelvis should be visible including the external iliac vessels, the spermatic cord, the superior pubic ramus (Cooper's ligament), the vas deferens, the iliopsoas fascia along the iliopectineal line lateral to the iliac vessels, and the femoral nerve just lateral and deep to the external iliac

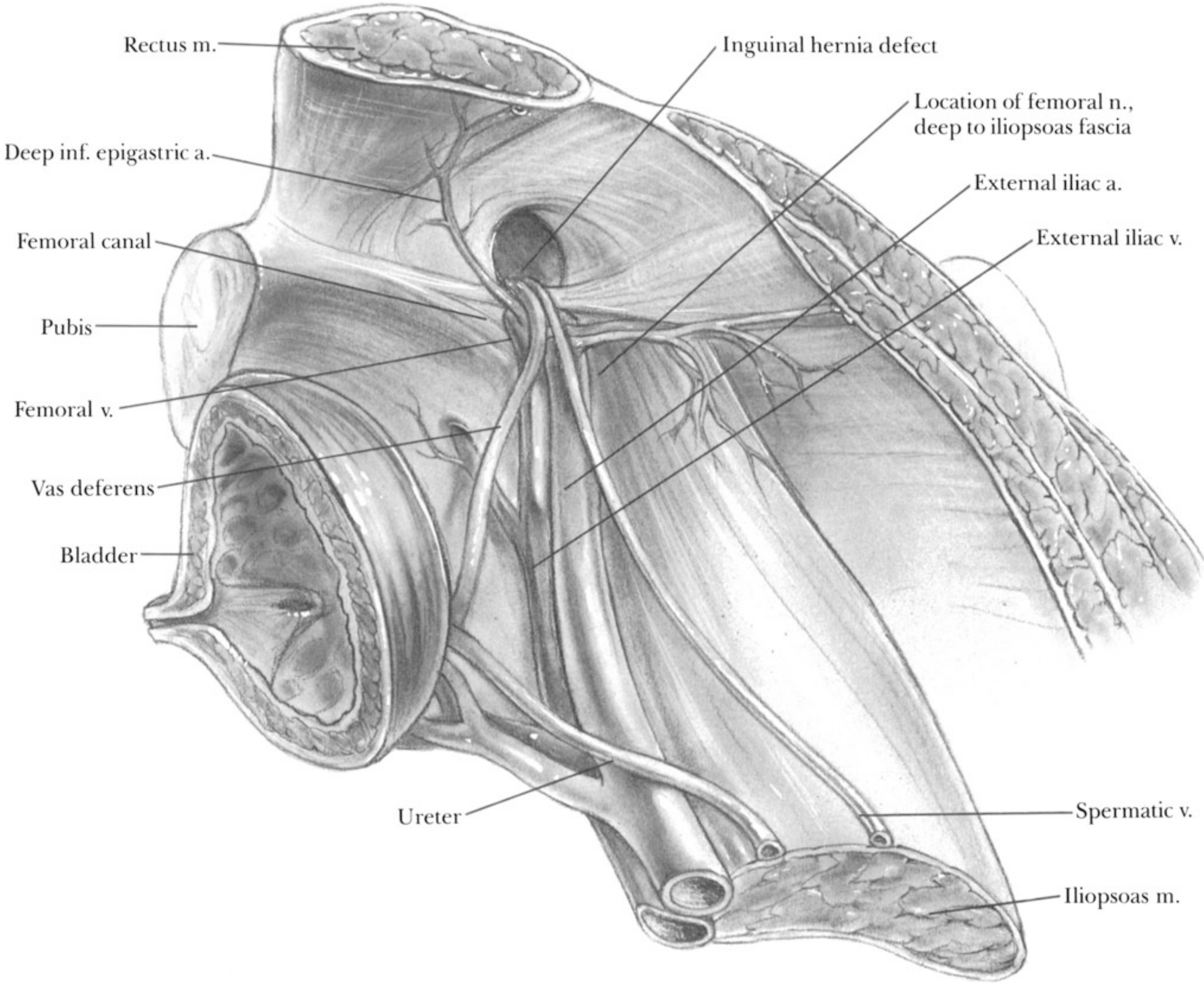


Fig. 83–2

artery. **Fig. 83–2** illustrates the anatomy of structures encountered in this preperitoneal dissection on the *right* side of the patient.

Suturing the Mesh

Cut a square of Marlex or Prolene mesh sufficiently large to provide a layer of prosthesis that will reach from the abdominal incision (cephalad) to Cooper's ligament and to the iliopsoas fascia (caudad), and from the midrectus region medially to the anterior superior iliac spine laterally.

In cases of recurrent hernia repaired by this approach, do not attempt to close the hernial defect by suturing it because the tension will be excessive. Use 2–0 atraumatic Prolene swaged on a stout needle and take substantial bites of strong tissue to assure that the mesh will remain permanently in place. Do not expect that the ingrowth of fibrous tissue into the mesh will assure fixation since the polypropylene is relatively inert and substantial fibrous ingrowth does not *always* take place. Place the first suture in the ligamentous tissue adjacent to the pubic symphysis. Continue the suture line laterally, passing interrupted 2–0 atraumatic Prolene sutures through the layer of mesh deep into Cooper's ligament along the pubic ramus. At the femoral ring, suture the mesh to the femoral sheath and the shelving edge of the inguinal ligament. When the internal inguinal ring is reached, leave a space for the spermatic cord to exit from the abdominal cavity in the male patient. Lateral to the external iliac artery carry the suture line in a posterior direction and attach the mesh to the iliopsoas fascia going laterally. Take deep bites into this fascia after identifying and protecting the femoral nerve, which runs just below the fascia. Continue the suture line in the iliopsoas fascia laterally towards the anterior superior iliac spine until the lateral margin of the abdominal incision is

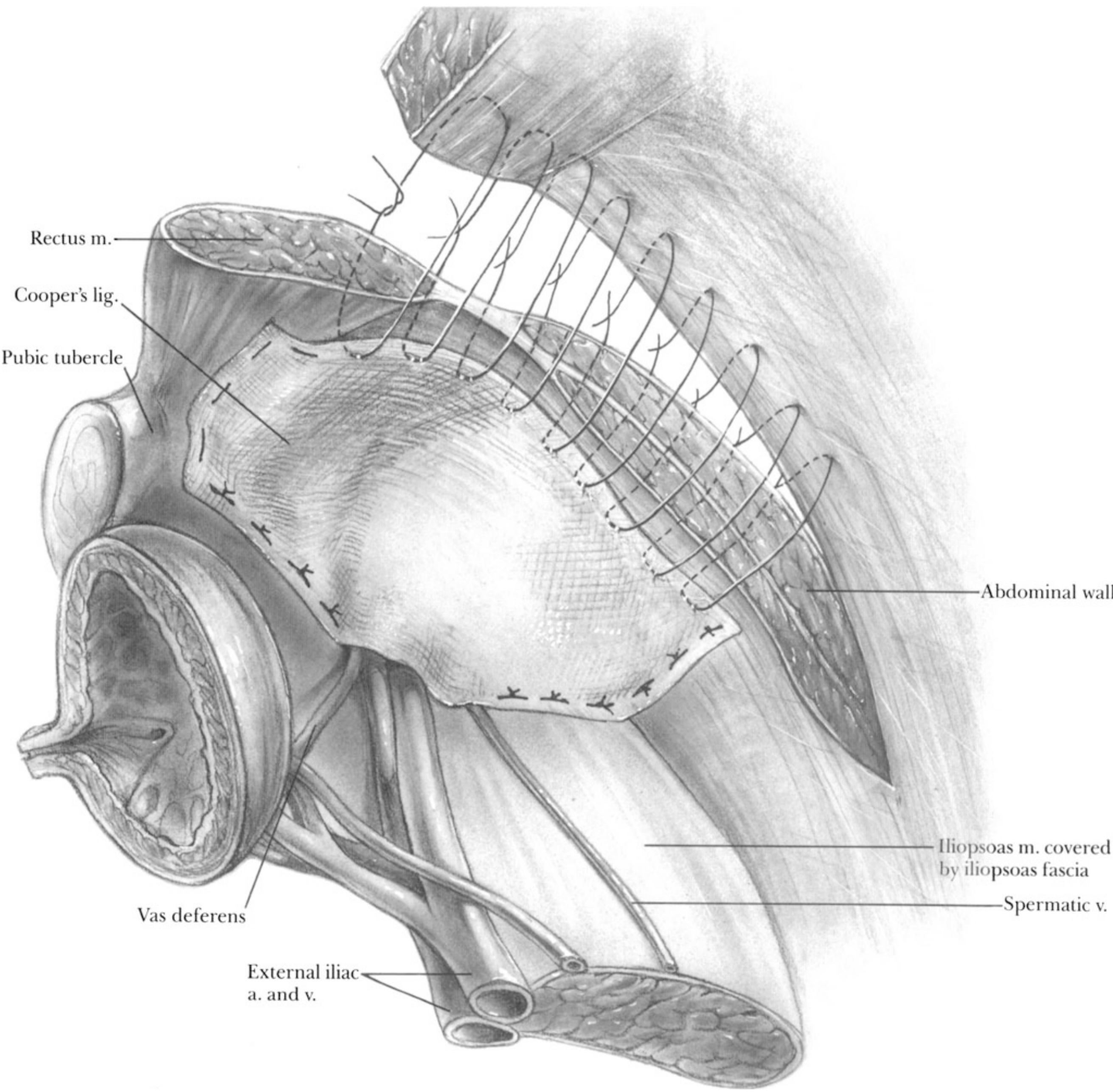


Fig. 83–3

reached. In the female patient, suturing the mesh to the femoral sheath and the iliopsoas fascia will completely obliterate the internal inguinal ring, although this operation, using mesh to repair a large recurrent inguinal hernia, will rarely be necessary in a woman.

Attach the medial margin of the layer of mesh to the medial portion of the rectus muscle. Accomplish this by dissecting the subcutaneous fat off the anterior rectus sheath down to the pubis. Then insert the 2–0 Prolene sutures by taking the bite, first through the anterior rectus sheath, next through the body of the rectus muscle, and then through the layer of mesh in the abdomen. Return the same suture as a mattress by taking a bite through the mesh, through the body of the rectus muscle, and finally through the anterior rectus sheath. After tying the stitch, the knot will be on the anterior rectus sheath. Continue this suture line up to the level of the transverse abdominal incision. **Fig. 83–3** depicts the appearance of the mesh, sutured in place.

Intermittently during the operation, irrigate the operative site with a dilute antibiotic solution. By this point in the operation, the mesh has been sutured into place medially, caudally, and laterally;

only the cephalad margin is left unattached. Trim the mesh so that this cephalad margin terminates evenly with the inferior margin of the transverse abdominal incision. Because of the irregular nature of the surface that has been covered by the flat patch of mesh, there will be a surplus of mesh in the lateral portion of the incision. Correct this by making a vertical fold in the mesh, as necessary, to include the mesh in the closure of the abdominal incision.

Prior to inserting many of the sutures, it will be necessary either to ligate and divide or to coagulate a number of blood vessels in the region of Cooper's ligament and the femoral sheath so that inserting the sutures will not produce bleeding.

Closing the Abdominal Incision

Close the anterior rectus sheath with interrupted nonabsorbable sutures. Lateral to the rectus muscle, close the abdominal incision by using the Smead-Jones technique of 0 interrupted Prolene sutures that grasp a width of at least 1.5 cm of the abdominal wall, including the external oblique aponeurosis, the internal oblique and transversus muscles, the transversalis fascia *and the proximal edge of the mesh* in the caudal margin of the incision, and the same layers on the cephalad margin except for the mesh. Close the skin with a continuous 4–0 PG subcuticular stitch. Fig. 83–3 illustrates the completed incision suture line.

Postoperative Care

Ambulate the patient the day of the operation.

Postoperative Complications

Testicular swelling and/or atrophy

Urinary retention in males

Wound hematoma

Wound sepsis

(When infection develops in patients who have had the insertion of a mesh prosthesis, it is not always necessary to remove this foreign body in order to remedy the infection as the mesh is made up of monofilament fibers. In most patients, wide drainage of the skin incision accompanied by parenteral antibiotics with, perhaps, local antibiotic irrigation may prove effective. We have had no experience in managing a pelvic infection after the insertion of a mesh prosthesis in the pelvis by the preperitoneal route. We would subject a patient of this type to a trial of conservative therapy after opening the incision to explore the pelvis and to insert indwelling irrigating catheters and sump-suction drains.)

Recurrence of hernia

References

Berliner S. Personal communication.

Berliner S, Burson L, Katz P et al. An anterior transversalis fascia repair for adult inguinal hernias. Am J Surg 1978;135:633.

Calne RY. Repair of bilateral hernia with Mersilene mesh behind rectus abdominis. Arch Surg 1974;109:532.

Clear J. Ten-year statistical study of inguinal hernias. Arch Surg 1951;62:70.

Dyson WL, Pierce WS. Changing concept of inguinal herniorrhaphy; experience with preperitoneal approach. Arch Surg 1965;91:971.

Gaspar MR, Casberg MA. An appraisal of preperitoneal repair of inguinal hernia. Surg Gynecol Obstet 1971; 132:207.

Glassow F. Femoral hernia following inguinal herniorrhaphy. Can J Surg 1970;13:27.

Glassow F. The Shouldice repair for inguinal hernia. In: Nyhus LM, Condon RE (eds) Hernia (see below).

Halverson K, McVay CB. Inguinal and femoral herniorrhaphy: a 22-year study of the author's methods. Arch Surg 1970;87:601.

Heifetz CJ. Resection of the spermatic cord in selected inguinal hernias. Arch Surg 1971;102:36.

Lichtenstein IL. A two-stitch repair of femoral and recurrent inguinal hernias by a "plug" technique. Contemp Surg 1982;20:35.

Ljungdahl I. [comment] In: Nyhus LM, Condon RE (eds) Hernia (see below) p. 239.

McVay CB, Halverson K. Inguinal and femoral hernias. In: Beahrs OH, Beart RW (eds) General Surgery. Boston: Houghton Mifflin; 1980.

Notaras ML. Experience with Mersilence mesh in abdominal wall repair. Proc R Soc Med 1974;67:1187.

Nyhus LM. The recurrent groin hernia: therapeutic solutions. World J Surg 1989;13:541–544.

Nyhus LM, Condon RE (eds) Hernia, 2nd ed. Philadelphia: Lippincott; 1978.

Ponka JL. Hernias of abdominal wall. Philadelphia: Saunders; 1980.

Postlethwait RW. Causes of recurrence after inguinal herniorrhaphy. Surgery 1971;69:772.

Quillinan RH. Repair of recurrent inguinal hernia. Am J Surg 1969;118:593.

Rutledge RH. Cooper's ligament repair for adult groin hernias. Surgery 1980;87:601.

Shulman AG, Amid PK, Lichtenstein IL. The "plug" repair of 1,402 recurrent inguinal hernias. Arch Surg 1990;125:265–267.

Thieme ET. Recurrent inguinal hernia. Arch Surg 1971; 103:238.

84 Femoral Hernia Repair

Concept: Choice among Low Groin, Preperitoneal, or Inguinal Approaches

In most cases of femoral hernia the diameter of the femoral canal, through which the femoral hernia protrudes, is quite narrow, often measuring less than 1.5 cm. By approaching the hernia from below, it is simple to free the sac, open it, reduce the hernia, and amputate the sac. Following this step, the ring is obliterated by means of 2–4 sutures attaching the inguinal ligament to Cooper's ligament and the pectineus fascia. An even simpler method has been suggested by Lichtenstein and Shore. They roll up a length of Marlex mesh into the form of a cigarette whose diameter is equal to the diameter of the femoral ring. After inserting this Marlex "cigarette" into the femoral ring, they fix it in place with 1–2 sutures through the inguinal ligament, the Marlex, and the ligament of Cooper. In the low approach, local anesthesia works well and the entire procedure takes only 20–30 minutes. Reducing the stress of the operation and the anesthesia is desirable because many of these operations are performed in elderly patients under emergency conditions.

Good results following the low groin approach have been reported by Glassow, by Ponka, by Tanner, and by Monro.

When strangulated bowel is encountered in a low groin incision, do not attempt a resection and anastomosis by this approach. A secondary laparotomy incision should be made in the middle of the lower abdomen. When this is done, general anesthesia will be required. In those patients in whom strangulation of bowel is suspected prior to initiating the operation, the preperitoneal approach of Henry or Nyhus has several advantages. Through the low abdominal incision of this method, the peritoneum is swept away from the cephalad surface of the femoral canal to expose the hernial sac from above as it enters the femoral ring. The ring may be opened under direct vision and the bowel reduced into the abdominal cavity where resection and anastomosis are easily performed. The hernia is repaired by suturing the inguinal ligament to Cooper's ligament medial to the iliac vein, which is easily seen from above. The disadvantages in using the preperitoneal approach routinely are that general anesthesia is required and that the operation is more complex than the low groin procedures.

We prefer to use the inferior approach in most cases of femoral herniorrhaphy, reserving the preperitoneal exposure for the patient suspected of suffering bowel strangulation. When the low groin approach has been erroneously selected for patients who suffer strangulation of intestine, make a midline abdominal incision for reduction of the strangulated bowel and subsequent resection. Using these criteria, over 85% of patients can be done by the low groin approach.

Some surgeons use an inguinal incision followed by incision of the external oblique aponeurosis and the transversalis fascia in order to expose the cephalad entrance to the femoral canal. After removing the sac, the hernia is corrected by suturing transversalis fascia and conjoined tendon down to Cooper's ligament and the femoral sheath. Although surgeons like McVay have mastered this operation and achieved excellent results, others who do not regularly use the Cooper's ligament operation will find that the McVay operation is more difficult to perform than is the low groin repair.

Indications

As strangulation is common in patients with femoral hernia, it is advisable to operate on all patients who suffer from a femoral hernia unless their medical status is so precarious that it contraindicates even an operation under local anesthesia.

Preoperative Care

If there are signs of intestinal obstruction, initiate nasogastric suction.

When a patient has symptoms suggestive of a femoral hernia but lacks definitive physical findings, request a sonogram of the groin. This study may reveal a small incarcerated femoral hernia. Sonography is also helpful in diagnosing symptomatic Spigelian and other interstitial hernias of the abdominal wall.

Pitfalls and Danger Points

Injuring or constricting femoral vein
Transecting aberrant obturator artery

Operative Strategy

Low Groin Approach

After the sac has been opened and its contents reduced, the sac is amputated. It is not necessary to close the neck of the sac with sutures (Ferguson). It is important, however, to clear the femoral canal of any fat or areolar tissue so that the sutures can bring the inguinal ligament in direct contact with Cooper's ligament and the pectineus fascia. This will obliterate the femoral canal but will leave an opening of 6–8 mm adjacent to the femoral vein. Equally good results can be obtained if the femoral canal is obliterated by inserting a plug of Marlex mesh. This technique avoids all tension on the suture line.

To reduce an incarcerated femoral hernia, an incision may be made to divide the constricting neck of the hernial sac. This should be done on the medial aspect of the hernial ring. Although we have never observed the phenomenon, a number of texts warn that an anomalous obturator artery may follow a course that brings it into contiguity with the neck of the hernial sac and thus makes it vulnerable to injury when the constricted neck is incised. This accident will *rarely* occur if the neck of the sac is incised on its medial aspect. If hemorrhage is indeed encountered during this maneuver and the artery cannot be ligated from below, then control the bleeding by finger pressure and rapidly expose the inner aspect of the pelvis by the Henry approach, which involves a midline incision from the umbilicus to the pubis, after which the peritoneum is swept in a cephalad direction to expose the femoral canal from above. With this exposure a bleeding obturator artery can be easily ligated. It should be emphasized that this complication is so rare that it does not constitute a significant disadvantage of the low approach to femoral herniorrhaphy.

If the sutures drawing the inguinal ligament down to Cooper's ligament have to be tied under excessive tension, abandon this technique and insert a plug of Marlex mesh to obliterate the femoral canal, as described below.

Operative Technique

Low Groin Approach for Left Femoral Hernia

Make an oblique incision about 6 cm in length along the groin skin crease curving down over the femoral hernia (**Fig. 84–1**). Carry the incision down to the external oblique aponeurosis and the inferior aspect of the inguinal ligament. Identify the hernial sac as it emerges deep to the inguinal ligament in the space between the lacunar ligament and the common femoral vein (**Fig. 84–2**). Dissect the sac down to its neck using Metzenbaum scissors.

Grasp the sac with two hemostats and incise with a scapel. Often the peritoneum is covered by two or more layers of tissue, each of which may resemble a sac. These consist of preperitoneal tissues and fat. This is especially true when intestine is incarcerated in the sac.

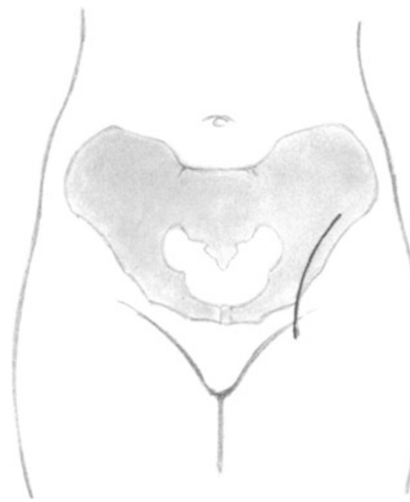


Fig. 84–1

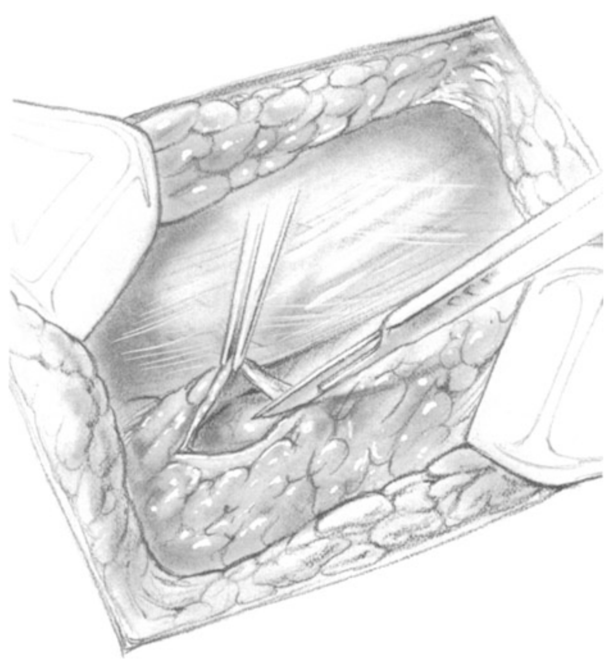


Fig. 84–2

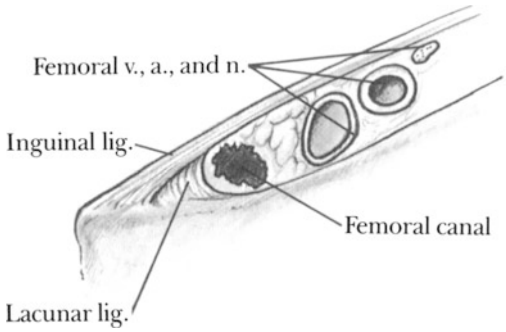


Fig. 84–3

When the bowel or the omentum remains incarcerated after opening the sac, incise the hernial ring on its medial aspect by inserting a scapel between the sac and the lacunar ligament (**Figs. 84–3 and 84–4**). After returning the bowel and the omentum to the abdominal cavity, amputate the sac at its neck. It is not necessary to ligate or suture the neck of the sac, but this step may be accomplished if desired (**Fig. 84–5**). Using a peanut sponge, push any remaining preperitoneal fat into the abdominal cavity, thus clearing the femoral canal of all extraneous tissues.

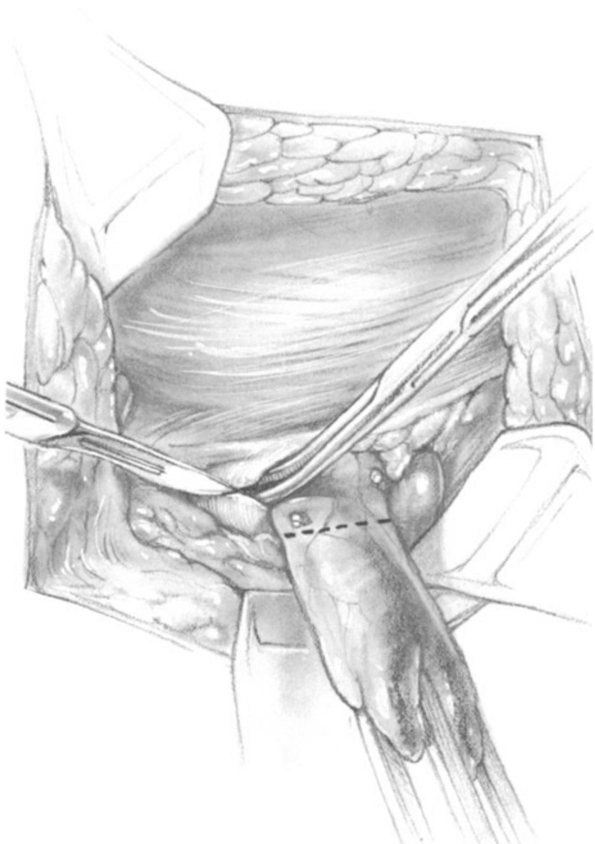


Fig. 84–4

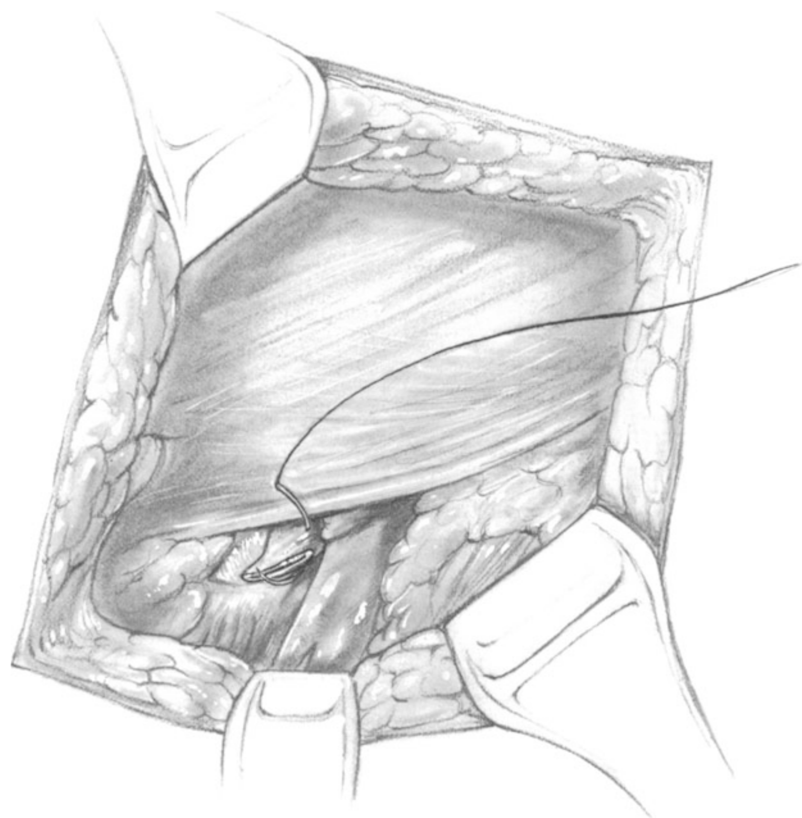


Fig. 84–5

Repair the hernial defect by suturing the inguinal ligament down to Cooper's ligament using interrupted 2–0 sutures of Prolene on a heavy Mayo needle. Often this can be accomplished if the inguinal ligament is pressed down and cephalad towards Cooper's ligament with the index finger. Then the needle is passed through the inguinal ligament and through Cooper's ligament in one simultaneous motion. Cooper's ligament is indistinguishable from the periosteum overlying the cephalad aspect of the pubic ramus. An alternative method involves placing the stitch first through the inguinal ligament, then placing a narrow retractor in the femoral canal in order to take a bite of Cooper's ligament and pectineus fascia. No more than 2–3 sutures are generally necessary. Identify the common femoral vein where it emerges from beneath the inguinal ligament. Leave a gap of 4–6 mm between the femoral

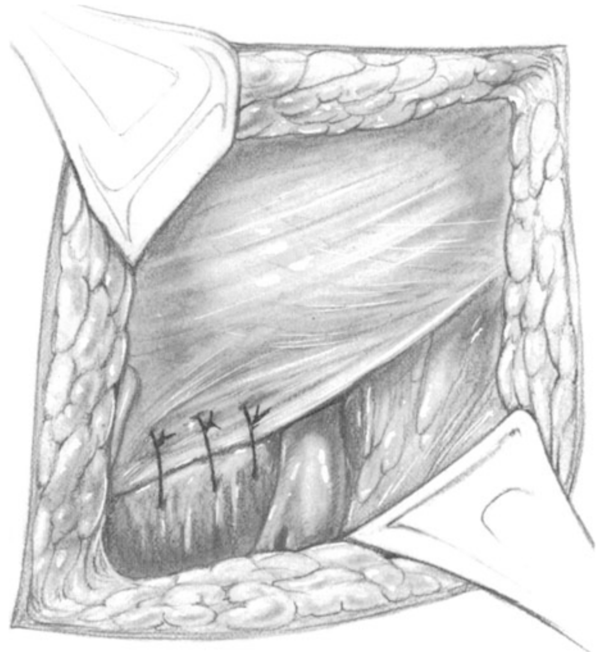


Fig. 84–6

vein and the lateralmost suture of hernia repair (**Fig. 84–6**).

Close the skin of the groin incision with either a continuous 4–0 PG subcuticular suture or interrupted 4–0 nylon sutures.

If strangulated bowel requiring resection is encountered after opening the hernial sac, make a second incision in the midline between the umbilicus and the pubis. Separate the two rectus muscles and identify the peritoneum. Do not incise the peritoneum. By blunt dissection elevate the peritoneum from the pelvis until the iliac vessels and the femoral hernial sac are identified. At this point, open the peritoneum just above the sac. Incise the constricting neck of the femoral canal on its medial aspect and reduce the strangulated bowel. After resecting the bowel, irrigate the femoral region with a dilute antibiotic solution and repair the femoral ring from below as already described. Irrigate the abdomen and close the abdominal incision in routine fashion.

Low Groin Approach Using Prosthetic Mesh "Plug"

Approximating the inguinal to the Cooper's ligament by sutures frequently requires excessive tension. Monro, who strongly favored the low groin approach, emphasized that the sutures should be tied loosely so that they form a lattice of monofilament nylon. This technique serves to occlude the defect without producing any tension. The same end can be accomplished even more simply by inserting a rolled up plug of Marlex mesh as advocated by Lichtenstein and Shore.

We believe this is the best method of repairing a femoral hernia. Cut a strip of Marlex mesh about 2 cm by 10–12 cm. Roll the Marlex strip in the shape of a cigarette, 2 cm in length. After the hernial sac has been eliminated and all the fat has been cleared out of the femoral canal, insert this Marlex plug into the femoral canal. The diameter of the plug may be adjusted by using a greater to lesser length of Marlex, as required. When the properly sized plug is snug in the femoral canal with about 0.5 cm of the plug protruding into the groin, fix the Marlex in place by inserting 2 sutures of 2–0 atraumatic Prolene (**Fig. 84–7**). Insert the needle first through the inguinal ligament, then through the Marlex plug, and finally into the pectineal fascia or Cooper's ligament. After the two sutures have been tied, the plug should fit securely in the canal. After irrigating the wound with a dilute antibiotic solution, check for complete hemostasis and then close the skin incision without drainage. If the patient accumulates serum in the incision postoperatively, aspirate the fluid occasionally with a needle.

Preperitoneal Approach for Right Femoral Hernia (Nyhus)

Anesthesia

Almost all practitioners of the preperitoneal approach believe that general anesthesia with good relaxation is a prerequisite for this type of hernia repair.

Incision

Start the skin incision at a point 2 fingerbreadths above the symphysis pubis (**Fig. 84–8**) and about 1.5 cm lateral to the abdominal midline. Carry the incision laterally for a distance of 8–10 cm and expose the anterior rectus sheath and the external oblique aponeurosis. Elevate the caudal skin flap sufficiently to expose the external inguinal ring.

Make a transverse incision in the anterior rectus sheath at a level about 1.5 cm cephalad to the upper margin of the external inguinal ring for a distance of about 5 cm in a direction parallel to the inguinal canal (**Fig. 84–9**). Retract the rectus muscle medially and deepen the incision through the full thickness of the internal oblique and transversus abdominis muscles. This will expose the transversalis fascia. Carefully make a transverse incision in this layer, but do not incise the peritoneum.

Apply a Richardson retractor against the lateral margin of the incised abdominal wall. Use blunt dissection to elevate the peritoneum out of the pelvis.

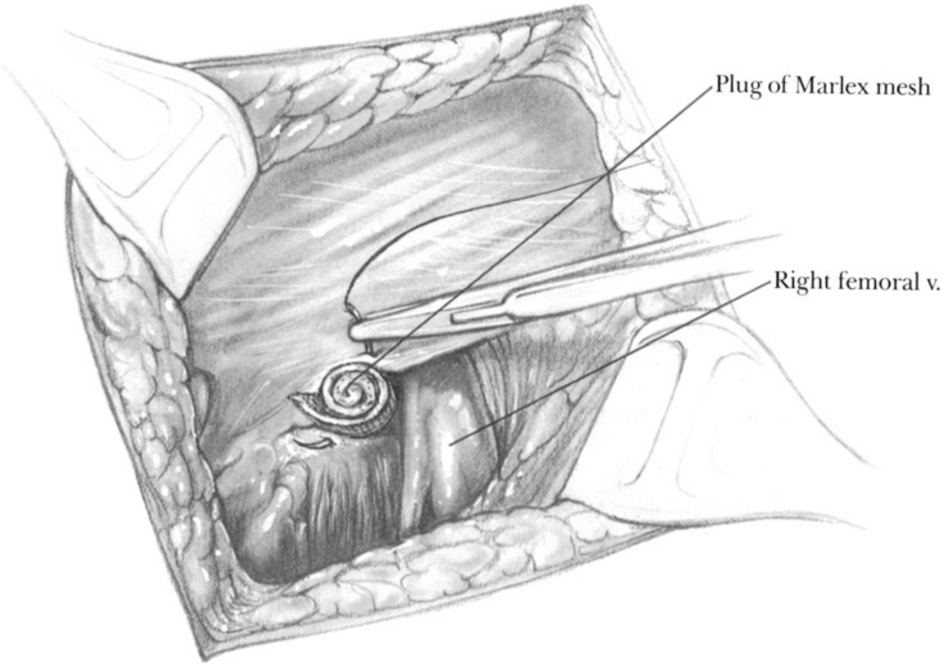


Fig. 84–7

Fig. 84–8

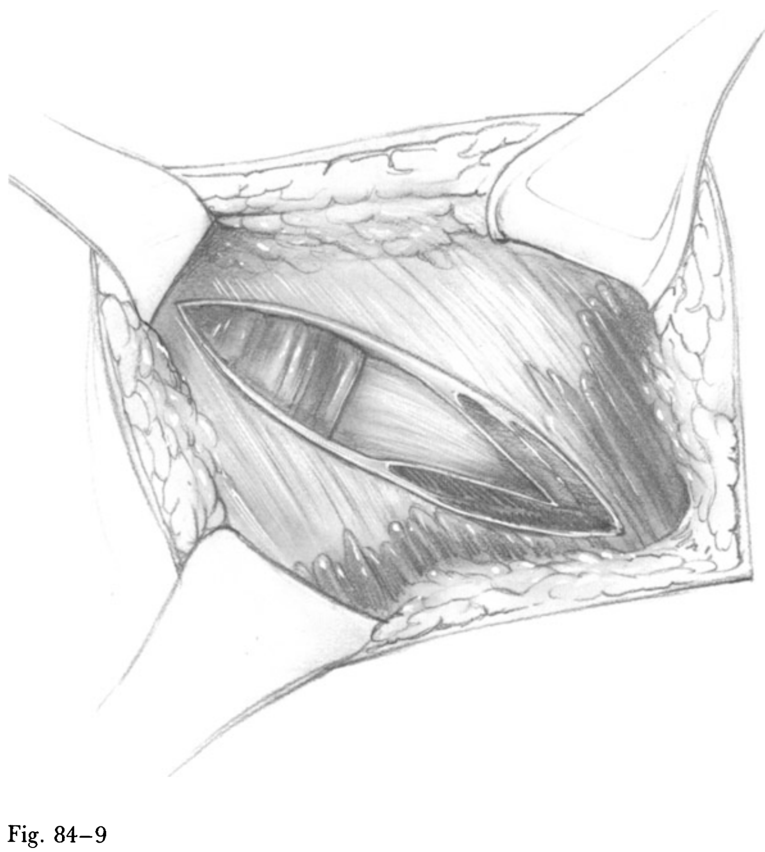


Fig. 84–9

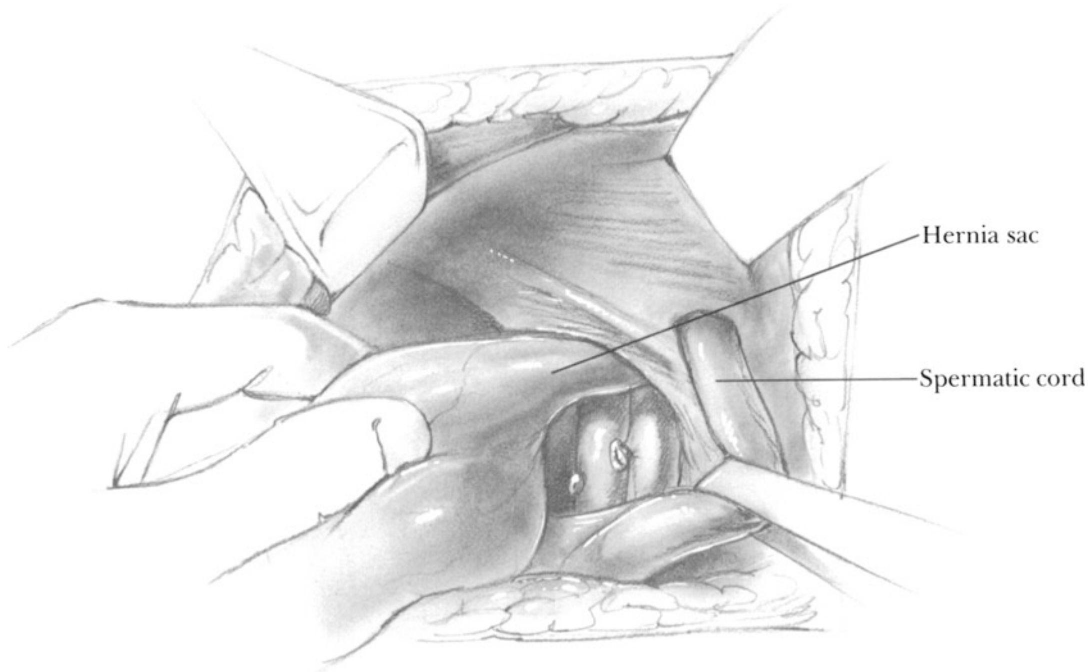


Fig. 84–10

Mobilizing the Hernial Sac

If the femoral hernia is incarcerated, it will be possible to mobilize the entire pelvic peritoneum except for that portion which is incarcerated in the femoral canal (**Fig. 84–10**). If the hernia cannot be extracted by gentle blunt dissection around the femoral ring, then incise the medial margin of the femoral ring and extract the hernial sac by combining traction plus external pressure against the sac in the groin.

Although the presence of an aberrant obturator artery along the medial margin of the femoral ring is a rarity, there may be one or two small venous branches that will require suture-ligation prior to incising the medial margin of the ring.

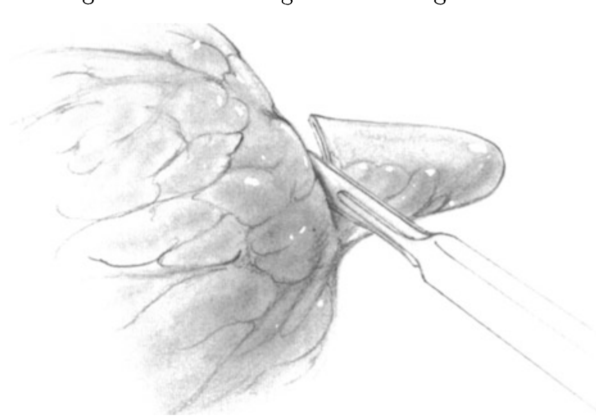


Fig. 84–11

Open the sac (**Fig. 84–11**). Evaluate the condition of the bowel. If strangulation mandates bowel resection, enlarge the incision enough so that adequate exposure for a careful intestinal anastomosis may be guaranteed. If bowel has been resected, change gloves and instruments before initiating the repair. Also irrigate the incision with a dilute antibiotic solution. Excise the peritoneal sac and close the peritoneal defect with continuous 3–0 PG.

Suturing the Hernial Ring

The superficial margin of the femoral ring consists of the iliopubic tract and the femoral sheath. These structures are just deep to the inguinal ligament. The deep margin of the femoral ring is Cooper's ligament, which represents the reinforced periosteum of the superior ramus of the pubis. In repairing the hernial defect, suture the strong tissue situated in the superficial margin of the femoral ring to Cooper's ligament with several interrupted sutures of 2–0 Tevdek or Prolene (**Fig. 84–12 and 84–13**). Whether the suture catching the superficial margin of the femoral ring contains only iliopubic tract or whether it also catches a bite of inguinal ligament is immaterial so long as there is not excessive tension when the knot is tied. If closing the ring by approximating strong tissues will result in tension, then it is preferable to suture a small "cigarette" of Marlex into the femoral ring from the cephalad approach.

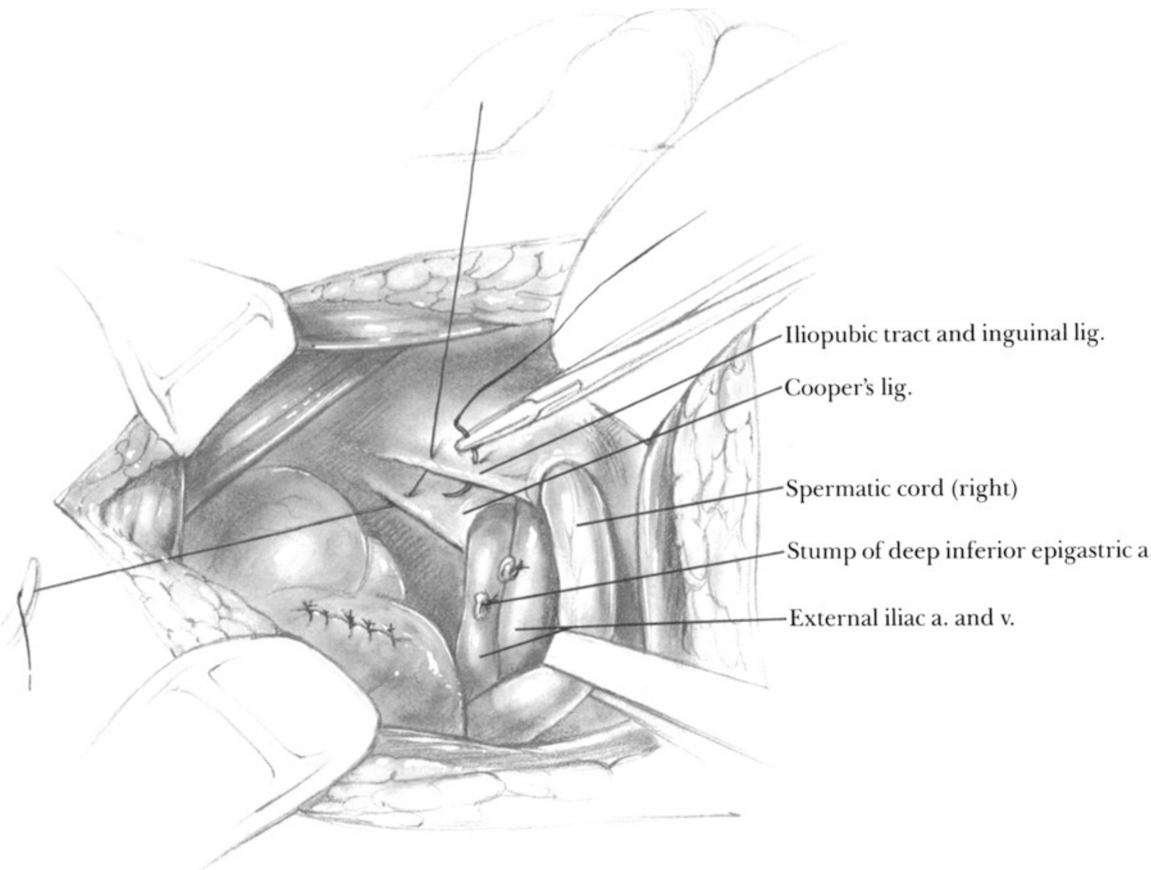


Fig. 84–12

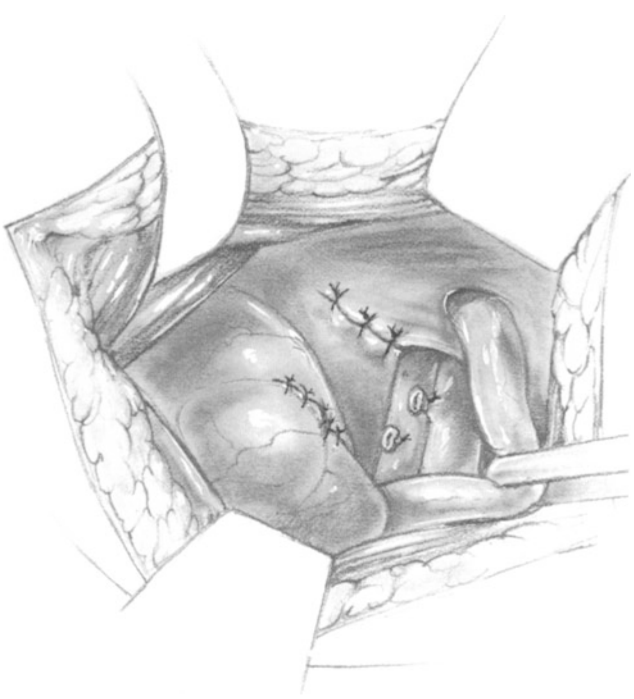


Fig. 84–13

In any case, do not permit the closure of the femoral ring to impinge upon the iliac vein because obstructing the venous flow may result in thrombosis and pulmonary embolism.

Closure of Abdominal Wall

Check the pelvis for the presence of a direct inguinal hernia. If present, this may be repaired by suturing the superior edge of the hernial defect (transversus abdominis aponeurosis) to the iliopubic tract below. Ascertain complete hemostasis. Irrigate the cavity with a solution of 1,000 ml of saline containing 1 gram of kanamycin and 50,000 units of bacitracin.

Close the anterior rectus sheath with interrupted 3–0 Tevdek. Close the remaining layers of the abdominal wall using modified Smead-Jones stitches of interrupted 1 PDS. Close the skin with a few 4–0 PG sutures to the subcutaneous fascia and a continuous subcuticular suture of 4–0 PG. No drain is necessary.

Postoperative Care

Early ambulation. Non-strangulated femoral hernias are repaired in our Ambulatory Surgery Unit.

Perioperative antibiotics are employed in patients with intestinal obstruction or those who have had bowel resection for strangulation. Use nasogastric suction in patients with intestinal obstruction or bowel resection.

Postoperative Complications

Deep vein thrombosis has been reported secondary to constriction of the femoral vein by suturing.

Wound infections (rare)

Ventral hernia following preperitoneal approach to femoral hernia repair

Recurrent femoral hernia appears to be in the 1% range in the hands of Nyhus for the preperitoneal operation. Using the low groin approach, Ponka reported a 3% recurrence rate and Glassow, 2%. Our experience with Lichtenstein's repair has been very favorable.

References

Ferguson DJ. In: Nyhus LM, Condon RE (eds) Hernia, 2nd ed. Philadelphia: Lippincott; 1978.

Glassow F. Femoral hernias: review of 1143 consecutive repairs. Ann Surg 1966;163:227.

Lichtenstein IL, Shore JM. Simplified repair of femoral and recurrent inguinal hernia by a "plug" technique. Am J Surg 1974;128:439.

Monro A. In: Nyhus LM, Harkins HN (eds) Hernia, 1st ed. Philadelphia: Lippincott; 1964.

Ponka JL. Hernias of the abdominal wall. Philadelphia: Saunders; 1980.

Tanner NC. In: Nyhus LM, Condon RE (eds) Hernia, 2nd ed. Philadelphia: Lippincott; 1978.

85 Operations for Large Ventral Hernia

Concept: Pathogenesis of Incisional Hernia

Sepsis

Infection of the postoperative abdominal wound not uncommonly leads to an incisional hernia at a later date, especially if the infection was not detected and drained widely early in the course of its development. Blomstedt and Welin-Berger studied 279 patients for 8–24 months after cholecystectomy. In the absence of a wound infection, 6% developed an incisional hernia. Of the patients suffering postoperative wound infections, 31% had incisional hernias.

A postoperative wound infection may be nosocomial in origin or it may be the result of endogenous contamination during the course of the abdominal operation. The prevention of infection following the contamination of an abdominal wound is discussed in Chap. 2.

Occult Wound Dehiscence

When a large ventral hernia appears within the first few months following an abdominal operation, a likely cause of the hernia is the dehiscence of the fascial and muscular layers of the abdominal wall during the early postoperative course in a patient whose skin incision has remained intact. For this reason, the wound dehiscence may be undetected by the surgeon until he notes a large hernia in the scar when the patient returns for a follow-up visit a month or two later. The prevention of postoperative wound dehiscence is discussed in Chap. 5.

Making Too Large a Drain Wound

When the stab wound for a latex drain is made too large, a postoperative hernia is likely to occur. Generally, if the stab wound admits only one finger, a postoperative hernia is unlikely. When drainage is designed to facilitate the escape of necrotic tissue (e.g., necrotizing acute pancreatitis), large drainage wounds are required despite the risk of developing a hernia.

Transverse versus Vertical Incision

As discussed in Chap. 5, we have not detected an increased incidence of incisional hernia or wound dehiscence when comparing the midline vertical incision with transverse or oblique subcostal incisions, provided that the midline incision has been closed with sutures that encompass large bites of abdominal wall, such as the Smead-Jones stitch.

Technique of Suturing

Type of Suture Material

Goligher, Irvin, Johnston, and associates demonstrated that closing an abdominal incision with catgut resulted in a larger number of wound dehiscences and incisional hernias than was experienced with nonabsorbable sutures, unless the catgut closure was supplemented by multiple large retention sutures. Also in the repair of inguinal and ventral hernias, suturing with catgut is followed by a larger number of recurrences than is the case with nonabsorbable suture material.

Whether the new and more slowly absorbable suture materials (e.g., Maxon and PDS) retain their strength long enough to equal the performance of nonabsorbable sutures is a question that has not yet been settled. We have performed over 400 consecutive closures of midline abdominal incisions with interrupted No. 1 PDS Smead-Jones sutures without experiencing a single wound dehiscence. We are aware of one fairly large and three quite small incisional hernias, but a complete follow-up study of these patients has not been performed. While we have confidence in this suture material for the closure of a primary abdominal incision, we do not believe that its use has been validated in hernia repair.

Size of Tissue Bites

We agree with the findings of Jenkins that the width of tissue included in each suture is an important determinant of the incidence of wound dehiscence or incisional hernia, regardless of whether a continuous or interrupted technique is used. Sutures that contain small bites of tissue tend to cut through in response to muscle tension. We believe that *at least*

2 cm of musculofascial tissue on each side of the incision should be included in the stitich.

Tension with Which Suture Should Be Tied

When a stitch in an abdominal incision is tied with strangulating force, no matter how large a bite of tissue the stitch contains, strangulation may cause the stitch to cut through the abdominal wall. This error will manifest itself by the appearance of a small hernia, 1–2 cm lateral to the scar several months following operation. The hernial ring will often be no more than 1.0–1.5 cm in diameter when first detected. This phenomenon is somewhat more likely to occur when using stainless steel wire than Prolene. The diameter of a 2–0 wire suture is considerably less than that of 1 PDS or 0 Prolene. For this reason it has a greater tendency to cut the tissue and must be tied without tension. In using Prolene for closing the abdominal wall, it is easy to tie the knot with excessive tension because the suture material is slippery. Consequently, as the surgeon applies an additional throw to the knot, the entire knot slips and tightens the suture. In any case, it is not necessary to tie the knot in an abdominal closure with any greater tension than one would apply to a suture in a bowel anastomosis. Insisting that the anesthesiologist provide adequate relaxation of the abdominal wall will facilitate the surgeon's effort to apply the proper tension to each suture.

Intercurrent Disease

Cirrhosis and ascites

Long-term high-dose steroid treatment

Marked obesity

Severe malnutrition

Abdominal wall defects secondary to tumor resection

(Defects in the abdominal wall, secondary to resection for tumor, may be managed by insertion of a prosthetic mesh as described below for ventral hernia repair, provided that adequate coverage of the mesh with viable skin and subcutaneous fat is possible. Otherwise, a full thickness pedicle flap will have to be designed to cover the mesh.)

Indications

Good-risk patients should have an elective repair of a ventral hernia that has a defect of more than 1–2 cm. Early repair of the small hernia is a simple procedure. Nonoperative therapy is almost always followed by gradual enlargement of the hernial ring over a period of time. Not only does this make the repair more difficult, but there is a significant incidence of intestinal obstruction due to the incarceration of intestines in the hernia.

Preoperative Care

Nasogastric tube prior to operation for large hernias

Perioperative antibiotics in patients with hernias large enough to require prosthetic mesh

Pitfalls and Danger Points

Excessive tension on the suture line

Sewing tissues that are too weak to hold sutures

Postoperative sepsis

Failure to achieve complete hemostasis

Operative Strategy

Identifying Strong Tissues

Every ventral hernia is characterized by a defect, small or large, in the tissue of the abdominal wall. In the hope of facilitating the approximation of the edges of the defect, the surgeon is often tempted to preserve and to insert sutures into weak scar tissue instead of carrying the dissection beyond the edge of the hernial ring to expose the normal musculoaponeurotic tissue of the abdominal wall. Depending on scar tissue to hold sutures for the repair of a hernia leads to a high recurrence rate. Carry the dissection for a width of 2–3 cm beyond the perimeter of the hernial ring on all sides and clearly expose the anterior surface of the muscle fascia. *Often an incisional hernia is accompanied by additional smaller hernias 3–5 cm away from the major defect.* These secondary hernias occur because more than one suture, inserted at the previous repair, has cut through the tissue leaving additional small defects. If the additional defects are close to the large hernial ring, incise the tissue bridges and convert the several defects into one large hernial ring.

Some surgeons advocate separating the abdominal wall into its component layers, namely peritoneum, muscle, and fascia. Then they suture each layer separately. We believe that in most cases it is preferable to insert the suture by taking a large bite of the entire abdominal wall in each stitch, following the principle of the Smead-Jones technique, rather than splitting the abdominal wall and closing each layer separately. By the same token, we have not used relaxing incisions through the aponeurosis of the external oblique layer to expedite hernial closure because we have observed subsequent herniation through the area of the relaxing incision. Other surgeons have advocated making a flap out of the anterior rectus sheath on each side and then bridging the hernial defect by suturing one fascial flap to the other. Our experience suggests that this technique will not be successful in repairing an incisional hernia larger than a few centimeters in diameter.

Avoiding Tension in the Repair

By far the most dangerous threat to long-term success in hernial repair is excessive *tension on the suture line*. While all surgeons agree with this principle, there is a wide variation in each surgeon's perception of what comprises "excessive" tension. We believe that *any degree of tension is "excessive"* because this judgment is always made with the patient under anesthesia. Even local anesthesia produces muscle relaxation in the area of anesthesia, so that any degree of tension will be magnified when the effects of anesthesia have disappeared.

Although it is sometimes possible under anesthesia to approximate abdominal wall defects 6–8 cm in width without appearing to have produced excessive tension, *many* of these patients will return with recurrent hernias if they are followed for 4–5 years or more. Berliner also has noted in his experience that ventral hernias of substantial size repaired by traditional techniques are followed by a very high rate of recurrence if the patient is observed for more than a few years subsequent to the operation. Ponka reported a 9% recurrence rate after 794 incisional herniorrhaphies, only 53% of which could be followed for up to 5 years.

In the case of *small* ventral hernias, less than 3 cm in diameter, success may be anticipated if the weakened tissues are excised and the remaining defect in the abdominal wall is simply approximated by the use of the Smead-Jones technique, just as one would close a primary abdominal incision (see Chap. 5). While it is important to excise all of the attenuated tissues, it is not necessary to remove the condensation of fibrous tissue that often forms a firm ring and separates the hernial defect from the normal tissues of the abdominal wall. Using the Smead-Jones stitch, simply insert the sutures 2–3 cm beyond the hernial ring through all the layers of the abdominal wall including peritoneum. If a circular defect can be closed in a transverse direction, this may be preferable to a vertical closure, but the main consideration is to select the direction that produces least tension.

Role of Prosthetic Mesh

If there is tension on the proposed suture line, do not close the defect at all. Rather, bridge the defect with one or two layers of a prosthetic mesh. With this technique no attempt is made to close the defect. The defect is *replaced* by the mesh, which is sutured in place by means of 2–0 or 0 Prolene mattress sutures that penetrate the full thickness of the abdominal wall. Although there are certain disadvantages to the use of a permanent prosthesis in the abdominal wall, the monofilament polypropylene (Prolene or Marlex) mesh has proved to be safe in our hands.

Cerise, Busuttil, Craighead et al. have demonstrated a statistically significant increase in the bursting pressure of abdominal incisions in rats when a sheet of polyester mesh is sutured as an onlay patch over the abdominal closure prior to suturing the skin. Nevertheless, it is not at all clear that closing a ventral hernia with sutures under significant tension and then placing an onlay patch of mesh will result in long-term success. It would seem that tension would still cause the primary abdominal sutures to cut through the tissues over a period of time, leaving the mesh as the only barrier to a recurrent hernia. It is possible that merely the presence of the mesh patch will stimulate fibrosis and prevent this type of recurrence, but this fact *has not yet been established* in humans. For this reason, when there is a defect in the abdominal wall that would require sutures to be tied with any significant degree of tension, we have preferred to leave the defect open and to use the mesh as a replacement for this portion of the abdominal wall. Whether this judgment is the correct one will require a complex randomized study to determine.

Since the mesh is composed of monofilament fibers, the patient will often tolerate a wound infection without the necessity of removing the mesh. Opening the skin widely for drainage will generally prove sufficient and, in many cases, avoid the need to remove the mesh.

The most serious complication following the use of prosthetic mesh arises when dense adhesions sometimes form between the small intestine and the fabric of the mesh. If intestinal obstruction in this situation requires a subsequent laparotomy, it may prove impossible to separate the mesh from the bowel without extensive intestinal damage. Prolene mesh seems less prone to this complication than Marlex (Stone, Fabian, Turkleson et al.). Although this complication is uncommon, it is important to take the precaution of interposing omentum between the mesh and the intestines whenever possible. In cases where omentum is not available for this purpose, one should preserve the hernial sac and interpose this tissue between the intestines and the mesh, which is then sutured as an onlay patch over the defect. Although using an onlay patch mechanically does not result in so strong a repair as inserting stitches through the entire abdominal wall to fasten the mesh, it may be preferable to taking the risk of producing excessive intestinal adhesions.

Use of Vicryl Mesh to Separate Bowel from Prolene Mesh

Wantz advocates inserting a layer of Vicryl absorbable mesh between the Marlex and bowel. He applies the two sheets together as in a sandwich. It is hypothesized that by the time the Vicryl is absorbed, a layer of pseudoperitoneum may develop on the Marlex mesh. However, valid data to support this concept are lacking.

Marlex versus Prolene Mesh

Although the Marlex (Davol) and the Prolene (Ethicon) meshes are both composed of the identical chemical, namely polypropylene monofilament fibers that are knitted into a mesh, Prolene appears to be somewhat more pliable than Marlex. As mentioned above, Stone and associates found that when they used Prolene mesh in complicated cases of abdominal wall defects subsequent to trauma and sepsis, there were fewer long-term complications than when they used Marlex mesh in similar circumstances. We are not aware of any other reports at this time that contradict their published follow-up experience with these two products.

Use of Pneumoperitoneum prior to Repair of Large Ventral Hernia

Another method of avoiding tension in the repair of large ventral hernias is to induce pneumoperitoneum, as suggested by Moreno in 1947. This is especially recommended for use in patients having a hernia so large that it has lost its right of domicile in the abdominal cavity. Although Connolly and Perri could find published reports of only 22 cases of adult hernia patients prepared for surgery by pneumoperitoneum in the American literature prior to 1969, Moreno reported that he personally performed 500 operations using this modality with excellent results and only 3 fatalities. Moreno described the following contraindications to the use of pneumoperitoneum: (1) advanced age combined with poor general condition; (2) cardiac decompensation; (3) hernias in which there is a danger of gangrene. In the latter case, emergency surgery would be indicated; this would not allow time for preoperative pneumoperitoneum. To this list of contraindications we would add the condition of intestinal obstruction. We have seen one case of a huge incarcerated inguinal hernia where the induction of pneumoperitoneum resulted in transection of the ileum requiring emergency surgery to salvage the patient. Incarceration of bowel in a huge hernia is not itself a contradiction. Most of the giant hernias for which Moreno recommended pneumoperitoneum were not reducible. In the absence of intestinal obstruction, the gradual induction of pneumoperitoneum not only enlarged the abdominal girth by stretching the abdominal muscles in a manner similar to that which takes place during pregnancy, but air also entered the hernial sac and stretched whatever adhesions existed between the intestines and the sac. This made subsequent dissection technically easy. Patients who have hernias with small rings should receive pneumoperitoneum cautiously. Moreno recommended starting with perhaps four daily "test doses" of 500 ml of air prior to instituting the routine pneumoperitoneum in patients who had small rings and a previous history of intermittent intestinal obstruction, as well as those whose general condition was borderline. If the test doses cannot be tolerated, pneumoperitoneum is contraindicated.

The technique of instituting pneumoperitoneum, as described by Moreno, was based on inserting a spinal needle into the abdomen at the midpoint of a line running from the anterior superior iliac spine to the umbilicus after an intradermal injection of a local anesthetic agent. Obviously, avoid inserting the needle in the vicinity of a previous abdominal scar. Steichen modified this technique by using an Intracath intravenous catheter and inserting it into the abdominal cavity. The advantage of the catheter is that it can remain in place for the entire duration of the pneumoperitoneum (7–21 days). Forrest used an indwelling peritoneal dialysis catheter inserted into the abdomen under local anesthesia and left in place until the course of intra-abdominal air injections had been completed. We have used a No. 20 gauge Angiocath, which consists of a plastic catheter fitted around a metal needle. When the Angiocath is in its proper location, remove the needle and leave the plastic catheter in place. Then suture the plastic catheter to the skin and attach a bacterial air filter to the catheter. Attach a 3-way stopcock to the air filter.

While Moreno injected 1,000–2,000 ml of air into the abdominal cavity every 2–3 days, we and others (Forrest) have injected 500–2,000 ml daily. In administering the pneumoperitoneum each day, we use a disposable sterile 50-ml syringe. With the aid of the 3-way stopcock, inject increments of air until the patient experiences significant abdominal discomfort or dyspnea, at which time the injection of air is discontinued for the day. Moreno measured the pressure of air in the abdominal cavity at the conclusion of each day's dose. He found that a pressure of 30–40 cm of water was generally as much as the average patient could tolerate. Moreno also measured the patient's vital capacity every 2–3 days. Remarkably enough, he noted that despite the cumulative injection of 20–30 liters of air, the patient's vital capacity at the end of the course of treatment was consistently greater than it was before pneumoperitoneum was instituted. He felt that this increase in vital capacity was one indication that the patient was ready for surgery. The usual patient with a giant ventral or scrotal hernia requires 10–21 days of preparation with the cumulative injection of 12–20 liters of air prior to operation.

Surprisingly, there have been no reported instances of air embolism following the use of pneumoperitoneum. The actual repair of the giant hernia has generally been relatively simple because of the extreme degree of stretching that the abdominal musculature has undergone. The postoperative course in these patients has been remarkably smooth because the abdominal cavity has been stretched sufficiently to receive the contents of the large hernia, yet allowing for abdominal closure with no tension.

Our experience with pneumoperitoneum in giant hernias has been limited to a small number of cases, but these results have confirmed the favorable reports by Moreno and others. What is not clear from the published literature and our own observations is the question whether the stretched abdominal wall will soon contract to its previous state of tension, and whether this tension will result in recurrence of the hernia in an unacceptable number of patients. None of the published reports includes a proper follow-up study to determine the exact rate of recurrence.

At this time, pneumoperitoneum would appear to be the best method of approaching a patient with a giant ventral or giant scrotal hernia, where the hernial contents appear to have forfeited their right of domicile in the abdominal cavity. In these cases, there is often no other satisfactory method of approaching the patient. In past years, excision of a large segment of the small intestine and the omentum was performed to reduce the bulk of the abdominal contents. Closure of the hernia was then often followed by extreme respiratory distress owing to the excessive pressure in the abdominal cavity.

In other cases of large abdominal hernias, it is not clear whether the use of pneumoperitoneum combined with primary suture of the defect under mild tension will prove superior to the use of prosthetic mesh without tension, when the patients are followed for 5–10 years.

Myocutaneous Flap

The recent increased interest in the myocutaneous flap has resulted in the development of techniques that facilitate the rotation of large flaps of muscle covered by skin and subcutaneous fat into defects of the abdominal wall with retention of excellent blood supply to the flap. The tensor fasciae latae muscle is one example of such a myocutaneous flap that can be used to bridge defects in the abdomen. A number of such flaps has been described by Mathes and Nahai. The exact role of this modality as compared to prosthetic mesh in replacing abdominal defects is still under study. It should be emphasized, however, that a split-thickness skin graft cannot consistently be expected to survive if it is placed over a layer of mesh, even if the mesh has been covered by healthy looking granulation tissue. In many cases, the mesh must be covered either by a pedicle flap of skin and subcutaneous tissue or the mesh must be replaced by means of a myocutaneous or a microvascular free flap.

Summary

While many papers have been written describing the virtues of various techniques of repairing a ventral hernia, we are not aware of any definitive publication that describes a careful 5-year follow-up study of patients subjected to various types of ventral hernia repair. Consequently, our operative strategy is based on our clinical experience and not on statistically validated data. After proper dissection to identify normal tissues around the ring, we would close a *small* hernia (3 cm) with large bites of Smead-Jones stitches, using heavy Prolene suture material, provided that the tissues could be approximated *without tension.*

In patients with larger hernias or multiple defects, suturing under tension has in our experience resulted in frequent recurrences. It is quite possible that one reason for the failure of the *initial* abdominal closure was some deficiency in the quality of the patient's collagen deposition. In these cases excellent results can be achieved by the proper use of polypropylene mesh to *replace* the defective section of abdominal wall and thereby to avoid tension.

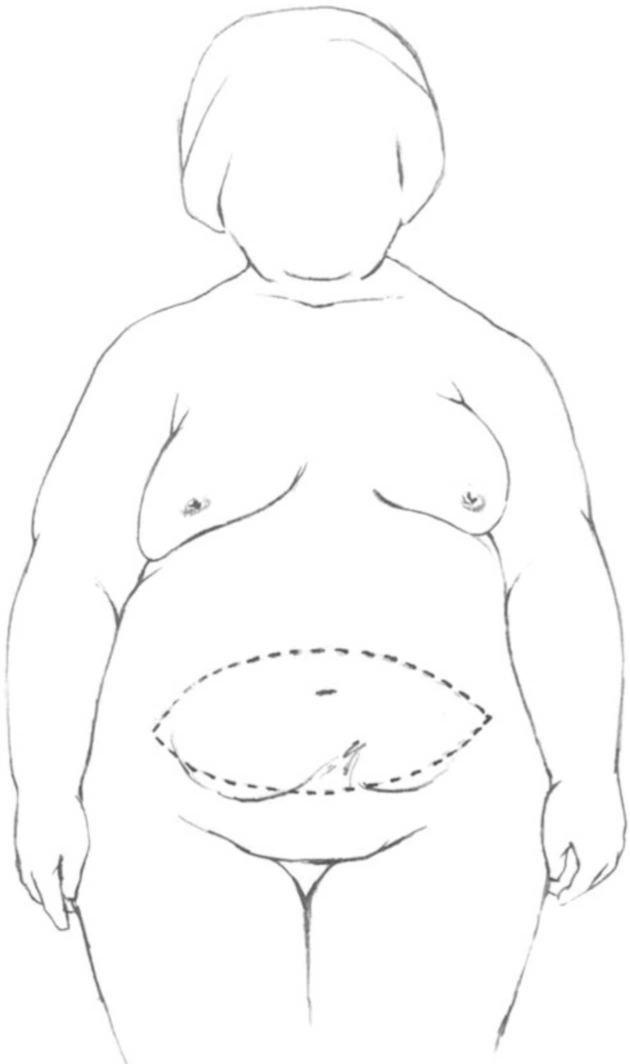


Fig. 85–1

Operative Technique—Elective Ventral Hernia Repair

Dissecting the Hernial Sac

Make an elliptical incision in the skin along the axis of the hernial ring and carry the incision down to the sac (**Figs. 85–1 and 85–2**). Dissect the skin away from the sac on each side until the area of the hernial ring itself has been exposed in its entire circumference (**Fig. 85–3**). Now retract the skin flap away from the sac and make a scalpel incision down to the anterior muscle fascia. Continue to dissect the normal muscle fascia, using either scalpel or Metzenbaum scissors, until at least a 2-cm width of fascia has been exposed around the entire circumference of the hernial defect. This dissection will generally leave some residual subcutaneous fat attached to the area where the sac meets the hernial ring. Using a scissors, remove this collar of fat from the base of the hernia.

Resecting the Hernial Sac

Now make an incision along the apex of the hernial sac and divide all of the adhesions between intestine and sac (**Figs. 85–4 and 85–5**), reducing the in-

Fig. 85–2

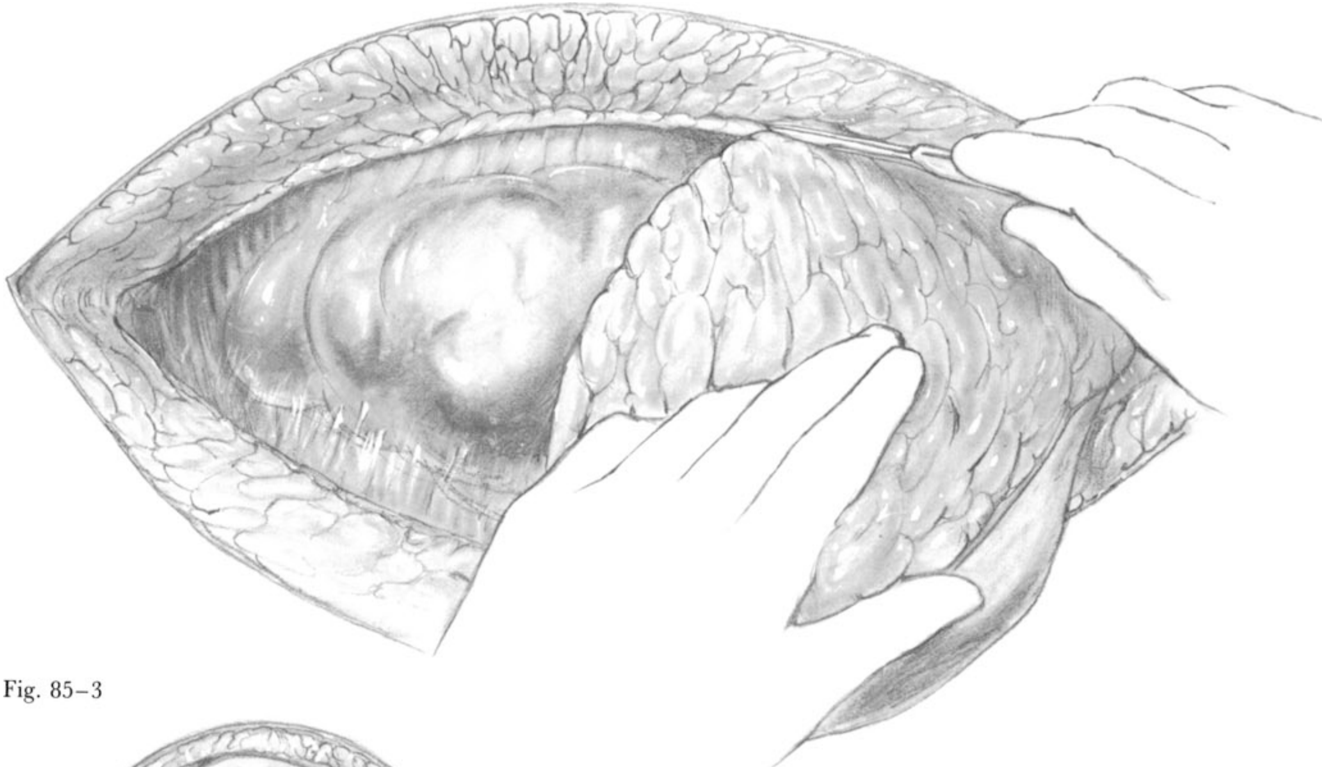


Fig. 85–3

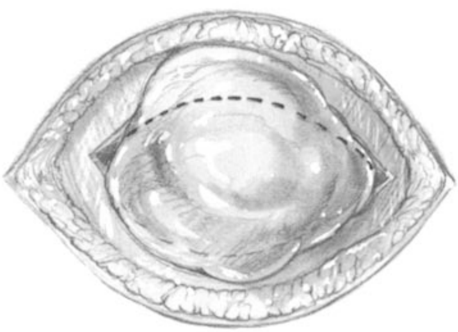


Fig. 85–4

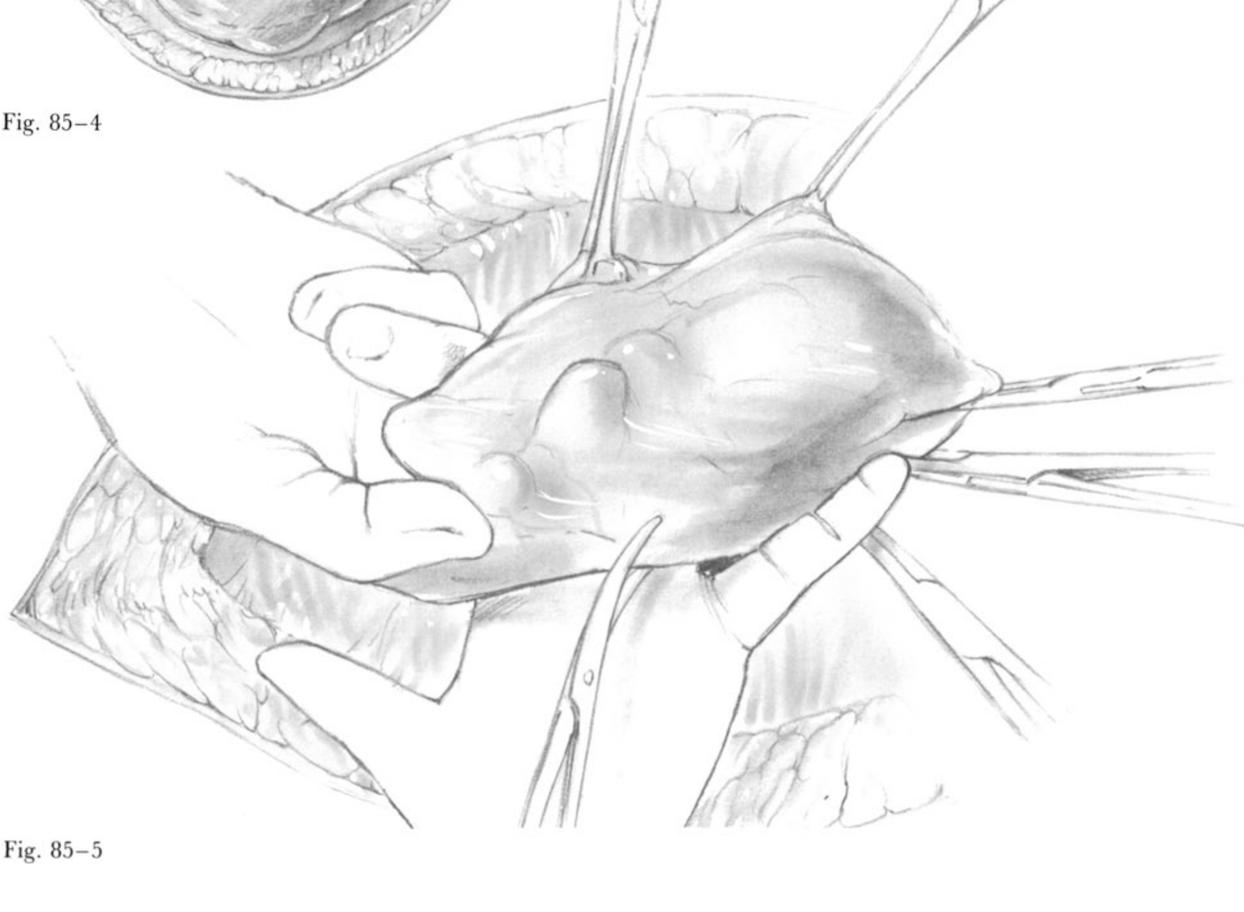


Fig. 85–5

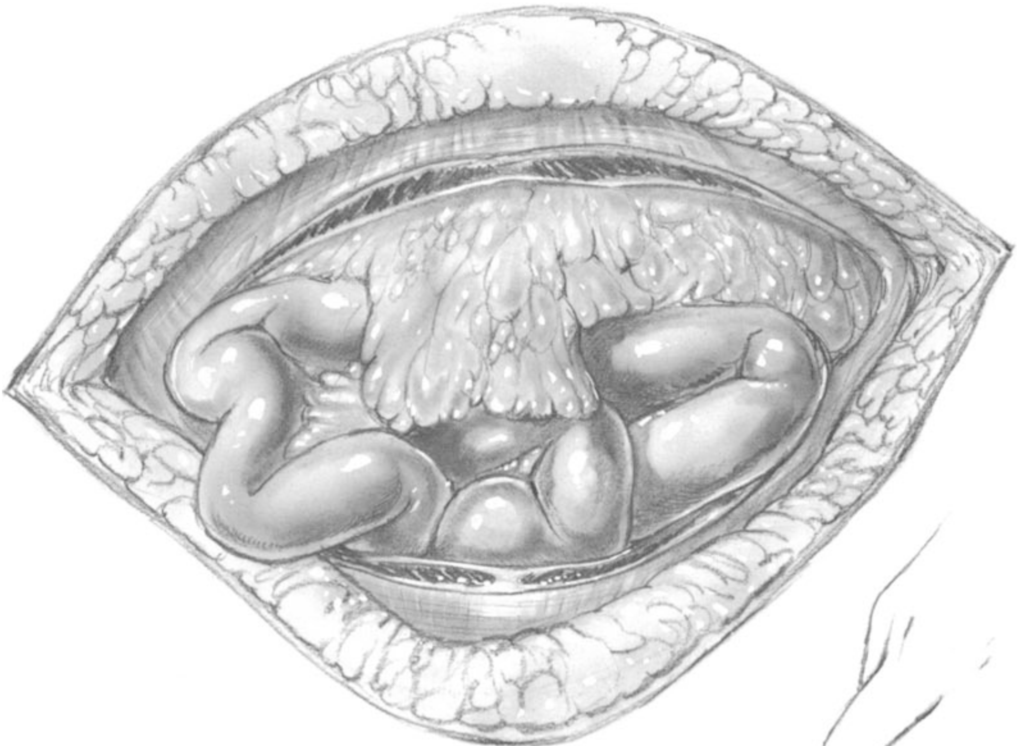


Fig. 85-6

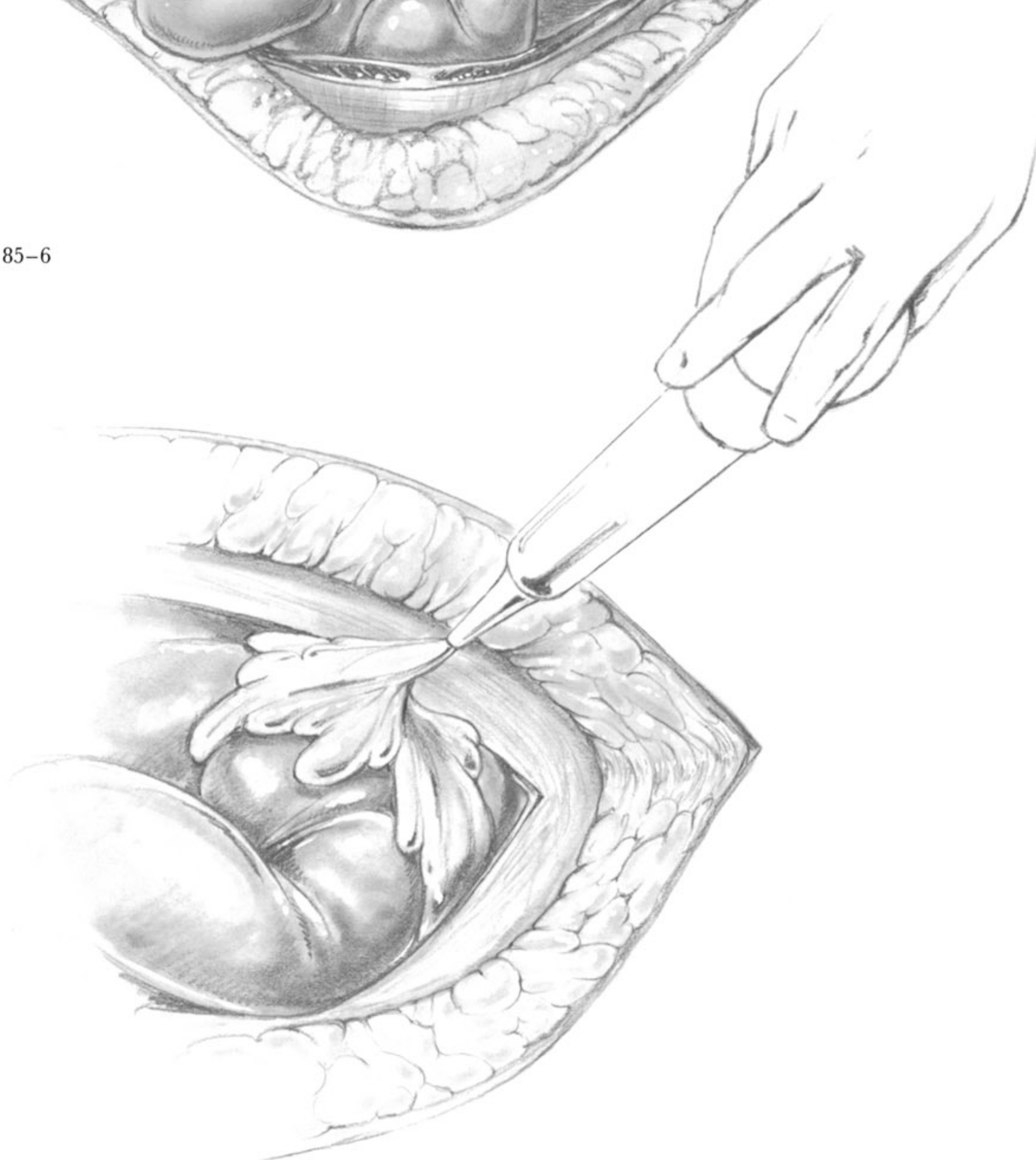


Fig. 85-7

testines into the abdominal cavity (**Fig. 85–6**). Expose the circumference of the hernial defect so that the neck of the sac and a width of peritoneum of 2–3 cm are freed of all adhesions around the entire circumference of the hernia. Irrigate the wound with a dilute antibiotic solution intermittently (**Fig. 85–7**).

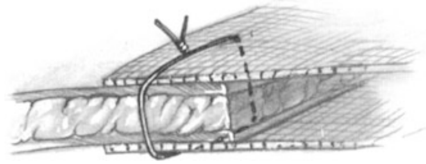


Fig. 85–8

Mesh Repair of Ventral Hernia

Sandwich Repair

The "sandwich repair" was first described by Usher. Two identical sheets of polypropylene mesh are cut from a large sheet. Each piece of mesh should be 2 cm larger than the hernial defect. One sheet is placed inside the abdominal cavity and the other makes contact with the fascia around the hernial ring. The two sheets are held by sutures that go through the top sheet, then through the full thickness of the abdominal wall, and then through the deep sheet of mesh. The stitch then returns as a mattress stitch penetrating the deep sheet of mesh, the full thickness of abdominal wall, and, finally, the superficial sheet of mesh before being tied with a knot located in the subcutaneous layer (**Fig. 85–8**). The deep layer of mesh should be separated from the bowel by the omentum. In the absence of a satisfactory layer of omentum, it may be preferable to omit the intraperitoneal layer of mesh and to preserve enough hernial sac so that the sac, after being trimmed and sutured closed, can be retained as a protective layer to separate the intestines from the mesh, which is now used as an onlay patch, as described in the next section (see Fig. 85–13).

Application of the sandwich technique to a large recurrent ventral hernia in an obese patient is illustrated beginning with **Fig. 85–9**. After the skin

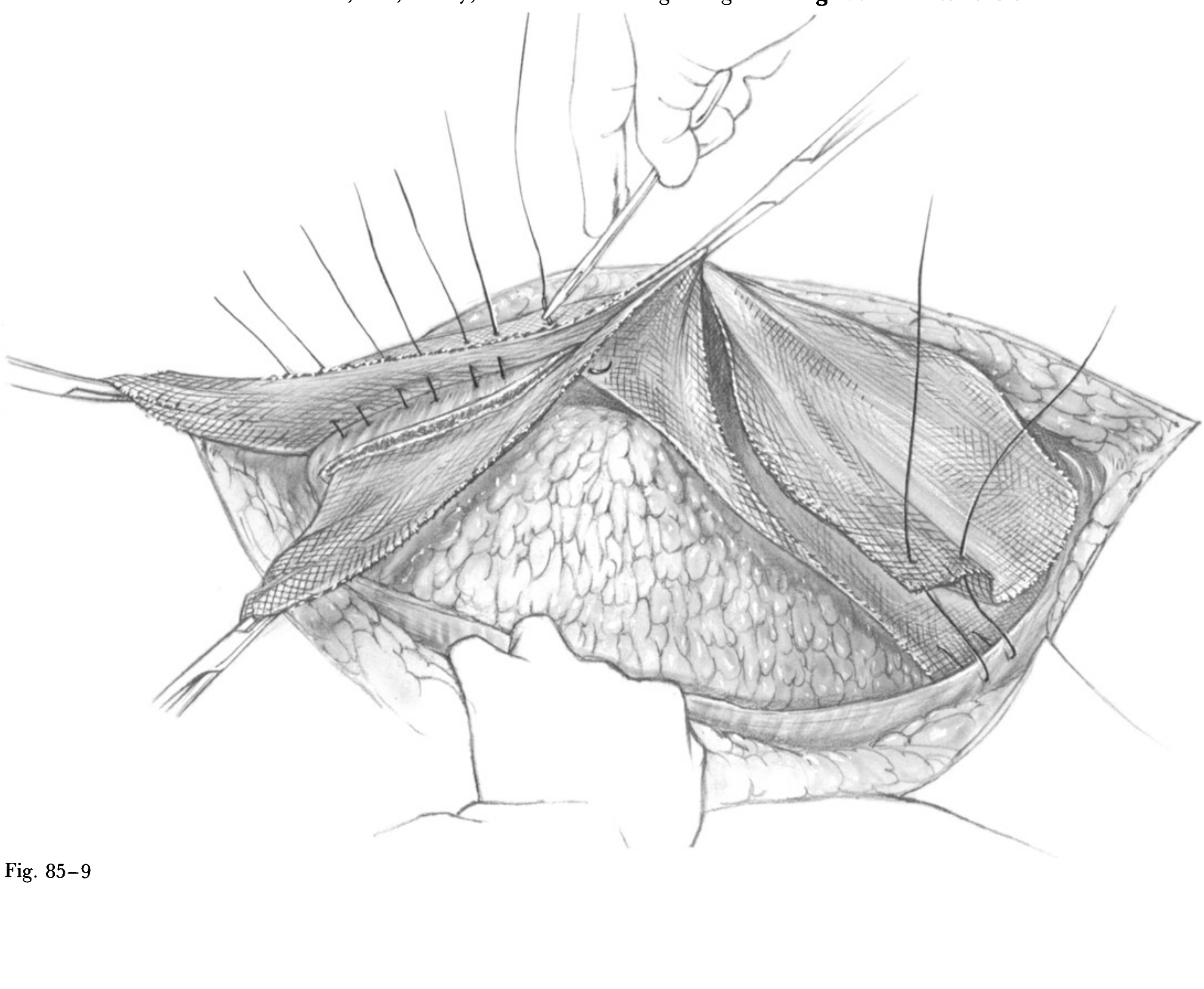


Fig. 85–9

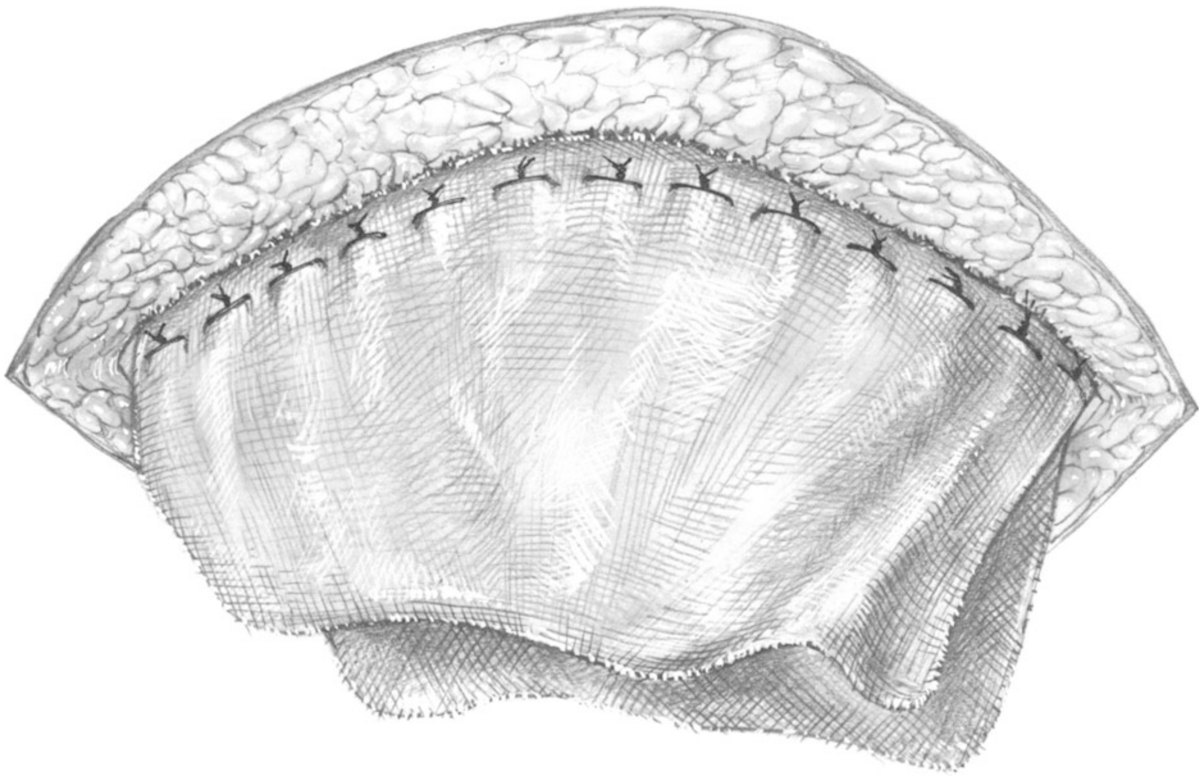


Fig. 85–10

flaps have been elevated, exposing healthy fascia around the entire circumference of the hernial defect, make certain that there are no additional hernial defects above or below the major hernia. If there are additional hernias, combine them into one large defect by incising the bridge of tissue between them. Excise the sac down to its point of attachment to the hernial ring and excise subcutaneous fat around the hernial ring. Then insert one sheet of mesh inside the abdominal cavity and the other over the rectus

Fig. 85–11

fascia. Place the mattress sutures through the mesh at a point about 2–3 cm away from the hernial ring to be certain the sutures engage normal abdominal muscle and aponeurosis. A horizontal mattress suture penetrates first the superficial layer of mesh, next the entire abdominal wall, and then the deep layer of mesh. In returning the suture, the width of the bite of mesh must be less than the width of the bite in the abdominal wall. Otherwise, the mesh will tend to bunch together when the stitch is tied rather than lying flat. Therefore, when returning the stitch through the deep layer of mesh, select a spot that will encompass only 7 mm of mesh while including a 1-cm width of abdominal wall. After penetrating the anterior rectus fascia, pass the needle through the anterior layer of mesh again at a point 7 mm away from the tail of the stitch. Tie the suture. We use the 3-1-2 knot (Fig. B–28), supplemented by a few additional throws. The suture material used is 2-0 Prolene on an atraumatic needle. Insert additional mattress sutures of the same material at intervals of about 1.0–1.5 cm until half of the sutures have been inserted and tied. Then insert the remaining sutures, but do not tie any of them until all have been properly inserted. After tying all of the sutures, check for any possible defects in the repair (**Figs. 85–10 and 85–11**).

When a hernial defect borders on the pubis, include the periosteum of the pubis in the sutures attaching the mesh to the margins of the defect.

Be certain to achieve complete hemostasis with electrocoagulation and fine PG ligatures. Insert a multiperforated closed-suction catheter through a small puncture wound in the skin. Lead the catheter across the superficial layer of the mesh. Attach the catheter to a Jackson-Pratt closed-suction device. Approximate the skin with interrupted nylon sutures. Apply a sterile pressure dressing.

Onlay Patch Mesh Repair

As mentioned above, this repair is suitable when there is no layer of omentum available to be interposed between the intestines and the mesh. Here the hernial sac is preserved. Trim away the excess sac leaving enough tissue so that it may be closed without tension by means of a continuous 2–0 atraumatic PG suture (**Fig. 85–12**). This will serve as a viable layer that hopefully will avoid the development of adhesions between the bowel and the mesh. The drawback to this technique is that its sutures, compared with those of the sandwich technique, are weaker because the bites of tissue are not equivalent to those of large mattress sutures that penetrate the entire abdominal wall. With this method only the peritoneum of the hernial sac is sutured to cover the

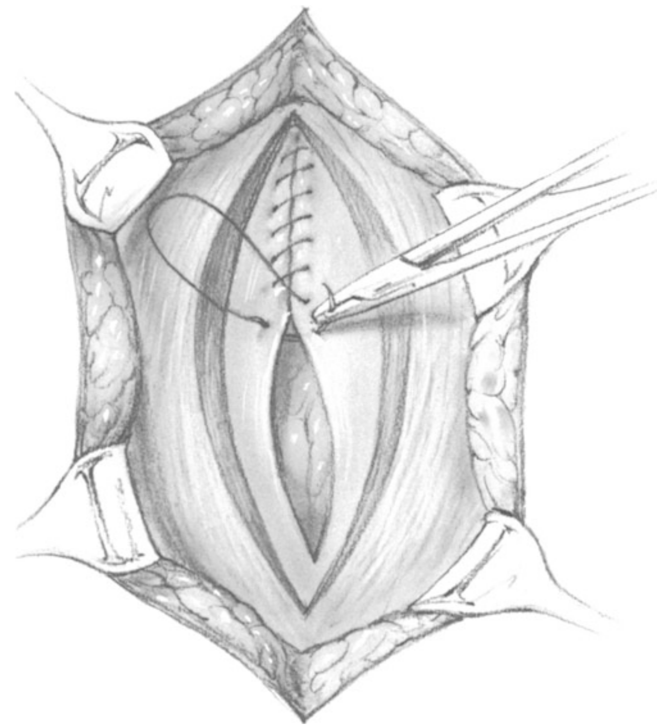


Fig. 85–12

defect. Then a piece of Prolene mesh is cut, 2–3 cm larger on all sides than the diameter of the hernial defect. The first stitch of 0 Prolene starts at the caudal margin of the defect and catches the edge of the hernial ring. Tie the stitch and then proceed with a continuous stitch fixing the mesh to the dense fibrous tissue at the margin of the hernial defect. When the cephalad edge of the hernial defect is reached, insert a second stitch and tie it. Anchor the first stitch by tying it to the tail of the second one. The second stitch runs in a continuous fashion along the opposite margin of the hernia and is terminated at the caudal edge of the hernial defect.

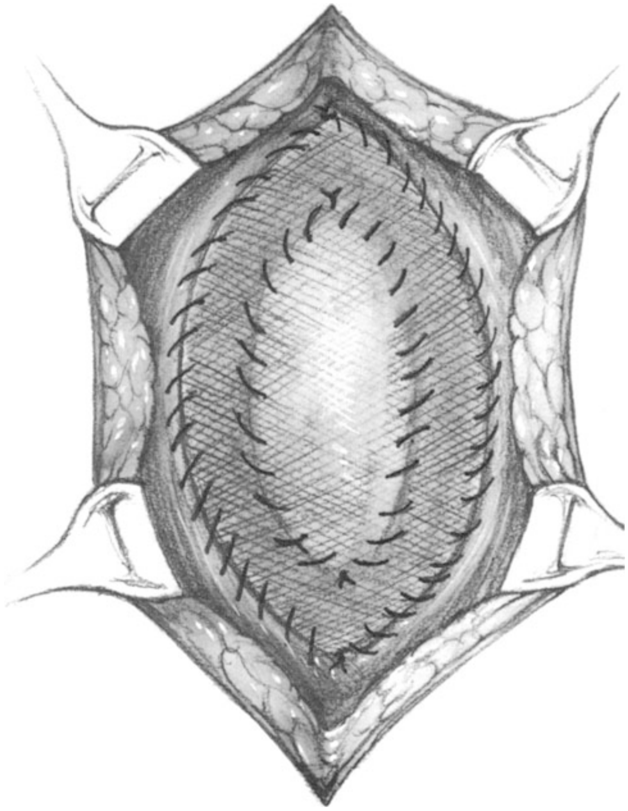


Fig. 85–13A

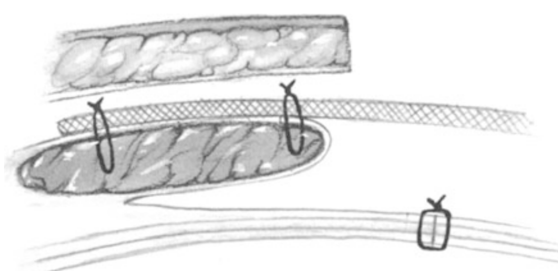


Fig. 85–13B

Using a similar technique, stitch the *edge* of the mesh to the anterior layer of muscle fascia in a continuous fashion, using atraumatic 2–0 Prolene in **Figs. 85–13a and 85–13b**.

Insert a closed-suction catheter through a puncture wound and close the skin in routine fashion.

Postoperative Care

Remove the suction drains 5–7 days following operation.

Give perioperative antibiotics.

Institute early ambulation promptly on recovery from anesthesia.

Postoperative Complications

Wound Infection

With proper precautions wound infection should be rare following the elective repair of a ventral hernia. If an infection of the subcutaneous wound does occur, it is not generally necessary to remove the mesh. Because of its monofilament nature, polypropylene mesh with monofilament Prolene sutures will resist infection if the skin incision is promptly opened widely for drainage. Change the moist gauze packing daily until clean granulations have formed over the mesh. Then permit the skin to heal by secondary intention.

Hematoma

Most hematomas, unless large, can be treated expectantly.

References

Berliner S. Personal communication.

Blomstedt B, Welin-Berger T. Incisional hernias. Acta Chir Scand 1972;138:275.

Cerise EJ, Busuttil RW, Craighead CC et al. The use of Mersilene mesh in repair of abdominal wall hernias: a clinical and experimental study. Ann Surg 1975;181: 728.

Connolly DP, Perri FR. Giant hernias managed by pneumoperitoneum. JAMA 1969;209:71.

Forrest J. Repair of massive inguinal hernia with pneumoperitoneum and without using prosthetic mesh. Arch Surg 1979;114:1087.

Goligher JC, Irvin TT, Johnston D et al. A controlled clinical trial of three methods of closure of laparotomy wounds. Br J Surg 1975;62:823.

Jenkins TPN. The burst abdominal wound—a mechanical approach. Br J Surg 1976;63:873.

Mathes SJ, Nahai F. Clinical atlas of muscle and musculocutaneous flaps. St. Louis: Mosby; 1979.

Moreno IG. Chronic eventrations and large hernias: preoperative treatment by progressive pneumoperitoneum. Surgery 1947;22:945.

Ponka JL. Hernias of the abdominal wall. Philadelphia: Saunders; 1980, p. 393.

Steichen FM. A simple method for establishing, maintaining, and regulating surgically induced pneumoperitoneum in preparation for large hernia repairs. Surgery 1965;58:1031.

Stone HH, Fabian TC, Turkleson ML et al. Management of acute full-thickness losses of the abdominal wall. Ann Surg 1981;193:612.

Usher FC. The surgeon at work: the repair of incisional and inguinal hernias. Surg Gynecol Obstet 1970;131:525.

Wantz GE. Atlas of hernia surgery. New York: Raven Press; 1991.

86 Operations for Necrotizing Infections of Abdominal Wall and Infected Abdominal Wound Dehiscence

Concept: Diagnosis and Management of Necrotizing Fasciitis

Necrotizing fasciitis that involves the *superficial fascia* of the abdominal wall produces necrosis primarily of the dead subcutaneous fat. The appearance of the overlying skin may be deceptively normal. A small area of apparent skin necrosis may be accompanied by an extensive (5–10 cm) area of necrotic subcutaneous fat. The underlying musculoaponeurotic layer often remains intact. The bacterial organisms are generally beta-hemolytic streptococci, staphylococci, or Gram-negative rods combined with anaerobes. Therapy requires the prompt excision of all of the dead subcutaneous fat and overlying skin until the surgeon encounters subcutaneous fat and skin that bleeds upon being incised. Take multiple samples of tissue and/or pus for culture and immediate Gram's stain studies. Aitken, Mackett, and Smith advise serial studies of muscle compartment pressures (wick catheter, Sorensen Research Co., Sandy, Ohio) in patients with necrotizing diseases of the extremities. Elevated compartmental pressure recordings constitute an indication for fasciotomy, biopsy, and debridement.

A more dangerous problem is the necrotizing soft tissue infection that attacks the fascia or the aponeurosis overlying the abdominal muscles (Dellinger). The infection in these cases may result in necrosis of the full thickness of the abdominal wall. While this type of necrotizing fasciitis may occur after some type of trauma, it is more often seen in the patient who has had several laparotomies for peritonitis or abdominal abscesses. Often the patient has a deficient immune mechanism or is diabetic. The first manifestations of necrotizing fasciitis in these patients may be moderate edema of the previous laparotomy wound and (perhaps) a small area of skin necrosis. This is followed by liquefaction of the fascia of the abdominal wall and dehiscence of the abdominal incision.

If detected in its early stages, the infection may be aborted prior to dehiscence of the abdominal incision by removing all of the skin sutures, opening the skin widely, debriding all of the necrotic tissues, and administering appropriate systemic antibiotics. If the patient's previous incision was closed with through-and-through retention sutures, which included the skin within the confines of the stitches, then these retention sutures must be removed without hesitation in the treatment of necrotizing fasciitis, despite the likelihood of causing a wound dehiscence.

Preoperative Care

Administer therapeutic doses of systemic intravenous antibiotics that are effective against Gram-negative rods, enterococci, and anaerobes, including the clostridia, until definitive bacterial cultures and sensitivity studies are available. This will require an aminoglycoside, ampicillin or penicillin, and clindamycin (or metronidazole or chloramphenicol). Third- and fourth-generation cephalosporins may also prove effective in these cases.

Since intra-abdominal sepsis is a frequent companion, if not the cause, of the necrotizing infection, many of these patients will require total parenteral nutrition.

Perform an abdominal CT scan to identify any abdominal sepsis.

Nasogastric suction

In the elderly and the critically ill patient, monitor the fluid requirements and cardiorespiratory function by means of pulmonary artery pressures, cardiac output determinations, and frequent blood gas determinations.

Pitfalls and Danger Points

Inadequate debridement of devitalized tissue

Failure to identify and drain intra-abdominal abscesses

Operative Strategy

Wide Debridement

Unhesitatingly cut away all devitalized tissue and continue the scalpel dissection until bleeding is encountered from the cut edge of the tissue. If even a small remnant of devitalized fat or other tissue is left, there will be a haven for the bacteria to proliferate and to destroy more of the abdominal wall.

Managing the Abdominal Wall Defect

If there is a small defect, less than 4–6 cm in diameter, simply place a layer of Adaptic gauze over the defect and cover it with moist gauze packing. Change the moist gauze twice a day until granulation tissue has covered the exposed abdominal viscera. Then the granulation tissue can be covered with a split-thickness skin graft. The resulting incisional hernia can be repaired at a time of election after the patient has made a complete recovery.

Do not, under any condition, try to achieve closure of the defect by suturing the edges together after debriding an area of myonecrosis. If you do, infection and liquefaction of the abdominal wall is very likely to recur. Stone, Fabian, Turkelson et al. found that out of 13 patients managed by debridement and primary closure *under tension*, dehiscence of the abdominal wound occurred in each case. The mortality rate in this group was 85%.

After debriding an infected abdominal wound that leaves a defect of more than 4–6 cm in diameter, replace the defect with a sheet of Prolene mesh. Do not use the same technique that has been described in Chap. 85 for the elective repair of large ventral hernias since this method consumes more operating time. Use one of the simpler techniques described below to suture a single layer of Prolene mesh to the edges of the wound by means of an interrupted or continuous suture of 2–0 Prolene. Apply daily dressings of moist saline gauze over the mesh until clean granulation tissue has formed. Some surgeons elect to apply a split-thickness graft to the granulating surface. Voyles, Richardson, Bland, and others found that in nine cases where split-thickness grafts were applied over Marlex mesh, in each case the mesh eventually extruded. Prolene mesh appears to be preferable in this respect (Stone et al.).

Alternatively, after the wound is clean and granulation tissue has formed, one may remove the Prolene mesh. Then apply a split-thickness graft directly to the granulation tissue overlying the intestinal viscera. This will provide a temporary cover until an elective repair of the massive abdominal defect can be performed after the patient has completely recovered and after any intestinal stomas have been closed. This may require a waiting period of 4–6 months. The eventual definitive repair may consist of a myocutaneous graft, such as the tensor fasciae latea flap. Alternatively, after excising the split-thickness graft, the large abdominal hernia may be repaired with Prolene mesh. The mesh should then be covered by skin and subcutaneous fat. If an adequate layer of skin cannot be dissected from the area adjacent to the hernial defect, a large pedicle skin flap of some type should be rotated to provide a permanent cover for the mesh.

Repeat Laparotomy for Recurrence of Abdominal Sepsis

After successfully debriding an infected abdominal incision and repairing the defect with Prolene mesh, subsequent clinical observation may disclose the necessity to reexplore the abdomen for recurrent sepsis between the loops of small bowel, the pelvis, the subhepatic or subphrenic spaces, or elsewhere. If necessary, it is generally simple to make an incision through the Prolene mesh, perform the abdominal exploration, and then repair the mesh with a continuous 2–0 Prolene suture. Stone and associates noted that adhesions between bowel and Prolene mesh were much less marked than when Marlex mesh was used. In some cases, where Marlex has been used and a layer of omentum has not been interposed between the mesh and the intestines, dense adhesions have formed between the small bowel and the Marlex mesh. When a patient who suffers from this condition requires laparotomy, entering the abdomen in the vicinity of the Marlex mesh may prove to be impossible without *extensive* damage to the bowel.

In some cases, placing the patient in a face-down position will encourage drainage of abdominal infections through the pores of the mesh.

Management of Intestinal Stomas and Fistulas

When a patient who is taken to the operating room for debridement of an infected abdominal incision also requires the exteriorization of an intestinal fistula or requires a colostomy, do not perform a loop colostomy or a loop enterostomy. Ostomies of the loop type are difficult to control. Consequently, secretions from these stomas will tend to contaminate continuously the layer of mesh and the open abdominal wound. Preferably, create matured end stomas of the small bowel or colon and bring them out at sites well away from the open abdominal wound if at all possible.

Operative Technique

In surgery for large abdominal defects that remain after wide debridement of infected abdominal incisions, we do not recommend the technique described in Chap. 85. In order to expedite the operation in these acutely ill patients, we prefer to use a single layer of Prolene mesh. Cut the mesh so that it is only 1 cm larger than the size of the abdominal defect. Be certain that all intra-abdominal abscesses have been evacuated. Make an attempt to place a layer of omentum between the mesh and the underlying bowel. In no case should a bowel *anastomosis* ever be left in contact with synthetic mesh. Then use atraumatic sutures of 2–0 Prolene to attach the cut end of the mesh to the undersurface of the abdominal wall. In most cases continuous sutures may be employed. The technique described either by Markgraf (**Fig. 86–1**) or that of Boyd (**Fig. 86–2**) may be used. In both cases, take a larger bite of abdominal wall than of the mesh. Otherwise the mesh will wrinkle. Apply slight tension to the mesh in inserting these sutures so that it will lie as flat as possible. Markgraf made the recommendation that when inserting sutures into the abdominal wall below the semicircular line, it is helpful to insert the suture through the entire thickness of the rectus muscle including the *anterior* rectus fascia. Otherwise the muscle and peritoneum may have inadequate holding power.

After the mesh has been sutured in place, apply gauze packing moistened with isotonic saline. In some cases, it may be appropriate to moisten the gauze with an antibiotic solution for the first 24 hours after debriding the wound.

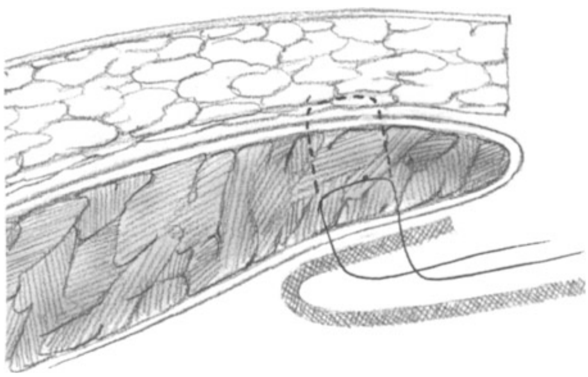


Fig. 86–1

Postoperative Care

Continue therapeutic dosages of appropriate antibiotics.

Change the gauze packing over the mesh every 8–12 hours until it is ascertained that there has been no extension of the necrotizing infection.

Thereafter, inspect the wound and change the dressing daily.

Observe the patient carefully for recurrent abdominal sepsis and take appropriate diagnostic, therapeutic, and surgical measures to correct this sepsis.

After the wound is clean and granulation has formed, it is possible, if the defect is small, that epithelization may proceed spontaneously. In most cases, as abdominal distention disappears, wrinkling of the mesh will preclude spontaneous healing. In these cases, remove the mesh when the wound is clean and the patient's condition has stabilized, preferably around the 20th postoperative day. Then apply a split-thickness graft over the granulations covering the intestinal viscera. Delay definitive repair of a large abdominal hernia until a later date. (See the discussion above under Operative Strategy.)

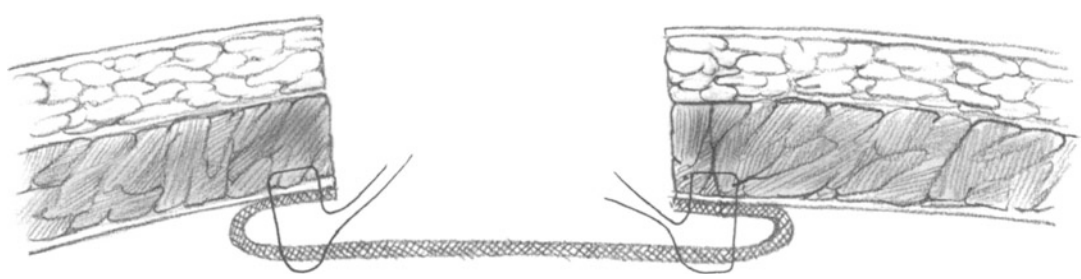


Fig. 86–2

References

Aitken DR, Mackett MCT, Smith LL. The changing pattern of hemolytic streptococcal gangrene. Arch Surg 1982;117:561.

Boyd WC. Use of Marlex mesh in acute loss of the abdominal wall due to infection. Surg Gynecol Obstet 1977;144:251.

Dellinger EP. Severe necrotizing soft-tissue infections: multiple disease entities requiring a common approach. JAMA 1981;246:1717.

Markgraf WH. Abdominal wound dehiscence: a technique for repair with Marlex mesh. Arch Surg 1972;105:728.

Stone HH, Fabian TC, Turkelson ML et al. Management of acute full-thickness losses of the abdominal wall. Ann Surg 1981;193:612.

Voyles CR, Richardson JD, Bland KI et al. Emergency abdominal wall reconstruction with polypropylene mesh: short-term benefits versus long-term complications. Ann Surg 1981;194:219.

Anus and Rectum

87 Rubber Band Ligation of Internal Hemorrhoids

Concept: When to Band a Hemorrhoid

Hemorrhoids, although extremely common, require treatment only when they are symptomatic. Symptoms consist of bleeding, discomfort due to protrusion, and pain generally due to thrombosis. Although painful thrombosis most often occurs in external hemorrhoids, the source of symptoms in most patients is the internal hemorrhoid. Surgical treatment for most cases of symptomatic internal hemorrhoids can be carried out in the office without anesthesia by utilizing rubber band ligation, by injecting sclerosing solution, or by applying cryosurgery. This last method, however, produces an excessive amount of drainage during the postoperative period, and because it has no compensating advantages, it is rarely used at the present time. If the proper guidelines are followed in the technique of rubber band ligation, this technique achieves satisfactory results over the long term in more cases than does the injection of sclerosing solution. The modern method of rubber band ligation was introduced by Barron. It involves the application of a strangulating rubber band ligature to an internal hemorrhoid, with the rubber band being placed above the mucocutaneous junction to avoid grasping sensory nerve endings. Nivatvongs and Goldberg point out that a hemorrhoid is caused by downward displacement of the anal cushion. Therefore, they advocate applying the rubber band to the redundant rectal mucosa above the hemorrhoid rather than to the hemorrhoid itself. When the banded segment of mucosa shrivels up into fibrous tissue, the hemorrhoid is eliminated. This method has the advantage of avoiding the sensitive tissues at the dentate line and thus minimizing pain. Alexander-Williams and Crapp experienced excellent results with this technique. This method is suitable for most patients with second-degree, and for many with third-degree, hemorrhoids.

When a patient's complaints are due to the prolapse of large hemorrhoidal masses of the combined external-internal type or when the neck of an internal hemorrhoid proves to be painful if pinched by a forceps, rubber band ligation is contraindicated. For large third-degree hemorrhoids, surgical excision may be necessary. For the smaller bleeding internal hemorrhoid that seems to be supplied with nerve endings or for the patient who is extremely apprehensive, then either injection with a sclerosing solution or surgery is the preferred procedure.

Rudd encountered only two patients in 1,000 who could not be treated by rubber band ligation. These two had extremely large external hemorrhoids. Rudd claims that his patients experienced recurrence of hemorrhoids in less than 4% of cases after banding.

Indication

Symptomatic (often bleeding) internal hemorrhoids situated above the area in the anal canal that is innervated by sensory nerves.

Pitfall and Danger Point

Applying a rubber band in an area supplied by sensory nerves

Operative Strategy

In order to avoid postoperative pain, apply the rubber band to a point at least *5–6 mm above the dentate line*. In some patients a margin of 5–6 mm is not sufficient to avoid pain. These patients can be identified by pinching the mucosa at the site of the proposed application of the band by using the curved Allis tissue forceps supplied with the McGivney rubber band applicator. If the patient has pain when the mucosa is pinched, apply the band at a higher level where the mucosa is not sensitive, or else abandon the rubber-banding procedure.

If the patient has severe pain after the rubber band has been applied, it is possible to remove the rubber band by using a fine-tipped forceps and a sharp pointed scissors. If the removal of the rubber band is attempted some hours after the application, the surrounding edema will often make this procedure difficult if not impossible without anesthesia and without causing bleeding.

Operative Technique

Perform sigmoidoscopy to rule out other possible sources of rectal bleeding.

With the patient in the knee-chest position, insert a fenestrated anoscope (e.g., Hinkel-James type) that permits the internal hemorrhoid to protrude into the lumen of the anoscope. Inspect the circumference of the anal canal. Try to identify the hemorrhoid that caused the bleeding. If this is not possible, identify the largest internal hemorrhoid. Insert the curved Allis tissue forceps into the anoscope and pinch the mucosa around the base of the hemorrhoid in order to identify an insensitive area. Ask the assistant to hold the anoscope in a steady position. Now inspect the McGivney rubber band applicator. Be sure that two rubber bands have been inserted into their proper position on the drum of the applicator. Ask the patient to strain. With the left hand pass the drum up to the *proximal* portion of the hemorrhoid. Insert the angled tissue forceps through the drum.

In grasping the rectal mucosa, be sure to grasp it along the cephalad surface of the hemorrhoid at point A, not point B, in **Fig. 87–1**. If this is done, then the rubber band will not encroach upon the sensitive tissue at the dentate line. Draw the mucosa into the drum, which is simultaneously pressed against the wall of the rectum (**Fig. 87–2**). When the McGivney applicator is in the proper position, compress the handle of the applicator. Remove the tissue forceps and the McGivney applicator from the anoscope. The result should be a round purple mass of hemorrhoid, about the size of a cherry, strangulated by the two rubber bands at its base.

Tchirkow, Haas, and Fox have recommended injecting 1–2 ml of a local anesthetic (we use 0.25% bupivacaine or lidocaine with epinephrine 1:200,000), using a 25-gauge needle, into the banded hemorrhoid. This appears to lessen some of the postoperative discomfort and may accelerate sloughing of the strangulated mass.

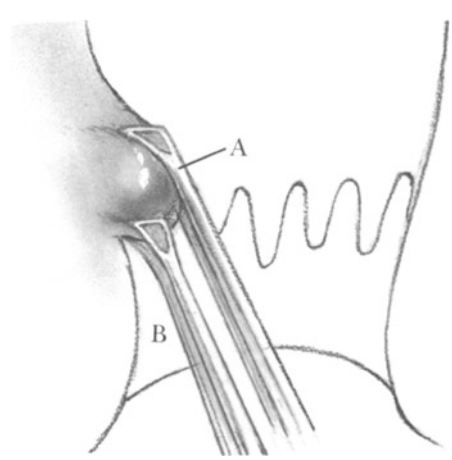


Fig. 87–1

When employing the method advocated by Nivatvongs and Goldberg, insert the slotted anoscope and ask the patient to strain. The redundant rectal mucosa just *proximal to the hemorrhoid* will bulge into the slot of the anoscope. Grasp this mucosa with the tissue forceps. Draw the tissue into the McGivney ligator and release the rubber bands.

In general, treat only one hemorrhoid at each office visit. Have the patient return in about 3 weeks for the second application. Rarely are more than 3 applications necessary. Applying 2 or 3 bands at one sitting will often cause significant discomfort.

Postoperative Care

Inform the patient that postoperatively he or she may feel a vague discomfort in the area of the rectum accompanied by mild tenesmus, especially for 1–2 days after the procedure. Mild analgesic medication should be prescribed. Apprehensive patients do well if this medication is supplemented by a tranquilizer like diazepam.

Also warn the patient prior to the procedure that on rare occasions sometime between the 7th and 10th postoperative day, when the slough separates, there may be active bleeding into the rectum. A serious degree of bleeding requiring hospitalization occurs in no more than 1%–2% of cases.

Prescribe a stool softener like Colace. For constipated patients, Senokot-S, 2 tablets nightly, constitutes a medication that helps to keep the stool soft and also stimulates colonic peristalsis.

Patients may return to their regular occupation if they so desire.

Postoperative Complications

Sepsis. Even though tens of thousands of patients have undergone hemorrhoid banding safely, there are reports in the literature of 9 cases of serious postoperative pelvirectal sepsis, of whom 5 died (Clay et al. O'Hara; Russell and Donohue; Shemesh et al.). The typical patient suffering postbanding sepsis complains of rectal pain and urinary retention on the 3rd or 4th postoperative day. Physical examination and leucocyte count at this time may be normal. Blood cultures in all 9 cases were found to be normal. In the next day or two edema of the rectum, the perineum, or the lower abdominal wall may develop. These findings can be confirmed by a CT scan.

Proctoscopic examination at this stage demonstrates marked edema of the rectum and necrosis at the sites of banding; fever and leucocytosis are also notable at this time and death is not far off. At autopsy, marked rectal and pelvic edema, sometimes phlegmonous, is common, occasionally accompanied by a small rectal or pelvic abscess. Shemesh et al. theorized that, following band ligation, transmural ischemic necrosis of the tissue enclosed in the band allowed egress of bowel bacteria into the surrounding pelvic soft tissues.

Although the blood cultures were all negative in the reported cases, postmortem bacterial cultures revealed coliform bacteria and, in one case, *Clostridium perfringens*, *Clostridium sporogenes*, and *Bacteroides* (O'Hara).

It is essential to recognize that all the patients who survived this complication were treated as soon as they presented with pain and urinary symptoms. Intensive and early treatment with intravenous antibiotics aimed at clostridia, other anaerobes, and Gram-negative rods is essential to preserve life in these patients. Patients who undergo banding must be told that if they experience urinary symptoms, fever, or pain 1 to 4 days after the procedure they must promptly return to the surgeon for hospital admission in order to receive immediate antibiotic treatment, even if physical signs at that time are negligible.

Pain. If *severe* pain occurs upon application of the band, remove the band promptly before the patient leaves the office. A *mild* degree of vague discomfort is treated with medication.

Bleeding. If the patient sustains a mild degree of blood spotting in the stool when the slough separates a week or 10 days after the banding, this may be treated expectantly. In case of a major bleed, proctoscope the patient. Suction out all the clots. Identify the bleeding point. If there is a significant amount of blood in the rectum or the patient has lost more than a few hundred milliliters, admit the patient to the hospital. In some cases, the bleeding point may be grasped with the Allis tissue forceps and a rubber band again applied to this area. Alternatively, under general or local anesthesia, either use the electrocoagulator or a suture to control the bleeding.

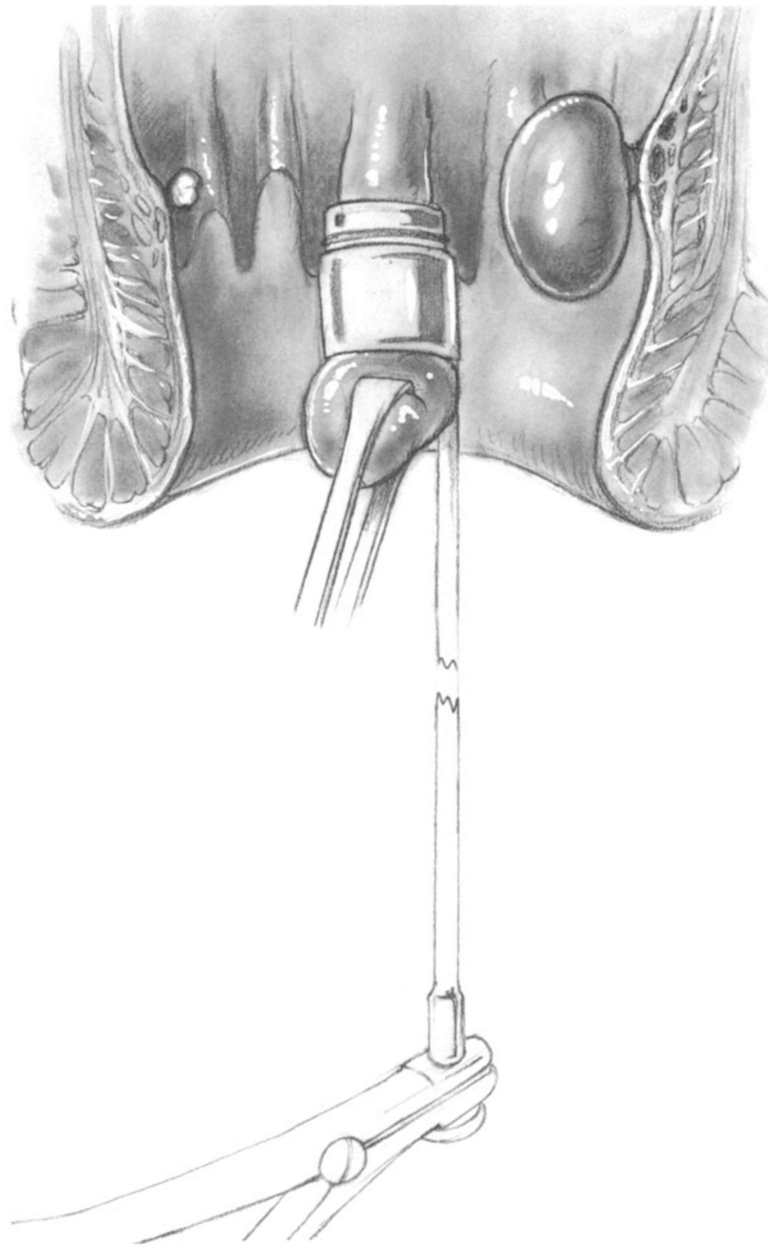


Fig. 87–2

References

Alexander-Williams J, Crapp AR. Conservative management of hemorrhoids. I. Injection, freezing and ligation. Clin Gastroenterol 1975;4:595.

Barron J. Office ligation treatment of hemorrhoids. Dis Colon Rectum 1963;6:109.

Clay LD III, White JJ Jr, Davidson JT et al. Early recognition and successful management of pelvic cellulitis following hemorrhoidal banding. Dis Colon Rectum 1986;29:579–581.

O'Hara VS. Fatal clostridial infection following hemorrhoidal banding. Dis Colon Rectum 1980;23:570–571.

Rudd WWH. Ligation of hemorrhoids as an office procedure. Can Med Assoc J 1973;108:56.

Russell TR, Donohue JH. Hemorrhoidal banding: a warning. Dis Colon Rectum 1985;28:291–293.

Shemesh EI, Kodner IJ, Fry RD et al. Severe complication of rubber band ligation of internal hemorrhoids. Dis Colon Rectum 1987;30:199–200.

Tchirkow G, Haas PA, Fox TA Jr. Injection of a local anesthetic solution into hemorrhoidal bundle following rubber band ligation. Dis Colon Rectum 1982;25:62.

Nivatvongs S, Goldberg SM. An improved technique of rubber band ligation of hemorrhoids. Am J Surg 1982; 144:379.

88 Hemorrhoidectomy

Concept: Selecting the Appropriate Treatment for Symptomatic Hemorrhoids

Hemorrhoids are known to have afflicted mankind for centuries, yet their pathogenesis remains obscure. Histologically, hemorrhoids do not differ significantly from normal anorectal submucosa; they resemble cushions of thickened submucosa. These cushions contain a vascular complex that includes arteriovenous communications. The submucosal cushions are normally located, even in children, in the left midlateral, the right anterolateral, and the right posterolateral positions in the anal canal. Thomson postulated that hemorrhoids represent normal anal submucosal cushions that, for some reason, have been displaced in a downward direction. The cause of this displacement may be constipation combined with chronic straining during defecation, although proof for this hypothesis is lacking.

The mere presence of nonsymptomatic hemorrhoids, internal or external, on routine physical examination cannot be considered a pathological finding. Treatment for nonsymptomatic hemorrhoids is not indicated. Hemorrhoids are best identified on physical examination by using an anoscope that has an opening on one side. This opening will permit a hemorrhoidal mass to protrude into the opening as the anoscope is rotated.

Bleeding, discomfort, and protrusion are the symptoms caused by hemorrhoids. Severe pain is not a symptom caused by hemorrhoids unless there has been an acute thrombosis. More commonly, painful defecation is due to an anal fissure. Persistent protrusion of a hemorrhoid accompanied by continuous discharge of mucus may cause excoriation of the perianal skin, resulting in chronic discomfort. Medical management of these symptoms should aim to correct chronic constipation and strain on defecation by adding unprocessed bran to the patient's diet to increase the bulk of the stool while simultaneously softening it. Hydrophilic laxatives like psyllium seed (Metamucil) are also helpful in this regard. When this type of management fails, some manipulative therapy is indicated. For the bleeding internal hemorrhoid that is situated above the dentate line and is not supplied with sensory nerves that carry pain impulses, the rubber band technique is an excellent choice (Chap. 87). It can be carried out as an office procedure without anesthesia. If the neck of the hemorrhoid is innervated by pain fibers, and the hemorrhoid can be classified as first or second degree in severity, it may be treated by the submucosal injection of 2–3 ml of a sclerosing solution like 5% phenol in oil. This is injected just proximal to each of the three usual locations of the internal hemorrhoidal masses near the anorectal ring (the proximal margin of the anal canal where the puborectalis muscle is situated). Injecting the sclerosing solution at these three sites presumably thromboses the hemorrhoidal veins and produces submucosal fibrosis that fixes the mucosa to the underlying internal sphincter muscle. Bleeding from small, nonprotruding hemorrhoids is almost always controlled by this technique, one which is very popular in Great Britain. Be sure to inject into the submucosal plane, as an injection into the mucosa will produce necrosis. For the majority of internal hemorrhoids, we prefer the rubber band ligation technique. However, be sure to take note of the complications of this method described in Chap. 87.

For first, second, and early third-degree bleeding internal hemorrhoids, we have also experienced excellent results with the Infrared Coagulator (Redfield). This device is applied circumferentially around a group of internal hemorrhoids as if to create a circle of "spot welds."

External hemorrhoids do not cause symptoms except in the case of acute thrombosis. In this situation, if the patient presents within 24–48 hours of the onset of symptoms, excision of the thrombosed hemorrhoid under local infiltration anesthesia may result in prompt relief of symptoms. In general, if the patient reports to the physician later in the course of this disease, local surgery is not effective in relieving pain. In these cases, conservative management with analgesic medication and the local application of moist heat appears to give results equally satisfactory as excisional therapy.

When a symptomatic hemorrhoid appears to be innervated by sensory nerves, the patient generally has combined internal and external hemorrhoids.

Often this is a large second- or third-degree hemorrhoidal mass. If symptoms persist, a formal hemorrhoidectomy may be required for relief. When a large protruding hemorrhoidal mass develops acute thrombosis, spasm of the internal sphincter muscle often results, which may produce strangulation necrosis of the hemorrhoidal mass. In previous years, it was feared that excisional surgery for strangulated hemorrhoids might introduce sepsis into the portal venous system and that, consequently, emergency hemorrhoidectomy was contraindicated for strangulated hemorrhoids. It has since been shown that prompt hemorrhoidectomy for strangulated hemorrhoids produces rapid relief of symptoms and is followed by a smooth postoperative course.

A widely adopted technique of hemorrhoidectomy was introduced at St. Mark's Hospital, London, by Miles and modified by Milligan and Morgan in 1934 (see Goligher). This method involves the dissection of each of the three major hemorrhoidal masses off the internal sphincter muscle, followed by transfixion of the hemorrhoidal "pedicle" with a suture-ligature. The hemorrhoid is excised distal to the ligature. The defect in the anoderm and rectal mucosa is not reapproximated by suturing. Various modifications of this technique are in widespread use. Properly performed, open hemorrhoidectomy gives highly satisfactory results although several weeks are necessary before the wound is completely healed. It is *essential* that a bridge of undisturbed anoderm be left intact between each of the three hemorrhoid excisions. Otherwise, anal stenosis is likely to occur.

In a "closed" hemorrhoidectomy, the defect in the mucosa and anoderm is closed with sutures in a technique first popularized by Ferguson and Heaton and more recently by Goldberg, Gordon, and Nivatvongs. In this technique, only narrow widths of anoderm and mucosa are excised, and the hemorrhoidal tissue is dissected from underneath the adjacent mucosa whenever necessary. In this fashion, sufficient tissue has been retained to permit primary suturing of the hemorrhoidectomy incisions without narrowing the anus or rectum. Advocates of this technique claim that the patients have less postoperative pain, more rapid healing, and a smoother postoperative course with less anal stenosis. In fact, many of these hemorrhoidectomy suture lines separate during the postoperative period and heal by secondary intention. Nevertheless, it appears that following closed hemorrhoidectomy, total time elapsed between the operation and complete healing is generally less than following open hemorrhoidectomy. Properly performed, either the open or the closed method gives satisfactory results (Goligher).

It must be emphasized that the vast majority of patients with symptomatic hemorrhoids can be managed by an office procedure (see Chap. 87) without anesthesia or surgery. The few patients who require surgery have large, prolapsing hemorrhoids with a large component of external hemorrhoids. This advanced stage of disease is often accompanied by what appears to be a circumferential prolapse of anoderm and rectal mucosa together with the hemorrhoids. The usual methods of hemorrhoidectomy do not efficiently correct the pathology in those patients who have a circumferential mucosal prolapse. For this group of patients we have employed the modified open method of hemorrhoidectomy described below.

In Great Britain, surgeons perform hemorrhoidectomy under general anesthesia in the lithotomy position, often supplementing the general anesthesia with a local block to achieve better relaxation of the sphincter muscles. In the United States, the prone position with the hips elevated on a rolled-up sheet or sandbag has achieved well-deserved popularity. Hemostasis is easier to achieve because the blood flows away from the field by gravity. Also, the surgeon and his first assistant can assume positions that allow for much greater operative efficiency than can be achieved when the patient is placed in the lithotomy position. With the patient lying prone, general anesthesia requires endotracheal intubation. Using exclusively local anesthesia for hemorrhoidectomy has the disadvantage that the initial injection of the anesthetizing agent is followed by considerable pain. Consequently, general anesthesia with endotracheal intubation, followed by local perianal anesthesia, has been recommended by Goldberg and associates for hemorrhoidectomy and similar anal canal operations.

Nivatvongs has recently described a technique for local anesthesia that will avoid the pain of the initial injection and therefore preclude the necessity for general anesthesia. We have found this method to be simple and effective. We use local anesthesia almost always for hemorrhoidectomy. Muscle relaxation is excellent, bleeding is decreased by incorporating epinephrine 1:200,000 in the anesthetic agent, and the duration of pain relief can be prolonged by selecting a long-acting agent.

Indications and Contraindications

Persistent bleeding, protrusion, or discomfort

Symptomatic second- and third-degree (combined internal-external) hemorrhoids

Symptomatic hemorrhoids combined with mucosal prolapse

Strangulation of internal hemorrhoids

Early stage of acute thrombosis of external hemorrhoid

Preoperative Care

A sodium phosphate packaged enema (Fleet) is adequate cleansing for most patients.

Sigmoidoscopy and/or colonoscopy as indicated by the patient's symptoms

Routine preoperative blood coagulation profile (partial thromboplastin time, prothrombin time, and platelet count)

Preoperative shaving of the perianal area is preferred by some surgeons, but is not necessary.

Pitfalls and Danger Points

Narrowing the lumen of the anus and thus inducing anal stenosis

Trauma to sphincter

Failing to identify associated pathology (e.g., inflammatory bowel disease, leukemia, portal hypertension, coagulopathy, or squamous carcinoma of anus)

Operative Strategy

Avoiding Anal Stenosis

The most serious error in performing hemorrhoidectomy is the failure to leave adequate bridges of mucosa and anoderm between each site of hemorrhoid excision. If a minimum of 1.0–1.5 cm of viable anoderm is left intact between each site of hemorrhoid resection, there need be no fear of the patient developing postoperative anal stenosis. Preserving viable anoderm is much more important than is the removal of all external hemorrhoids and redundant skin.

One method of preventing anal stenosis is to insert a large anal retractor like the Fansler or large Ferguson after resecting the hemorrhoids. Now if you can suture the incisions in the mucosa and anoderm ("closed hemorrhoidectomy") with the retractor in place, there is scant danger that anal stenosis will occur.

Achieving Hemostasis

Traditionally, surgeons have depended on mass ligature of the hemorrhoid "pedicle" for achieving hemostasis. This policy ignores the fact that small arteries penetrate the internal sphincter and enter the operative field. Also numerous vessels are divided when incising the mucosa to dissect the pedicle. In fact, the concept of a "pedicle" as being the source of a hemorrhoidal mass is largely erroneous. A hemorrhoidal mass is not a varicose vein situated at the termination of the portal venous system. It is, indeed, a vascular complex with multiple channels that is not fed predominantly by a large single vessel in the pedicle. Therefore it is important to control bleeding from each of the many vessels that are transected during the operation. A convenient method of accomplishing this is with careful and accurate application of the coagulating electrocautery. As pointed out by Goldberg and associates, most of the vessels come from the incised mucosa. Before suturing the defect following hemorrhoid excision, perfect hemostasis should be achieved.

Associated Pathology

Even though hemorrhoidectomy is a minor operation, a complete history and physical examination are necessary to rule out important systemic diseases like leukemia. Leukemic infiltrates in the rectum can cause severe pain and can mimic hemorrhoids and anal ulcers. Operating erroneously on an undiagnosed acute leukemia patient is fraught with the dangers of bleeding, failure of healing, and sepsis. Crohn's disease must also be ruled out by careful local examination and sigmoidoscopy, as well as biopsy in doubtful situations.

Another extremely important condition, which is sometimes overlooked during the course of hemorrhoidectomy, is squamous cell carcinoma of the anus. This may resemble nothing more than a small ulceration on what appears to be a hemorrhoid. Any suspected hemorrhoid that demonstrates a break in the continuity of the overlying mucosa should be suspected of being a carcinoma, as should any ulcer of the anoderm, except for the classical anal fissure located in the posterior commissure. Prior to scheduling a hemorrhoidectomy, biopsy all ulcerations and atypical lesions of the anal canal.

Operative Technique—Closed Hemorrhoidectomy

Local Anesthesia

Choosing an Anesthetic Agent

A solution of 0.5% lidocaine (maximum dosage 80 ml) or 0.25% bupivacaine (maximum dosage 80 ml), combined with epinephrine 1:200,000 and 150–300 units of hyaluronidase, is an anesthetic agent that is effective and has an extremely low incidence of toxicity.

Since the perianal injection of these agents is painful, the patient is generally premedicated with an intramuscular injection 1 hour before the operation of some combination of a narcotic and a seda-

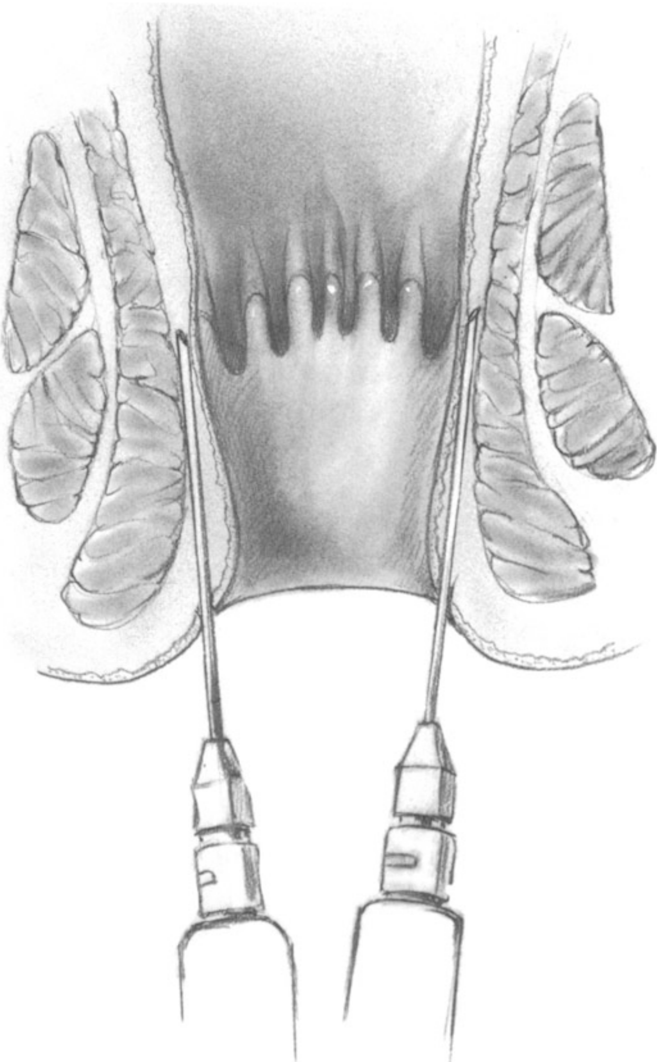


Fig. 88-1

tive (e.g., Demerol and a barbiturate, or Innovar, 1-2 ml). Alternatively, diazepam in a dose of 5-10 mg, may be given intravenously just before the perianal injection.

Techniques of Local Anesthesia

In the technique originally introduced by Kratzer, the anesthetic agent is placed in a syringe with a 25-gauge needle. The needle should be at least 5 cm in length. Initiate the injection at a point 2-3 cm lateral to the middle of the anus. Inject 10-15 ml of the solution in the *subcutaneous* tissues surrounding the right half of the anal canal including the area of the anoderm at the anal verge. Warn the patient that this injection may be quite painful. Repeat this maneuver through a needle puncture site to the left of the anal canal. After placing a slotted anoscope in the anal canal, insert the needle into the tissues just beneath the anoderm and into the plane between the submucosa and the internal sphincter 3-4 cm deep into the anal canal (**Fig. 88-1**). If the injection creates a wheal in the mucosa similar to that seen in the skin after an intradermal injection, then the needle is in too shallow a position. An injection into the proper submucosal plane will produce no visible change in the overlying mucosa. Inject 3-4 ml of anesthetic solution in the course of withdrawing the needle. Make similar injections in each of the four quadrants until the subdermal and submucosal tissues of the anal canal have been surrounded with anesthetic agent. This should require a total of no more than 30-40 ml of anesthetic solution. Satisfactory relaxation of the sphincters will be achieved without the necessity of directly injecting solution into the muscles or of attempting to block the inferior hemorrhoidal nerve in the ischiorectal space. Wait 5-10 minutes for complete relaxation and anesthesia.

Nivatvongs in 1982, described a technique that avoids pain. Insert a small anoscope into the anal canal. Make the first injection into the *submucosal* plane 2 mm *above* the dentate line. Since the mucosa above the dentate line lacks sensory innervation, this step is free of pain, unlike the initial injection of the Kratzer technique of inducing local anesthesia. Inject 2-3 ml of anesthetic solution. Inject an equal amount of solution in each of the remaining three quadrants of the anus. Then remove the anoscope and insert a well-lubricated index finger into the anal canal. Use the tip of the index finger to massage the anesthetic agent from the submucosal area down into the tissues beneath the anoderm. Repeat this maneuver with respect to each of the four injection sites. By spreading the anesthetic agent distally, this maneuver will serve to anesthetize the very sensitive tissues of the anoderm just distal to the dentate line. When this has been accomplished, make another series of injections 2 mm *distal* to the dentate line. Inject 2-3 ml of solution beneath the anoderm and the subcutaneous tissues in the perianal region through four sites, one in each quadrant of the anus. Then use the index finger again to massage the tissues of the anal canal in order to spread the anesthetic solution circumferentially around the anal and perianal area. In some cases additional anesthetic agent may be necessary for complete circumferential anesthesia. An average of 20-25 ml of solution is required. Nivatvongs states that this technique will provide excellent relaxation of the sphincters and permit operations like hemorrhoidectomy to be accomplished without general anesthesia. For a lateral internal sphincterotomy, it is not necessary to anesthetize the entire circumference of the anal canal when using this technique. Inject only the area of the sphincterotomy.

Intravenous Fluids

Since local anesthesia has a minimum of systemic effects, it is not necessary to administer a large volume of intravenous fluid during the operation. In fact, if large volumes of fluid are administered during a hemorrhoidectomy or even during an inguinal hernia repair, the bladder becomes rapidly distended. In the presence of general anesthesia or even heavy sedation during local anesthesia, the patient is not sufficiently alert to have the desire to void. By the time the patient is alert, the bladder muscle has been stretched and may be too weak to empty the bladder, especially if the patient also has some degree of prostatic hypertrophy. This can be the cause of postoperative urinary retention, requiring catheterization. All of this can be prevented by avoiding general anesthesia and heavy premedication and, in addition, by limiting the dosage of intravenous fluids to 100–200 ml during and after hemorrhoidectomy.

Positioning the Patient

We prefer to place the patient in the semiprone jacknife position with either a sandbag or rolled-up sheet under the hips and a small pillow to support the feet. It is not necessary to shave the perianal area; if the buttocks are hirsute, shave this area. Then apply tincture of benzoin. When this solution has dried, apply wide adhesive tape to the buttock and attach the other end of the adhesive strap to the operating table. In this fashion lateral traction is applied to each buttock, affording excellent exposure of the anus.

Incision and Dissection

Gently dilate the anal canal so that it admits two fingers. Insert a bivalve speculum like the Parks retractor or a medium size Hill-Ferguson retractor. One advantage of using the medium Hill-Ferguson retractor is that it approximates the diameter of the normal anal canal. If the defects remaining in the mucosa and anoderm can be sutured closed with the retractor in place following hemorrhoid excision, then no narrowing of the anal canal will occur. By rotating the retractor and applying countertraction to the skin of the opposite wall of the anal canal, each of the hemorrhoidal masses can be identified. Generally three hemorrhoidal complexes will be excised, one in the left midlateral position, another in the right anterolateral, and the third in the right posterolateral location. Avoid placing incisions in the anterior or posterior commissures. Grasp the most dependent portion of the largest hemorrhoidal mass in a Babcock clamp. Then make an incision in the anoderm outlining the distal extremity of

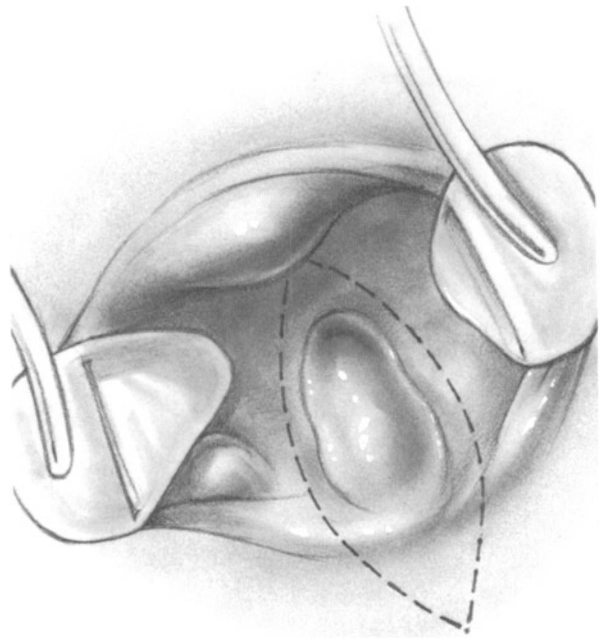


Fig. 88–2

the hemorrhoid (**Fig. 88–2**) using a No. 15 (Bard-Parker) scalpel. If the hemorrhoidal mass is unusually broad (more than 1.5 cm), do not excise all of the anoderm and mucosa overlying a hemorrhoid of this type. If each of the hemorrhoidal masses is equally broad, excising all of the anoderm and mucosa overlying each of the hemorrhoids will result in inadequate tissue bridges between the sites of hemorrhoid excision. In such a case, incise the mucosa and anoderm overlying the hemorrhoid in an elliptical fashion. Then initiate a submucosal dissection using small, pointed scissors to elevate the mocosa and anoderm from that portion of the hemorrhoid that still remains in a submucosal location. Carry the dissection of the hemorrhoidal

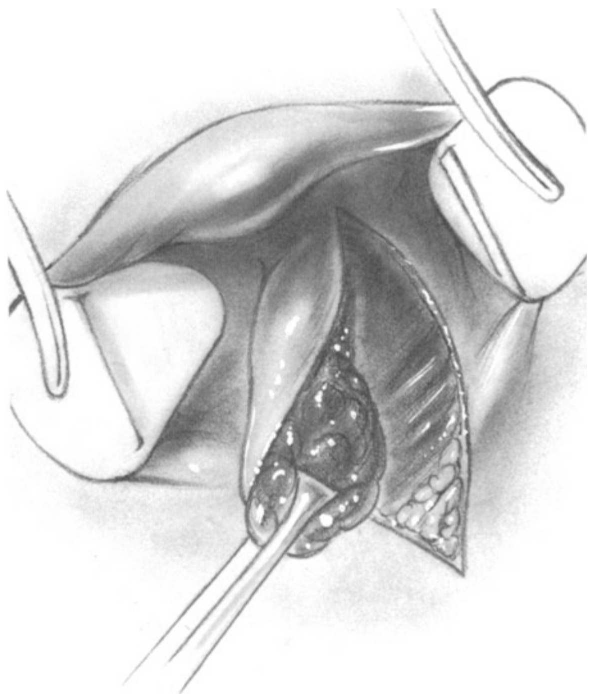


Fig. 88–3

mass down to the internal sphincter muscle (**Fig. 88–3**). After incising the mucosa and anoderm, draw the hemorrhoid away from the sphincter, using blunt dissection as necessary, to demonstrate the lower border of the internal sphincter. This muscle has whitish muscle fibers that run in a transverse direction. A thin bridge of fibrous tissue will often be seen connecting the substance of the hemorrhoid to the internal sphincter. Divide these fibers with a scissors. Dissect the hemorrhoidal mass for a distance of about 1–2 cm above the dentate line where it may be divided with the electrocoagulator (**Fig. 88–4**). Remove any residual internal hemorrhoids from beneath the adjacent mucosa. Achieve complete hemostasis, primarily with careful electrocoagulation. It is not necessary to clamp and suture the hemorrhoidal "pedicle," but many surgeons prefer to do so (**Fig. 88–5**). Although it is helpful to remove all the internal hemorrhoids, we do not attempt to extract fragments of external hemorrhoids from beneath the anoderm as this step does not appear to be necessary. Most of these small external hemorrhoids will disappear spontaneously following internal hemorrhoidectomy.

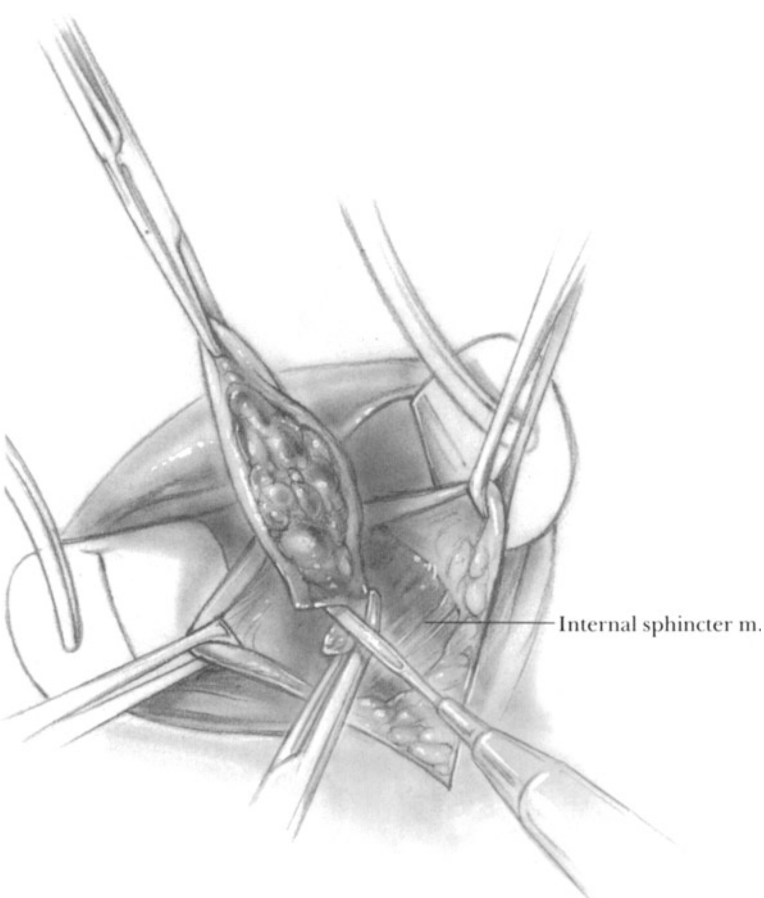


Fig. 88–4

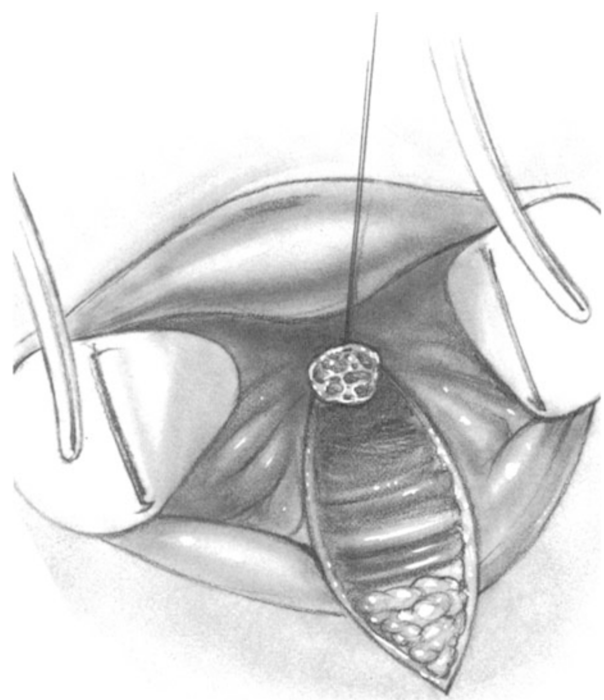


Fig. 88–5

After complete hemostasis has been achieved, insert an atraumatic 5–0 Vicryl suture into the apex of the hemorrhoidal defect. Tie the suture and then close the defect with a continuous suture taking

2–3 mm bites of mucosa on each side (**Fig. 88–6**). Also include a small bit of the underlying internal sphincter muscle with each pass of the needle. This will serve to force the mucosa to adhere to the underlying muscle layer and thereby help prevent mucosal prolapse and recurrent hemorrhoids. Continue the suture line until the entire defect has been closed.

Now repeat the same dissection for each of the other two hemorrhoidal masses. Close each of the mucosal defects by the same technique (**Fig. 88–7**). Be certain not to constrict the lumen of the anal canal. The rectal lumen should admit a Fansler or a large Ferguson rectal retractor after the suturing is completed. To avoid anal stenosis remember that the ellipse of mucosa–anoderm, which is excised with each hemorrhoidal mass, must be relatively narrow. Also, remember that if the tissues are sutured under tension, the suture line will undoubtedly break down.

A few patients prior to surgery will suffer some degree of anal stenosis together with their hemorrhoids. Under these conditions, rather than forcibly dilating the anal canal at the onset of the operation, perform a lateral internal sphincterotomy to provide adequate exposure for the operation. This is also true for patients who have a concomitant chronic anal fissure.

For those surgeons who prefer to keep the skin unsutured for drainage, it is possible to modify the above operative procedure by discontinuing the mucosal suture line at the dentate line, thereby leaving the defect in the anoderm unsutured. It is also permissible not to suture the mucosal defects at all after hemorrhoidectomy (see above).

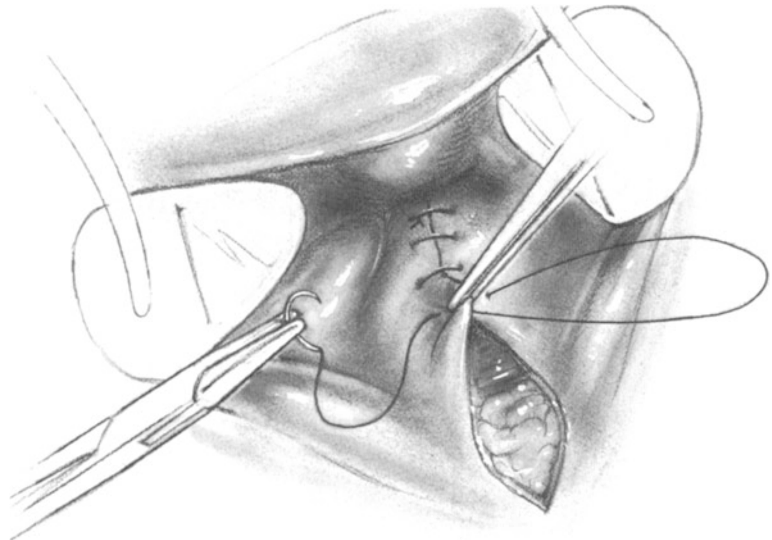


Fig. 88–6

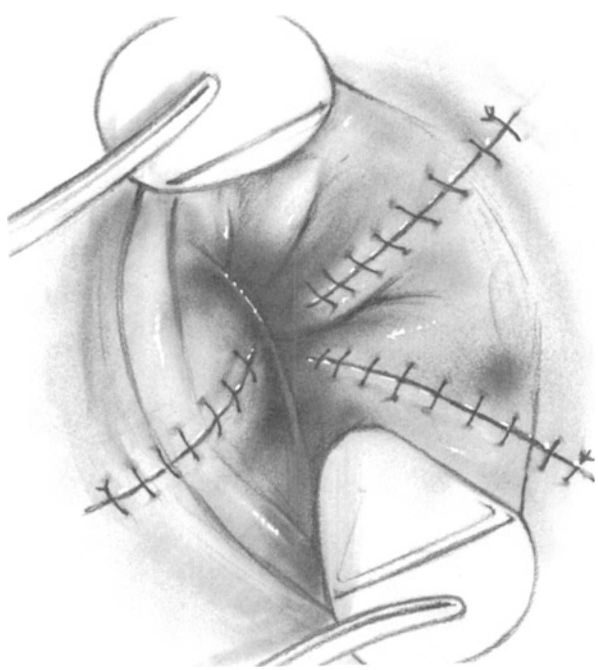


Fig. 88–7

Operative Technique—Radical Open Hemorrhoidectomy

Incision

This operation is restricted to patients who no longer have three discrete hemorrhoidal masses, but in whom all of the hemorrhoids and prolapsing rectal mucosa seem to have coalesced into an almost circumferential mucosal prolapse. For these patients the operation will excise the hemorrhoids, both internal and external, the redundant anoderm, and prolapsed mucosa from both the left and right lateral portions of the anus, leaving 1.5-cm bridges of intact mucosa and anoderm at the anterior and posterior commissures. With the patient in the prone position, as described above for the closed hemorrhoidectomy,

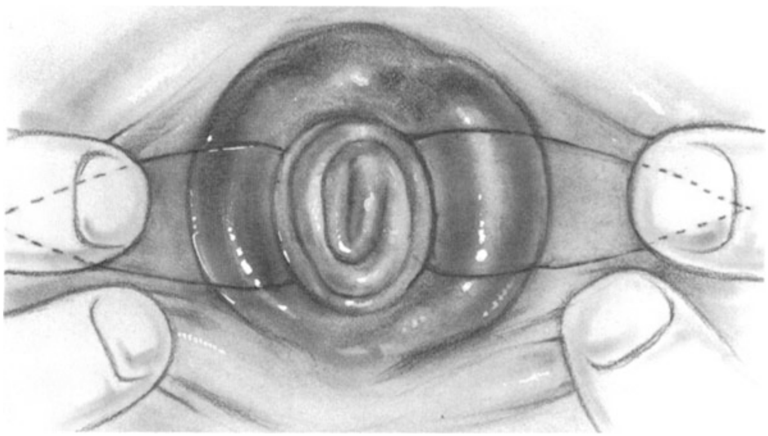


Fig. 88–8

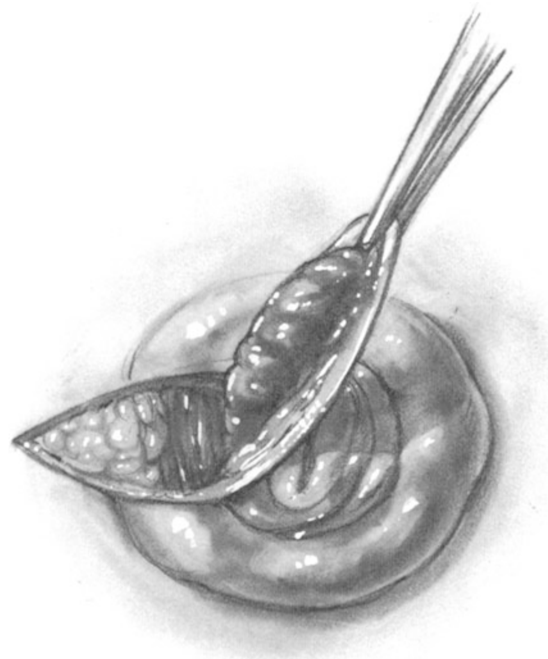


Fig. 88–9

outline the incision on both sides of the anus as shown in **Fig. 88–8**.

Excising the Hemorrhoidal Masses

Elevate the skin flap together with the underlying hemorrhoids by sharp and blunt dissection until the lower border of the internal sphincter muscle has been unroofed (**Fig. 88–9**). This muscle can be identified by the transverse whitish fibers. Now elevate the anoderm above and below the incision in order to enucleate adjacent hemorrhoids that have not been included in the initial dissection (**Fig. 88–10**). This will permit the removal of almost all the hemorrhoids and still permit an adequate bridge of anoderm in the anterior and posterior commissures.

After the mass of hemorrhoidal tissue with overlying mucosa has been mobilized to the level of the normal location of the dentate line, amputate the mucosa and hemorrhoids with the electrocoagulator at the level of the dentate line. This will leave a free

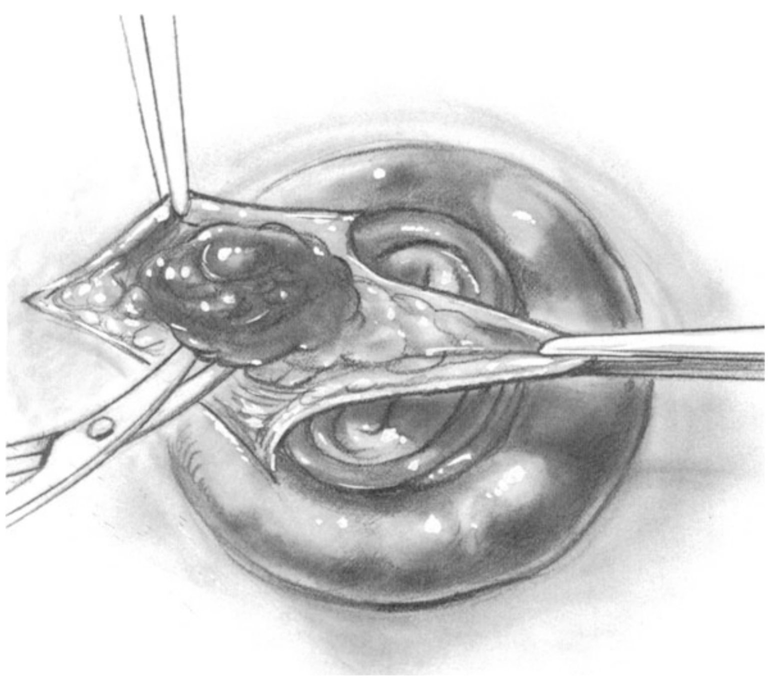


Fig. 88–10

edge of rectal mucosa. Suture this mucosa to the underlying internal sphincter muscle with a continuous 5–0 atraumatic Vicryl suture as illustrated in **Fig. 88–11**. This will recreate the dentate line at its normal location. Do not bring the rectal mucosa down to the area that is normally covered by anoderm or skin, because this will cause continuous secretion of mucous that will irritate the perianal skin.

Execute the same dissection to remove all of the hemorrhoidal tissue between 1 and 5 o'clock on the right side and reattach the free cut edge of rectal mucosa to the underlying internal sphincter muscle as depicted in **Fig. 88–12**. There may be some redundant anoderm together with some external hemorrhoids at the anterior or the posterior commissure of the anus. Do not attempt to remove every last bit of external hemorrhoid because this will jeopardize the viability of the anoderm in the commissures. Unless viable bridges, about 1.5 cm each in width, are preserved in the anterior and posterior commissures, the danger of a postoperative anal stenosis far outweighs the ill effect of leaving behind a skin tag or an occasional external hemorrhoid.

Be certain that hemostasis is complete, using the electrocoagulator and occasional suture-ligatures of fine PG or chromic catgut. Then insert into the anus a small piece of rolled up Gelfoam. This roll should not be more than 1 cm in thickness. It will serve to apply gentle pressure and will encourage coagulation of minor bleeding points that may have been overlooked. The Gelfoam need not be removed since it will dissolve when the patient starts having his sitz baths postoperatively. Apply a sterile dressing to the perianal area.

Anal packing with anything more substantial than the 1-cm roll of soft Gelfoam is rarely necessary, as hemostasis with the electrocoagulator should be meticulous. Large gauze or other rigid packs are associated with increased postoperative pain and urinary retention.

Postoperative Care

Encourage ambulation the day of operation.

Prescribe analgesic medication preferably of a nonconstipating type like Darvocet.

Prescribe Senokot-S, Metamucil, or mineral oil while the patient is in the hospital. After discharge, limit the use of cathartics because the passage of a well-formed stool is the best guarantee that the anus will not become stenotic. In patients with severe chronic constipation, the intake of dietary bran and some type of laxative or stool softener will be necessary following discharge from the hospital.

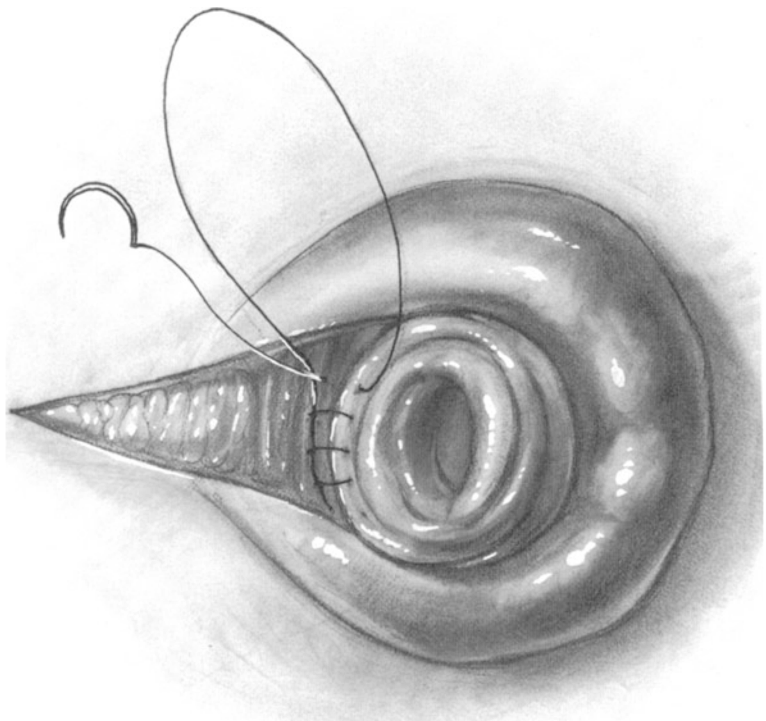


Fig. 88–11

Order warm sitz baths several times a day, especially following each bowel movement.

Discontinue intravenous fluids as soon as the patient returns to his room and initiate a regular diet and oral fluids as desired.

If the patient was hospitalized for the hemorrhoidectomy, he may generally be discharged on the first or second postoperative day. Most patients will tolerate hemorrhoidectomy as ambulatory outpatients.

Postoperative Complications

Serious bleeding during the postoperative period is rare if complete hemostasis has been achieved in the operating room. However, when it does occur, the

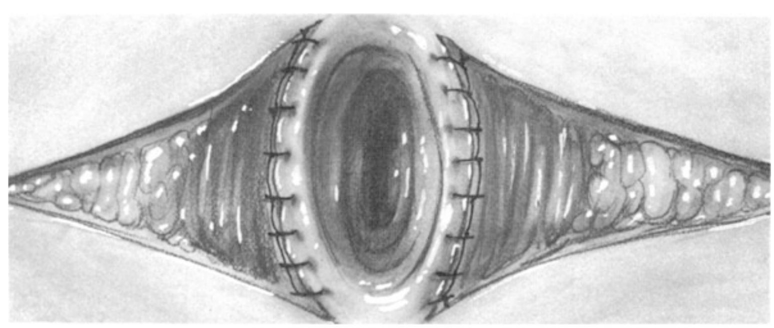


Fig. 88–12

patient should probably be returned to the operating room in order to have the bleeding point suture-ligated, as the majority of patients who experience major bleeding after discharge from the hospital have experienced a minor degree of bleeding before discharge (Buls and Goldberg). About 1% of patients will present with hemorrhage severe enough to require reoperation for hemostasis, generally 8–14 days following operation.

If, for some reason, the patient is not returned to the operating room for the control of bleeding, it is possible to achieve at least temporary control by inserting a 30-ml Foley catheter into the rectum. Then blow up the Foley balloon and apply downward traction to the cathether. Reexploration of the anus for surgical control of bleeding is far preferable.

Infection is rare.

Skin tags follow hemorrhoidectomy in 6%–10% of cases. Although no treatment is required, for cosmetic purposes a skin tag may be excised under local anesthesia as an office procedure when the operative site has healed completely.

References

Buls JG, Goldberg SM. Modern management of hemorrhoids. Surg Clin North Am 1978;58:469.

Ferguson JA, Heaton JR. Closed hemorrhoidectomy. Dis Colon Rectum 1959;2:176.

Goldberg SM, Gordon PH, Nivatvongs S. Essentials of anorectal surgery. Philadelphia: Lippincott; 1980.

Goligher JC. Surgery of the anus, rectum and colon, 4th ed. London: Balliere Tindal; 1980.

Kratzer GL. Improved local anesthesia in anorectal surgery. Am Surg 1974;40:609.

Nivatvongs S. An improved technique of local anesthesia for anorectal surgery. Dis Colon Rectum 1982;25:259.

Thomson WHF. The nature of hemorrhoids. Br J Surg 1975;62:542.

89 Anorectal Fistula and Pelvirectal Abscess

Concept: Pathogenesis and Treatment of Anorectal Fistulas

Anorectal Anatomy

The muscles of the pelvic floor may be thought to assume the anatomical configuration of two cylinders, one within the other. The inner cylinder consists of the lower rectum and anal canal, which contains mucosa and submucosa as well as the circular and the longitudinal muscle layers. In the anal canal the circular muscle layer is very well developed and constitutes the internal sphincter muscle, an involuntary sphincter made up of smooth muscle. The outer cylinder consists of the external sphincter and the puborectalis muscles. At its proximal extremity the outer cylinder fans out in the shape of a funnel since it is continuous with the levator ani muscles that form the pelvic diaphragm. The inner visceral muscle cylinder and the outer somatic cylinder are separated by the intersphincteric space (**Fig. 89–1**). It is striking that in the

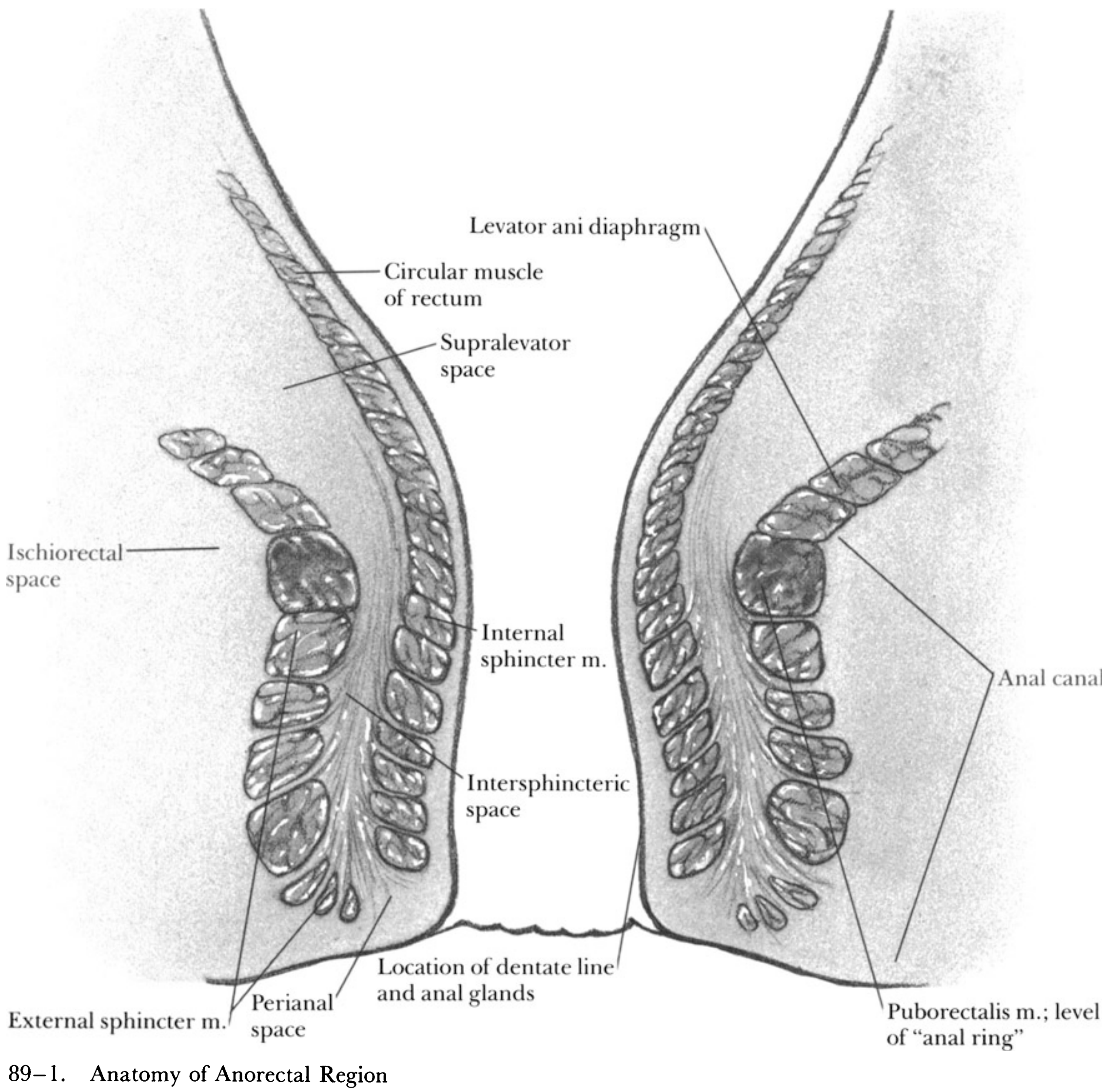


Fig. 89–1. Anatomy of Anorectal Region

course of a low anterior resection, if the surgeon dissects the rectum down to the puborectalis level, it is possible to insert a finger or an instrument along the outer wall of the rectum all the way down to the perianal skin without dividing any structure. This passage takes place in the intersphincteric space external to the internal sphincter muscle and internal to the external sphincter. This fact is important in understanding the spread of infection and the formation of anal fistulas.

Above the levator ani muscle diaphragm is the pararectal or pelvirectal space that is the site of the supralevator abscess. Distal to the levator diaphragm is the ischiorectal space, the location of the common perirectal abscess (see Fig. 89–1).

Normal fecal continence requires, among other elements, the presence of a functional anorectal ring. The anorectal ring consists of the voluntary muscles at the proximal margin of the anal canal, primarily the puborectalis. When an index finger is inserted into the posterior segment of the anal canal, it is easy to identify the anorectal ring because this is the proximal margin of the external sphincter musculature, a point about 4.0–4.5 cm above the anal verge. What the finger is palpating is the proximal margin of the powerful puborectalis sling. If the finger is directed anteriorly, the proximal margin of the anal canal (the anorectal ring) will be more difficult to identify because the puborectalis sling does not encircle the anterior wall of the rectum. Before dividing any portion of the external sphincter muscle during the course of an anal fistulotomy, be certain to leave the proximal portion of this sphincter (anorectal ring) intact. This can be accomplished by inserting a probe into the fistula while the patient is awake with the index finger in the canal. If the internal opening of the fistula is at the midpoint of the anal canal, well below the anorectal ring, complete division of the portion of the internal and external sphincters distal to the midpoint will not be followed by fecal incontinence in most patients. In certain aged individuals, with weakness of the sphincter muscles, division of even half the internal and external sphincters will interfere with normal fecal continence.

Pathogenesis of Anorectal Abscesses and Fistulas

The following discussion of pathogenesis, classification, and treatment of anorectal abscesses and fistulas is based primarily on two excellent reports by Parks, Hardcastle, and Gordon and by Parks and Stitz, as well as the earlier work of Eisenhammer. Anorectal sepsis is believed to arise in the small anal glands situated in the intersphincteric space. These glands have ducts that discharge into the anus at a point close to the mucocutaneous junction or dentate line. After one of these glands has become infected, a small abscess forms in the intersphincteric space at the midpoint of the anal canal. Pus from a chronic intersphincteric abscess may then track in multiple directions to form various types of anal fistulas. A Type 1 fistula develops when the track extends from the intersphincteric abscess down the intersphincteric space to the perianal skin (see Fig. 89–3). In the Type 2 fistula the intersphincteric abscess erodes directly through the external sphincter muscle and the track then continues to the skin of the buttock (see Fig. 89–8). A Type 3 fistula (extremely rare) travels in a proximal direction in the intersphincteric plane, enters the supralevator space, erodes through the levator ani muscle, and continues in a distal direction to the skin of the buttock. Since this fistula encircles the entire external sphincter muscle, Parks calls it a suprasphincteric fistula (see Fig. 89–10).

The Type 4 extrasphincteric fistula (extremely rare) does not arise from an intersphincteric abscess. This type of fistula reaches from the orifice in the skin of the buttock up through the ischiorectal space, through the levator ani muscle, through the supralevator space, and through the wall of the rectum above the levator diaphragm (see Fig. 89–11). Many extrasphincteric fistulas are secondary to trauma, Crohn's proctocolitis, or diverticulitis with perforation and abscess formation.

Parks, Hardcastle, and Gordon summarize the pathogenesis of anal fistula in this fashion.

> The present concept of pathogenesis strongly suggests that both abscess and fistula are one and the same disease: abscess is the acute phase, fistula the chronic . . . the epithelial channel between the anal crypt and intersphincteric gland may become blocked. In this case a fistula in the true sense of the word no longer exists; a sinus is present down to an infected primary (intersphincteric) abscess.

Treatment of Fistulas

Although Eisenhammer proposed that successful treatment of a chronic anal fistula could comprise an incision of the internal sphincter muscle in the region of the intersphincteric abscess, thus presumably eliminating the cause of the fistula, most authorities advocate identifying the site from which the fistula arose and then performing either an excision of the fistulous tract or a fistulotomy. Actually, there is no evidence that it is necessary to excise the infected anal gland that presumably gave rise to the fistula. Simple fistulotomy appears to be curative. Also, there is no data to demonstrate that excising a fistulous tract is more beneficial than simply incising it and laying it open. On the other hand, some patients present with anal pain owing to an *intersphincteric abscess* that has not yet developed into a fistula. After identifying the point of maximal tenderness in these patients, perform an internal sphincterotomy over this point (or the point of fluctuation, if present) to drain the abscess and relieve the patient's symptoms.

When a fistula appears to be suprasphincteric (Type 3) in nature, under no conditions should the surgeon divide the entire external sphincter during the fistulotomy. Since this type of fistula is extremely rare, patients suffering from this condition should be referred to a specialist. One method of management is to lay the fistula open and divide only the distal half of the sphincter mechanism. Then insert a seton of heavy silk into the portion of the tract that goes above the puborectalis muscle. Parks and Stitz left the seton in place an average of 5.4 months in these cases in order to stimulate fibrosis and permit adequate drainage of the supralevator infection. At the end of this period of time, in some cases the seton could be removed and satisfactory healing followed, but in most cases the muscles enclosed in the seton were divided to complete the operation. Most patients maintained good fecal continence after this sequence of procedures.

Parks and associates emphasized that the 400 cases included in their study were not typical of the unselected patients who would appear in the practice of a general surgeon, since many of these patients were specifically referred to the authors because of their acknowledged expertise in this area. They estimated that in an unselected series the following distribution would be more likely: intersphincteric fistulas 70%, transsphincteric 23%, suprasphincteric 5%, and extrasphincteric 2%.

For complex fistulas which would require the division of a large amount of external sphincter and/or puborectalis muscle according to traditional thinking, we have instead closed the internal opening of the fistula by advancing a flap of rectal mucosa and submucosa after draining the pus and removing any epithelialized tracks. It is advisable for most general surgeons to refer these unusual cases to specialists in this area.

Indications

When the diagnosis of an anorectal abscess is made, operation is indicated. There is no role for conservative management because severe sepsis can develop and spread before fluctuation and typical physical findings appear. This is especially true in diabetic patients.

When patients have recurrent or persistent drainage from a perianal fistula, operation is indicated.

Having weak anal sphincter muscles constitutes a relative contraindication to fistulotomy, especially in the unusual cases in which the fistulotomy must be performed through the anterior aspect of the anal canal. In the anterior area of the canal the absence of the puborectalis muscle explains why the sphincter mechanism is already weaker in this location. This category of case is probably better suited for treatment by inserting a seton or by an advancement flap, especially in women.

Preoperative Care

Cathartic the night before operation and saline enema on the morning of operation

Preoperative anoscopy and sigmoidoscopy

Barium colon enema, small bowel X-ray series, or both when Crohn's enteritis or colitis is suspected

Antibiotic coverage if an advancement flap is contemplated

Pitfalls and Danger Points

Failing to diagnose anorectal sepsis and to perform early incision and drainage

Failing to diagnose or to control Crohn's disease

Failing to rule out anorectal tuberculosis or acute leukemia

Inducing fecal incontinence by excessive or incorrect division of the anal sphincter muscles

Operative Strategy

Localizing Fistulous Tracts

Goodsall's Rule

When a fistulous orifice is identified in the perianal skin posterior to a line drawn between 3 o'clock and 9 o'clock, the internal opening of the fistula will almost always be found in the posterior commissure in a crypt approximately at the dentate line. Goodsall's rule also states that if a fistulous tract is identified anterior to the 3 o'clock–9 o'clock line, its internal orifice is likely to be located along the course of a line connecting the orifice of the fistula to an imaginary point exactly in the middle of the anal canal. In other words, a fistula that is draining in the perianal area at 4 o'clock, in a patient lying prone, is likely to have its internal opening situated at the dentate line at 4 o'clock. There are exceptions to this rule. For instance, a horseshoe fistula may drain anterior to the anus but continue in a posterior direction and terminate in the posterior commissure.

If the external fistula opening is more than 3 cm from the anal verge, be suspicious of unusual pathology such as Crohn's disease or tuberculosis.

Physical Examination

First, attempt to palpate the course of the fistula in the perianal area. Frequently the fibrosis along the tract can be identified in this fashion. Second, insert a bivalve speculum into the anus and try to identify the internal opening by gentle probing at the point indicated by Goodsall's rule. If the internal opening is not readily apparent, do not make any false passages. The most accurate method of identifying the direction of the tract is to gently insert a silver probe into the fistula with the index finger in the rectum. In this fashion it may be possible to identify the internal orifice by palpating the probe with the index finger in the anal canal.

Injection of Dye or Radiopaque Material

On rare occasions the injection of a blue dye may help identify the internal orifice of a complicated fistula. Some surgeons have advocated the use of milk or hydrogen peroxide instead of a blue dye. The injection of a radiopaque liquid followed by X-ray studies can be valuable for the extrasphincteric fistulas leading high up into the rectum, but it does not appear to be helpful for the usual type of fistula.

Endorectal sonography and CT scan fistulography have recently been described as improved methods of evaluating complex fistulas.

Preserving Fecal Continence

As mentioned in the discussion above, the puborectalis muscle (anorectal ring) must be functioning normally in order to preserve fecal continence following fistulotomy. It is important to identify this muscle accurately before dividing the anal sphincter muscles during the course of a fistulotomy. Use local anesthesia with sedation or regional anesthesia for the operation of fistulotomy. If the fistulous tract can be identified with a probe *preoperatively*, the surgeon's index finger in the anal canal can identify the anorectal ring without difficulty, especially if the patient is asked to tighten the voluntary sphincter muscles.

If there is any doubt about the identification of the anorectal ring (the proximal portion of the anal canal), then do not complete the fistulotomy but rather insert a heavy silk or braided polyester ligature through the remaining portion of the tract. Tie the ligature loosely with 5–6 knots without completing the fistulotomy. When the patient is examined in the awake state, it will be simple to determine whether the upper border of the seton has encircled the anorectal ring or whether there is sufficient puborectalis muscle (1.5 cm or more) above the seton to complete the fistulotomy by dividing the muscles enclosed in the seton, at a later stage. If no more than half of the external sphincter muscles in the anal canal have been divided, fecal continence should be preserved except in those patients who had a weak sphincter muscle prior to operation.

Fistulotomy versus Fistulectomy

In performing surgery for the cure of an anal fistula, most authorities are satisfied that incising the fistula along its entire length constitutes adequate therapy. Others have advocated the actual excision of the fibrous cylinder that constitutes the fistula, leaving only surrounding fat and muscle tissue behind. The latter technique leaves a larger open wound, which takes much longer to heal. Much more bleeding is encountered during a fistulectomy than a fistulotomy. There is no evidence to indicate that excising the wall of the fistula has any advantages.

Combining Fistulotomy with Drainage of Anorectal Abscess

Some surgeons have advocated, in patients with an acute ischiorectal abscess, that the surgical procedure include a fistulotomy simultaneous with drainage of the abscess. After the pus has been evacuated, a search is first made for the internal opening of the fistulous tract; then the tract is opened. This combination of operations is contraindicated for two reasons. First, 40%–50% of our patients who undergo simple drainage of an abscess never develop a fistula. It is likely that the internal orifice of the anal duct has become occluded before the abscess is treated. These patients do not require a fistulotomy. Second, acute inflammation and edema surrounding the abscess make accurate detection and evaluation of the fistulous tract extremely difficult. There is great likelihood that the surgeon will create false passages that may prove so disabling to the patient that any time saved by combining the drainage operation with a fistulotomy is insignificant.

We presently drain many anorectal abscesses in the office under local anesthesia, in part because this method removes the temptation to add a fistulotomy to the drainage procedure.

Operative Technique—Anorectal and Pelvirectal Abscess

Perianal Abscess

In draining an anorectal abscess, it is important to excise a patch of overlying skin so that the pus will drain freely. Do not depend on packing or indwelling drains, since it is difficult to keep these drains in place unless the patient is at complete rest. The typical perianal abscess is located fairly close to the anus. Treatment consists of excising, often under local anesthesia, an ellipse of overlying skin combined with evacuation of the pus. Generally no indwelling pack is necessary if the bleeding points have been controlled by ligature or electrocoagulation.

Ischiorectal Abscess

The ischiorectal abscess is generally larger than the perianal, develops at a greater distance from the anus, and may be deep seated. Fluctuation on physical examination may be a late sign. Early drainage is indicated. Under general anesthesia, make a cruciate incision over the apex of the inflamed area. Excise enough of the overhanging skin to permit free drainage and evacuate the pus. Explore the abscess for loculations.

Intersphincteric Abscess

Many physicians fail to diagnose an intersphincteric abscess until the abscess ruptures into the ischiorectal space and forms an ischiorectal abscess. A patient who complains of persistent anal pain should be suspected of harboring an intersphincteric abscess. This is especially true if, on inspecting the anus with the buttocks spread apart, the physician can rule out the presence of an anal fissure. In order to confirm the idagnosis of an intersphincteric abscess, examination under anesthesia may be necessary, although digital exmination in the unanesthetized patient may indicate at which point in the anal canal the abscess is located. Parks and Thomson found that 61% of the intersphincteric abscesses occurred in the posterior quadrant of the anal canal. In half their patients a small mass could be palpated in the anal canal with the index finger inside the canal and the thumb just outside. Occasionally an internal opening that is draining a few drops of pus can be identified near the dentate line. Rarely, a patient may have both an anal fissure and an intersphincteric abscess.

Under a local or general anesthesia, carefully palpate the anal canal. Then insert a bivalve speculum and inspect the circumference of the anus to identify a possible fissure or an internal opening of the intersphincteric abscess. After identifying the point on the circumference of the anal canal that is the site of the abscess, perform an internal sphincterotomy by the same technique as described in Chap. 90 for an anal fissure. Place the internal sphincterotomy directly over the site of the intersphincteric abscess. Explore the cavity, which is generally small, with the index finger. If the abscess has been properly unroofed, simply reexamine the area daily with an index finger for the first week or so postoperatively. Uneventful healing can be anticipated unless the abscess has already penetrated the external sphincter muscle and created an undetected extension in the ischiorectal space.

Pelvirectal Supralevator Abscess

An abscess above the levator diaphragm is manifested by pain (gluteal and perineal), fever, and leucocytosis; it often occurs in patients with diabetes or other illnesses. Pus can appear in the supralevator space by extension upward from an intersphincteric fistula, by penetration through the levator diaphragm of a transsphincteric fistula, or by direct extension from an abscess in the rectosigmoid area. When there is obvious infection in the ischiorectal fossa, secondary to a *transsphincteric* fistula, as manifested by local induration and tenderness, make an incision at the dependent point of the ischiorectal infection (**Fig. 89–2**). Make the incision large

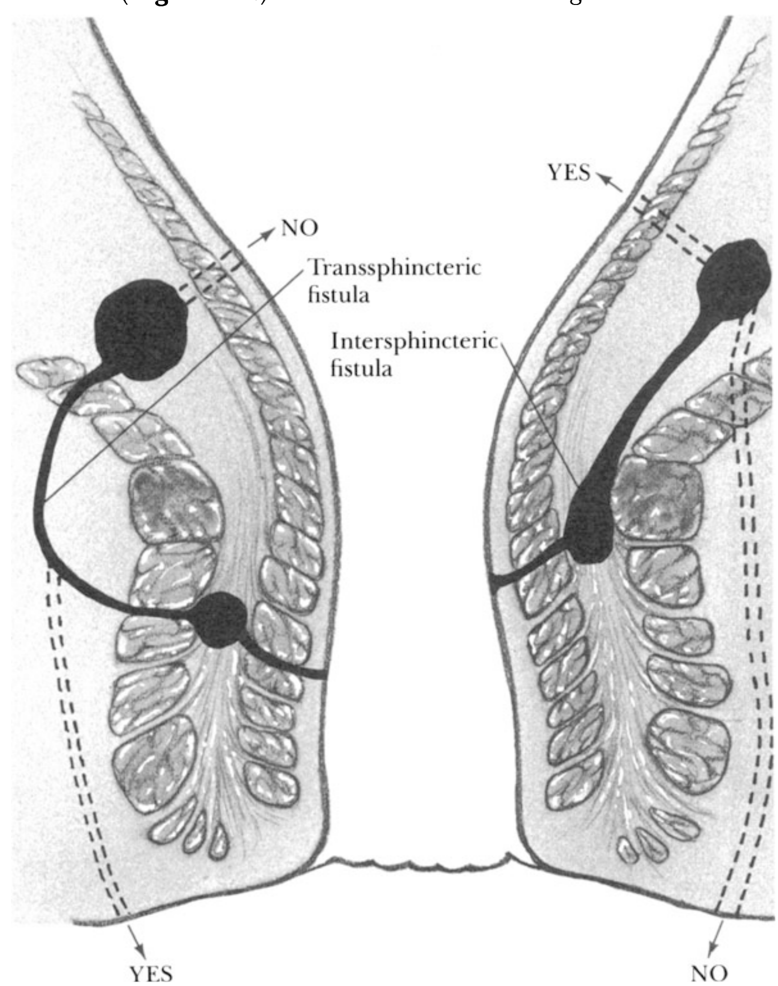


Fig. 89–2

enough to explore the area with the index finger. It may be necessary to incise the levator diaphragm from below and to enlarge this opening with a long Kelly hemostat in order to provide adequate drainage of the supralevator abscess. After thoroughly irrigating the area, insert gauze packing.

In those pelvirectal abscesses arising from an *intersphincteric* fistula, one will often be able to palpate the fluctuant abscess by inserting the index finger high up in the rectum. Under general anesthesia, aspirate the region of fluctuation. If pus is obtained, make an incision in the rectum with the electrocautery and drain the abscess through the rectum (Goldberg, Gordon, and Nivatvongs) (see Fig. 89–2).

Under no condition should one drain a supralevator abscess through the rectum if the abscess has its origin in an *ischiorectal* space infection (see Fig. 89–9). This error may result in a high extrasphincteric fistula. Similarly, if the supralevator sepsis has arisen from an intersphincteric abscess, draining the supralevator infection through the ischiorectal fossa also leads to a high extrasphincteric fistula, and this error should also be avoided (see Fig. 89–6).

Operative Technique—Anorectal Fistula

Intersphincteric Fistula

Simple Low Fistula

When dealing with an unselected patient population, simple low fistula occurs in perhaps half of all patients presenting with anorectal fistulas. Here

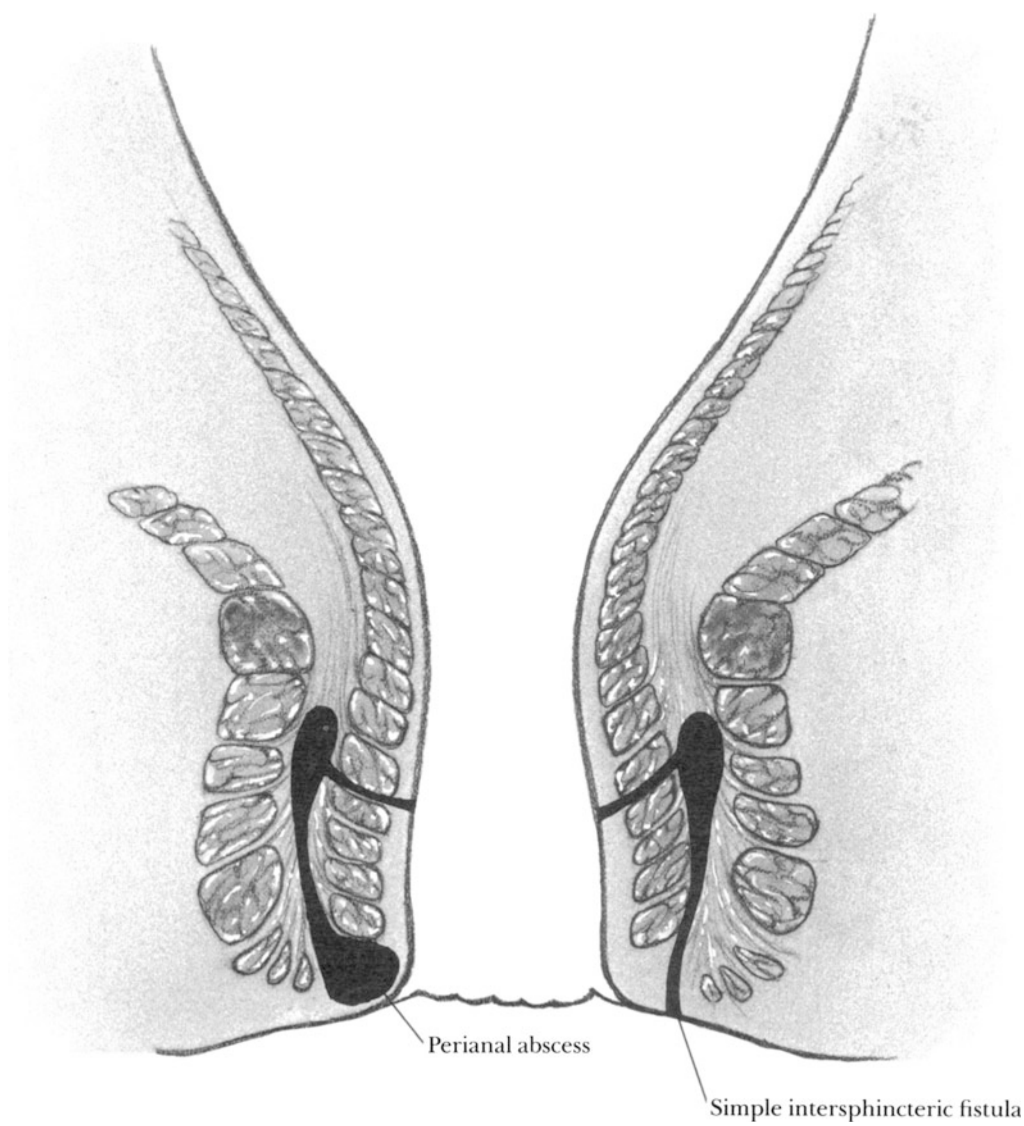


Fig. 89–3

the infected anal gland burrows distally in the intersphincteric space to form either a perianal abscess or a perianal fistula as illustrated in **Fig. 89–3**. Performing a fistulotomy in this type of case requires only the division of the internal sphincter and overlying anoderm up to the internal orifice of the fistula approximately at the dentate line. This will divide the distal half of the internal sphincter, rarely producing any permanent disturbance of function.

High Blind Track (Rare)

In this type of fistula the midanal infection burrows in a cephalad direction between the circular internal sphincter and the longitudinal muscle fibers of the upper canal and lower rectal wall to form a small *intramural* abscess above the levator diaphragm (**Fig. 89–4**). This abscess can be palpated by digital examination. The infection will probably heal if the primary focus is drained by excising a 1 cm × 1 cm square of internal sphincter at the site of the internal orifice of this "fistula." Parks, Hardcastle, and Gordon state that even if the entire internal sphincter is divided in laying open this high blind track by opening the internal sphincter from the internal orifice of the track to the upper extension of the track, little disturbance of continence will develop because the edges of the sphincter are held together by the fibrosis produced as the track develops.

High Track Opening into Rectum (Rare)

In this type of fistula, a probe inserted into the internal orifice will continue upward between the internal sphincter and the longitudinal muscle of the rectum. The probe will open into the rectum at the upper end of the fistula (see Fig. 89–4). If the surgeon recognizes, by palpating the probe, that this fistula is quite superficial and is located deep only to

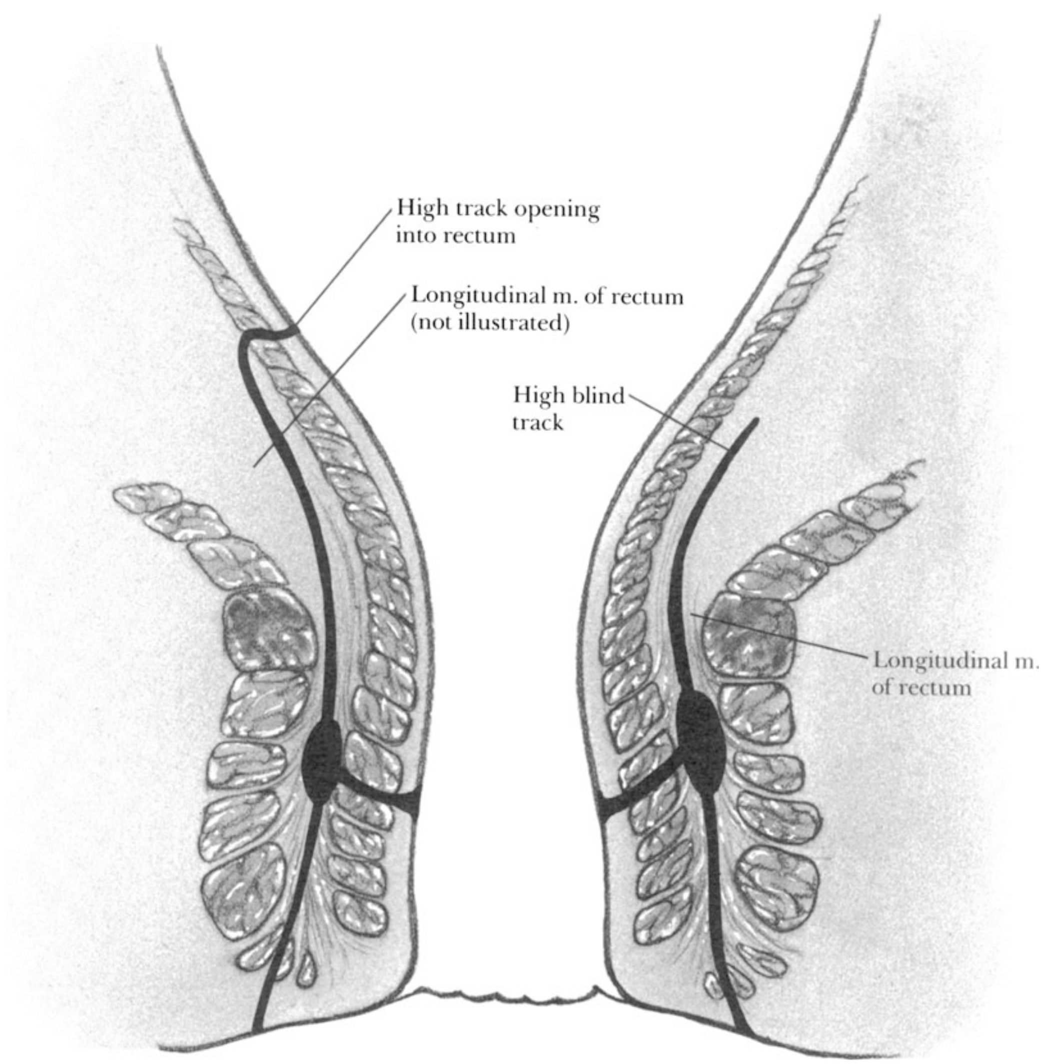


Fig. 89–4. High Intersphincteric Fistulas

the circular muscle layer, the tissue overlying the probe can be laid open without risk. On the other hand, if the probe does in fact go deep to the *external* sphincter muscle prior to reentering the rectum (see Fig. 89–11) this constitutes a type of extrasphincteric fistula, one which is extremely difficult to manage (see below). If the surgeon has any doubt about the true nature of this type of fistula, the patient should be referred to a specialist.

High Track with No Perineal Opening (Rare)

In this unusual intersphincteric fistula the infection begins in the midanal intersphincteric space and burrows upward in the rectal wall, reentering the lower rectum through a secondary opening above the anorectal ring (**Fig. 89–5**). There is no downward spread of the infection and no fistula in the perianal skin. To treat this fistula it is necessary to lay the track open from its internal opening in the midanal canal up into the lower rectum. Parks and associates emphasize that the lowermost part of the track in the midanal canal must be excised because this contains the infected anal gland that is the primary source of the infection. Leaving it behind may result in a recurrence. If a fistula of this type presents in the acute phase, it resembles a "submucous abscess," but this is an erroneous term because the infection is indeed deep not only to the mucosa but also deep to the circular muscle layer (see Fig. 89–5). This type of abscess is drained by incising the overlying mucosa and circular muscle of the rectum.

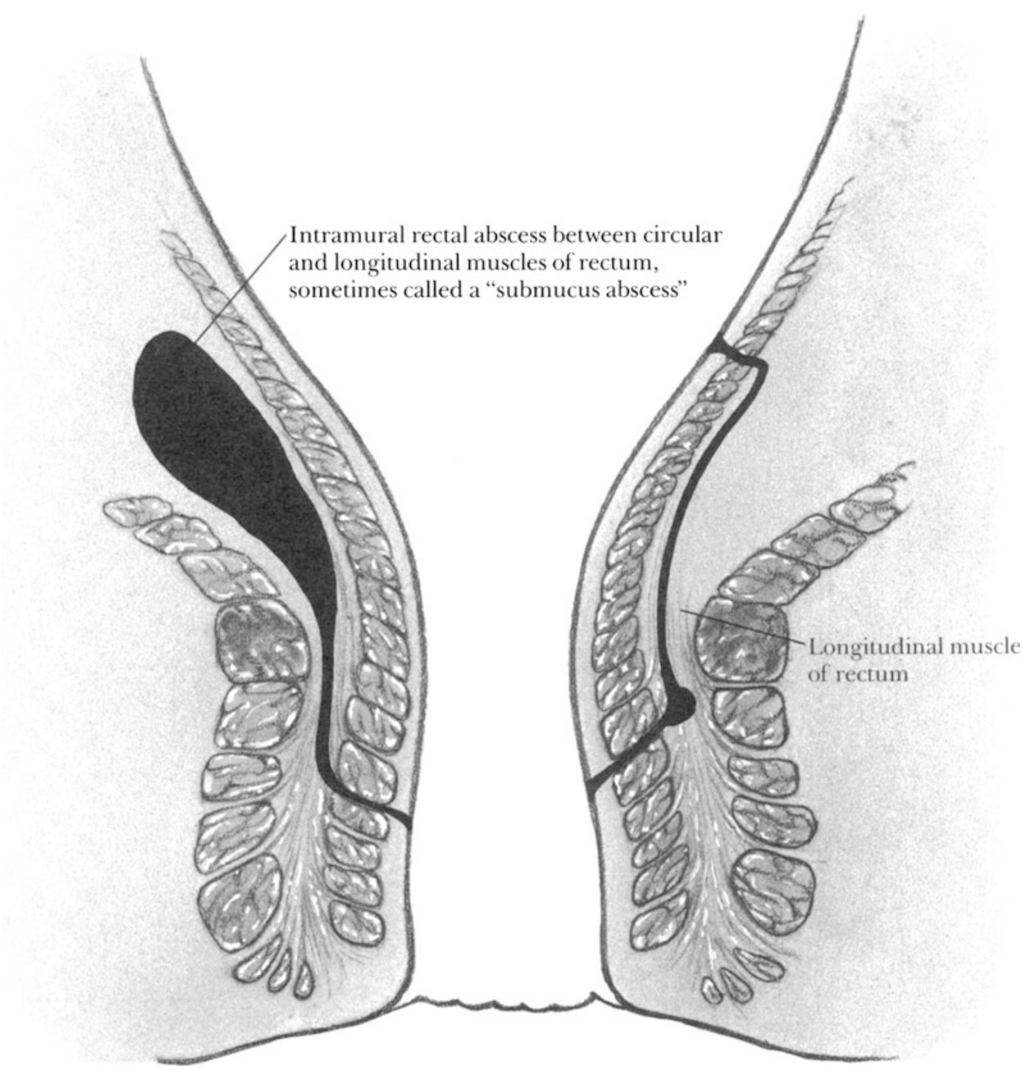


Fig. 89–5. High Intersphincteric Fistula (or abscess) with no perineal openings

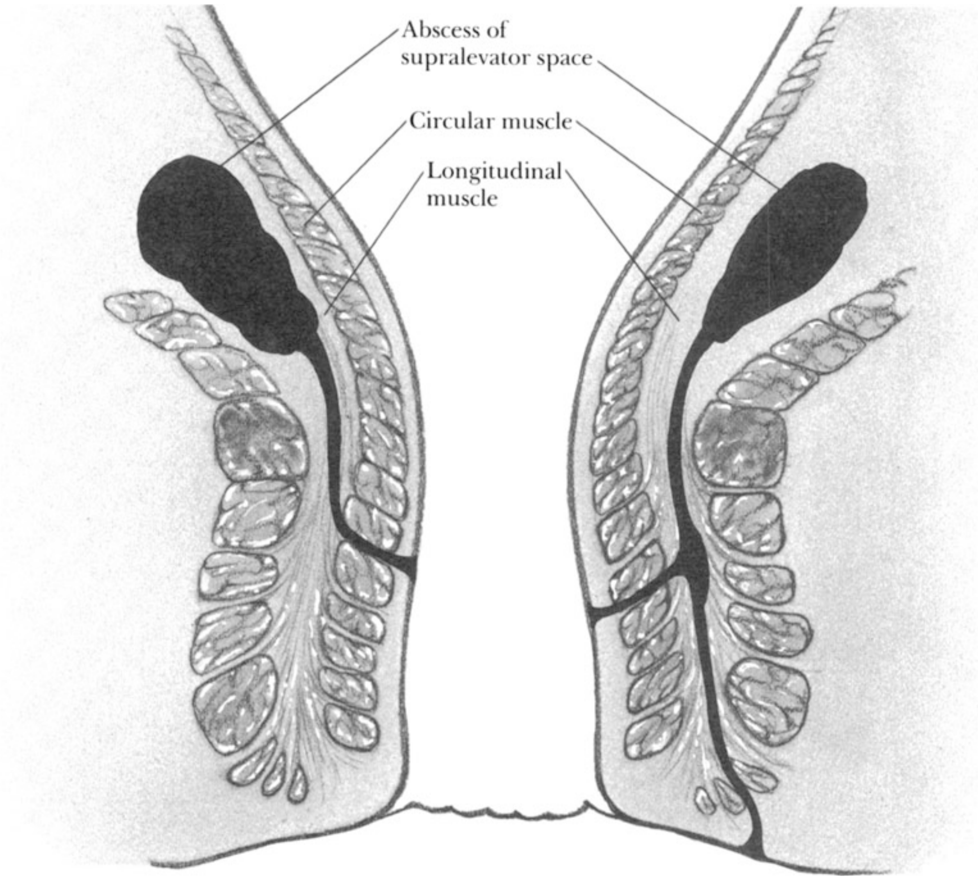


Fig. 89–6. High Intersphincteric Tracks (with supralevator abscesses)

High Track with Pelvic Extension (Rare)

In this case the infection spreads upward in the intersphincteric space, breaks through the longitudinal muscle, and enters the pelvis (supralevator) (**Fig. 89–6**). Proper treatment requires that the fistulous track be laid open by incising the internal sphincter together with the overlying mucosa or anoderm, up into the rectum for 1–3 cm, and draining the pelvic collection through this incision, the drain exiting into the rectum.

High Track Secondary to Pelvic Disease (Rare)

As mentioned above, the intersphincteric plane "is a natural pathway for infection from the pelvis to follow should it track downwards" (Parks, Hardcastle, and Gordon). This type of fistula (**Fig. 89–7**) does not arise from anal disease and does not require perianal surgery. Treatment consists of removing the pelvic infection by abdominal surgery.

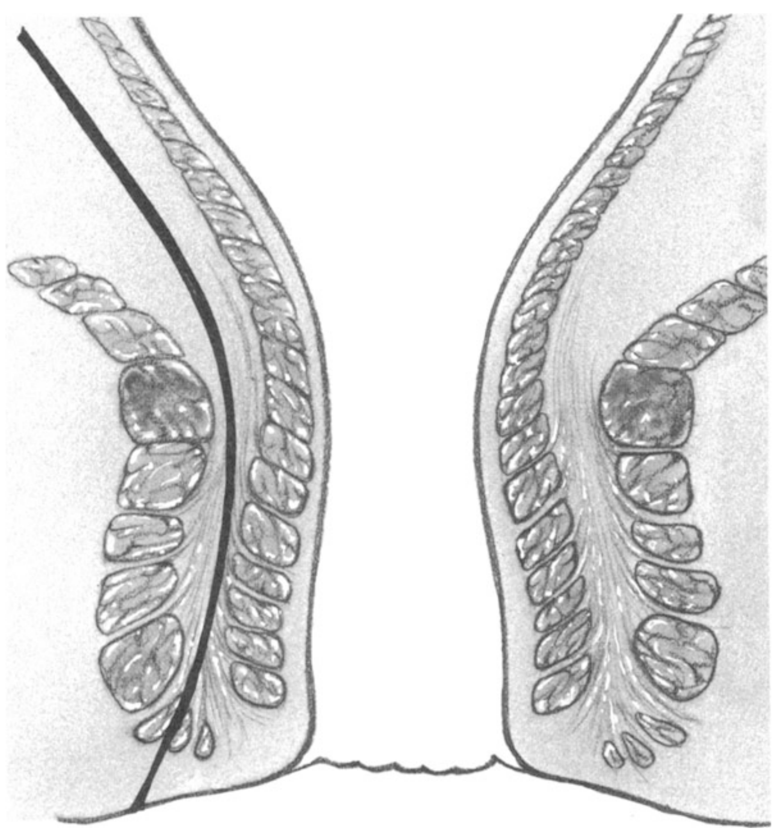


Fig. 89–7. High Intersphincteric Track (*secondary* to pelvic sepsis)

Transsphincteric Fistula

Uncomplicated

As illustrated in **Fig. 89–8**, the fairly common uncomplicated transsphincteric fistula arises in the intersphincteric space of the midanal canal, and then the infection burrows laterally directly through the external sphincter muscle. There it may form either an abscess or a fistulous track down through the skin overlying the ischiorectal space. If a probe is passed through the fistulous opening in the skin and along the track until it enters the rectum at the internal opening of the fistula, all of the overlying tissue may be divided without serious functional disturbance because only the distal half of the internal sphincter and the distal half of the external sphincter will have been transected. Occasionally one of these fistulas crosses the external sphincter closer to the puborectalis muscle than is illustrated. In this case, if there is doubt that the entire puborectalis can be left intact, the external sphincter may be divided in two stages. Divide the distal half in the first stage. Insert a seton through the remaining fistula, around the remaining muscle bundle, and leave it intact for 2 or 3 months before dividing the remainder of the sphincter.

High Blind Track

In this group of patients, the fistula burrows through the external sphincter, generally at the level of the midanal canal. Then the fistula not only burrows downward to the skin but also in a cephalad direction to the apex of the ischiorectal fossa (**Fig. 89–9**). Occasionally the fistula burrows through the levator ani muscles into the pelvis. Parks, Hardcastle, and Gordon point out that when a probe is passed into

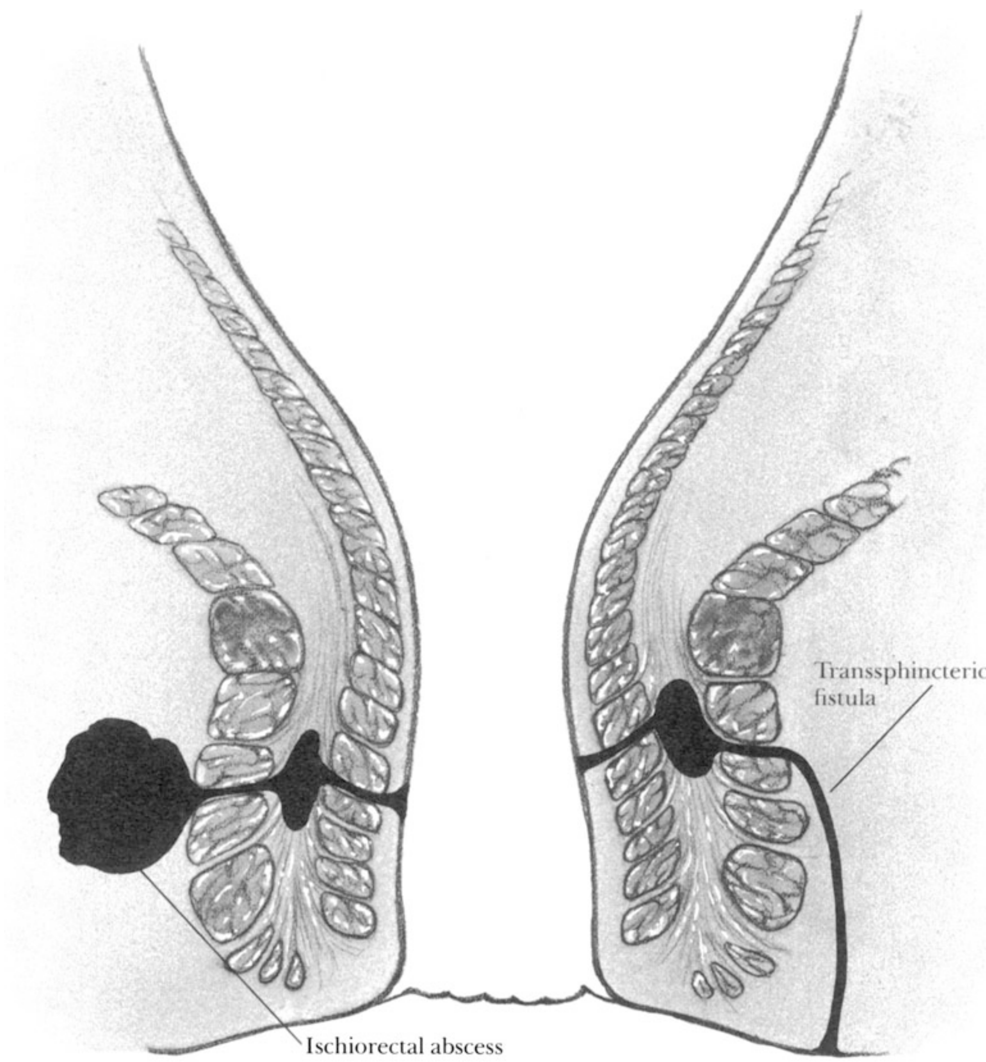


Fig. 89–8. Transphincteric Fistula and Ischiorectal Abscess

the external opening, it will generally go directly to the upper end of the blind track and that the internal opening in the midanal canal may be difficult to delineate by this type of probing. Occasionally there is localized induration in the midanal canal to indicate the site of the infected anal gland that initiated the pathological process. Probing of this area should indicate the internal opening. By inserting the index finger into the anal canal, one can often feel, above the anorectal ring, the induration that is caused by the supralevator extension of the infection. With the index finger the surgeon can often feel the probe in the fistula. The probe may feel close to the rectal wall. Parks emphasizes that it is dangerous to penetrate the wall of the rectum with this probe or to try to drain this infection through the upper rectum. If this should be done, an extrasphincteric fistula would be created with grave implications for the patient. The proper treatment for this type of fistula, even with a supralevator extension, is to transect the mucosa, the internal sphincter, the external sphincter, and the perianal skin from the midanal canal down to the orifice of the track in the skin of the buttock. The upper extension will heal with this type of drainage.

Suprasphincteric Fistula (Extremely Rare)

This type of fistula originates, as usual, in the midanal canal in the intersphincteric space where its internal opening can generally be found. The fistula extends upward in the intersphincteric plane above the puborectalis muscle into the supralevator space, where it often causes a supralevator abscess. Then the fistula penetrates the levator diaphragm and continues downward in the ischiorectal space to its external orifice in the perineal skin (**Fig. 89–10**). This type of supralevator infection must not be drained through an incision in the rectum. Parks and Stitz recommend an internal sphincterotomy from the internal opening of the fistula distally and an excision of the abscess in the intersphincteric space, if present. They then divide the lower 30%–50% of the external sphincter muscle. Continue this incision laterally until the lower portion of the fistulous track has been opened down to its external opening in the skin. This will leave the upper half of the external and internal sphincter muscles intact, as well as the puborectalis muscle. Insert a seton of heavy braided nylon through the fistula as it surrounds the muscles. Tie the seton with 5–6 knots, but keep the loop in the seton loose enough so it does not constrict the remaining muscles at this time. Insert a drain into the supralevator abscess, preferably in the intersphincteric space between the seton

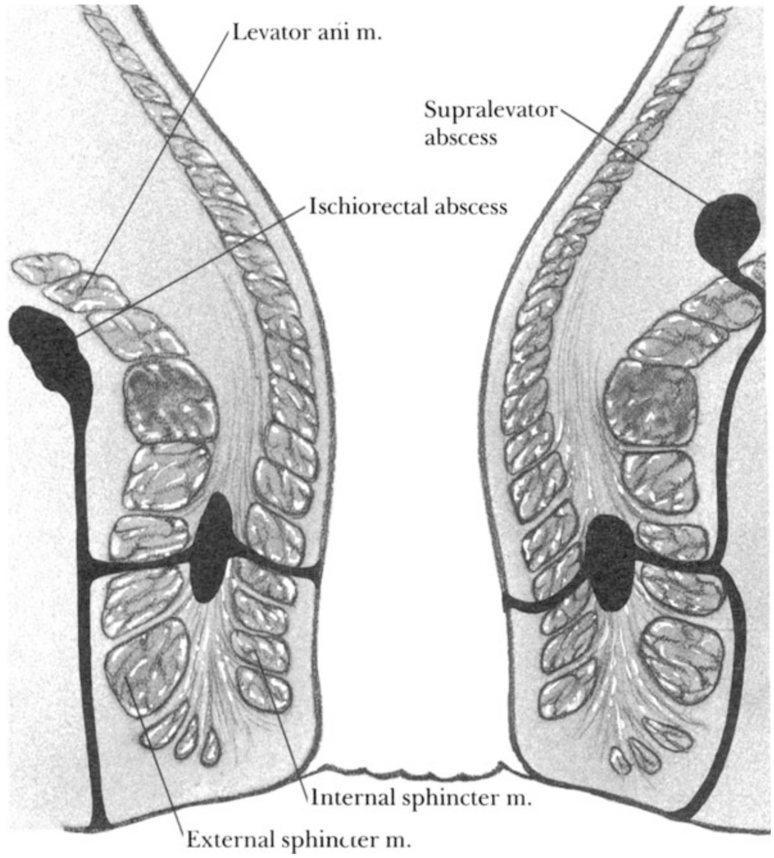


Fig. 89–9. Transsphincteric Fistulas (with high blind tracks)

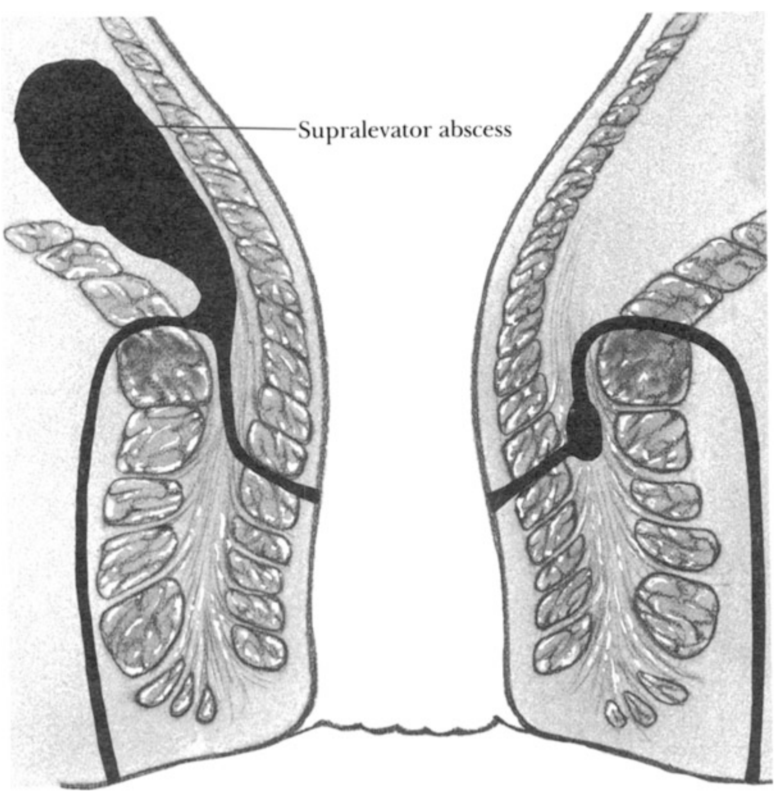


Fig. 89–10. Suprasphincteric Fistulas

and the remaining internal sphincter muscle. Once adequate drainage has been established, remove this drain as the heavy seton will prevent the lower portion of the wound from closing prematurely. Parks does not remove these setons for at least 3 months. It is often necessary to return the patient to the operating room 10–14 days following the initial operation to examine the situation carefully and to ascertain that no residual pocket of infection has remained undrained. Examination under anesthesia may be necessary on several occasions before complete healing has been achieved. In the majority of cases, after 3 or more months have passed, the supralevator infection will have healed completely, and it will not be necessary to divide the muscles enclosed in the seton. In these cases, simply remove the seton and permit the wound to heal spontaneously. If after 3–4 months there is lingering infection in the upper reaches of the wound, it will be possible to divide the muscles contained in the seton because the long-standing fibrosis will not permit these muscles to retract significantly and they will generally heal with restoration of fecal continence.

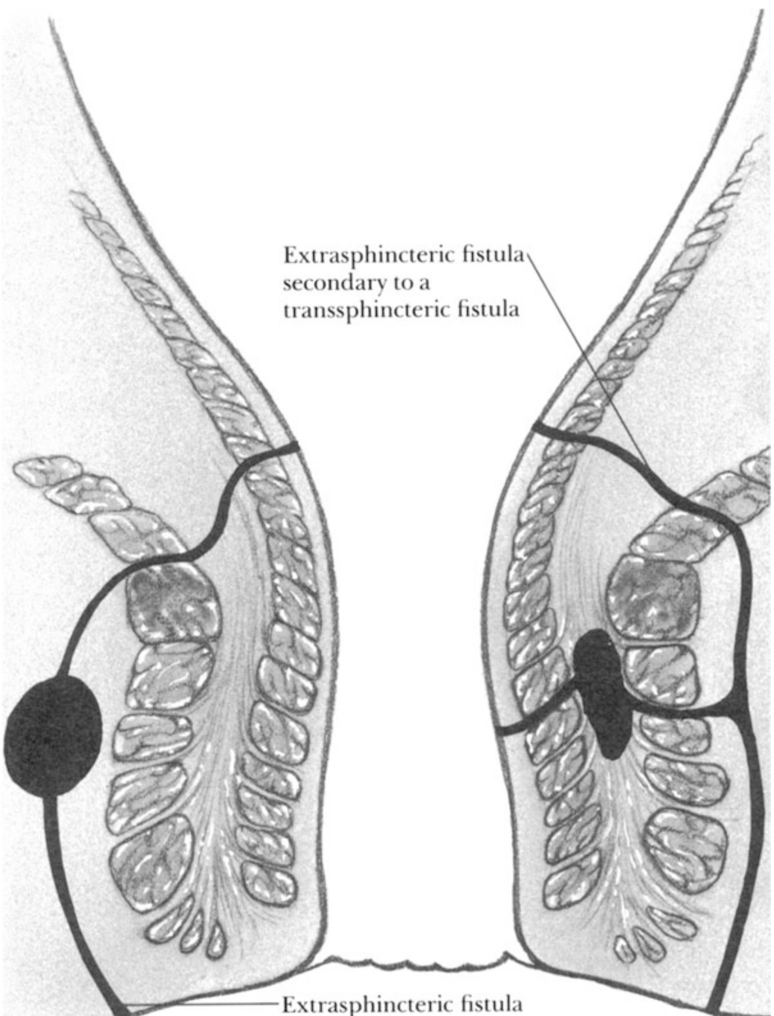


Fig. 89–11. Extrasphincteric Fistulas

Alternatively, an advancement flap to close the internal opening of the fistula may save these patients multiple operations.

Extrasphincteric Fistula (Extremely Rare)

Secondary to Transsphincteric Fistula

In this unusual situation, a transsphincteric fistula, after entering the ischiorectal fossa, travels not only downward to the skin of the buttocks, but also in a cephalad direction, penetrating the levator diaphragm into the pelvis, and then through the entire wall and mucosa of the rectum (**Fig. 89–11**). If this fistula were to be completely laid open surgically, the entire internal and entire external sphincter together with part of the levator diaphragm would have to be divided. The result would be total fecal incontinence. The proper treatment here consists of a temporary diverting colostomy combined with a simple laying open of the portion of the fistula that extends from the midanal canal to the skin. After the defect in the rectum heals, the colostomy can be closed.

The extrasphincteric fistula may also be treated by fashioning an advancement flap, often without the necessity of performing a temporary colostomy.

Secondary to Trauma

A traumatic fistula may be caused by a foreign body penetrating the perineum, the levator ani muscle, and then the rectum. Also, a swallowed foreign body, such as a fish bone, may perforate the rectum above the anorectal ring and be forced through the levator diaphragm into the ischiorectal fossa. An infection in this space may then drain out through the skin of the perineum to form a complete extrasphincteric fistula. In either case, treatment consists of removing any foreign body, establishing adequate drainage, and sometimes performing a temporary colostomy. It is not necessary to divide any sphincter muscle because the anal canal is not the cause of the patient's pathology.

Secondary to Specific Anorectal Disease

Conditions such as ulcerative colitis, Crohn's disease, and carcinoma may produce unusual and bizarre fistulas in the anorectal area. These are not usually amenable to local surgery. The primary disease must be remedied, often requiring total proctectomy.

Secondary to Pelvic Inflammation

A diverticular abscess of the sigmoid colon or Crohn's disease of the terminal ileum or a perforated pelvic appendicitis may result in perforation of the levator diaphragm with the infection tracking downwards to the perineal skin. In making the proper diagnosis, performing an X-ray sinogram by injecting an aqueous iodinated contrast medium into the fistula may demonstrate its supralevator entrance into the rectum. Therapy in this type of fistula consists of eliminating the pelvic sepsis by abdominal surgery. There is no need to cut any of the anorectal sphincter musculature.

Technical Hints in Performing Fistulotomy

Position

We prefer the prone position with the patient's hips elevated on a small pillow, with the patient under regional or local anesthesia with sedation.

Exploration

In accordance with Goodsall's rule, search the suspected area of the anal canal after inserting a Parks bivalve retractor. The internal opening should be located in a crypt near the dentate line, most often in the posterior commissure. If an internal opening has been identified, insert a probe to confirm this fact. Then, insert a probe into the external orifice of the fistula. In a simple fistula, in which the probe goes directly into the internal orifice, simply make a scalpel incision dividing all of the tissues superficial to the probe. In this maneuver, a grooved directional probe is helpful.

In complex fistulas the probe may not pass through the entire length of the track. In some cases gentle maneuvering with various sizes of lacrimal probes may be helpful. If these maneuvers are not successful, Goldberg and associates suggest the injection of a dilute (1:10) solution of methylene blue dye into the external orifice of the fistula. Then incise the tissues over a grooved director along that portion of the track that the probe enters easily. At this point it is generally easy to identify the probable location of the fistula's internal opening. For those fistulas in the posterior half of the anal canal, this opening will be located in the posterior commissure at the dentate line. If a patient has multiple fistulas, including a horseshoe fistula, the multiple tracks generally enter into a single posterior track that leads to an internal opening at the usual location in the posterior commissure of the anal canal. In patients with multiple complicated fistulas, Goldberg and associates recommend a preoperative fistulagram X ray to help delineate the pathology.

Marsupialization

In order to accelerate healing in cases where fistulotomy results in a large gaping wound, Goldberg and associates suggested that the wound be marsupialized by suturing the outer walls of the laid-open fistula to the skin by means of a continuous absorbable suture.

In any case, curet all of the granulation tissue away from the wall of the fistula that has been laid open.

Postoperative Care

Administer a bulk laxative such as Metamucil daily. For the first bowel movement, an additional stimulant, such as Senokot-S, 2 tablets, may be necessary.

See that the patient begins a regular diet.

For patients who have had operations for fairly simple fistulas, warm sitz baths, 2–3 times daily, may be initiated beginning on the first postoperative day, after which no gauze packing may be necessary.

For patients who have complex fistulas, a light general anesthesia may be required for the removal of the first gauze packing on the 2nd or 3rd postoperative day.

In the early postoperative period, check the wound every day or two to be sure that healing takes place in the depth of the wound before any of the more superficial tissues heal together. Later on, check the patient once or twice weekly.

When a significant portion of the external sphincter has been divided, warn the patient that for the first week or so there will be some degree of fecal incontinence.

In the case of the rare types of fistula with high extension and a deep wound, Parks and Stitz recommend that the patient be taken to the operating room at intervals for careful examination under anesthesia.

Perform a weekly anal digital examination and dilatation, when necessary, in order to avoid an anal stenosis secondary to the fibrosis that takes place during the healing of a fistula.

Postoperative Complications

Urinary retention

Postoperative hemorrhage

Fecal incontinence

Sepsis including cellulitis and recurrent abscess

Recurrent fistula

Thrombosis of external hemorrhoids

Anal stenosis

References

Eisenhammer S. A new approach to the anorectal fistulous abscess based on the high intermuscular lesion. Dis Colon Rectum 1958;106:595.

Goldberg SM, Gordon PH, Nivatvongs S. Essentials of anorectal surgery. Philadelphia: Lippincott; 1980.

Parks AG, Hardcastle JD, Gordon PH. A classification of fistula-in-ano. Br J Surg 1976;63:1.

Parks AG, Stitz RW. The treatment of high fistula-in-ano. Dis Colon Rectum 1976;19:487.

Parks AG, Thomson JPS. Intersphincteric abscess. Br Med J 1973;2:537.

90 Lateral Internal Sphincterotomy for Chronic Anal Fissure

Concept: Pathogenesis and Treatment of Anal Fissure

A typical anal fissure presents in its acute stage as a linear superficial tear, always distal to the dentate line and in 90% of cases in the posterior commissure of the anus. It is believed to result from the trauma of passing an inspissated stool. In the acute stage, conservative management aimed at softening the stool, combined with the local application of an anesthetic ointment and sitz baths, may reverse the pathology in less than a week's time. When the narrow linear fissure becomes chronic, it resembles an ulcer with slightly thickened sides, measuring perhaps 1–2 mm in thickness, and the fissure widens for a distance of 3–6 mm. Characteristically, the base of a chronic anal fissure demonstrates transverse muscle fibers of the circular muscle that constitutes the internal sphincter. Further along in the development of a chronic anal fissure, a sentinel pile develops. This is an inflammatory thickening of the skin situated at the distal margin of the fissure. Once the anal fissure has reached a chronic stage, it is theorized that spasm of the internal sphincter prevents healing, while at the same time the spasm produces the intense pain on defecation that constitutes the patient's chief complaint.

In past years the surgical treatment for a chronic anal fissure consisted of excising the chronic ulcer together with a few millimeters of surrounding normal tissue, combined with the division of some part of the internal sphincter in the posterior commissure. Ferguson divided only the superficial fibers of the distal margin of the internal sphincter and achieved excellent results with the excision technique. Other authors found that, perhaps because a deeper incision was made in the internal sphincter, a keyhole deformity occurred in the posterior commissure, causing annoying seepage of stool at the point of this deformity. Eisenhammer in 1959 suggested that this problem could be averted by placing the internal sphincterotomy in the lateral aspect of the anal canal. Comparative study by a number of authorities (Goligher; Abcarian) confirmed that the results of a lateral internal sphincterotomy are superior to the older techniques. Notaras developed the method of performing the lateral internal myotomy with a sharp cataract knife through a tiny incision in the perianal skin.

When planning surgery for chronic anal fissure, be certain to rule out the possibility that this "fissure" may represent Crohn's disease, ulcerative colitis, or even a syphilitic chancre. Occasionally multiple fissures of the anus are caused by the trauma of anal sexual intercourse. None of these conditions requires a sphincterotomy. Be wary about diagnosing as a chronic anal fissure any lesion in an atypical location, i.e., other than the anterior or posterior midline of the anus.

Indication

Chronic anal fissure

Preoperative Care

Many patients with anal fissure will not tolerate a preoperative enema due to excessive pain. Consequently, a mild cathartic the night before operation constitutes the only preoperative care necessary.

Pitfalls and Danger Points

Injury to external sphincter
Inducing fecal incontinence by overly extensive sphincterotomy
Bleeding, hematoma

Operative Strategy

Accurate identification of the lower border of the internal sphincter is essential to the successful completion of an internal sphincterotomy. Placing a bivalved speculum (like a Parks retractor) into the anal canal and opening the speculum for a distance of about two fingerbreadths will place the internal sphincter on stretch. At this time palpation will disclose a distinct groove between the subcutaneous external sphincter and the lower border of the tense internal sphincter. Palpating this groove serves to identify accurately the lower border of the internal sphincter. Optionally, the surgeon may make a

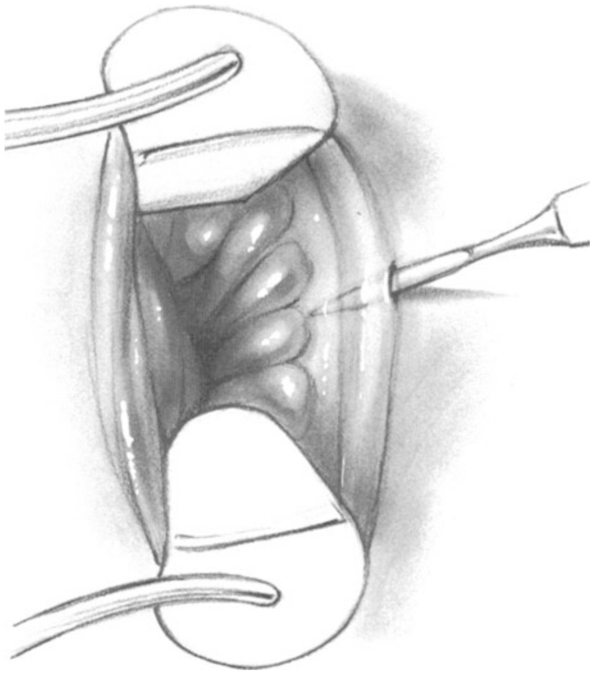


Fig. 90-1

radial incision through the mucosa directly over this area to identify visually the lower border of the internal sphincter, but we have not found this step to be necessary.

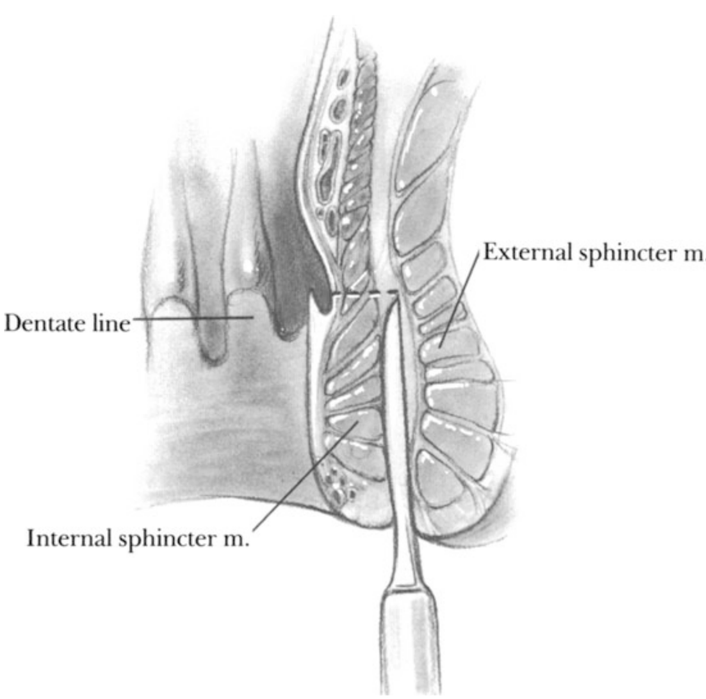


Fig. 90-2

Operative Technique

Anesthesia

Either a light general or a local anesthesia is satisfactory for this procedure.

Closed Sphincterotomy

Place the patient in the lithotomy position. (If local anesthesia is used, the prone position is also satisfactory.) Insert a Parks retractor with one blade placed in the anterior and the other in the posterior aspect of the anal canal. Open the retractor about two fingerbreadths. Now, at the right or left lateral margin of the anal canal, palpate the groove between the internal and external sphincter. Once this has been clearly identified, insert a No. 11 scalpel blade into this groove (**Fig. 90-1**). During this insertion keep the flat portion of the blade parallel to the internal sphincter. When the blade has reached the level of the dentate line (about 1.5 cm), rotate the blade 90° so that its sharp edge rests against the internal sphincter muscle (**Fig. 90-2**). Insert the left index finger into the anal canal opposite the scalpel blade. Then, with a gentle sawing motion transect the lower portion of the internal sphincter muscle. There is a gritty sensation while the internal sphincter is being transected, followed by a sudden "give" when the blade has reached the mucosa adjacent to the surgeon's left index finger. Remove the knife and palpate the area of the sphincterotomy with the left index finger. Any remaining muscle fibers will be ruptured by lateral pressure exerted by this finger. In the presence of bleeding, apply pressure to this area for at least 5 minutes. It rarely will be necessary to make an incision in the mucosa for the identification and coagulation of a bleeding point.

An alternative method of performing the subcutaneous sphincterotomy is to insert a No. 11 scalpel blade between the mucosa and the internal sphincter. Then turn the cutting edge of the blade so that it faces laterally and cut the sphincter in this fashion. This approach has the disadvantage of possibly lacerating the external sphincter if excessive pressure is applied to the blade. Do not suture the tiny incision in the anoderm.

Open Sphincterotomy

In this variation, a radial incision is made in the anoderm just distal to the dentate line and carried across the lower border of the internal sphincter in the midlateral portion of the anus. Then the lower border of the internal sphincter is identified as is the intersphincteric groove. The fibers of the internal sphincter have a whitish hue. Divide the lower portion of the internal sphincter up to a point level with the dentate line. Achieve hemostasis with the electrocautery, if necessary. The skin wound may be left open and a dressing applied.

Removal of the Sentinel Pile

If the patient has a sentinel pile more than a few millimeters in size, simply excise it with a scissors. Leave the skin defect unsutured. Nothing more elaborate need be done for this condition.

If, in addition to the chronic anal fissure, the patient has symptomatic internal hemorrhoids that require surgery, hemorrhoidectomy may be performed simultaneously with the lateral internal sphincterotomy. If the patient has large internal hemorrhoids, and hemorrhoidectomy is not performed simultaneously, then it is possible that a lateral internal sphincterotomy operation may induce prolapse of these hemorrhoids, but this is an unusual occurrence.

Postoperative Care

Apply a simple gauze dressing to the anus. Remove this the following morning.

Discharge patients the same day. Generally, there is dramatic relief of the patient's pain promptly after sphincterotomy, which is performed in the ambulatory surgical unit.

Have the patient continue taking the bulk laxative (e.g., psyllium) which was initiated prior to surgery. Add to this medication a stool softener such as Surfak.

Prescribe a mild analgesic in case the patient has some discomfort in the operative site.

Postoperative Complications

Hematoma or bleeding (rare)

Perianal abscess (rare)

Flatus and fecal soiling. (Some patients complain that they have less control over the passage of flatus following sphincterotomy than they had before operation, or they may have some fecal soiling of their underwear, but generally both these complaints are temporary and rarely last more than a few weeks.)

References

Abcarian H. Surgical correction of chronic anal fissure: results of lateral internal sphincterotomy vs fissurectomy—midline sphincterotomy. Dis Colon Rectum 1980;23:31.

Eisenhammer S. The evaluation of the internal anal sphincterotomy operation with special reference to anal fissure. Surg Gynecol Obstet 1959;109:583.

Ferguson JA, MacKeigan JM. Hemorrhoids, fistulae and fissures: office and hospital management—a critical review. In: Rob C (ed) Advances in surgery, Vol 12. Chicago: Yearbook Medical Publishers; 1978.

Goligher JC. Surgery of the anus, rectum and colon, 4th ed. London: Balliere Tindall; 1980.

Notaras MJ. The treatment of anal fissure by lateral subcutaneous internal sphincterotomy—a technique and results. Br J Surg 1971;58:96.

91 Anoplasty for Anal Stenosis

Concept: Operations for Anal Stenosis

Although most cases of anal stenosis appear to follow a previous hemorrhoidectomy, we have encountered a number of elderly patients, especially women, who developed this condition without having had any prior surgery. The etiology in these cases is not clear. However, in most cases of anal stenosis the stricture appears to be limited to the superficial layer of the anal canal without much involvement of the sphincter musculature. Because of this fact, it is not difficult to dissect the anoderm and rectal mucosa away from the muscle, making enlargement of the anal orifice possible by the simple application of the Heineke-Mikulicz principle. We have been pleased with this technique except for severe cases. When marked fibrosis occurs, construct a sliding skin flap to fill in the defect.

Indication

Symptomatic fibrotic constriction of the anal canal not responsive to simple dilatation

Preoperative Care

Preoperative saline enema

Pitfalls and Danger Points

Fecal incontinence
Slough of flap
Inappropriate selection of patients

Operative Strategy

Some patients have a tubular stricture where the fibrosis involves not only the anoderm but also the mucosa and the anal sphincters. This type of condition, frequently following inflammatory bowel disease, is not susceptible to local surgery. In other cases of anal stenosis, elevating the anoderm and mucosa in the proper plane will succeed in freeing these tissues from the underlying muscle and permitting the formation of sliding pedicle flaps to resurface the denuded anal canal subsequent to dilating the stenosis.

Fecal incontinence is avoided by performing only a gradual dilatation of the anal canal to 2–3 fingerbreadths and performing, when necessary, a lateral internal sphincterotomy.

Patients with milder forms of anal stenosis may respond to a simple internal sphincterotomy, if there is no loss of anoderm.

Operative Technique—Sliding Mucosal Flap

Incision

With the patient under local or general anesthesia, in the prone position and the buttocks retracted laterally by means of adhesive tape, make an incision at 12 o'clock. This incision should extend from the dentate line outward into the anoderm for about 1.5 cm, as well as internally into the rectal mucosa for about 1.5 cm. This will result in a linear incision about 3 cm in length. Elevate the skin and mucosal flaps for about 1 to 1.5 cm to the right and to the left of the primary incision. Gently dilate the anus (**Fig. 91–1**).

Internal Sphincterotomy

Insert the bivalved Parks or a Hill-Ferguson retractor into the anal canal after gently dilating the anus. Identify the groove between the external and internal sphincter muscles. If necessary, incise the distal portion of the internal sphincter muscle, no higher than the dentate line (**Fig. 91–2**). This should permit dilatation of the anus to a width of 2–3 fingers.

Advancing the Mucosa

Complete the elevation of the flap of rectal mucosa. Then advance the mucosa so that it can be sutured circumferentially to the sphincter muscle (**Fig. 91–3**). This suture line should fix the rectal mucosa near the normal location of the dentate line. Advancing the mucosa too far will result in an ectropion with annoying chronic mucus secretion in

Fig. 91–1

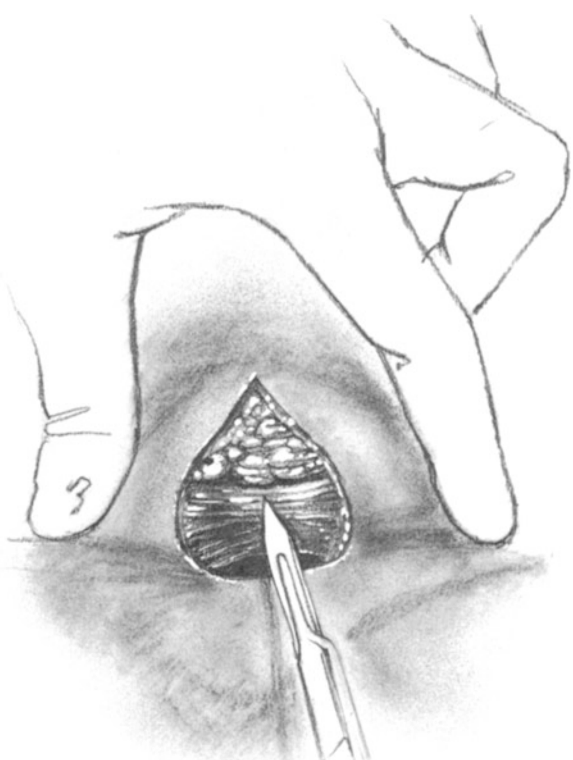


Fig. 91–2

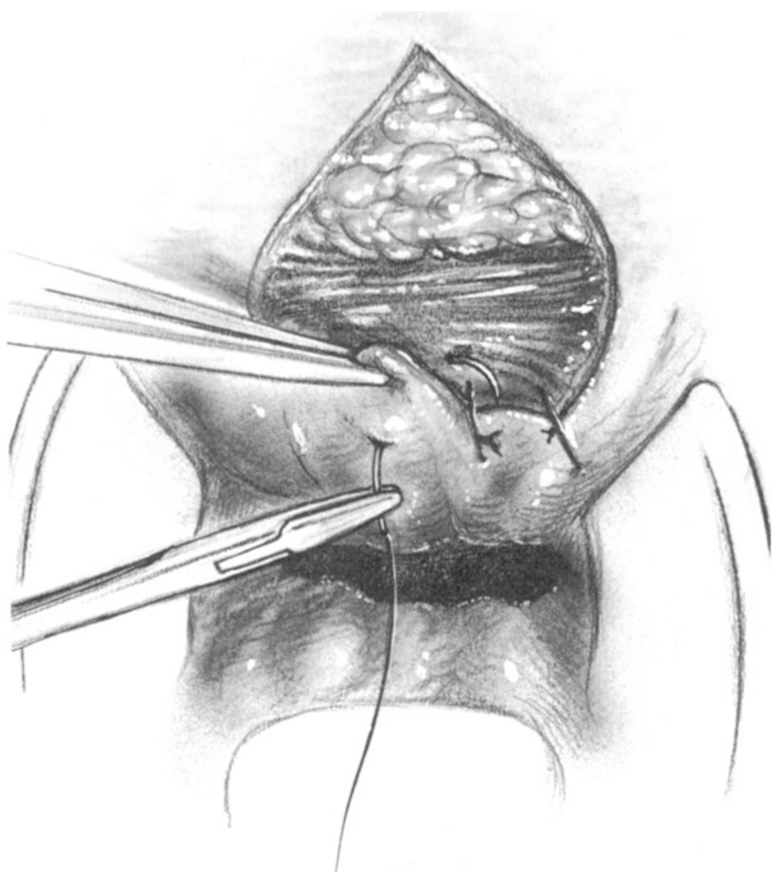


Fig. 91–3

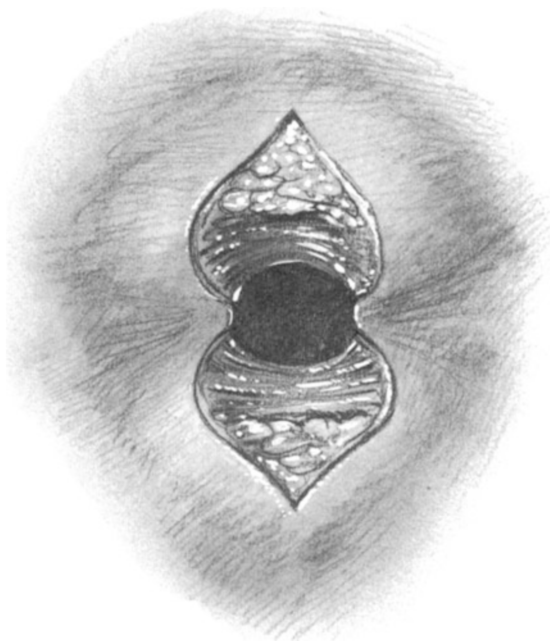


Fig. 91–4

the perianal region. Use fine chromic catgut or PG for the suture material. It is not necessary to insert any sutures into the perianal skin. In a few cases of severe stenosis it may be necessary to repeat this process and create a mucosal flap at 6 o'clock (**Figs. 91–4 and 91–5**).

Hemostasis should be complete following the use of accurate electrocoagulation and fine ligatures. Insert a small Gelfoam pack into the anal canal.

Operative Technique—Sliding Anoderm Flap

Incision

After gently dilating the anus so that a small Hill-Ferguson speculum may be inserted into the anal canal, make a vertical incision at the posterior commissure, beginning at the dentate line and extending upward in the rectal mucosa for a distance

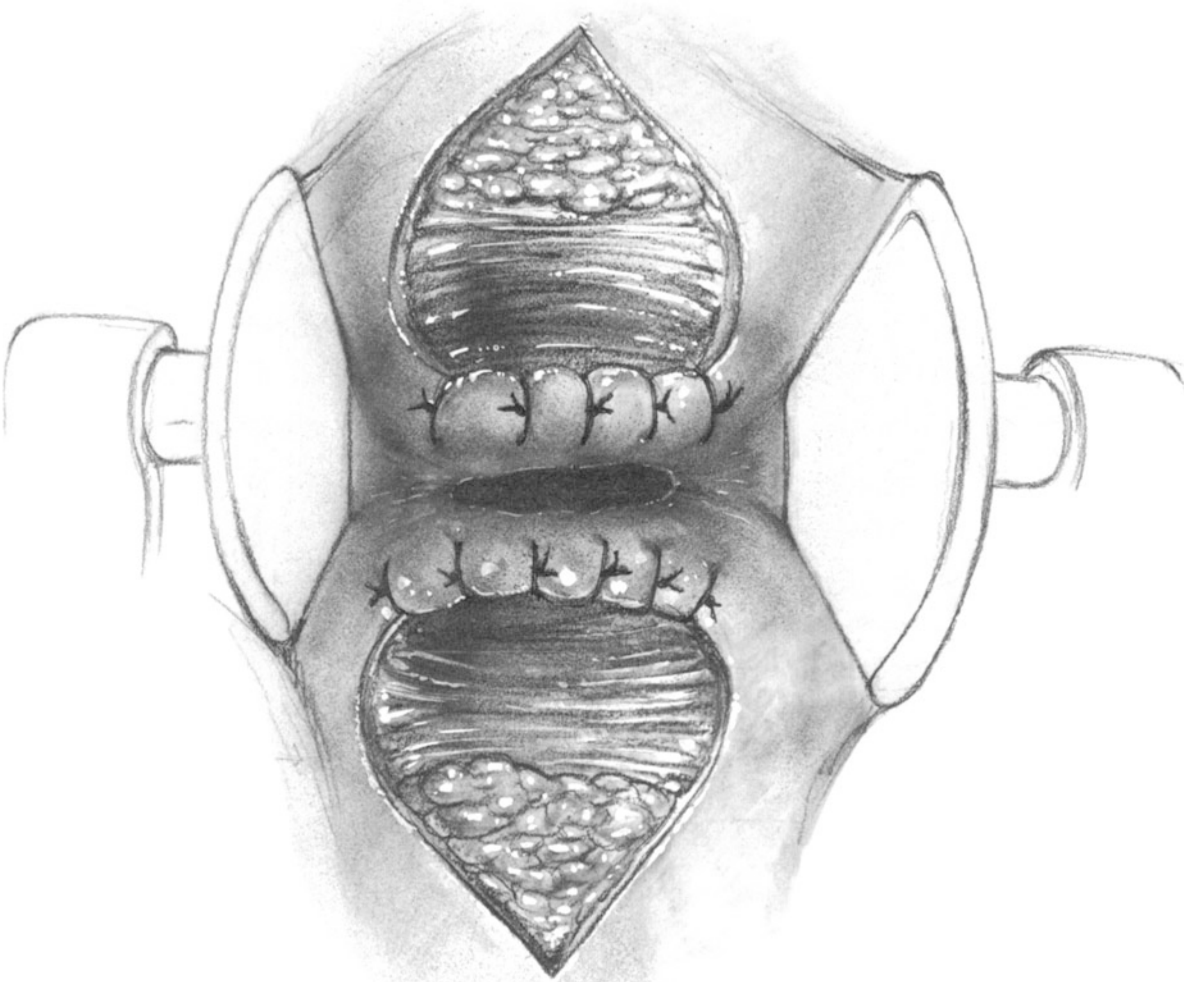


Fig. 91–5

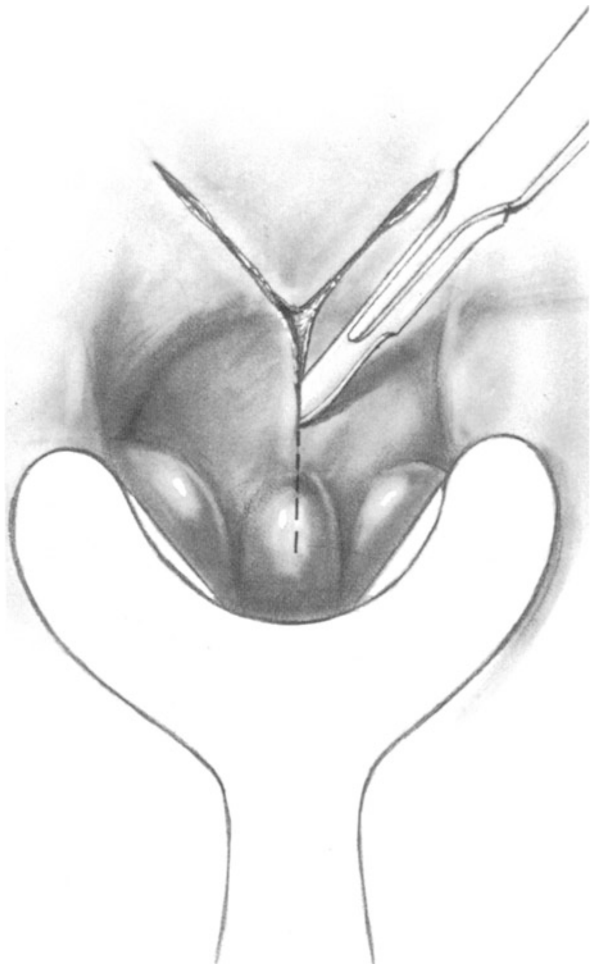


Fig. 91–6

of about 1.5 cm. Then make a "Y" extension of this incision on to the anoderm as in **Fig. 91–6**. Be certain that the two limbs of the incision in the anoderm are separated by an angle of at least 90° (angle A in **Fig. 91–7a**). Now by sharp dissection, gently elevate the skin and mucosal flaps for a distance of about 1–2 cm. Take special care not to injure the delicate anoderm during the dissection. When the dissection has been completed, it will be possible to advance point A on the anoderm to point B on the mucosa (**Fig. 91–7b**) without tension.

Internal Sphincterotomy

In most cases enlarging the anal canal will require division of the distal portion of the internal sphincter muscle. This may be performed through the same incision at the posterior commissure. Insert a sharp scalpel blade in the groove between the internal and external sphincter muscles. Divide the distal 1.0–1.5 cm of the internal sphincter. Then dilate the anal canal to a width of 2–3 fingers.

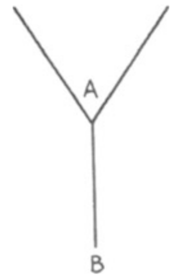


Fig. 91–7a

Fig. 91–7b

Advancing the Anoderm

Using continuous sutures of 5–0 atraumatic Vicryl, advance the flap of anoderm so that point A meets point B (Fig. 91–7b and **Fig. 91–8**) and suture the anoderm to the mucosa with a continuous suture that catches a bit of the underlying sphincter muscle. When the suture line has been completed, the original "Y" incision in the posterior commissure will

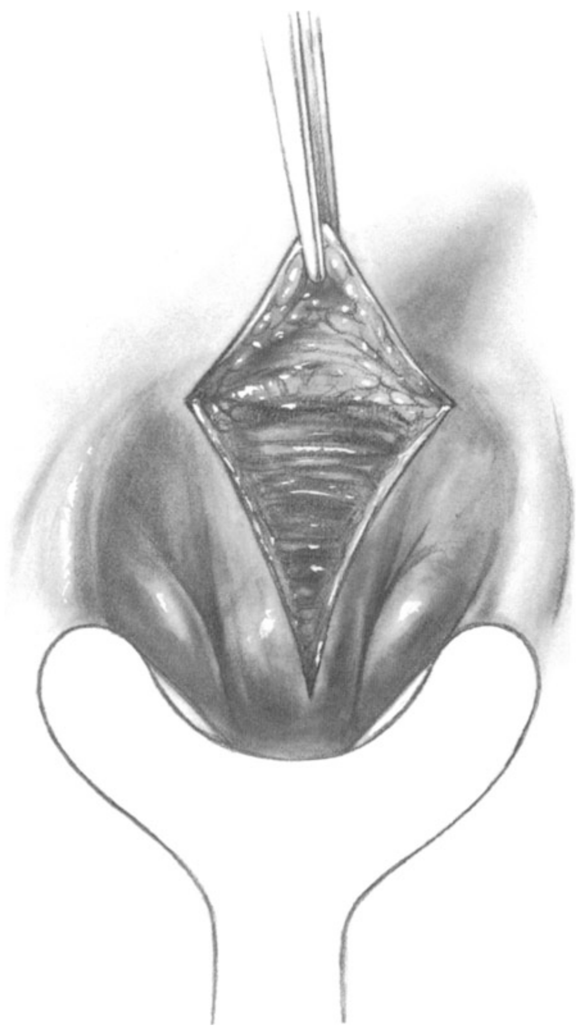


Fig. 91–8

Fig. 91-9

resemble the "V" as illustrated in Fig. 91-7b and **Fig. 91-9**. Insert a small Gelfoam pack into the anal canal.

Postoperative Care

Remove the gauze dressings from the anal wound. It is not necessary to mobilize the Gelfoam because it will tend to dissolve in the sitz baths that the patient should initiate 2 or 3 times daily on the day following the operation.

Regular Diet

Mineral oil (45 ml) nightly for the first 2 or 3 days. Thereafter a bulk laxative, such as Metamucil, is prescribed for the remainder of the postoperative period.

Discontinue all intravenous fluids in the recovery room if there has been no postanesthesia complication. This will reduce the incidence of postoperative urinary retention.

Postoperative Complications

Urinary retention

Hematoma

Anal ulcer and wound infection (quite rare)

92 Operation for Rectal Prolapse (Thiersch)

Concept: When to Perform a Thiersch Operation

Prolapse of the rectum is, in fact, a form of intussusception with the proximal rectum and the sigmoid colon sliding through the anal canal to the outside. The concept behind the Thiersch operation is to prevent this intussusception by narrowing the diameter of the anal canal. This may be accomplished by encircling the anal sphincters with a heavy No. 20 SWG silver wire. By tying the encircling ligature with sufficient tension, intussusception and prolapse is prevented. Unfortunately, in patients who have large prolapses the wire either breaks, producing a recurrence of the prolapse, or the wire cuts through the tissues, causing an infection (Goligher). In the latter case the wire must be removed. It is uncommon for the wire repairs to last more than 1–2 years subsequent to operation.

In an attempt to prolong the successful result of the Thiersch operation, surgeons have used materials other than silver wire for the encircling ligature, such as heavy nylon, stainless steel wire, or strips of synthetic fabric, such as Prolene mesh. Lomas and Cooperman have used a four-ply strip of Marlex mesh 1.5 cm wide to encircle the anal canal in 50 patients with excellent results in 47. Labow and associates use a Dacron-impregnated Silastic sheet (Dow Corning No. 501–7) because it has the advantage of elasticity. This modification of the Thiersch operation appears to us to be the method of choice. The great advantage of the Thiersch operation is its basic simplicity. It can be performed rapidly with minimal risk even in patients who suffer from serious concurrent disease. For good-risk patients, the Ripstein operation, described in Chap. 52, has a superior record of successful long-term follow-up, or for patients with severe constipation, a sigmoid colon resection.

Indications

The Thiersch operation is indicated in poor-risk patients who have prolapse of the full thickness of rectum. (See Chap. 52.)

Preoperative Care

Sigmoidoscopy: barium colon enema

Since many patients with rectal prolapse suffer from severe constipation, cleanse the colon over a period of a few days with cathartics and enemas. Initiate an antibiotic bowel preparation 18 hours prior to scheduled operation, as for colon resection. (See Chap. 34.)

Pitfalls and Danger Points

Tying the encircling band too tight so that it causes obstruction

Wound infection

Injury to vagina or rectum

Fecal impaction

Operative Strategy

Selecting Proper Suture or Banding Material

Lomas and Cooperman recommend that the anal canal be encircled by a four-ply layer of polypropylene mesh. Since the band is 1.5 cm in width, the likelihood that it will cut through the tissues is minimized. Labow and associates use a Dacron-impregnated Silastic sheet (Dow Corning No. 501-7) because it has the advantage of elasticity.

Achieving Proper Tension of the Encircling Band

Although some surgeons advocate that the encircling band be adjusted to fit snugly around a Hegar dilator, we have not found this technique to be satisfactory. If the surgeon will insert an index finger into the anal canal and have his assistant adjust the tension of the encircling band so that it fits snugly around the index finger, proper tension can be achieved. If the band is too loose, prolapse will not be prevented.

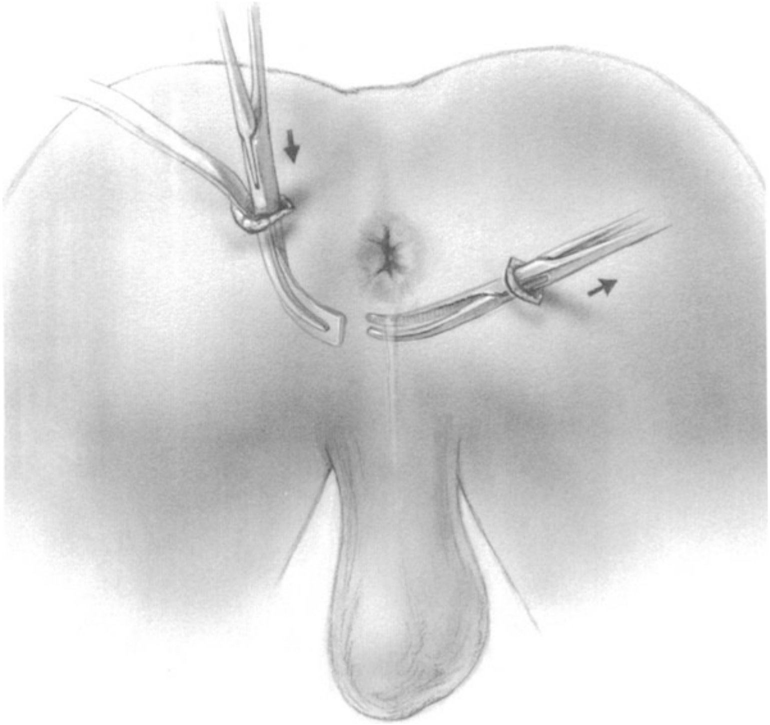


Fig. 92–1

Placing the Encircling Band

In order to avoid erosion of the synthetic mesh through the skin, it is important that the encircling band be placed around the anal canal approximately at its midpoint.

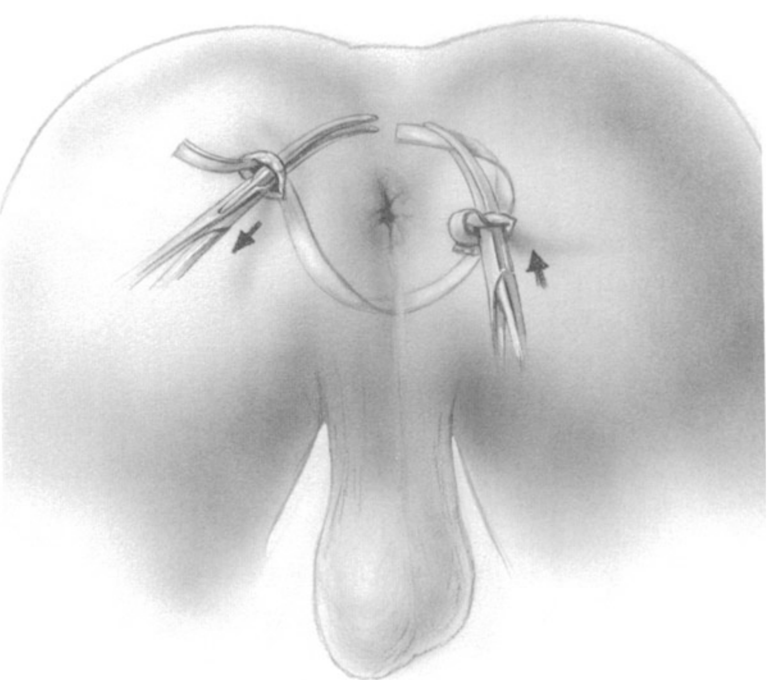


Fig. 92–2

Operative Technique—Thiersch Procedure Using Mesh

Fabricating the Encircling Band of Mesh

Although Lomas and Cooperman prefer Marlex mesh, we believe that Dacron-impregnated Silastic mesh is preferable because of its elasticity. Cut a rectangle of Silastic mesh 1.5 × 20 cm. Cut the strip so that it is elastic along its longitudinal axis. While **Fig. 92–1** and subsequent drawings illustrate Lomas and Cooperman's technique using a tight roll of Marlex, we now use a 1.5-cm strip of elasticized Silastic. Except for the nature of the mesh, the surgical technique is unchanged.

Incision and Position

This operation may be done with the patient in either the prone jackknife or the lithotomy position, under general or regional anesthesia. We prefer the prone position. Make a 2-cm radial incision at 10 o'clock starting at the lateral border of the anal sphincter muscle and continue laterally. Make a similar incision at 4 o'clock. Make each incision about 2.5 cm deep.

Inserting the Mesh Band

Insert a large curved Kelly hemostat or a large right-angled clamp into the incision at 4 o'clock and gently pass the instrument around the external sphincter muscles so that it emerges from the incision at 10 o'clock. Insert one end of the mesh strip into the jaws of the hemostat and draw the mesh through the upper incision and extract it from the incision at 4 o'clock. Then pass the hemostat through the 10 o'clock incision around the other half of the circumference of the anal canal until it emerges from the 4 o'clock incision. Insert the end of the mesh into the jaws of the hemostat and draw the hemostat back along this path (**Fig. 92–2**) so that it delivers the end of the mesh band into the posterior incision. At this time the entire anal canal has been encircled by the band of mesh and both ends protrude through the posterior incision. In this manipulation be careful not to penetrate the vagina or the anterior rectal wall. Also, do not permit the mesh to become twisted during its passage around the anal canal. Keep the band flat.

Adjusting Tension

Apply a second sterile glove on top of the previous glove on the left hand. Insert the left index finger into the anal canal. Apply a hemostat to each end of the encircling band. Ask the assistant to gradually increase the tension by overlapping the two ends of mesh. When the band feels snug around the index finger, ask the assistant to insert a 2–0 Prolene suture to maintain this tension. After the suture has been inserted, recheck the tension of the band. Then remove the index finger and remove the contaminated glove. Insert several additional 2–0 Prolene interrupted sutures or a row of TA-55 staples to approximate the two ends of the mesh and amputate the excess length of the mesh band. The patient should now have a 1.5-cm-wide band of mesh encircling the external sphincter muscles at the midpoint of the anal canal with sufficient tension to be snug around an index finger in the rectum (**Fig. 92–3**).

Closure

Irrigate both incisions thoroughly with a dilute antibiotic solution. Close the deep perirectal fat with interrupted 4–0 PG interrupted sutures in both incisions. Close the skin with interrupted or continuous subcuticular sutures of the same material (Fig. 94–4). Apply collodion over each incision.

Postoperative Care

Perioperative antibiotics

Prescribe a bulk-forming laxative like Metamucil, plus any additional cathartic that may be necessary to prevent fecal impaction. Periodic Fleet's enemas may be required.

Initiate sitz baths after each bowel movement and two additional times daily for the first 10 days.

Postoperative Complications

If the patient develops a wound infection, it may not be necessary to remove the band. First, open the incision to obtain adequate drainage and treat the patient with antibiotics. If the infection heals, it will not be necessary to remove the foreign body.

Some patients may experience perineal pain following surgery. This usually improves in time. If the pain is severe and unrelenting, removal of the mesh is required. If the removal of the mesh can be postponed for 4 to 6 months, there may be enough residual perirectal fibrosis to prevent recurrence of the prolapse.

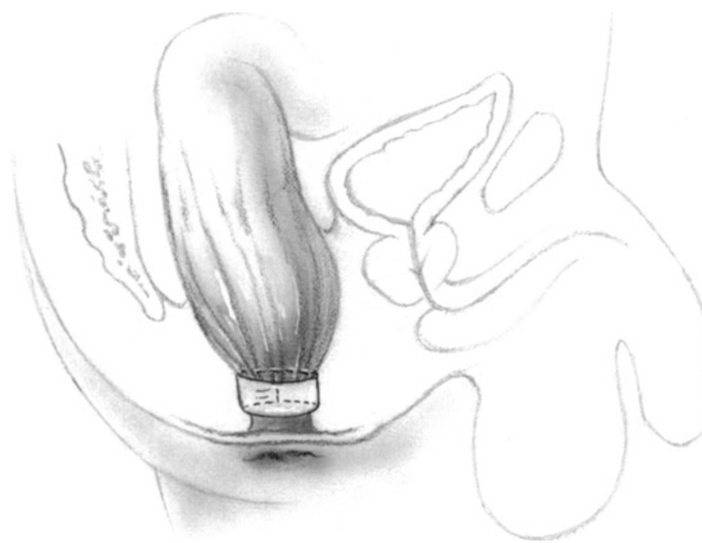


Fig. 92–3

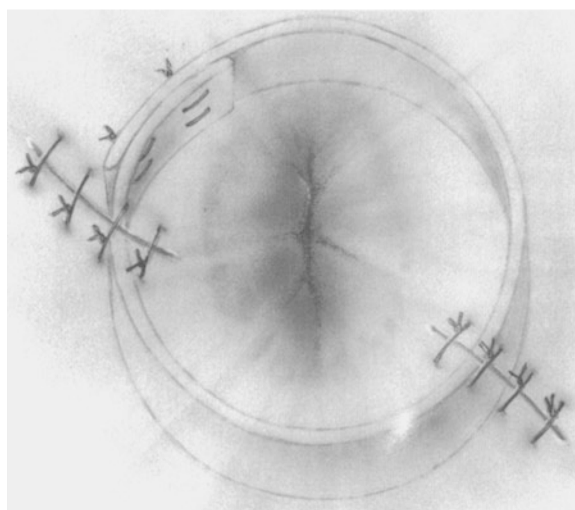


Fig. 92–4

References

Goligher JC. Surgery of the anus, rectum and colon, 4th ed. London: Balliere Tindall; 1980.

Labow S, Rubin RJ, Hoexter B et al. Perineal repair of rectal procidentia with an elastic sling. Dis Colon Rectum 1980;23:467–469.

Lomas ML, Cooperman H. Correction of rectal procidentia by use of polypropylene mesh (Marlex). Dis Colon Rectum 1972;15:416.

93 Operations for Pilonidal Disease

Concept: Pathogenesis and Selection of Optimal Operation

In past decades it was thought that a pilonidal sinus was the result of a congenital remnant of epithelium or an invagination of skin. The presence of hair in the pilonidal cyst was explained by the persistence of hair follicles in the invaginated epithelium. If this hypothesis were true, corrective surgery would require a complete excision of the congenital lesion. Consequently, wide excision of a large elliptical segment of skin down to the post-sacral fascia was advocated. This often left a large skin defect which could not be closed per primam. Consequently, complicated operations, such as sliding flaps of gluteal muscle or broad-based sliding skin flaps, were devised to close the defect. Despite the extensive surgery, primary healing was not uniformly achieved, and recurrences were not uncommon. If the wound was left open after a radical excision, healing by granulation tissue and contraction often required 6–12 months.

Evidence against the congenital theory is the fact that in 90% or more of cases, a pilonidal cyst or sinus is lined by dense fibrous tissue, and no epithelium or hair follicles can be identified (Patey and Scarff). Rather than resulting from a congenital remnant, it appears much more likely that the pilonidal sinus is an acquired disease. One mechanism, especially in the hirsute male, is the penetration of the skin by hairs in the midgluteal cleft. This apparently can take place when twisted hair is stimulated by the rolling action of the buttocks during the process of walking, resulting in a drilling action that permits the hair to penetrate the skin. When the hair accumulates in the subcutaneous fat, it acts as a foreign body. When the area has been contaminated by bacteria, chronic recurrent infection, abscess formation, and persistent drainage is perpetuated by the presence of the foreign body (hair). This theory of pathogenesis easily explains the presence of pilonidal sinuses in the interdigital clefts of barbers.

Whether or not the hypothesis that the entry of hair beneath the skin explains the origin of pilonidal disease, it is certainly true that the entry of hair into the healing wound following excision of a pilonidal cyst is a common cause of a recurrence.

After a histological study of excised pilonidal specimens, Bascom came to the conclusion that almost all pilonidal disease begins with an infected hair follicle in the midgluteal cleft. The infection follows the occlusion of the follicle's orifice with keratin. Then the infection ruptures through the deep side of the follicle into the subcutaneous fat, creating a pilonidal abscess. If this is a virulent infection, an acute abscess becomes the presenting complaint of the patient. In other cases a chronic pilonidal abscess with intermittent purulent drainage may occur. Eventually the abscess burrows laterally, forming additional sinuses. Based on this hypothesis of pilonidal pathogenesis, Bascom has designed a therapy based on local excision of each of the dilated hair follicles (sinus pits) located in the midgluteal cleft. These are left unsutured. Drainage of the pilonidal cyst or sinus is then accomplished by a lateral incision. Granulation tissue and hair is carefully evacuated through this lateral incision. Bascom performs this surgery under local anesthesia on an ambulatory outpatient basis. He never performs definitive surgery in the presence of an acute abscess. Rather, the acute abscess is drained through a lateral incision and the definitive operation performed 5–7 days later. Bascom treated 50 consecutive cases by these principles. The mean disability was no more than 1 day. Average time for complete healing of the wounds was 3 weeks. After 24 months' follow-up, recurrence was noted in 8%. Each recurrence was healed within 3 weeks after similar outpatient surgery. There were no second recurrences. The principle of avoiding a midline incision, one that is notoriously slow to heal, appears to be an important contribution to conservative surgery for pilonidal disease.

When a patient has a midline chronic sinus following the rupture of an infected follicle into the deep fat, hair is sucked into the depth of the sinus. The presence of loose hair in the midgluteal cleft is due to inadequate hygiene. When the patient is in a sitting position the pilonidal cyst is collapsed, but when the patient assumes the erect position, air and loose hair are sucked into the sinus as the cavity reforms when the overlying skin is no longer pressed against the sacrum.

Although none of these theories completely explains all of the manifestations of pilonidal disease, the evidence against the congenital nature of this condition encourages the trend towards conservatism in therapy. It is not necessary to perform radical excision to cure a pilonidal sinus. In the presence of chronic infection, conservative excision of a narrow strip of skin will unroof the pilonidal cyst, will also eliminate the pits, and will permit the surgeon to remove all of the hair and chronic granulation tissue. This leaves behind the fibrous base of the pilonidal cyst. Healing of the defect can be accelerated if the opening is marsupialized by suturing the skin to the cut edge of the cyst. As the fibrous tissue contracts, the skin edges will be brought into approximation, generally within a period of 3–6 weeks. During this time, careful cleansing of the area and weekly shaving of the skin around the cyst will prevent the ingress of hair into the healing wound. Abramson has reported excellent results with this method.

Excision of pilonidal disease with primary suture of the skin is an operation that can be successfully accomplished only in carefully selected patients. Operation must be done at a time when infection is quiescent. The ideal patient for this operation will not have more than one lateral sinus tract. Preferably, the entire diseased area can be encompassed by excising a width of no more than 1.0–1.5 cm of skin and underlying fat. Plan the operation so that the dissection encompasses the pilonidal sinus tract without entering into the diseased area. If this can be accomplished by a conservative excision, then the resulting defect can be reconstructed by suturing the fat in one layer and the skin in a second layer *without excessive tension.* Simply suturing the skin together and leaving a large subcutaneous empty space will often result in postoperative infection. Similarly, closures that require large retention sutures to be tied under tension will also lead to an unacceptable number of wound failures. When a primarily sutured pilonidal wound develops a secondary wound infection that requires open drainage, the time required for eventual healing will be much longer than if a simple marsupialization operation were performed in the first instance. Consequently, good judgment will restrict primary suture to those patients in whom primary healing can be assured. Holm and Hulten noted primary healing in 94% of 48 operations by this method.

Indication

Recurrent symptoms of pain, swelling, and purulent drainage

Pitfalls and Danger Points

Unnecessarily radical excision

Operative Strategy

Acute Pilonidal Abscess

If an adequate incision can be made, and all of the granulation tissue and hair removed from the cavity, a cure may be accomplished in a number of patients with acute abscesses.

Marsupialization

In this procedure a narrow elliptical incision is made unroofing the length of the pilonidal cavity. Do not excise any significant width of the overlying skin but only enough to remove the sinus pits. If this is accomplished, one can approximate the lateral margin of the pilonidal cyst wall to the subcuticular layer of the skin with interrupted sutures. At the conclusion of this procedure, there should be no subcutaneous fat visible in the wound. Healing of exposed subcutaneous fat tends to be very slow. On the other hand, the fibrous tissue lining the pilonidal cyst tends to contract fairly rapidly. This produces approximation of the marsupialized edges of skin during a period of only several weeks. There is no necessity to excise a width of skin more than 0.8–1.0 cm. Conservative skin excision is followed by more rapid healing. Of course, all granulation tissue and hair must be curetted away from the fibrous lining of the pilonidal cyst.

Excision with Primary Suture

Successful accomplishment of primary healing requires that the pilonidal cyst be encompassed by the excision of a narrow strip of skin including the sinus pits and a patch of subcutaneous fat not much more than 1 cm in width. If this can be achieved without entering the cyst, closing the relatively shallow and narrow wound will not be difficult. Perform the dissection with the electrocautery because hemostasis must be perfect if the surgeon is to be certain that he has not transected some part of the pilonidal sinus resulting in an incomplete excision of the cyst and possible contamination of the wound. If this technique has been successfully accomplished, the postoperative convalescence is quite short.

It is not necessary to carry the dissection down to the sacrococcygeal ligaments in order to assure the successful elimination of the pilonidal disease. In essence, the surgeon is simply excising a chronic granuloma surrounded by a fibrous capsule and covered by a strip of skin containing the pits that constituted the original portal of entry of infection and hair into the abscess. For primary excision, the operation should be timed some months after an episode of acute infection so that the bacterial content of the pilonidal complex is minimal. Primary

Fig. 93–1

Fig. 93–2

healing following this excision will require that the surgeon achieve the principles of good wound architecture. If a large segment of subcutaneous fat is excised, simply approximating the skin over a large dead space may result in temporary healing in the absence of bacteria, but eventually the wound is likely to separate. Unless the surgeon is willing to construct extensive sliding skin flaps or a Z-plasty, the operation of excision with primary closure should be restricted to those cases in whom wide excision is not necessary.

Operative Technique

Acute Pilonidal Abscess

Although it is possible under local anesthesia to excise the midline sinus pits, and to evacuate the pus and hair through this incision, often the abscess points in an area away from the gluteal cleft and complete extraction of the hair will prove to be too painful to the patient. Consequently, in most cases, evacuate the pus during the initial drainage procedure and postpone a definitive operation until the infection has subsided.

Infiltrate the skin overlying the abscess with 1% lidocaine containing 1:200,000 epinephrine. Make a scalpel incision of sufficient size to evacuate the pus and necrotic material. Whenever possible, avoid making the incision in the midline. If it is possible to extract the loose hair in the abscess, do so. Otherwise, simply insert loose gauze packing.

Marsupialization Operation

This operation, first described by Buie in 1944, begins with the insertion of a probe or grooved director into the sinus. Then incise the skin overlying the probe with a scalpel. Do not carry the incision beyond the confines of the pilonidal cyst. If the patient has a tract leading in a lateral direction, insert the probe into the lateral sinus and incise the skin over it. Now excise no more than 1–3 cm of the skin edges on each side to include the epithelium of all of the sinus pits along the edge of the skin wound (**Fig. 93–1**). This will expose a narrow band of subcutaneous fat between the lateral margins of the pilonidal cyst and the epithelium of the skin. Achieve complete hemostasis by carefully electrocoagulating each bleeding point.

Upon unroofing the pilonidal cyst, remove all granulation tissue and hair, if present, by using dry gauze, the back of a scalpel handle, or a large curet to wipe clean the posterior wall of the cyst (**Fig. 93–2**).

Then approximate the subcuticular level of the skin to the lateral margin of the pilonidal cyst with

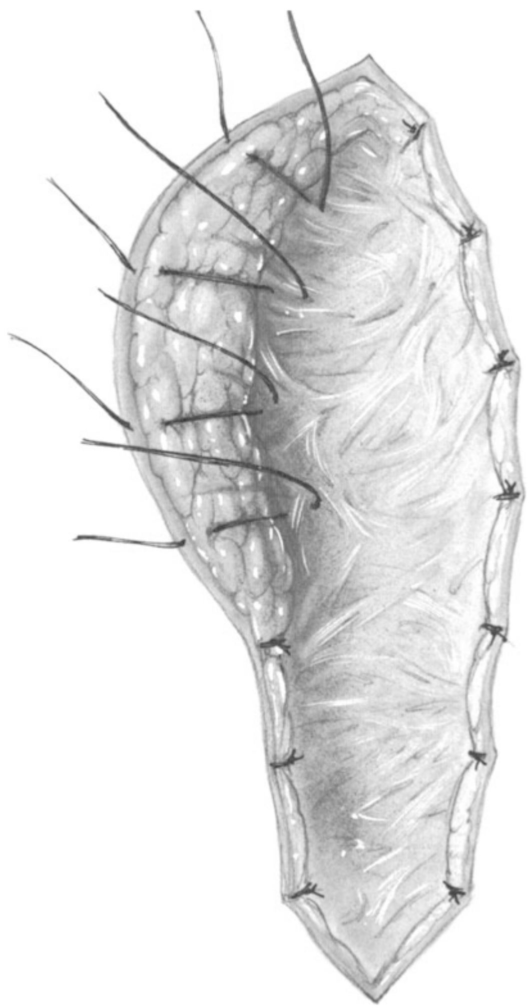


Fig. 93–3

interrupted sutures of 3–0 or 4–0 PG (**Fig. 93–3**). Ideally, at the conclusion of this procedure there will be a fairly flat wound consisting of skin attached to the fibrous posterior wall of the pilonidal cyst, with no subcutaneous fat being anywhere visible. In the quite rare situation where the pilonidal cyst wall is covered by squamous epithelium, the marsupialization operation will be just as effective as in the great majority of cases where the wall consists only of fibrous tissue.

We usually perform this operation with the patient in the prone position with the buttocks retracted laterally by adhesive straps under local anesthesia as Abramson advocates for his modification of the marsupialization operation.

Pilonidal Excision with Primary Suture

Use either caudal, general, or local field block anesthesia. Place the patient in the prone position with a pillow under the hips and the legs slightly flexed. Apply adhesive strapping to each buttock and retract each in a lateral direction by attaching the adhesive tape to the operating table. Before scrubbing, in preparation for the surgery, insert a sterile probe into the pilonidal sinus and gently explore the dimensions of the underlying cavity in order to confirm the fact that it is not too large for excision and primary suture.

After shaving, cleansing, and preparing the area with an iodophor solution, make an elliptical incision only of sufficient length and width to encompass the underlying pilonidal sinus and the sinus pits in the gluteal cleft (see Fig. 93–1). In properly selected patients, this will require the excision of a strip of skin no more than 1.0–1.5 cm in width. Deepen the incision on each side of the pilonidal sinus (**Fig. 93–4**). Use the electrocoagulator for the dissection to achieve complete hemostasis. Otherwise, the presence of blood will prevent the accurate visualization that is necessary to avoid entering one of the potentially infected pilonidal tracts. Dissect the specimen

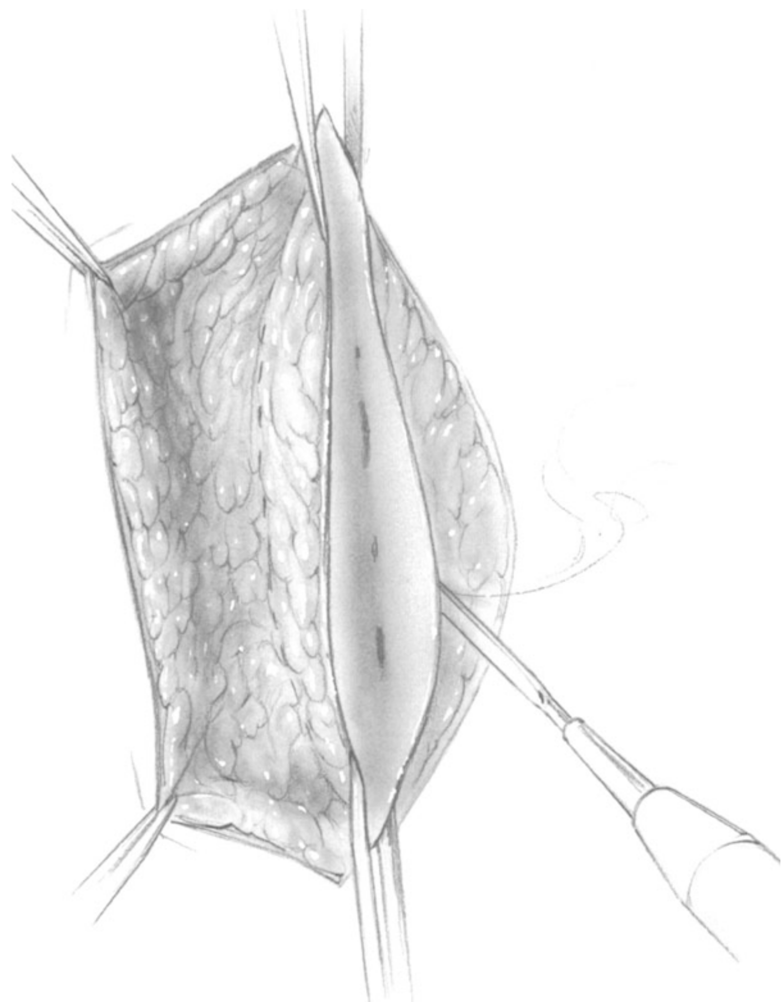


Fig. 93–4

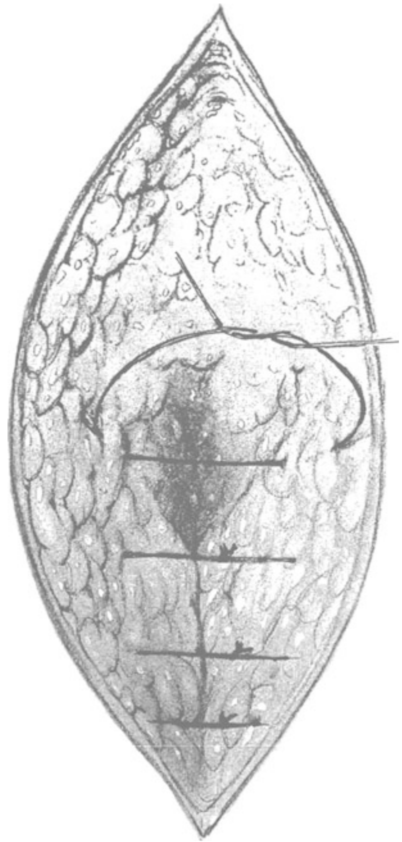


Fig. 93–5

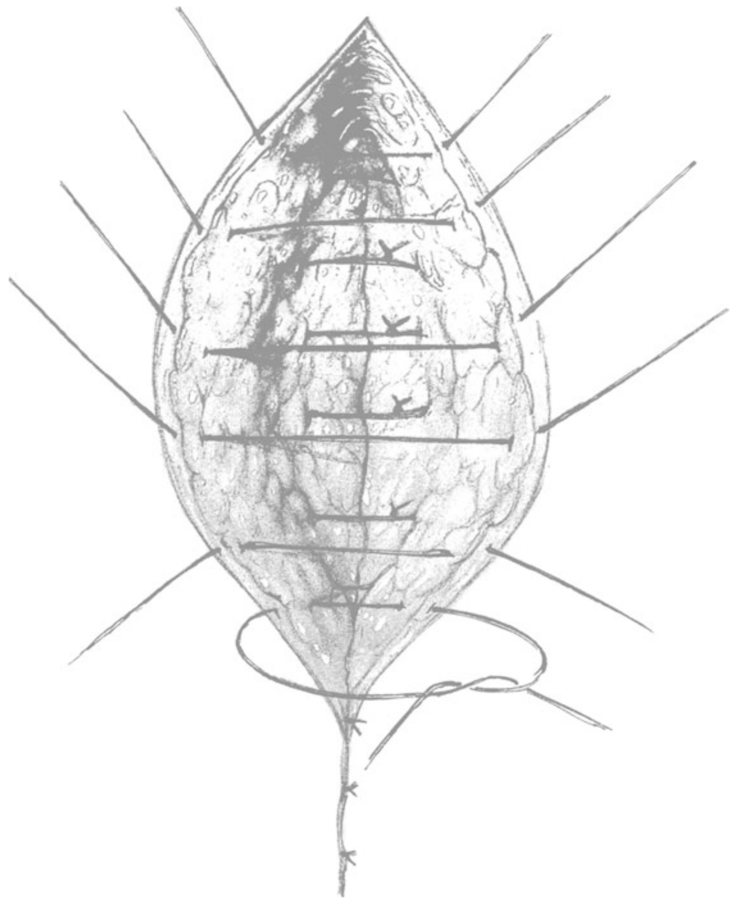


Fig. 93–6

away from the underlying fat without exposing the sacrococcygeal periosteum or ligaments. Remove the specimen and check for complete hemostasis. The specimen should not measure more than 5 × 1.5 × 1.5 cm in size. This makes it possible to approximate the subcutaneous fat with interrupted 3–0 or 4–0 PG sutures without tension (**Fig. 93–5**). Insert interrupted subcuticular sutures of 4–0 PG (**Fig. 93–6**) or close the skin with interrupted nylon vertical mattress sutures. Avoid leaving any dead space in the incision. If at some point in the operation the pilonidal cyst has been inadvertently opened, irrigate the wound with a dilute antibiotic solution and complete the operation as planned unless frank pus has filled the wound. In the latter case, simply leave the wound open and insert gauze packing without any sutures. Primary closure requires the patient to remain inactive to encourage primary healing.

Excision of Sinus Pits with Lateral Drainage

In Bascom's modification of Lord and Millar's operation, only the sinus pits (**Fig. 93–7**) are excised in the midgluteal cleft. This may be accomplished with a pointed No. 11 scalpel blade (**Fig. 93–8a**), or with the dermatologist's round skin biopsy punches. These are available in diameters as large as 5 mm. They simply represent cork borers whose ends have been sharpened to a cutting edge. Most of the pits are simply epithelial tubes going down toward the pilonidal cyst for a distance of a few millimeters. Leave unsutured the resulting wounds from the pit excisions.

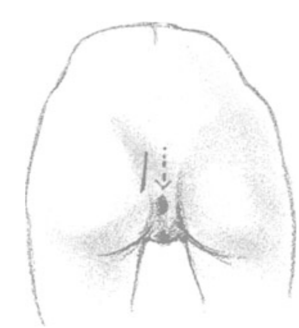


Fig. 93–7

Insert a probe into the underlying pilonidal cavity to determine its dimensions. Then make a vertical incision parallel to the long axis of the pilonidal cavity. Make this incision about 1.5 cm lateral to the midgluteal cleft (**Fig. 93–8b**). Open the pilonidal cyst through this incision. Curet out all of the granulation tissue and hair. Achieve complete hemostasis with the electrocoagulator. A peanut gauze dissector is also useful in this step. Bascom does not insert any drains or packing. Occasionally three or more enlarged follicles (pits) are so close together in the midgluteal cleft that individual excision of each follicle is impossible. In this case Bascom simply excises a narrow strip of skin encompassing all of the pits. If the skin defect in the cleft exceeds 7 mm, he sutures it closed. The lateral incision is always left open. In patients who have lateral extensions of their pilonidal disease, each lateral sinus pit is excised.

Bascom found that occasionally there was an ingrowth of dermal epithelium into the subcutaneous fat forming an epithelial tube resembling a thyroglossal duct remnant. These resemble pieces of macaroni, and Bascom advises excising these epithelial tubes through the lateral incision.

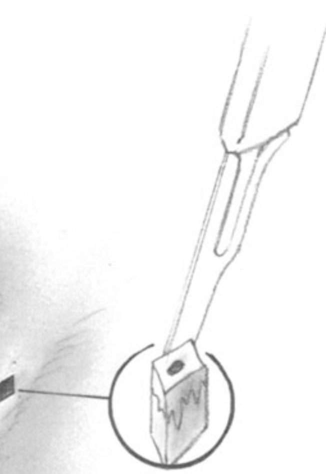


Fig. 93–8b

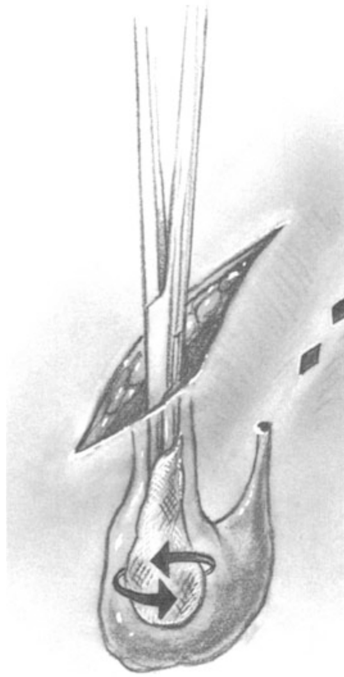


Fig. 93–8a

Postoperative Care

Following the drainage of an *acute pilonidal abscess*, remove the gauze packing the next day and have the patient shower daily in order to keep the gluteal cleft clean and free of any loose hair.

Shave the skin for a distance of about 5 cm around the midgluteal cleft weekly. In some cases it is possible to use a depilatory cream to achieve the same result. Otherwise, hair will find its way into the pilonidal cavity and act as a foreign body, initiating a recurrence of infection.

Following *excision and primary suture*, remove the gauze dressing on the 2nd day and leave the wound exposed. Initiate daily showering especially after each bowel movement. Observe the patient closely 2 or 3 times a week in the office. If evidence of a localized wound infection appears, open this area of the wound and administer appropriate antibiotics, treating the condition in the same way as you would treat an infection in an abdominal incision. If the infection is extensive, it is necessary to lay open the entire incision. With good wound architecture, infection will be uncommon. Also, shave or apply a depilatory cream to the area of the midgluteal cleft for the first two or three postoperative weeks or until the wound is completely healed.

If the patient has undergone *pit excision and lateral drainage*, postoperative care is limited to daily showers and weekly observation by the surgeon to remove any hairs that may have invaded the wound. Bascom applies Monsel's solution to granulation tissue. All of his patients have been operated upon as ambulatory outpatients.

No matter what the operative procedure, patients with pilonidal disease require instruction to always avoid the accumulation of loose hair in the midgluteal cleft. Daily showering with special attention to cleaning this area should prevent recurrence.

Postoperative Complications

Infection may follow the primary suture operation.

Hemorrhage has been reported in the series described by Lamke, Larsson, and Nylen. Of the patients treated by wide excision and packing, 10% experienced postoperative hemorrhage requiring blood transfusion and reoperation. This complication is easily preventable by meticulous electrocoagulation of each bleeding point in the operating room. It is rare following primary suture or marsupialization operations.

In patients followed for a number of years, recurrence of pilonidal disease seems to take place in 15% of cases whether treated by primary suture, excision and packing, or marsupialization. Goligher noted that even the radical excision operation did not seem to prevent recurrence. Consequently, it appears that in most cases recurrence is caused by poor hygiene permitting hair to drill its way into the skin of the midgluteal cleft, rather than inadequate surgery. Most recurrences are in the midline.

There may be a failure to heal. Some patients, especially those who have had a radical excision of pilonidal disease which leaves a large midline defect bounded by sacrococcygeal periosteum in its depths and subcutaneous fat around its perimeter, may sometimes endure failure of healing for a period as long as 2 years (Bascom). In some cases this is due to inadequate postoperative care in which the bridging of unhealed cavities has taken place, or in which loose hair has found its way into the cavity and produced reinfection. Occasionally, even when postoperative care is conscientious in these patients, there appears to be a cessation of the continuing fibrous contracture that should bring the lips of the wound together over a period of time. Bascom states that the preferred treatment is to unroof the wound widely followed by packing it with cotton saturated with Monsel's solution once or twice weekly. The patient is permitted to bathe with the packing in place. Because these midline wounds may occasionally take one or more years to heal, Bascom strongly recommends lateral incisions for pilonidal operations and claims never to have had the problem of delayed healing in his experience with the lateral incision.

References

Abramson DJ. A simple marsupialization technique for treatment of pilonidal sinus; long-term follow-up. Ann Surg 1960;151:261.

Bascom J. Pilonidal disease: origin from follicles of hairs and results of follicle removal as treatment. Surgery 1980;87:567.

Buie LA. Jeep disease (pilonidal disease of mechanized warfare). South Med J 1944;37:103.

Goligher JC. Surgery of the anus, rectum and colon, 4th ed. London: Balliere Tindall; 1980.

Holm J, Hulten L. Simple primary closure for pilonidal disease. Acta Chir Scand 1970;136:537.

Lamke LO, Larsson J, Nylen B. Results of different types of operation for pilonidal sinus. Acta Chir Scand 1974; 140:321.

Lord PH, Millar DM. Pilonidal sinus: a simple treatment. Br J Surg 1965;52:298.

Patey DH, Scarff RW. Pathology of postanal pilonidal sinus: its bearing on treatment. Lancet 1946;2:484.

Lymph Nodes

94 Inguinal and Pelvic Lymphadenectomy

Concept: When to Perform Inguinal and Pelvic Lymphadenectomy (See also Chap. 56.)

Groin lymphadenectomy is comprised of two separate lymph node groups: inguinal and pelvic. The inguinal nodes are located in the femoral triangle, based on the inguinal ligament with its apex formed by the crossing of the adductor longus and the sartorius muscles. The pelvic component of the dissection includes the lymph nodes in a triangular area whose apex is formed by the bifurcation of the common iliac artery and whose base is essentially the fascia over the obturator foramen. If the *inguinal* lymphadenectomy specimen is negative for metastases from the primary malignant melanoma or epidermoid carcinoma of the skin of the extremities or lower trunk, performing the *pelvic* dissection is probably unnecessary because the incidence of positive nodes will then be less than 5% (Holmes et al.).

For primary carcinoma of the external genitalia, the vulva, or the vagina, often a combined excision of the primary lesion together with bilateral inguinal lymphadenectomy is carried out. When a patient has a primary epidermoid carcinoma of the anus that is accompanied by metastatic lymph nodes in the groin, radical lymphadenectomy does not appear to influence prognosis and is therefore not indicated. Patients who have epidermoid carcinoma of the skin, in general, are not subjected to prophylactic groin lymphadenectomy, but rather the node dissection is postponed until a suspicious node is palpated. As discussed in Chap. 56, for patients with malignant melanomas 1.5 mm or more in thickness, prophylactic lymphadenectomy is warranted. If a patient has a melanoma of the trunk in the midline or within 2 cm of the midline, tumor emboli may metastasize either to the ipsilateral or the contralateral groin or axilla.

Indications

Metastatic involvement of inguinal lymph nodes secondary to malignant melanoma or epidermoid carcinoma of the skin of the lower extremity, the lower trunk, or the external genitalia.

Preoperative Care

Administer perioperative systemic antibiotics.

Prior to hospitalization, have the patient's lower extremity measured for a fitted elastic stocking to cover the area from the toes to the upper thigh (e.g., Jobst).

Check for distant metastases by performing chest X ray and CT liver scan.

Pitfalls and Danger Points

Impairing the viability of the skin flaps

Injuring the iliofemoral artery or vein, or the femoral nerve and its branches

Operative Strategy

Preserving Skin Viability

Traditionally, surgeons have used a vertical elliptical incision centered on the femoral vessels and have emphasized a wide dissection of thin skin flaps. This often led to areas of necrosis in the dissected skin. Delayed healing by secondary intention will then cause some degree of subacute cellulitis and occlusion of collateral lymphatic pathways, thus increasing the incidence or severity of postoperative lymphedema of the extremity. It is not necessary to dissect the skin flaps beyond the confines of the femoral triangle. The less the dissection, the less the impairment of blood supply to the skin flaps. Also, we agree with Holmes and associates that a primarily oblique skin incision along the inguinal crease is less prone to loss of viability than is the vertical type of incision.

Exposing the Iliac Region

In exposing the region of the iliac vessels for a pelvic lymphadenectomy, two approaches have commonly been employed. One involves vertical division of the inguinal ligament along the line of the iliofemoral vein with later resuturing of this ligament and the floor of the inguinal canal. In some patients the suture line is insecure and this results in a hernia. Also, patients in whom this approach is employed appear to have an increased number of skin complications. An alternative approach to the pelvis for iliac lymphadenectomy is to perform a second incision in the lower abdomen parallel to and about 3–4 cm cephalad to the inguinal ligament. After this incision has been carried through the transversalis fascia, the peritoneal sac is retracted upward to expose the iliac vessels and their adjacent fat and lymph nodes. Exposure by this approach is adequate and closing the incision is simple.

Operative Technique

Incision and Exposure

Position the lower extremity so that the thigh is mildly abducted and flexed as well as being externally rotated. Support the leg in this position by a firm pillow or sandbag.

Start the incision 2–3 cm cephalad and medial to the anterior superior spine of the ilium. Continue caudally to a point 1–2 cm below the inguinal crease. Continue along the inguinal crease in a medial direction until the femoral vein has been reached. At this point curve the incision gently in a caudal direction for about 5 cm as noted in **Fig. 94–1**. Elevate the cephalad skin flap with rake retractors. Use either the electrocautery with a low cutting current or a scalpel to dissect the skin flap in a superior direction in a plane that leaves 4–5 mm of subcutaneous fat on the skin. In obese patients, we make the plane of dissection somewhat deeper than 4–5 mm. As the skin flap is dissected toward the outer margin of the operative field, increase the thickness of the flap in a tapered fashion so that the base of the flap is thicker than its apex. The cephalad margin of the dissection should be 5–6 cm above the inguinal ligament.

Fig. 94–1

Now dissect the inferior skin flap in a similar fashion. Remember that it is not necessary to elevate this skin flap beyond the lower boundaries of the femoral triangle. The lateral boundary consists of the medial border of the sartorius muscle. The lateral aspect of the adductor longus muscle is the medial boundary. The apex of the femoral triangle constitutes the point where the sartorius muscle meets the adductor longus. Dissecting the skin beyond the femoral triangle has no therapeutic value and may impair the blood supply to the skin.

Exposing the Femoral Triangle

Initiate the dissection along a line parallel and 5–6 cm cephalad to the inguinal ligament. Incise the fat down to the aponeurosis of the external oblique muscle. Then, using a scalpel, dissect the abdominal fat off this aponeurosis down to and beyond the inguinal ligament. In men, identify and preserve the spermatic cord as it emerges from the external inguinal ring (**Fig. 94–2**).

Use a scalpel or Metzenbaum scissors to incise the fat overlying the adductor longus muscle just below the inguinal ligament about 2 cm medial to the pubic tubercle. Expose the muscle fibers of the adductor muscle and use a scalpel to dissect the fat and fascia down along the lateral border of this muscle. Continue the dissection along this muscle in a caudal direction to a point where the sartorius muscle crosses the lateral margin of the adductor longus muscle. Sweep the muscle fascia, fat, and lymph nodes in a medial direction (**Fig. 94–3**). At the apex of the femoral triangle, identify, ligate, and divide the internal saphenous vein. Then incise the fascia overlying the sartorius muscle beginning at the apex of the femoral triangle and continuing in a cephalad direction up to the origin of the sartorius muscle at the iliac bone. Sweep the fat, lymphatic tissue, and fascia overlying the sartorius muscle by dissecting in a medial direction.

Dissecting Femoral Artery, Vein, and Nerve

Identify the femoral artery and vein near the apex of the femoral triangle. Using Metzenbaum scissors

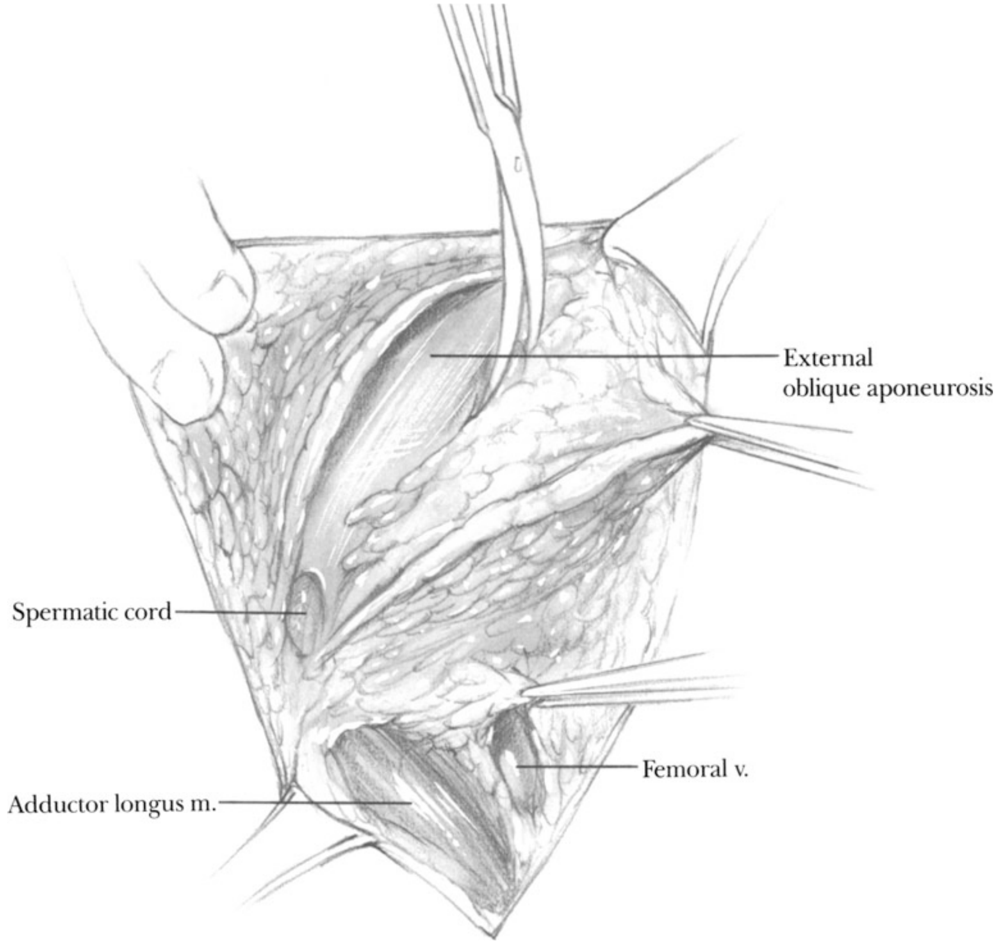


Fig. 94–2

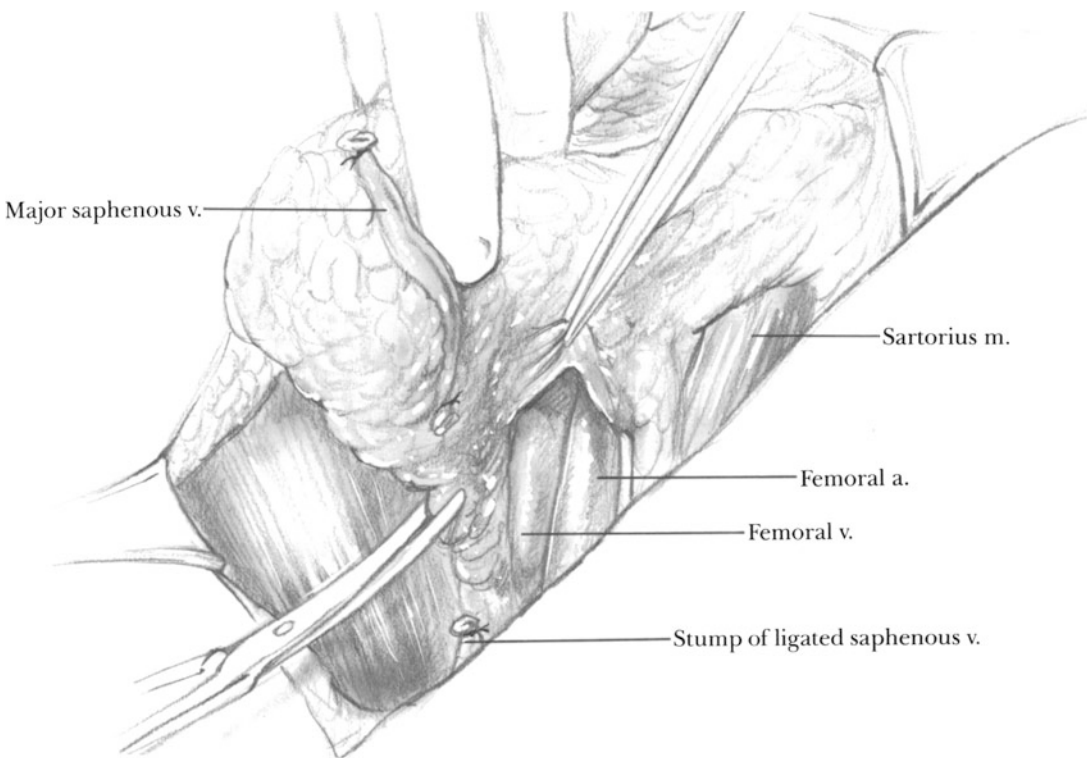


Fig. 94–3

dissection, elevate the areolar tissue and fat from the anterior surfaces of the femoral vessels proceeding in a cephalad direction (Fig. 94–3). Dissect the specimen from the medial border of the femoral triangle in a lateral direction to expose the medial aspect of the femoral vein. There are no branches on this side of the vein. Identify the entrance of the internal saphenous vein into the anterior surface of the femoral vein. Ligate and divide the saphenous vein. This dissection will have exposed the pectineus muscle deep to the femoral vein and medial to the adductor longus muscle. The femoral canal is located deep to the inguinal ligament just medial to the femoral vein. Remove and identify the cephalad lymph node situated in this triangle. Label it for the pathologist. Continue to dissect the specimen laterally exposing the length of the femoral artery. Several small arterial branches going to the specimen have to be divided and ligated before the specimen can be separated from this vessel.

Take note of the fact that the femoral nerve, situated just lateral to the femoral artery, is covered by a thin fibrous layer of the femoral sheath. Carefully incise this layer at a point below the inguinal ligament and lateral to the femoral artery. Identify and perserve the branches of the femoral nerve as it passes deep to the sartorius muscle. After this step, detach the specimen and submit it for frozen section pathological examination to determine the presence of metastatic disease in the lymph nodes.

Irrigate the operative field with a dilute antibiotic solution and achieve complete hemostasis by means of PG ligatures and electrocoagulation. If the inguinal specimen does not contain any metastatic lymph nodes, terminate the operation and omit the pelvic lymphadenectomy. If metastatic lymph nodes are found, proceed to a pelvic lymphadenectomy.

The appearance of the operative field at the conclusion of the inguinal lymphadenectomy is illustrated in **Fig. 94–4.**

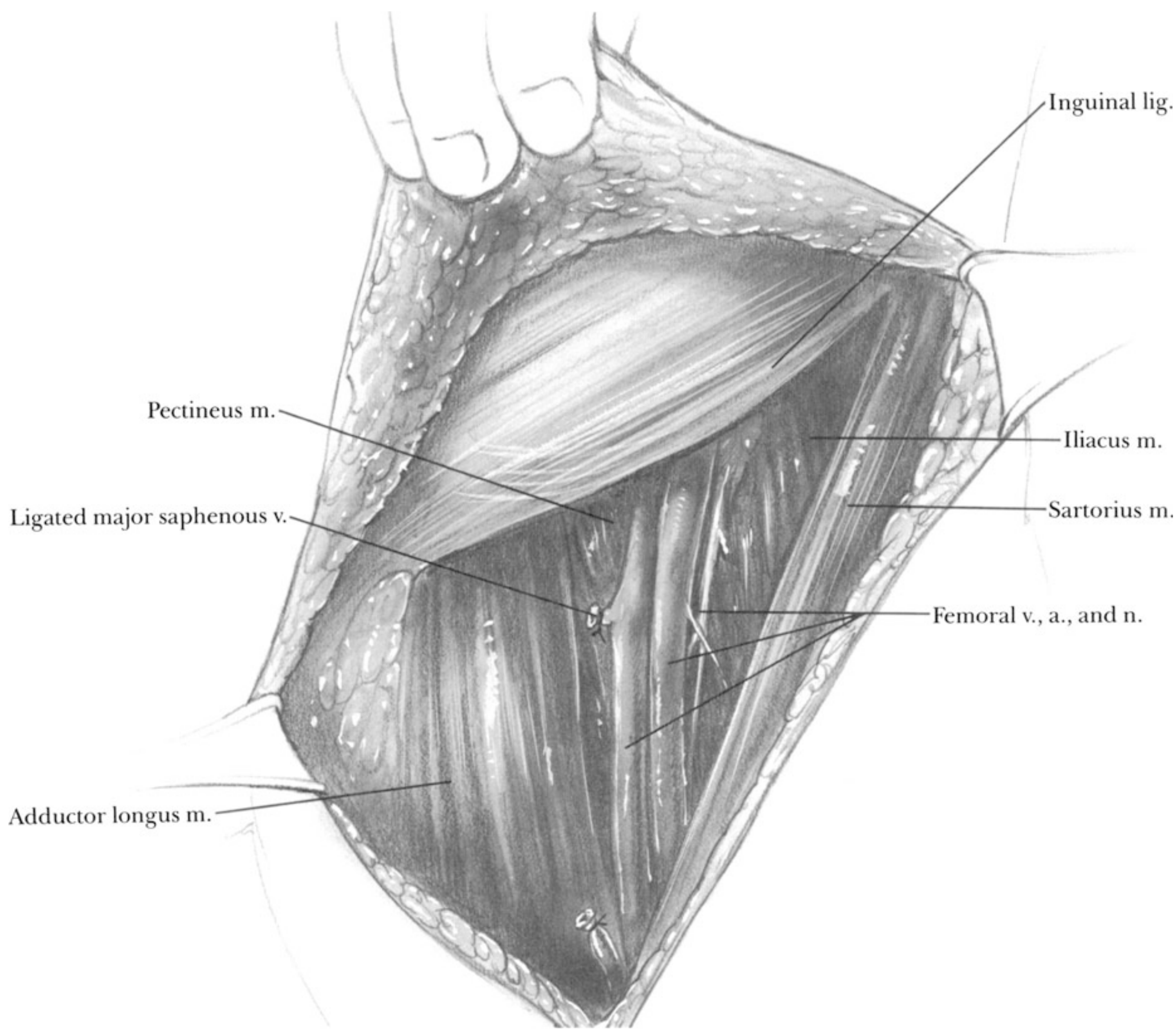


Fig. 94–4

Transposing Sartorius Muscle

In some patients necrosis of the skin overlying the femoral vessels may occur and thus endanger the viability of these structures. In order to protect the femoral artery and vein from the consequences of a possible slough, transpose the sartorius muscle in a medial direction so that it lies over the femoral vessels (**Fig. 94–5**). Transect the sartorius muscle at its insertion by using the electrocoagulating device (**Fig. 94–6**). Free the proximal 6–7 cm of this muscle from underlying attachments and transpose it in a medial direction so that it is now situated in a vertical line overlying the femoral vessels. Suture the cut end of the sartorius muscle to the inguinal ligament using interrupted 3–0 Tevdek sutures (**Fig. 94–7**), prior to closing the skin.

Pelvic Lymphadenectomy

Make an incision with the scalpel in the direction of the fibers of the external oblique aponeurosis at a level about 3–4 cm above the inguinal ligament from the region above the external inguinal ring to the anterior superior spine (Fig. 94–7). Next, divide the underlying internal oblique muscle with the electrocoagulator. Carry the incision through the transversus muscle together with the underlying transversalis fascia but not through the peritoneum. This procedure is similar to that used in Chap. 82 for the exposure required in a Cooper's ligament repair of an inguinal or femoral hernia. Identify the deep inferior epigastric artery and vein arising just above the inguinal ligament from the external iliac artery and vein. Ligate and divide the deep inferior epigastric vessels. Now use gauze dissection to sweep

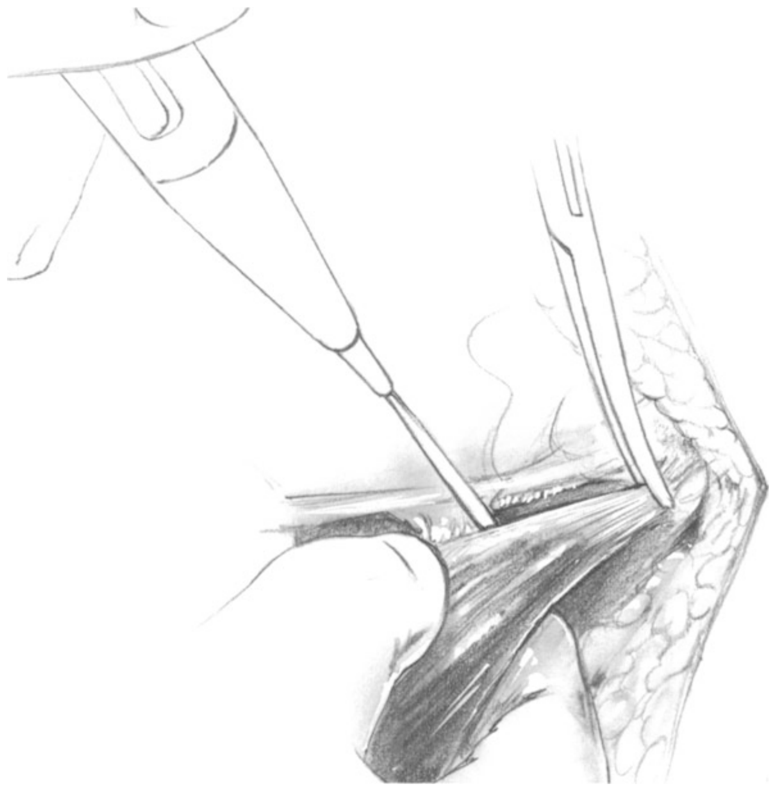


Fig. 94–6

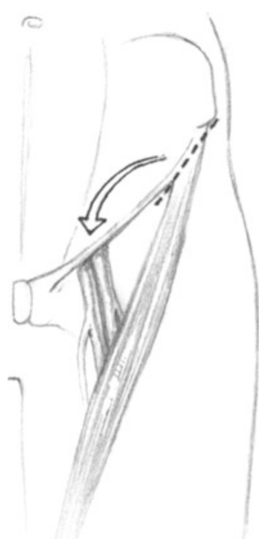


Fig. 94–5

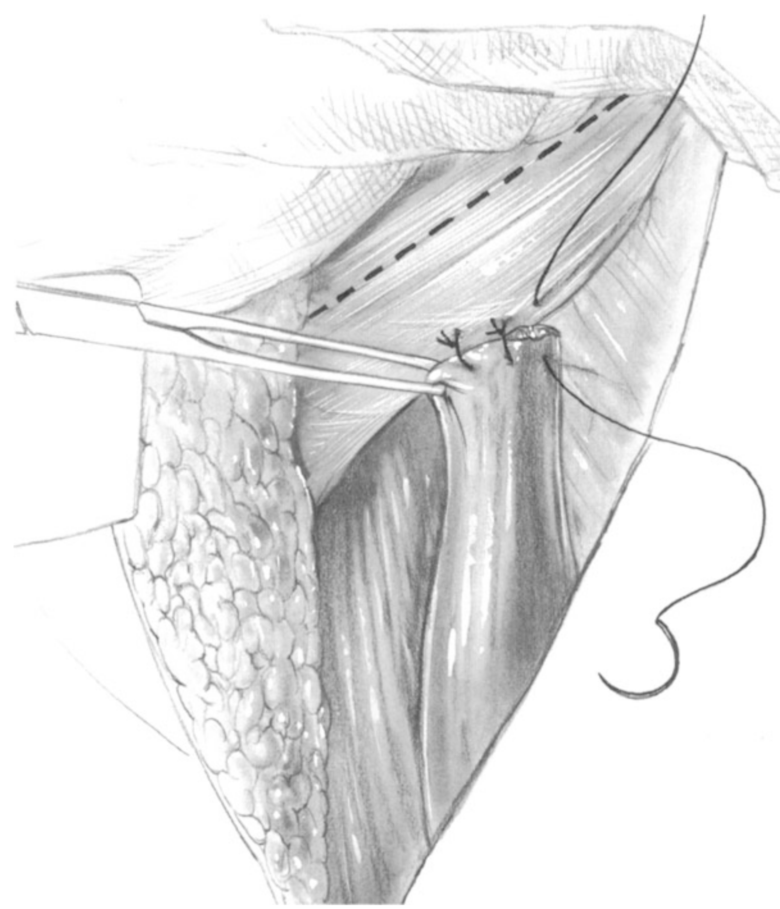


Fig. 94–7

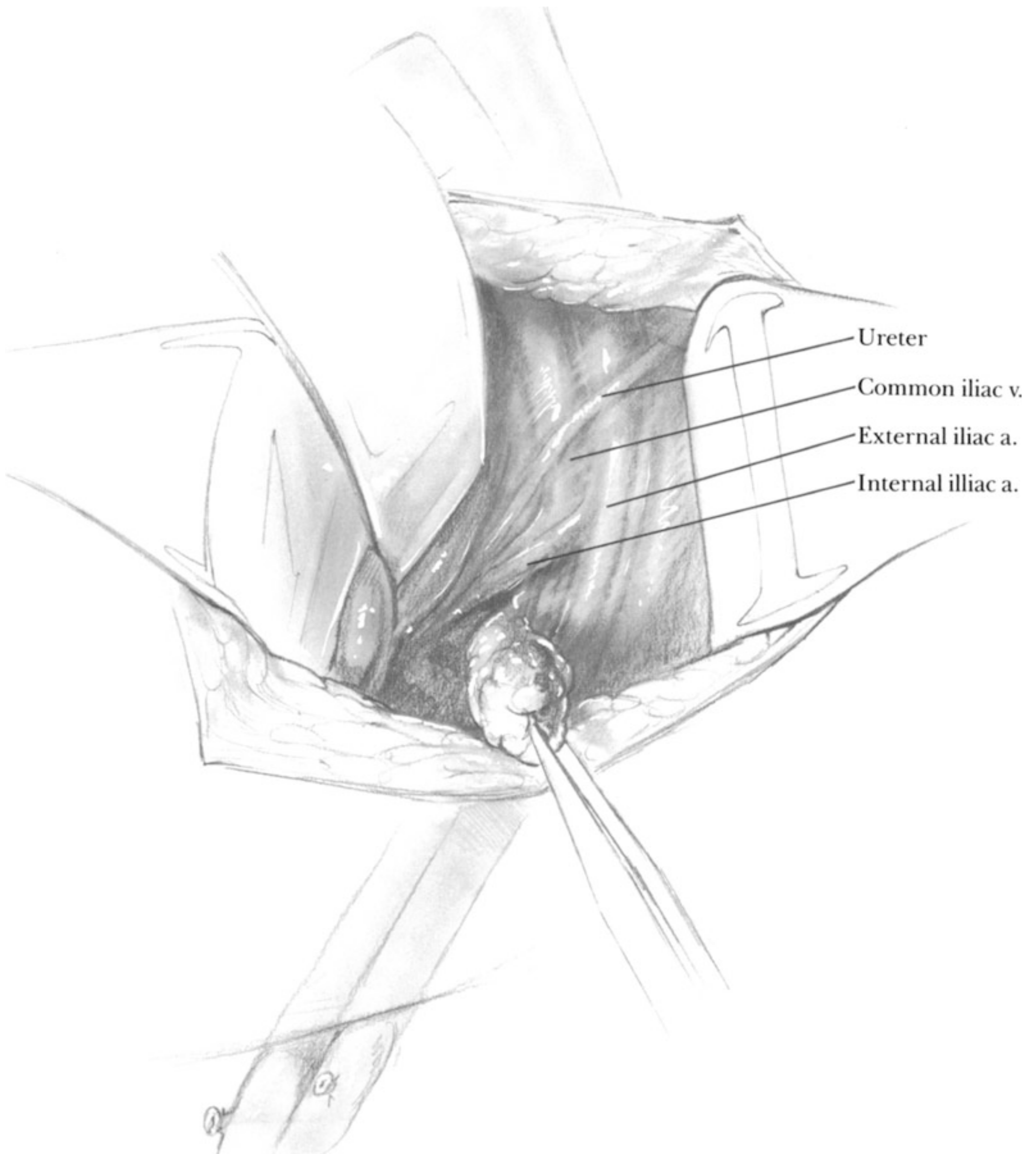


Fig. 94–8

the peritoneum together with the abdominal contents in a cephalad direction. Insert a moist gauze pad and a wide deep retractor to elevate these structures out of the pelvic cavity. *Identify and preserve* the ureter. Generally it will remain adherent to the peritoneal layer and will have been elevated together with the abdominal structures behind the retractor.

The area to be dissected is that contained between the external iliac and the internal iliac vessels down to the obturator membrane overlying the obturator foramen (**Fig. 94–8**).

Initiate the mobilization by dissecting the lymph nodes and fat overlying the external iliac artery and vein beginning at the inguinal ligament and proceeding in a cephalad direction to the junction with the internal iliac vessels. Be careful in clearing fat and lymphatic tissue from the iliac vein since this structure is quite fragile. Lacerations of the vein produce considerable hemorrhage and are difficult to control. After sweeping the fat and lymphatic tissues from the apex of the dissection in a downward direction, identify and preserve the obturator artery and vein. Terminate the dissection at this point and remove the specimen. Hemostasis is achieved in this dissection primarily by careful application of Hemoclips and ligatures. After hemostasis is assured, irrigate the pelvis with a dilute antibiotic solution.

Now close the incision of the lower abdomen in layers by inserting interrupted 2–0 silk sutures into the transversalis fascia and the overlying aponeurosis of the transversus muscle; then into the internal oblique muscle; and finally into the external oblique aponeurosis. Close the defect in the femoral canal by suturing the inguinal ligament down to either Cooper's ligament or the pectineus fascia from below. No drains are placed in the pelvis.

Skin Closure and Drainage

Drain the area of the femoral triangle by passing two perforated plastic catheters, 3.0 mm in internal diameter, through puncture wounds in the area of the inguinal lymphadenectomy. Attach the catheters to a closed-suction drainage device. Irrigate the operative field again with a dilute antibiotic solution. Trim away any portion of the skin that seems devitalized. Close the skin with interrupted sutures of 4–0 nylon.

Postoperative Care

Perioperative antibiotics

Continue closed-suction drainage until the volume is less than 40 ml per day.

In the operating room, apply the elastic stocking that was ordered preoperatively to fit this patient's lower extremity.

Keep the patient at bed rest with the extremity elevated for no more than 2 or 3 days. Thereafter, although the patient is permitted to walk, he should not spend much time in a chair. Rather, much of the day should be spent in bed with the leg elevated. After discharge from the hospital, the patient should continue to wear a snug elastic stocking up to the upper thigh for at least 6 months. For the first 6–8 weeks he should lie down with the leg elevated for 1 hour 3 times daily. Otherwise permanent lymphedema of the extremity is likely to occur.

Postoperative Complications

Skin necrosis is preventable if care is taken in preparing the skin flaps and if unnecessarily extensive dissection of the skin flaps is avoided.

Reference

Holmes EC, Mosely S, Morton D et al. A rational approach to the surgical management of melanoma. Ann Surg 1977;186:481.

Head and Neck

95 Parotidectomy

Concept: How Much Gland to Remove for a Parotid Tumor

In designing an operation for the removal of benign tumors of the parotid gland, two important facts must be noted. First, although over 75% of parotid tumors are benign, the vast majority of these benign tumors are mixed tumors (pleomorphic adenomas). Simple enucleation of a mixed tumor is followed by a high recurrence rate. Often the *recurrent* mixed tumor will become malignant. Consequently, a wide margin of normal salivary gland must be excised around the benign mixed tumor. Second, although the parotid gland is not anatomically a truly bilobed structure, for purposes of surgical anatomy it may be considered to have a superficial and deep lobe with the branches of the facial nerve passing between these two structures. Consequently, it is feasible to excise the superficial lobe with preservation of the branches of the facial nerve. This dissection will be indicated for most patients who have mixed tumors of the parotid gland. A few mixed tumors will arise in the deep lobe of the gland. In these cases, perform a superficial parotid lobectomy in order to identify each of the facial nerve branches. Then, with preservation of the facial nerve, remove the deep lobe. The Warthin tumor (papillary cystadenoma lymphomatosum) does not require a margin of normal parotid tissue and may be enucleated. However, in most cases the surgeon will not be able to make a positive diagnosis of a Warthin's tumor preoperatively so that most of these tumors will also require exposure of the facial nerve and a partial superficial lobectomy. Small mixed tumors may similarly require a dissection of the facial nerve only in the region of the tumor. Then the tumor may be resected with a good margin of parotid tissue by doing a partial superficial lobectomy.

Malignant tumors of the parotid gland, unless unusually small in size, should be removed by total parotidectomy with excision of that portion of the facial nerve lying within the tumor. The nerve may be reconstructed by using microsurgery to insert a nerve graft, which is often taken from the auriculotemporal nerve.

Indications

Tumors of parotid gland

Chronic sialadenitis or calculi of the parotid ducts

Pitfalls and Danger Points

Damage to facial nerve and its branches

Failure to excise a mixed tumor with a sufficient margin of normal parotid tissue

Operative Strategy

Locating and Preserving the Facial Nerve

Some surgeons prefer to locate the major trunk of the facial nerve by first identifying a peripheral branch such as the marginal mandibular branch. Then they trace this nerve backward toward its junction with the cervical facial branch and finally to the main facial trunk. However, most authorities prefer to identify the main trunk of the facial nerve posterior to the parotid gland as the initial step in the nerve dissection. Before it enters the parotid gland, the main facial nerve is a large structure, often measuring 2 mm in diameter. Once this main trunk is identified, the key to dissection technique is to use either a fine, blunt-tipped Jones scissors or a mosquito hemostat. The closed hemostat tip is inserted in the plane immediately anterior to the nerve. After the surgeon gently opens the hemostat, the assistant will cut the loose fibrous tissue that attaches the nerve to the overlying parotid gland. Never divide any parotid tissue before identifying the facial nerve and its branches.

If the proper plane of dissection is maintained, bleeding is rarely a problem. Most bleeding will arise from small veins. These will generally stop with application of gauze pressure. An important part of the dissection technique is for the surgeon to apply pressure on the tissue posterior to the nerve with gauze while the assistant applies tension to the superficial lobe of the parotid gland using either Allis clamps or small retractors. An occasional small vein will have to be clamped with a small mosquito hemostat and tied with a fine absorbable ligature. Electrocautery may be used for hemostasis in areas of the dissection away from the facial nerve and its branches.

Using a nerve stimulator has not generally been found useful in this dissection. The surgeon should have sufficient familiarity with the appearance of the facial nerve so that he can make a positive visual identification. Occasionally some fibers of questionable nature attach to the facial nerve branches. These may be tested by gently pinching the fiber. Then look at the cheek for muscle twitching. This, of course, requires that the entire cheek and the corner of the eye be exposed when the surgical field is draped.

The key to successful nerve preservation is early identification of the main facial trunk. The facial nerve emerges from the skull through the stylomastoid foramen. This is situated just anterior to the mastoid process and just below the external auditory canal. Beahrs emphasizes that if the surgeon will place the tip of his index finger over the mastoid process with the fingertip aimed toward the nose, the middle of his finger will be pointing to the facial trunk which will emerge about 0.5 cm anterior to the center of the fingertip and perhaps 1 cm deep to the external surface of the mastoid process. An idea of the depth at which the nerve will emerge can be gained by identifying the posterior digastric muscle and tracing it toward its insertion deep to the mastoid process. The nerve will cross at a level equivalent to the surface of the digastric muscle. In other words, dissect along the anterior surface of the sternomastoid muscle and the mastoid process posterior to the parotid gland. There will be no vital structure in this plane crossing superficial to the main trunk of the facial nerve.

There is a tiny arterial branch (posterior auricular artery) crossing just superficial to the facial trunk. If the exposure is not adequate for accurate clamping and ligating, simple pressure will stop bleeding from this vessel if it has been transected. Consequently, focus intense attention on an area about 1 cm in diameter just anterior to the mastoid process and about 1 cm deep to its surface. This is where the facial trunk will be found unless there is a tumor in the deep portion of the parotid gland that has displaced the nerve to a more superficial plane. The cephalad margin of this 1 cm area of intense attention may be considered to be the fissure between the external auditory canal and the superior portion of the mastoid process.

Another point of caution in avoiding nerve damage is the elevation of the skin flap along the inferior border of the parotid. Avoid elevating the caudal portion of the flap beyond the anterior edge of the parotid gland before the facial nerve dissection because the marginal mandibular branch of the facial nerve emerges from the parotid gland together with the posterior facial vein with which the nerve may be in contact. This is the smallest branch of the facial nerve and the easiest to injure since it is quite superficial at this point. Damage to this nerve will cause weakness in the area of the lateral portion of the lower lip.

Operative Technique

Incision and Exposure

Although many incisions have been devised for this operation, we prefer the one illustrated in **Fig. 95–1**. It starts in a skin crease just anterior to the tragus and continues in the form of a "Y" as shown. Continue the posterior limb of the incision over the mastoid process in a caudal direction roughly parallel to the underlying sternomastoid muscle down to a point about 1 cm below the angle of the mandible. Do not make the angle of the "Y" too acute. Carry the incision through the platysma

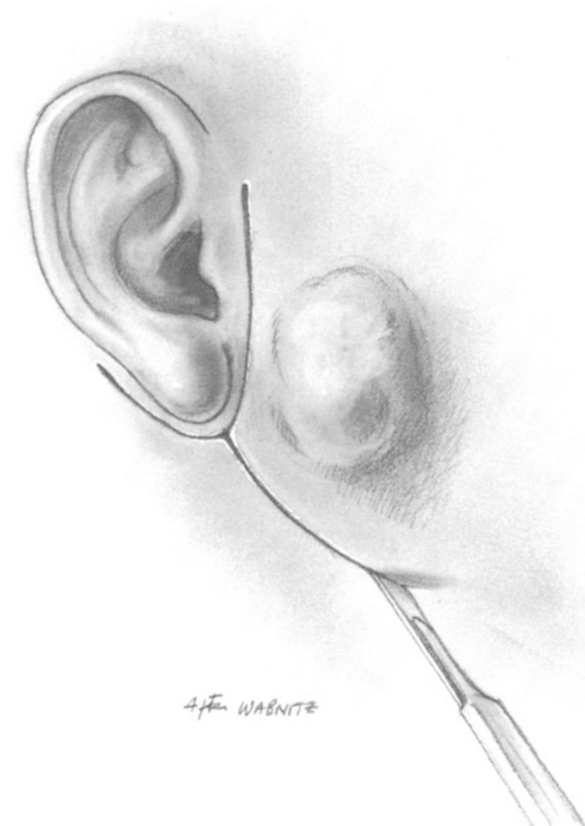


Fig. 95–1

muscle. Obtain hemostasis with accurate electrocoagulation. Apply small rake retractors to the anterior skin flap and strongly elevate the tissue in the plane just deep to the platysma. As soon as the surface of the parotid gland is exposed, continue the dissection with a small Metzenbaum scissors. Some of the fibrous tissue attaching the parotid gland to the overlying tissue will resemble tiny nerve fibers. There are no facial nerve fibers superficial to the parotid gland. Therefore each of these fibers may be rapidly divided. If a total superficial lobectomy is planned, continue the dissection in a cephalad direction to the level of the zygomatic process and anteriorly to the anterior margin of the parotid gland. Do not continue the dissection beyond the anterior and inferior margins of the gland as the small facial nerve branches may inadvertently be injured if this is done prior to identifying the facial nerve.

Elevate the skin flaps and the lobe of the ear in a cephalad posterior direction to expose the underlying sternomastoid muscle, the mastoid process, and the cartilage of the external auditory canal. Elevate the posterior flap to expose 1–2 cm of underlying sternomastoid muscle. Obtain complete hemostasis. Some surgeons prefer to place a few sutures to temporarily attach the skin flaps to the underlying cheek, maintaining exposure of the gland.

Exposing the Posterior Margin of the Parotid Gland

Identify the great auricular nerve overlying the surface of the sternomastoid muscle about 3–4 cm caudal to the mastoid process. Divide the branch of the great auricular nerve that enters the parotid gland. Adjacent to this nerve will be found the external jugular vein, which is generally also divided and ligated posterior to the parotid gland (**Fig. 95–2**). Now expose the anterior border of the sternomastoid muscle. Continue this dissection in a cephalad direction toward the mastoid process. In dissecting the tissues away from the anterior surface of the mastoid process, some bleeding may occur from branches of the superficial temporal vessels. These may be controlled by accurate clamping or electrocoagulation.

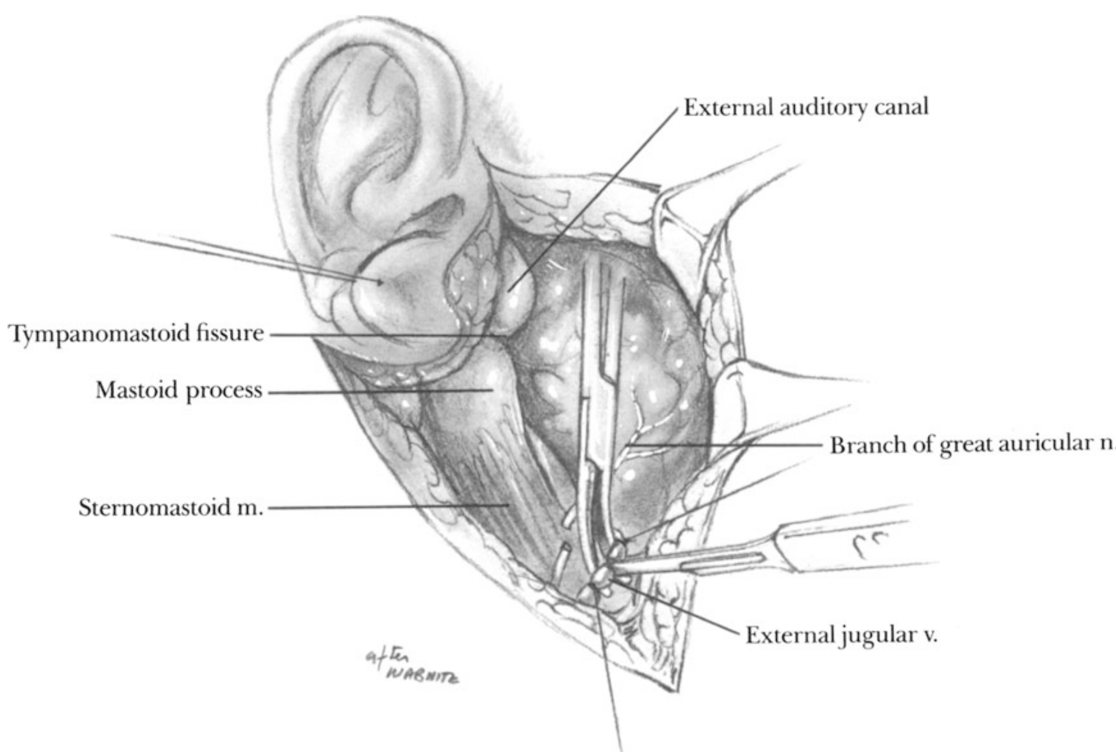


Fig. 95–2

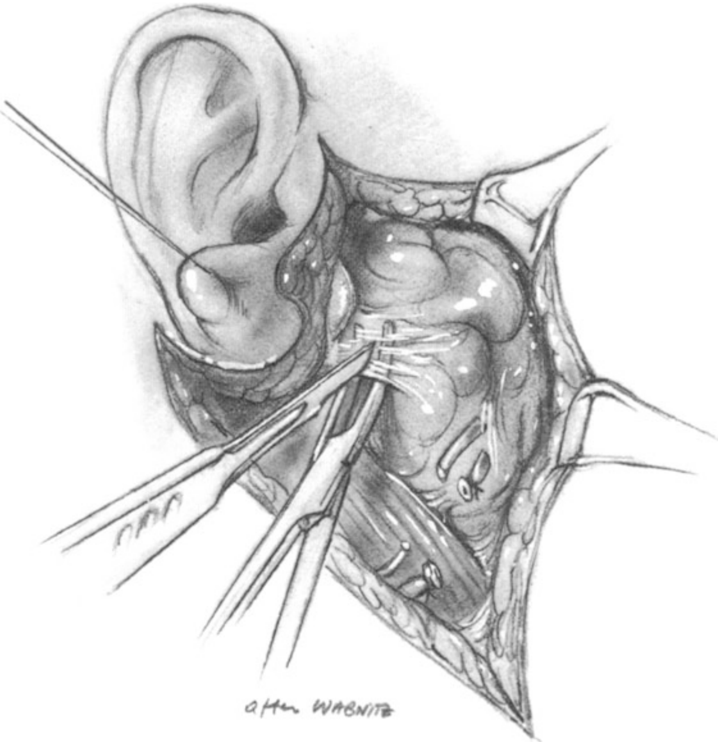


Fig. 95–3

Locating the Facial Nerve

Running from the tympanomastoid fissure to the parotid gland is a fairly dense layer of temporoparotid fascia. Elevate this layer of fascia with a small hemostat or right-angle clamp and divide it (**Fig. 95–3**). Continue the dissection deep along the anterior surface of the mastoid process. Remember that the main trunk of the facial nerve is located in a 1 cm area anterior to the tympanomastoid fissure and the upper half of the mastoid process at 0.5–1.0 cm depth. Try to identify the small arterial branch of the posterior auricular artery in this area. Divide and ligate it. If it has been inadvertently divided and accurate clamping cannot be achieved, simply apply pressure for a few minutes and the bleeding will stop. Continue the blunt dissection using a hemostat until the posterior portion of the parotid gland can be retracted away from the mastoid process. Continuing to separate and divide the fibrous tissue in this area will uncover the main trunk of the facial nerve. Although the nerve usually runs in a transverse direction from the mastoid process toward the gland, it sometimes can run obliquely from the upper left portion of the operative field toward the right lower portion as it enters the parotid gland. Some idea of how deep the dissection must be carried to expose the facial nerve can be obtained by observing the depth of the surface of the posterior digastric muscle as it reaches its origin behind the mastoid process. The nerve will be at or just superficial to this level (**Fig. 95–4**).

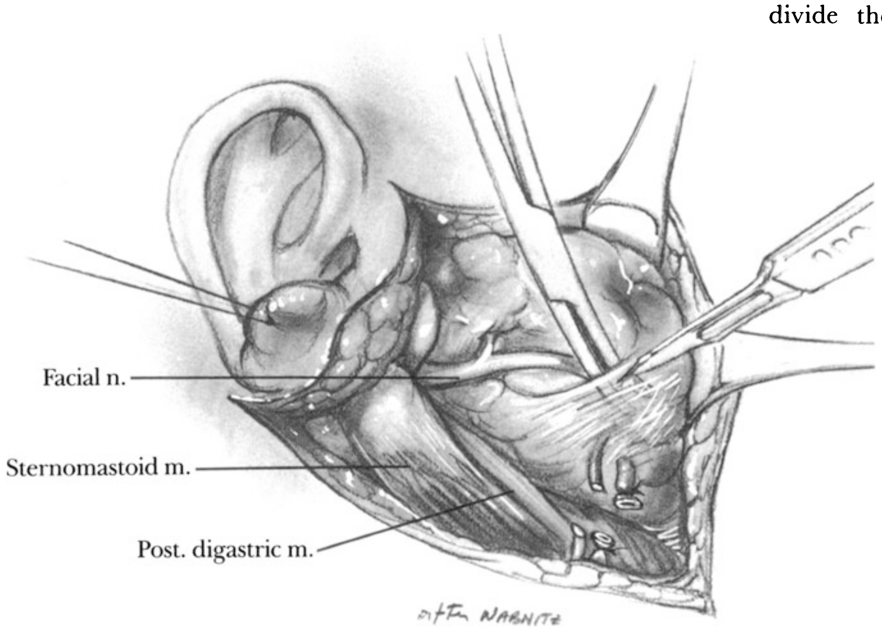


Fig. 95–4

Dissecting the Facial Nerve Branches

Now apply traction to the superficial lobe of the parotid using either several Allis clamps or retractors. Insert a small hemostat in the plane *just superficial* to the facial nerve. Ask the assistant to divide the fibrous tissue being elevated by the hemostat (see Fig. 95-4). Continue the dissection in this plane until each of the branches of the facial nerve has been separated from the overlying parotid tissue. Pay special attention the the cervical division and its marginal mandibular branch as this will permit elevation of the lowermost portion of the parotid gland. As the dissection reaches the anterior margin of the parotid gland, identify Stensen's duct. Ligate with 3-0 PG and divide the duct (**Fig. 95–5**). After all of the nerve branches have been identified and the duct has been divided, remove the superficial lobe of the gland.

Hemostasis during the nerve dissection can generally be achieved by gauze pressure. At this point in the dissection, carefully identify each bleeding point and clamp it with a mosquito hemostat. Ligate with 4-0 or 5-0 PG. Do not use electrocautery in areas close to the nerve.

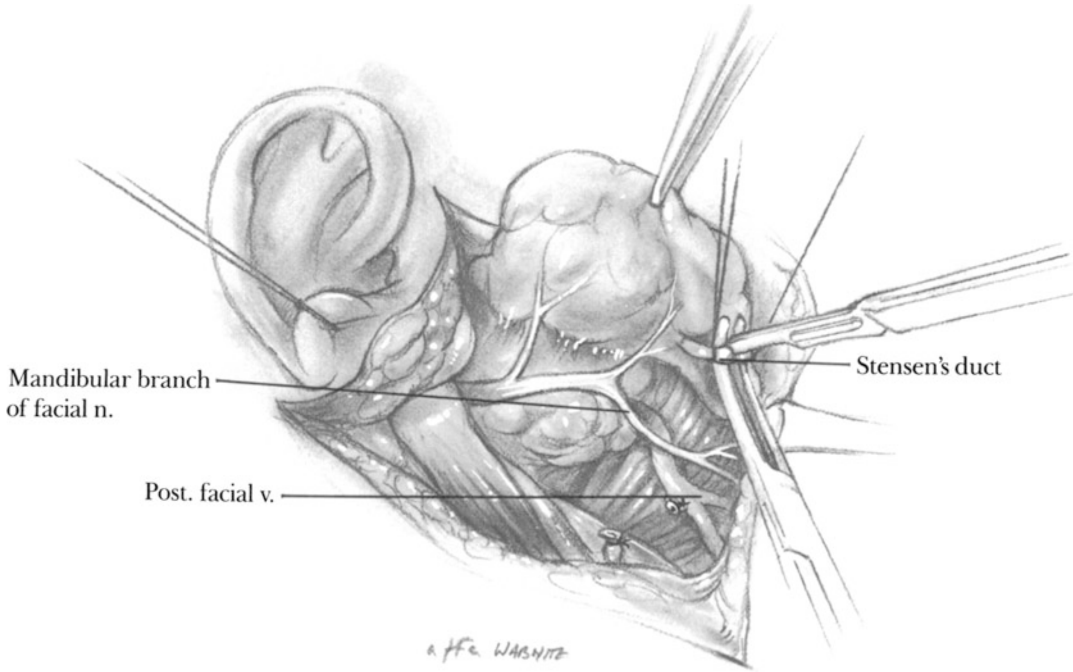


Fig. 95–5

Removing Deep Lobe of Parotid Gland (When Indicated)

First, excise the superficial lobe of the parotid as described above. Then, carefully free the lower division of the facial nerve from the underlying tissue. By retracting one or more of these divisions, one can begin to mobilize the deep lobe.

Identify the posterior facial vein. Separate the marginal mandibular nerve branch from the vein. Then divide and ligate the posterior facial vein with 4–0 PG as in **Fig. 95–6**. Now divide the superficial

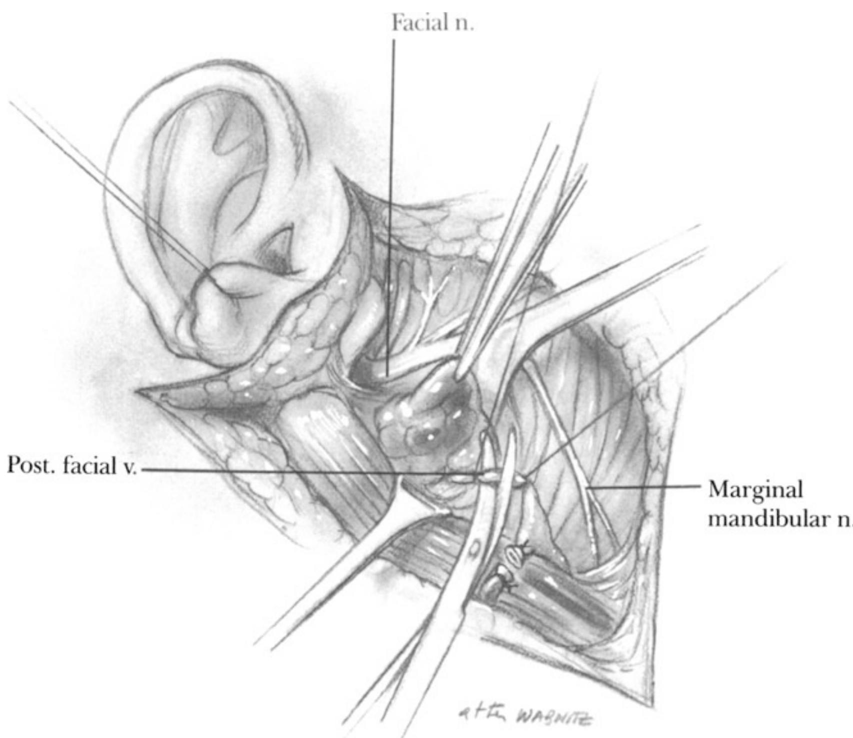


Fig. 95–6

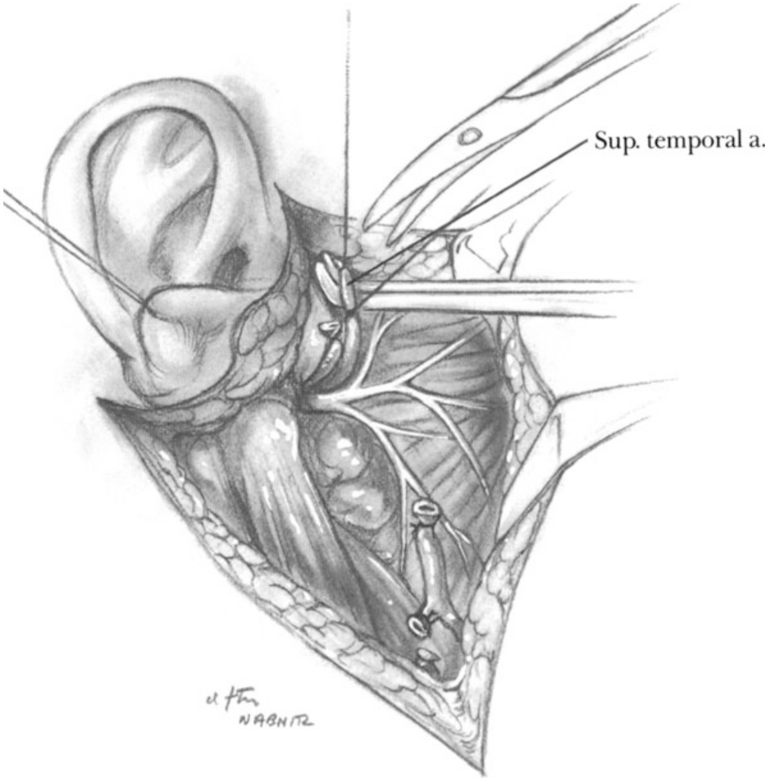


Fig. 95–7

temporal artery and vein as in **Fig. 95–7**. Elevate the lower border of the gland and divide and ligate the external carotid artery. Then divide and ligate the internal maxillary and the transverse facial arteries at the anterior border of the gland, after which the deep lobe may be removed. The appearance of the operative field after removing the deep lobe is seen in **Fig. 95–8**.

Drainage and Closure

Place a small Silastic closed-suction drain through a puncture wound posterior to the incision. Close the incision using interrupted 5–0 PG sutures to the platysma and subcutaneous fat. Close the skin with interrupted 5–0 nylon sutures.

Postoperative Care

Leave the closed suction drain in place until the drainage has essentially ceased (3–4 days).

Postoperative Complications

Gustatory sweating, or Frey's syndrome, manifested by the occurrence of almost painful sweating in the skin of the operative area while eating, may occur to some extent in as many as 25% of patients. This is believed to be due to the regrowth of parasympathetic motor nerve fibers of the auriculotemporal nerve into cutaneous nerve fibers of the skin flap. This crossed innervation of the sweat glands produces uncomfortable gustatory sweating. Loré states that this may be prevented by removing a section of the auriculotemporal nerve during surgery of the parotid gland.

Facial weakness due to nerve damage

Hematoma

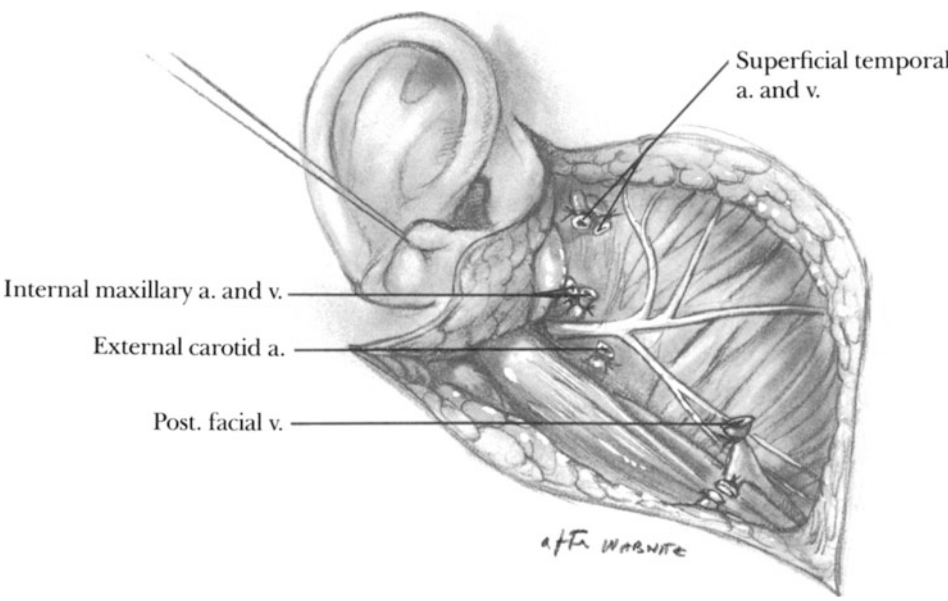


Fig. 95–8

A salivary fistula may appear when a significant portion of the parotid gland has been left intact. This complication will generally correct itself with expectant treatment.

Infection

References

Beahrs OH. Parotidectomy. Surg Clin North Am 1977; 57:477.

Loré JM. An atlas of head and neck surgery. Philadelphia: Saunders; 1962.

Woods JE. Parotidectomy: points of technique for brief and safe operation. Am J Surg 1983;145:678.

96 Thyroidectomy

Concept: Which Diseases of the Thyroid Require Operation?

Hyperthyroidism

Diffuse Toxic Goiter

Most patients with diffuse hyperthyroidism or Graves' disease are now treated with radioactive iodine. This method has the advantage of simplicity and safety, although a longer period of time is required to correct the hyperthyroidism than is necessary with surgery. Operating on a toxic thyroid gland is more difficult than excising a solitary adenoma. The gland is larger and more vascular, especially if the patient has been prepared with propylthiouracil or methimazole. With the use of propranolol for the preoperative preparation of a toxic patient, the symptoms of hyperthyroidism disappear quite rapidly and the thyroid gland is less vascular than is the case after the more traditional preparatory medications. Nevertheless, even a skilled thyroid surgeon experiences a 5% morbidity rate, including laryngeal nerve damage (less than 1%) and permanent hypoparathyroidism (less than 1%). Transient postoperative hypoparathyroidism may occur in an additional 5%–10% of cases.

Earlier fears that radioiodine therapy would be followed by the late development of thyroid cancer, leukemia, or genetic damage have not been confirmed in long-term follow-up studies. It has been noted, however, that when radioiodine is administered to patients under age 30, a number of them in later decades do develop benign thyroid tumors (Dobyns, Sheline, and Workman).

Treatment with radioactive iodine is simple and effective, and in patients over age 30 it is quite safe, although at least half of the treated patients will develop permanent hypothyroidism during the subsequent two decades. In pregnant women, using radioactive iodine is contraindicated. Surgery, in expert hands, is safe and effective but does have the small risk of recurrent nerve damage and hypoparathyroidism. Postoperative permanent hypothyroidism may be somewhat less common than is the case after radioactive iodine treatment.

Nodular Toxic Goiter

Patients with hypermetabolism secondary to nodular toxic goiter do not respond as well to thiocarbamide or radioactive iodine therapy as do patients with diffuse toxic goiter. Consequently, there is a stronger argument to advise surgical treatment in the case of patients with nodular toxic goiter.

Autonomous Hyperfunctioning Adenoma

Some patients with a solitary nodule in the thyroid gland can be demonstrated on scintiscan to have a hyperfunctioning adenoma. The scan in these patients will show a hot nodule with diminished function in the remainder of the thyroid tissue, which indicates that the adenoma is autonomous in its hyperactivity. The circulating level of thyroid-stimulating hormone (TSH) will be diminished. Surgical therapy in a patient of this type requires only that the entire adenoma be excised. Some endocrinologists treat this type of patient with radioactive iodine.

Nontoxic Solitary Thyroid Nodule

Differential Diagnosis

A *family history* suggestive of multiple endocrine neoplasia, type 2a, (MEN-2a; medullary thyroid cancer, pheochromocytoma, and parathyroid adenoma) indicates that the patient may have medullary thyroid cancer. Patients with medullary thyroid cancer of familial origin will have an elevation of their serum thyrocalcitonin levels. If the patient has a borderline thyrocalcitonin level, repeat the test after stimulation with pentagastrin. Also study the patient for the possible presence of a pheochromocytoma or a parathyroid adenoma. Elevation of the serum thyrocalcitonin level, even if pentagastrin stimulation is required, indicates that the patient is suffering from medullary thyroid cancer and total thyroidectomy is indicated.

In pursuing the *past history* of a patient with a thyroid nodule, inquire carefully whether he or she was exposed to radiation therapy of the neck during childhood. About one-third of exposed patients were found to develop thyroid nodules, of which one-third were malignant (Becker, Economou, and Southwick). These nodules should all be excised and biopsied.

If, on *physical examination*, a thyroid nodule is hard, or there appears to be fixation to surrounding structures, or there is paralysis of a vocal cord, the nodule has a high likelihood of being malignant and surgery is indicated purely on physical findings, although we would perform a preoperative needle aspiration cytology also. The palpation of cervical lymphadenopathy is also highly suggestive of malignancy in a patient who harbors a solitary thyroid nodule. If there is a history of rapid recent growth of the nodule, this also increases the likelihood of malignancy.

Age and *sex* are also important factors in deciding the likelihood that a given nodule is malignant. Benign solitary nodules are rare in patients under age 20 and in children. Therefore, in patients younger than 20 years of age all nodules are presumed to be malignant until ruled out by a proper biopsy. Benign solitary nodules are uncommon in the male sex while such nodules are common in women. Therefore, a solitary thyroid nodule in a man should arouse suspicion of cancer. Those patients who do not have the indications for surgery mentioned above will require further diagnostic study.

If a skilled cytologist is available to read the smears, needle aspiration of the thyroid nodule for *cytological study* can be a valuable test. Several experts (Block; Rosen, Wallace, Strawbridge, and Walfish) use aspiration cytology as the prime diagnostic tool in differentiating malignant from benign thyroid nodules. Of course, this test does require an experienced thyroid cytologist before the method achieves reliability. There are additional important considerations in the use of aspiration cytology. For instance, a follicular adenoma cannot be differentiated from follicular carcinoma by this method. Also, lesions that are partly cystic or that contain degenerating tissue give rise to difficulty in interpretation. However, when the cytologist unequivocally reports the presence of cancer, prompt operation is indicated. Clearly benign lesions can be treated by continued observation. The large number of solitary nodules that are caused by benign cystic lesions may be cured by simple aspiration. If any residual mass remains after aspiration, further diagnostic studies or open biopsy is necessary. When the expertise to interpret aspiration cytology specimens is not available, then patients with a solitary thyroid nodule should be subjected to a thyroid scintiscan.

Those patients categorized as indeterminate by aspiration cytology should also be subjected to a thyroid scintiscan. Patients whose nodules show a normal or high radioiodine uptake have a low incidence of carcinoma. This group of patients is usually treated by a 3-month trial of suppression with thyroid hormone. Blum and Rothschild administer 25 micrograms of L-triiodothyronine four times a day. This therapy is contraindicated in patients with cardiac disease or advanced age. Medication is continued for a period of 3 months unless adverse symptoms occur. The adequacy of the suppressive therapy is determined by measuring the serum level of TSH, which should be very low. If after 3 months of adequate TSH suppression, a nodule fails to shrink as much as 50% in diameter, surgery is recommended. If successful shrinkage has been achieved, these authors recommend lifelong suppression with L-thyroxine 0.2 mg–0.3 mg daily. An objective method of measuring and recording the changes in the size of a thyroid nodule is sonography.

Thyroid sonography can identify solitary thyroid nodules over 0.5 cm in size, and can identify simple cysts, solid tumors, and other solid lesions that have undergone hemorrhagic degeneration. Simple cystic nodules are treated by aspiration. If the mass disappears completely after aspiration, continued observation is the only further treatment required. Solid, cold nodules require operation, although some physicians treat these nodules by means of thyroid suppression if no other high-risk factors of cancer are present.

Block, Daily, and Robb believe that obtaining a *core biopsy* with a cutting needle (like the Travenol Tru-Cut) in nodules greater than 2 cm in diameter can be a valuable supplement to thin-needle aspiration cytology. These authors advise operation for most of the indeterminate cases.

Surgical Management

Surgical management of thyroid nodules is greatly enhanced by the availability of cryostat frozen-section histopathology and a pathologist experienced in thyroid disease. Lesions that appear grossly to be benign need only be excised locally with a rim of adjacent normal thyroid tissue and submitted for frozen-section examination. Larger or deeper nodules may require subtotal or total thyroid lobectomy for complete excision after visualization of the recurrent laryngeal nerve and parathyroid glands.

If the frozen-section examination discloses that the nodule is malignant, perform the operation that is appropriate to the specific malignancy, as discussed under "Thyroid Cancer" below. In addition to excising the thyroid nodule for diagnosis, also identify and palpate the lymph nodes both in the jugular chain and, even more important, the paratracheal nodes in the superior mediastinum. Biopsy any of these nodes that appear to be suspicious.

A patient with a history of radiation therapy to the neck in infancy, who has a benign nodule by frozen-section examination, should probably have near-total thyroidectomy (Block) or total thyroidectomy (Paloyan).

Multinodular Goiter

A nonsymptomatic, nontoxic multinodular goiter does not generally require surgery unless one can palpate a suspicious hard nodule in the gland or one obtains a positive biopsy. On the other hand, nodular goiter can produce annoying symptoms due to pressure partially occluding the trachea. Some patients are unwilling to accept the unsightly appearance that a large goiter presents. All of these represent adequate reasons for subtotal thyroidectomy. Patients who have a toxic nodular goiter do not respond well to radioactive iodine and toxicity constitutes an indication for thyroidectomy.

Thyroid Cancer

Papillary and Mixed Papillary-Follicular Carcinoma

Follicular thyroid carcinoma that contains an element of papillary tumor behaves clinically in a manner quite similar to that of pure papillary carcinoma. For this reason treatment of pure papillary or mixed papillary-follicular tumors is identical. Although many physicians feel that papillary thyroid cancer is a relatively benign disease that does not require early detection or radical treatment, Cady, Sedgewick, Meissner, and associates (1979) report that of the patients who developed papillary cancer after age 50, 29% died of this disease. Of 441 patients with papillary and mixed papillary-follicular thyroid cancer treated at the Lahey Clinic from 1931 to 1970, 12% died of this cancer. At the same time, 190 patients were treated for follicular thyroid cancer and 25% died of this disease. It is fascinating to note that among patients who were suffering from papillary cancer, those who had cervical node metastases enjoyed better prognoses than those who had no node involvement. Also, none of the 16 patients who had 10 or more metastatic nodes died of thyroid cancer after a follow-up period of at least 15 years. These authors emphasized that relatively few of their patients with papillary cancer over age 50 had cervical node metastases.

Woolner, Beahrs, and Black demonstrated that patients who had occult (less than 1.5 cm in diameter) papillary tumors experienced a 20-year survival curve no different from that of the normal population. Papillary tumors, small enough to be confined completely within the capsule of the thyroid gland, also did not greatly affect the patient survivorship curve compared with normal persons of comparable age and sex. The papillary group of thyroid cancers constitutes the most common type and predominates in children and young adults. It is twice as common in women as in men. Clark, White, and Russell reported that 90% of patients with papillary cancer in one lobe of the thyroid had evidence of microscopic multicentric papillary cancer when the thyroid gland was studied by serial microscopic sections of the entire gland following total bilateral thyroidectomy. However, Tollefson, Shah, and Huvos reported that only 5.7% of 298 patients who had undergone unilateral lobectomy for papillary cancer developed recurrent cancer in the opposite lobe during follow-up periods of 5–35 years. About half of the patients with recurrence died of metastatic disease.

Because the presence of microscopic cancer did not lead to clinical disease very often, Tollefson and his associates felt that total thyroidectomy for all papillary cancers would lead to an unacceptable number of serious complications. They did not do a total contralateral lobectomy unless there was palpable evidence of bilateral cancer. In reviewing total thyroidectomies performed at Memorial (Sloan-Kettering) Hospital, Tollefson and associates reported a 29% incidence of permanent hypoparathyroidism following total thyroidectomy for cancer. They advocated total lobectomy and removal of the thyroid isthmus as the primary treatment for unilateral papillary cancer. Other surgeons (Attie; Block; Clark; and Mazzaferri, Young, Oertel, Kemmerer et al.) feel that total thyroidectomy for papillary cancers larger than 1.5 cm is the most effective treatment, providing that the surgeon is experienced and has the technical skill to avoid nerve and parathyroid injuries. The surgeon's skill and experience are extremely important considerations in deciding to perform a total thyroidectomy. If the patient has evidence of bilateral disease on clinical examination, total thyroidectomy and appropriate cervical lymph node dissection are indicated as the primary operation, and the patient should be referred to a surgeon who can do this type of operation safely. Total thyroidectomy also has the advantage of permitting later treatment of distant metastases with large doses of radioactive iodine. The patient with unilateral papillary cancer following external radiation therapy in childhood is also a suitable candidate for total thyroidectomy in the hands of an expert. Complications like permanent hypoparathyroidism or vocal cord paralysis following total thyroidectomy by an expert surgeon should occur in less than 2% of cases (Attie; Clark).

Follicular Carcinoma

Follicular cancer of the thyroid also is more common in women than men. This category of disease constitutes about 20% of all thyroid cancer. Patients who develop the disease prior to age 40 appear to have a good prognosis. However, over 60% in the study of Cady and associates (1979) were over 40, and 36% of these patients died of thyroid cancer. Distant metastases are the common cause of death in these patients.

Encapsulated, small, well-differentiated follicular carcinoma that shows no significant degree of blood vessel invasion has a good prognosis, and patients with this disease may be treated by unilateral lobectomy if the opposite lobe is normal to palpation.

The aggressive follicular carcinoma with a high degree of blood vessel invasion is also a relatively slow-growing tumor, but 80% of patients with angioinvasive follicular tumors in the study reported by Woolner and associates were dead within 20 years. For these patients Block recommends a total or near-total thyroidectomy. One reason for performing a total thyroidectomy is that it facilitates the use of therapeutic dosages of radioactive iodine to treat distant metastases, should they develop at a later date. Wanebo, Andrews, and Kaiser were not impressed with the efficacy of radioactive iodine in improving patient survival, while Cady, Sedgewick, Meissner, and associates (1976) felt that it was beneficial when given to patients in the low-risk category, but not in the older, high-risk category of patients. Actually, there is inadequate data to determine the value of using ^{131}I radiotherapy. Also, randomized follow-up studies comparing total thyroidectomy with subtotal thyroidectomy or lobectomy in follicular cancer patients have not been reported. For truly angioinvasive follicular carcinoma, we would perform a near-total or total thyroidectomy.

Another subdivision of follicular cancer is the Hürthle cell cancer. These tumors resemble follicular cancer in their behavior and are treated in a similar fashion.

Cady and associates (1976) found that thyroid suppression by means of administering thyroid hormone postoperatively did not improve the prognosis in follicular cancer, while such therapy was indeed demonstrated to have a beneficial effect on survival following papillary and mixed cancers. Also, therapeutic external radiation administered because the surgeon suspected that residual cancer had been left behind had no effect on survival. Nor did prophylactic adjuvant radiotherapy improve survival, either in papillary or follicular cancer.

Medullary Carcinoma

Seven percent of thyroid carcinomas are medullary in type. These may be either sporadic or hereditary. The sporadic type appears to be more common than the hereditary. While the sporadic type may be unilateral in distribution, the hereditary type is always multicentric and involves both lobes. The average age at which the diagnosis is made is over 40 in the sporadic type and under 40 in the hereditary. Medullary cancer is an aggressive tumor with frequent lymph node and distant metastases. In Woolner's report, patients with medullary cancer who had negative lymph nodes tended to have a survival curve not greatly lower than that of a comparable normal population, while 60% of those with positive nodes died within 10 years.

Elevation of the serum calcitonin level, stimulated by pentagastrin when necessary, is characteristic of medullary carcinoma. Families of patients with hereditary medullary thyroid cancer should have semiannual serum calcitonin determinations in order to detect the cancer at an early stage, often even before a nodule can be palpated. It is important to study all patients suspected of having the hereditary form of medullary thyroid cancer for the presence of a pheochromocytoma (MEN-2 syndrome). The MEN-2a syndrome also includes hyperparathyroidism, while patients with the MEN-2b syndrome invariably have multiple mucosal neuromas. If the patient has a pheochromocytoma, this lesion (often bilateral in MEN-2 cases) will have to be removed prior to thyroidectomy. If the patient suffers from hyperparathyroidism, it will be necessary to explore the parathyroid glands and evaluate their pathology while performing the thyroidectomy.

Total thyroidectomy is recommended for patients with medullary thyroid cancer. The middle third of the jugular lymph node chain should routinely be explored and biopsied to determine the presence of metastatic lymph nodes, as should the paratracheal nodes in the superior mediastinum. If nodes are involved, a neck dissection is indicated in addition to total thyroidectomy.

Anaplastic Carcinoma

Constituting about 5%–10% of all thyroid cancers, anaplastic carcinoma is a very aggressive tumor occurring primarily during the sixth and seventh decades of life. When it is first detected, the tumor has generally already shown invasion of the larynx or trachea and overlying muscles as well as metastatic lymph nodes and distant metastases. This disease is almost invariably fatal, often due to respiratory obstruction. The tumor should be resected, if possible, to avoid tracheal obstruction.

Indications

Diffuse toxic goiter in selected young patients (under age 30), or in pregnant women

Toxic nodular goiter

Selected solitary thyroid nodules (see discussion above)

Suspicious nodules in multinodular goiter

Thyroid carcinoma

Preoperative Care

In patients with Graves' disease of mild or moderate severity, it may be possible to prepare the patient by administering Lugol's iodine solution, 10 drops three times a day for a week or 10 days. In more severe cases, give an adequate amount of propylthiouracil, beginning with a dose of 100 mg three times a day. In some patients larger doses must be given for many weeks, although generally 8 weeks of propylthiouracil treatment is adequate. During the last 10–14 days give the patient Lugol's solution 5–10 drops three times a day together with the propylthiouracil. A third method of preparing the toxic patient for surgery has been introduced. Propranolol is administered in sufficient quantities to reduce the pulse rate to normal. Frequently no more than one week of preoperative propranolol treatment is necessary. Continue the drug during and after the operation for 7–10 days. Although this method appears to be effective in most patients, occasional cases of postoperative thyroid storm have been reported with propranolol management.

For patients with a thyroid nodule, preoperative management may include aspiration cytology, thyroid scan, thyroid sonogram, and thyroid suppression therapy as discussed under "Concept."

A patient suspected of having medullary carcinoma of the thyroid should have preoperative studies to detect a pheochromocytoma or a parathyroid adenoma.

Pitfalls and Danger Points

Trauma to or inadvertent excision of parathyroid glands

Trauma to or inadvertent laceration of recurrent laryngeal or external laryngeal nerves

Inadequate preoperative preparation of the toxic patient resulting in postoperative thyroid storm

Inadequate surgery for the more aggressive thyroid cancers

Operative Strategy

Preserving Parathyroid Glands

Preventing damage to the parathyroid glands requires the surgeon to achieve thorough familiarity with the anatomical location and appearance of these structures. Wearing telescopic lenses with about 2.5 times magnification can be helpful in identifying both the parathyroid glands and the recurrent nerve. If the surgeon will take the time to identify the parathyroid glands in every thyroid operation, he will soon find that this maneuver can be accomplished with progressively more efficiency. The inferior parathyroid gland is frequently found in the fat that surrounds the inferior thyroid artery at the point where it divides into several branches (**Fig. 96–1**). Normally, the inferior gland is anteromedial to the recurrent laryngeal nerve while the superior parathyroid is posterolateral to the nerve (**Fig. 96–2**). With the thyroid gland retracted anteriorly, both parathyroids may assume an anteromedial position relative to the nerve (**Fig. 96–3**). The superior gland is generally situated on the posterior surface of the upper third of the thyroid gland, fairly close to the cricoid cartilage. Frequently, the parathyroids are loosely surrounded by fat and have a red-brown color. Measuring only about 5–8 mm in maximum diameter, the average gland weighs about 30 mg.

One method of protecting the parathyroid glands is to preserve the posterior capsule of the thyroid gland by incising the thyroid along the line sketched in Fig. 96–11. Also, divide the branches of the inferior thyroid artery at a point distal to the origin of the blood supply to the parathyroids. Some surgeons feel that ligating the inferior thyroid artery lateral to the thyroid gland may impair the blood supply to the parathyroid glands, although this contention has never been proved.

When a total lobectomy is performed, the only means of insuring the preservation of the parathyroid glands is to positively identify the inferior and the superior gland. Then dissect each gland carefully away from the thyroid without impairing its blood supply.

If a parathyroid gland has been inadvertently excised, and this error is recognized during the operation, it is possible to slice the gland into particles measuring 1 mm by 1 mm and then to transplant these fragments into pockets made in the muscles of the neck or of the forearm (Wells, Ross, Dale et al.).

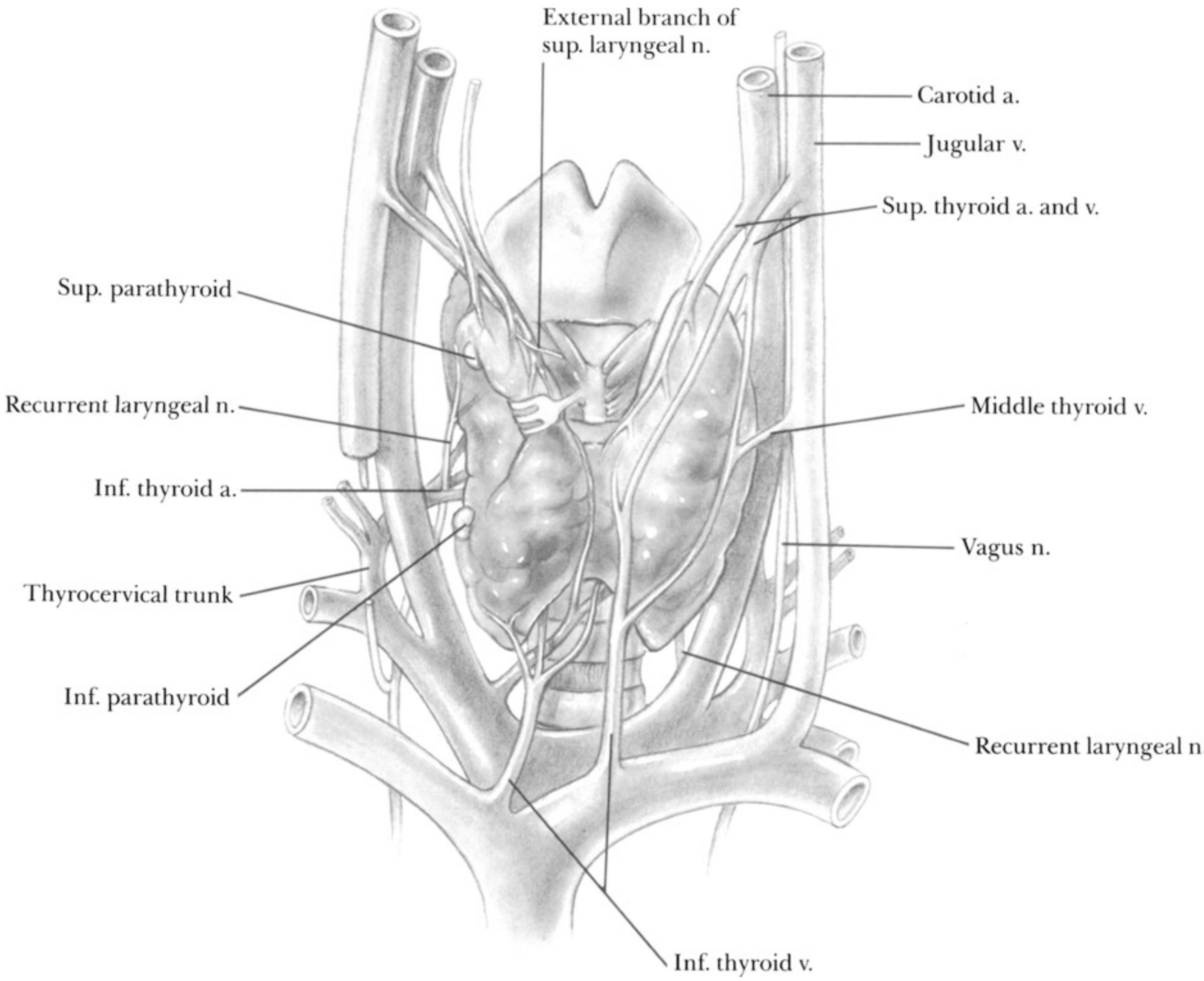


Fig. 96–1

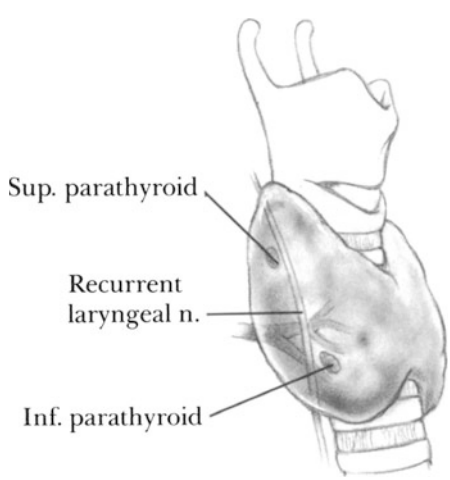


Fig. 96–2

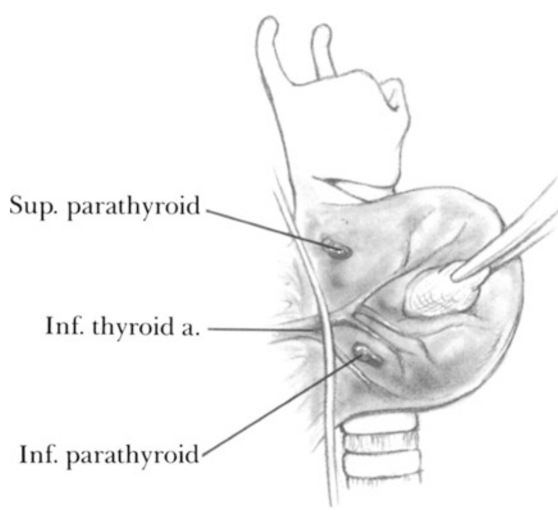


Fig. 96–3

Preserving the Recurrent Laryngeal Nerve

The recurrent laryngeal nerve ascends slightly lateral to the tracheoesophageal groove. At the level of the inferior thyroid artery, the nerve almost always makes contact with this vessel, passing either directly under or over the artery. Sometimes the nerve passes between the branches of the inferior thyroid vessel. Above the level of the artery, the nerve ascends to enter the larynx between the cricoid cartilage and the inferior cornu of the thyroid cartilage. In this area the nerve lies in close proximity to the posterior capsule of the thyroid gland. It may divide into two or more branches prior to entering the larynx. On rare occasions the recurrent nerve does not recur, but it travels from the vagus directly medially to enter the larynx near the superior thyroid vessels or at a slightly lower level relative to the thyroid gland.

For most surgeons, the best way of locating the recurrent laryngeal nerve is to trace the inferior thyroid artery from the point where it emerges behind the carotid artery to the point where it crosses over or under the recurrent nerve. Using the inferior thyroid artery as a guide, locate the recurrent nerve immediately deep to or superficial to this artery and carefully dissect the nerve in a cephalad direction until it reaches the cricothyroid membrane just below the inferior cornu of the thyroid cartilage. Remember that the nerve may divide into two or more branches in the area cephalad to the inferior thyroid artery. Once the nerve has been exposed throughout its course behind the thyroid gland, it is a simple matter to avoid damaging it.

Preserving the Superior Laryngeal Nerve

The internal branch of the superior laryngeal nerve penetrates the thyrohyoid membrane and is the sensory nerve of the larynx, while the external branch controls the cricothyroid muscle. Although it is possible to damage both branches of the superior laryngeal nerve by passing a mass ligature around the superior thyroid artery and vein above the superior pole of the thyroid, the external branch is the one most often injured. Transection of the external branch impairs the patient's ability to voice high-pitched sounds. Since the external branch may be intertwined with branches of the superior thyroid artery and vein (see Fig. 96–1), avoiding damage to this nerve requires that each branch of the superior thyroid vessels be isolated, ligated, and divided individually at the point where it enters the thyroid gland. If the superior thyroid artery and vein are dissected *above* the superior pole of the thyroid, it will be necessary to identify and preserve the superior laryngeal nerve and its branches. This step is not necessary if the terminal branches of the superior thyroid vessels are individually isolated and ligated.

Operative Technique

Incision and Exposure

Place a small pillow or other support beneath the patient's shoulders in order to extend the head and neck. It is helpful, also, to elevate the upper half of the operating table so that the patient assumes a semisitting position. Make a slightly curved incision transversely in the neck at a level 2–3 fingerbreadths above the sternal notch (**Fig. 96–4**). The incision should extend just beyond the anterior border of the sternomastoid muscle on each side. In patients who have large goiters a longer incision will be necessary. Carry the incision down to the platysma muscle. This muscle will be easier to identify in the lateral portions of the incision. When the longitudinal fibers of this muscle are seen, transect them with precision because the upper flap will be dissected in a plane along the deep aspect of the platysma. There is a thin layer of fat deep to this muscle. If the plane of dissection is carried down to the cervical fascia, a number of veins will be encountered that will produce unnecessary bleeding. Leaving a thin layer of fat on these veins will avoid this problem. Continue the dissection along the deep surface of the platysma muscle in a cephalad direction by using both sharp and blunt maneuvers until a point 1–2 cm above the notch of the thyroid cartilage has been reached in the midline of the dissection (**Fig. 96–5**). Once this has been accomplished, elevate the lateral portions of the flap. Adequate exposure requires wide dissection of this musculocutaneous flap. Achieve hemostasis, primarily with electrocoagulation. Also elevate the inferior flap for a distance of about 2 cm.

Now palpate the prominence of the thyroid cartilage in order to identify the midline. Make an incision through the cervical fascia in the midline (**Fig. 96–6**) and extend the incision in the fascia to expose the full length of the strap muscles. Elevate the sternohyoid muscle in the midline. Then elevate the sternothyroid muscle and dissect the thyroid capsule away from it on both sides. This will permit an adequate digital exploration of the entire thyroid gland. In most cases retracting the strap muscles laterally while the thyroid lobe is retracted in the opposite direction will provide good exposure for a thyroidectomy. If the gland is unusually large or the exposure is inadequate, do not hesitate to transect

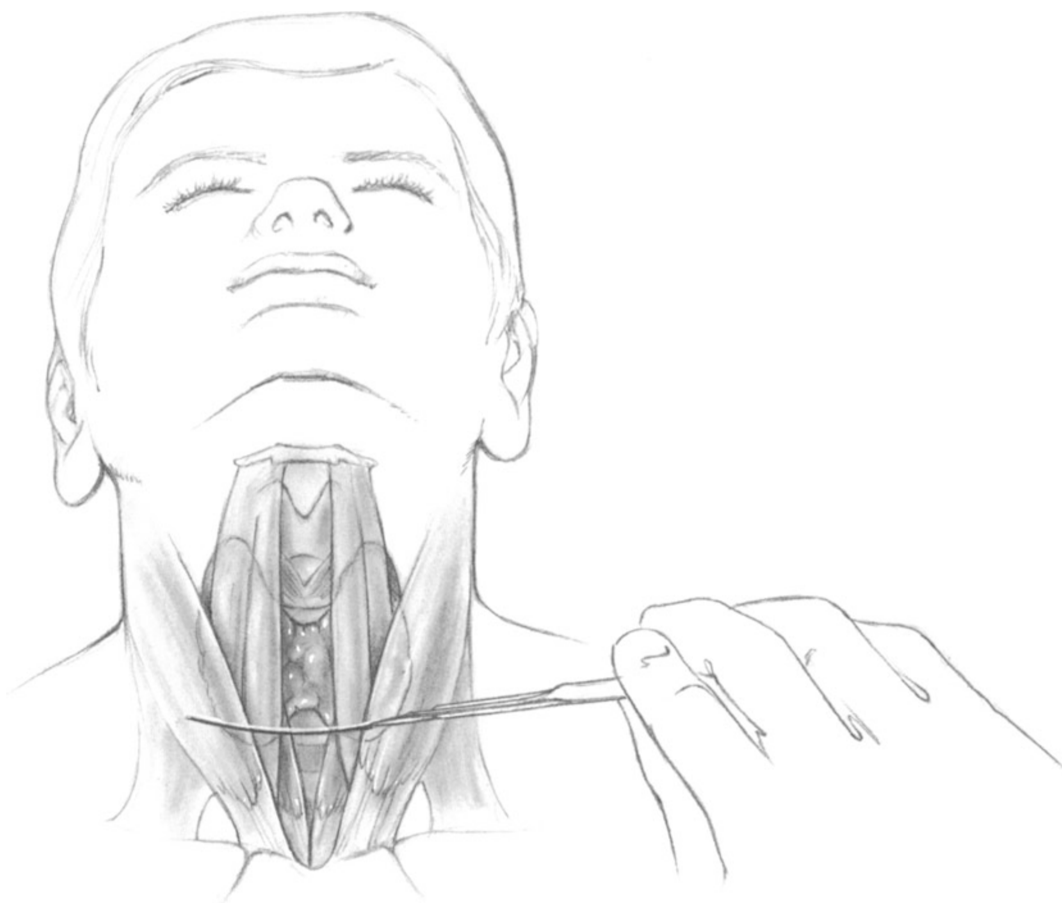


Fig. 96–4

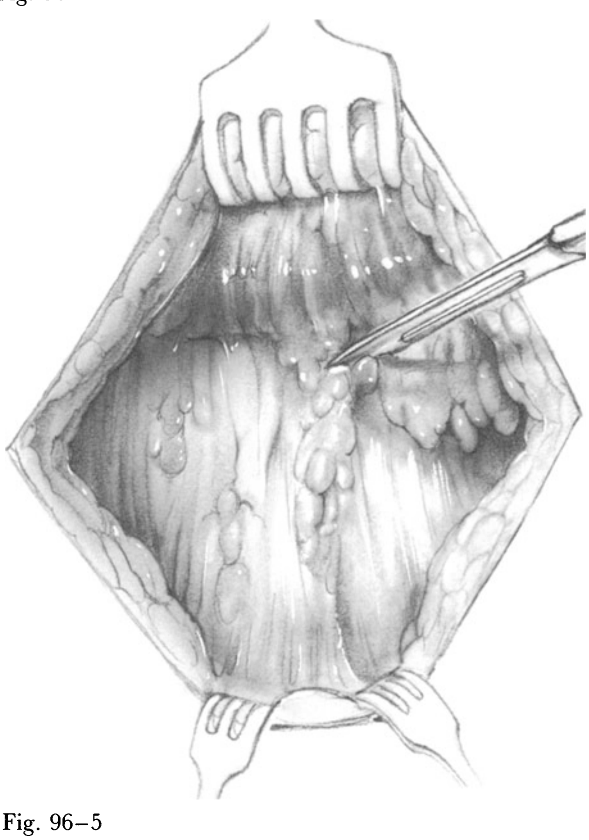


Fig. 96–5

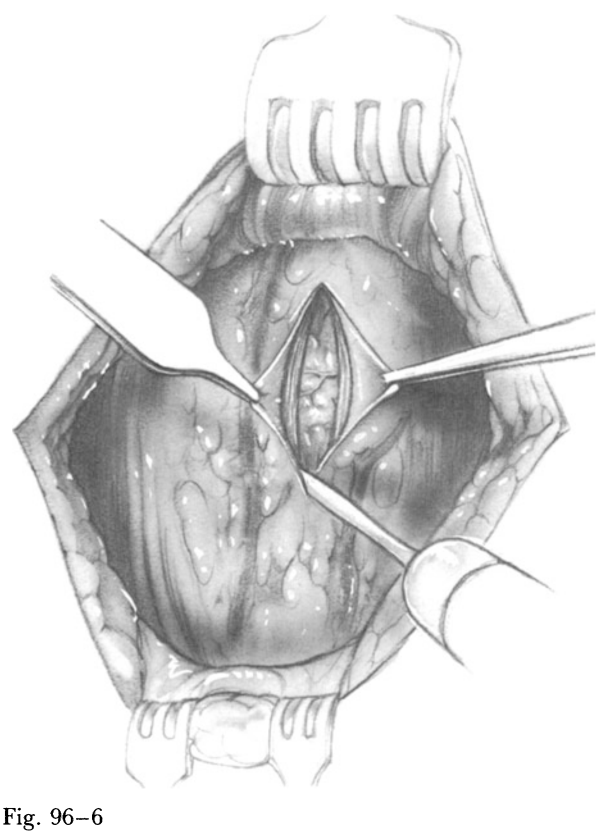


Fig. 96–6

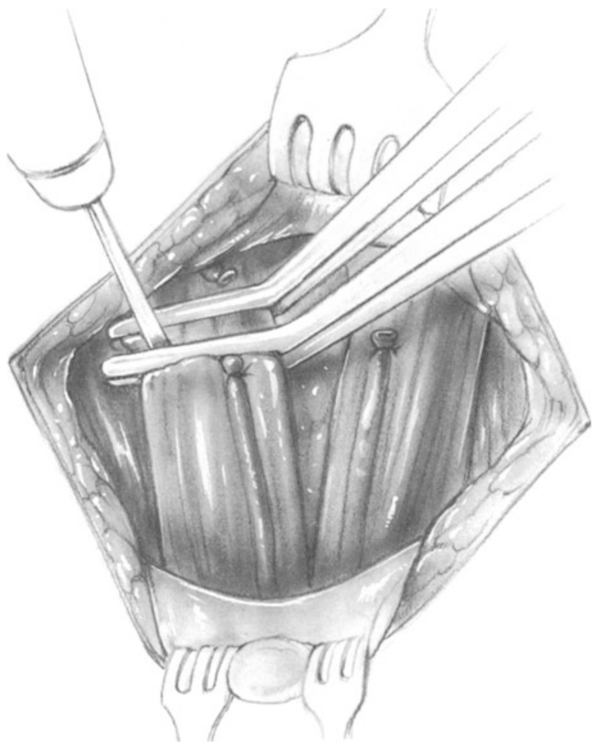


Fig. 96–7

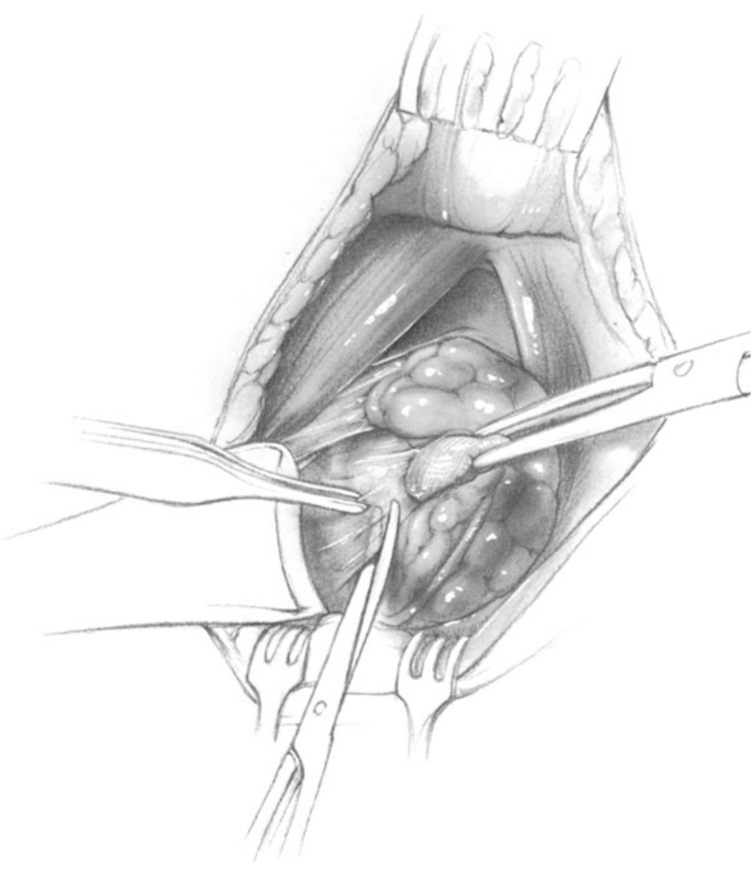


Fig. 96–8

the sternohyoid and sternothyroid muscles. Transect them in their upper thirds (**Fig. 96–7**) as their innervation enters from below.

Identifying the Inferior Thyroid Artery, Recurrent Laryngeal Nerve, and Inferior Parathyroid Gland

Retract the strap muscles firmly with a small Richardson retractor while forcefully drawing thyroid gland in a medial direction using either a peanut sponge (**Fig. 96–8**) or a gauze square held in the assistant's fingers. A layer of thin fibrous and areolar tissue is now divided in layers, either by using Metzenbaum scissors or dissecting bluntly with a hemostat. A variable distribution of one or more middle thyroid veins may be encountered along the anterolateral margin of the thyroid. Divide these veins between ligatures (**Fig. 96–9**). This will permit further elevation of the lower portion of the thyroid lobe.

Identify the carotid artery. Carry the dissection through the fibrous tissue along the medial surface of the carotid artery down to the level of the prevertebral fascia. Now retract the carotid artery laterally. Dissection medial to this vessel will reveal the inferior thyroid artery passing deep to the carotid toward the junction of the middle and lower thirds of the thyroid gland (**Fig. 96–10**). Once the inferior thyroid artery has been identified, encircle it with a Vesseloop. Apply mild traction to the artery and follow the anterior surface of this structure in a medial direction by blunt dissection with a Metzenbaum scissors.

Before this vessel enters the thyroid gland, it will either pass directly beneath or cross directly over the recurrent laryngeal nerve. Make use of the inferior thyroid artery as a guide to the nerve. If the nerve is not immediately seen, dissect the loose fibrous tissue at a point just inferior to the artery near the groove between the trachea and the esophagus in order to identify the recurrent nerve. Once the nerve is identified, use a small hemostat to delineate the plane just superficial to the nerve. Continue this plane of dissection in a cephalad direction up to the inferior cornu of the thyroid cartilage, the point near which the nerve enters the larynx. Be aware that the nerve may divide into two or more branches along its course from the level of the inferior thyroid artery to that of the larynx.

Now identify the inferior parathyroid gland, generally located close to the point where the inferior

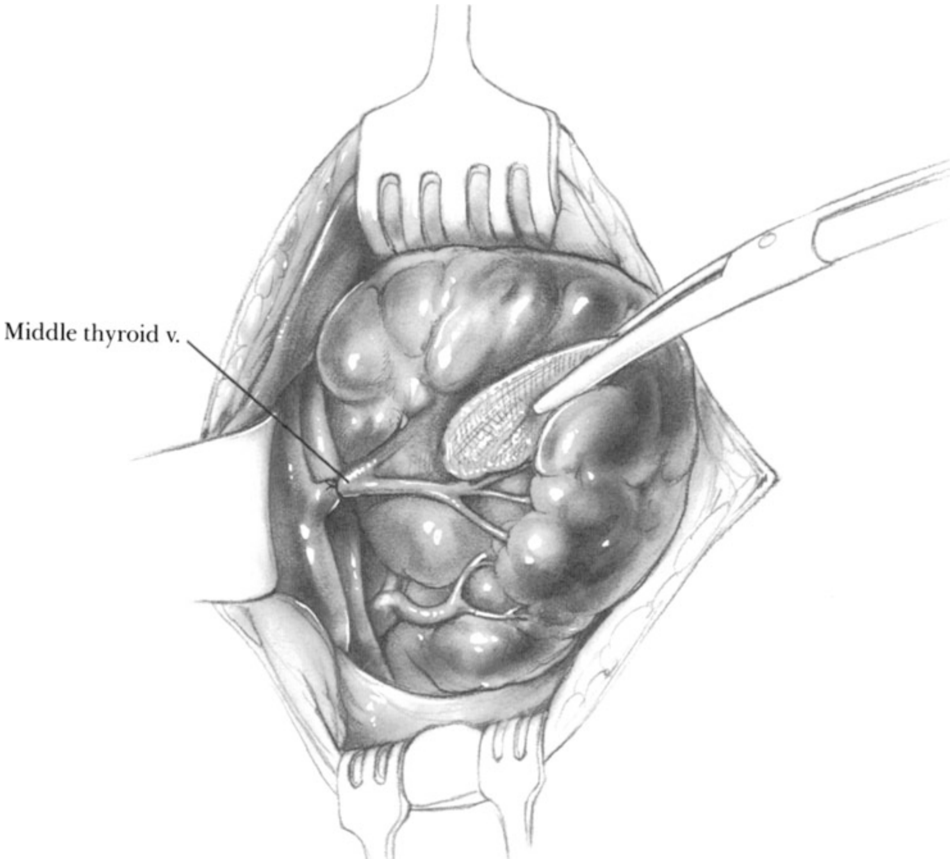


Fig. 96–9

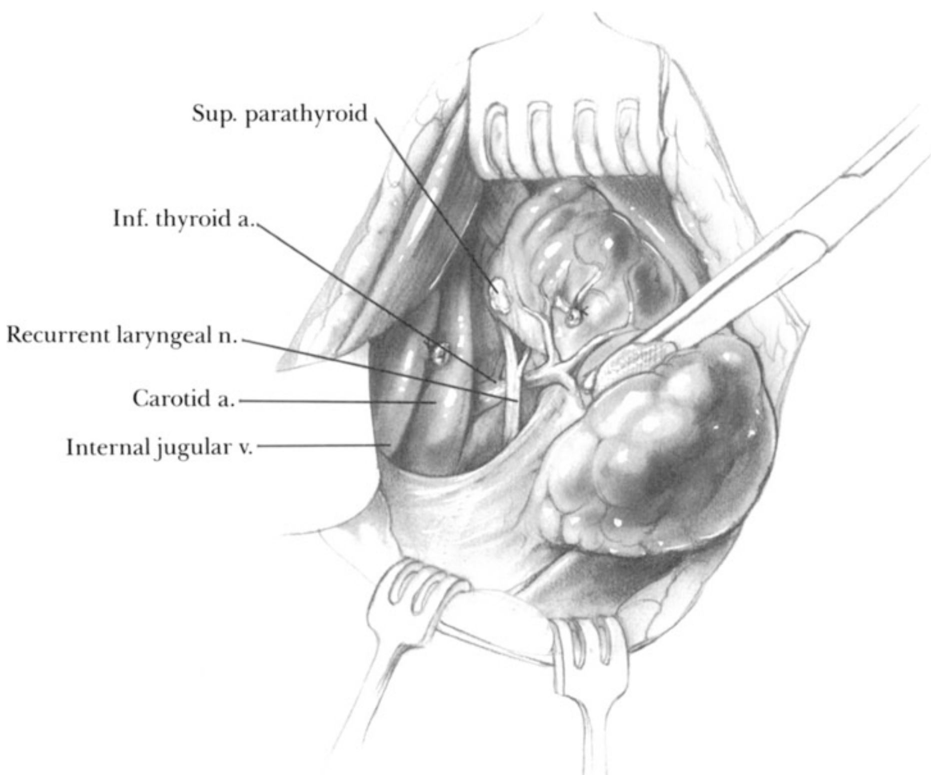


Fig. 96–10

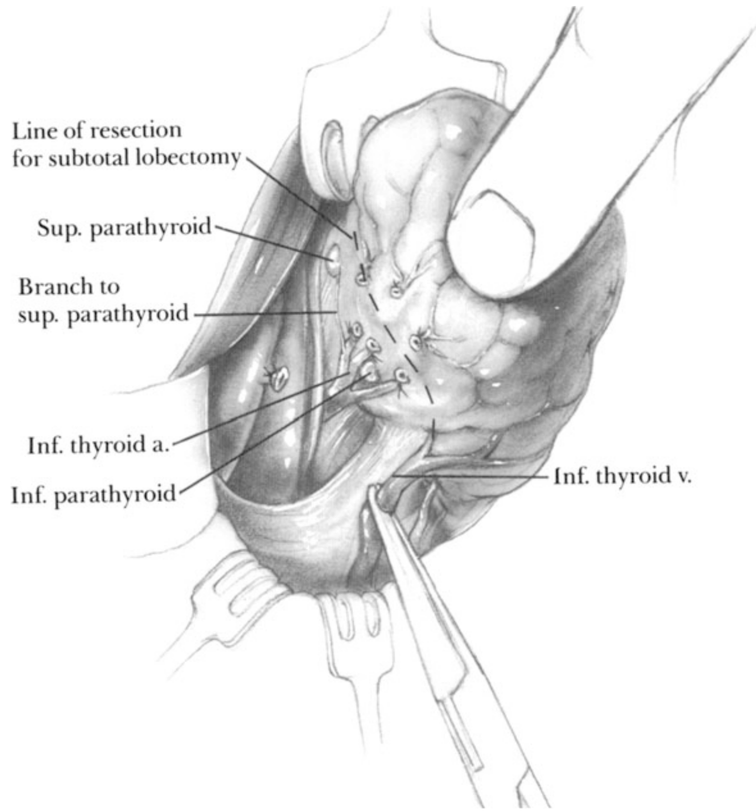


Fig. 96–11

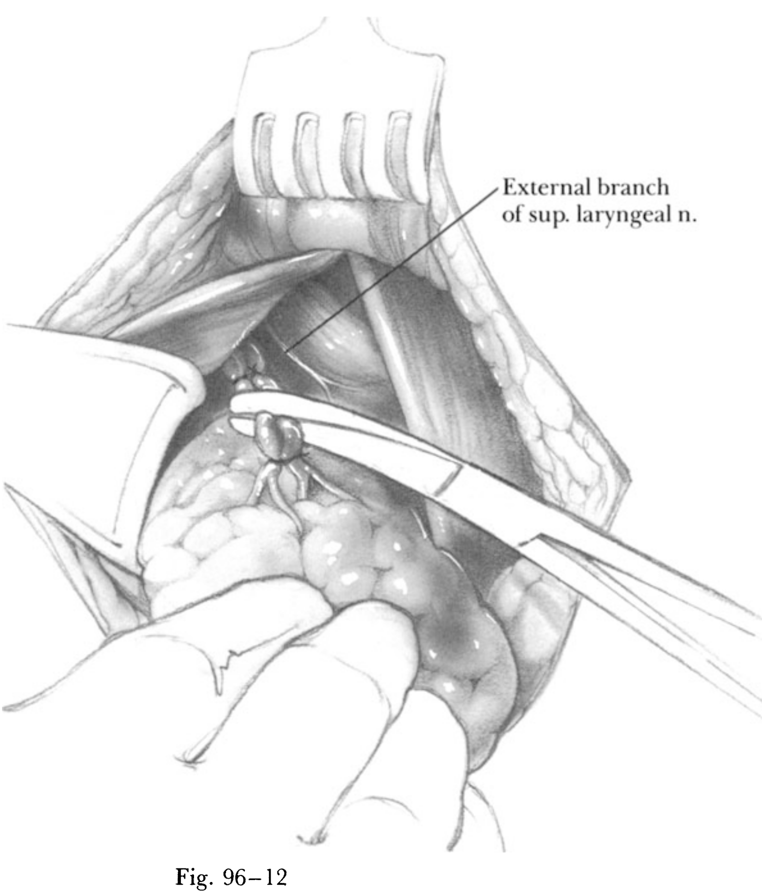


Fig. 96–12

thyroid artery divides into its branches (**Fig. 96–11**). Divide each of these branches of the inferior thyroid artery between ligatures on a line medial to the parathyroid gland so that the blood supply to the parathyroid is not impaired.

Once the recurrent nerve has been identified, proceed to dissect out the lower pole of the thyroid lobe. One or more inferior thyroid veins will be encountered in this location. Divide and ligate each of these veins and liberate the inferior pole.

Dissecting the Superior Pole and Superior Parathyroid Gland

Identify the upper portion of the thyroid isthmus. If a fingerlike projection of thyroid tissue can be identified extending from the region of the isthmus in a cephalad direction, this represents the pyramidal lobe of the thyroid. If a thyroidectomy is being performed for Graves' disease, it is important to remove the pyramidal lobe. Otherwise, postoperatively, it may become markedly hypertrophied and cause a serious cosmetic deformity overlying the thyroid cartilage.

With a retractor drawing the upper portion of the strap muscles in a cephalad direction, use a peanut sponge dissector to sweep the upper pole of the thyroid away from the larynx. This will separate the upper pole from the external branch of the superior laryngeal nerve, which is closely applied to the cricothyroid muscle at this level. Also free the lateral portion of the superior pole by blunt dissection. There may be one or two small veins entering the posterior portion of the upper pole. Be careful to identify and occlude these branches if encountered. Then identify the terminal branches of the superior thyroid artery and vein. Ligate each of these with two 2–0 Vicryl ligatures and then divide each of these vessels between the ligatures (**Fig. 96–12**). After these vessels have been ligated and divided, the superior pole of the thyroid will be completely liberated and can be lifted out of the neck. Now search along the posterior surface of the upper third of the thyroid lobe for the superior parathyroid gland. Its usual location is sketched in Fig. 96–11. Dissect the gland away from the thyroid into the neck.

It should be remembered that if any difficulty is encountered in exposing the recurrent laryngeal nerve, the inferior thyroid artery, or the inferior parathyroid gland, do not hesitate to perform the superior pole dissection earlier in the operation in order to improve exposure of the posterior aspect of the thyroid gland.

At this point the surgeon must decide whether to perform a subtotal or a total thyroid lobectomy. Generally, if the patient has what obviously appears to be a localized benign tumor, perform a subtotal thyroid lobectomy and obtain an immediate frozen section, if possible. If the frozen section should prove malignant, a total lobectomy is indicated as discussed above. For larger tumors that are suspicious of malignancy, a total thyroid lobectomy should be carried out.

Subtotal Thyroid Lobectomy

If a subtotal resection of the lobe is the operation elected, free the upper pole completely and divide the lobe along the line of resection as outlined in Fig. 96–11. At this level of dissection both parathyroid glands and the recurrent nerve, all of which have been previously identified, may be left in their normal locations. Divide the remaining gland between hemostats until the anterior surface of the trachea has been reached. At this point transect the isthmus as described below. Some surgeons feel that the lateral margin of the residual segment of thyroid should be sutured to the trachea, although this step is not essential.

For patients undergoing bilateral subtotal thyroidectomy for Graves' disease, leave no more than 2–4 grams of thyroid tissue on each side.

Total Thyroid Lobectomy

Before considering a total lobectomy, be certain that you have positively identified the recurrent nerve as well as the superior and the inferior parathyroid glands. After these structures have been dissected away from the thyroid, one can proceed with the total lobectomy. The gland is firmly attached to the two upper tracheal rings by dense fibrous tissue that constitutes the ligament of Berry (**Fig. 96–13**). The upper portion of the recurrent laryngeal nerve passes very close to the point where this ligament attaches to the trachea. Also, very often there is a small artery passing very close to the recurrent nerve in this ligament. Be careful to control this vessel without injuring the nerve, before dividing the ligament. After this ligament has been freed, the thyroid lobe can easily be liberated from the trachea by clamping and dividing several small blood vessels until the isthmus has been elevated. The isthmus may be divided serially between hemostats or by a single application of the TA-55 stapling device containing

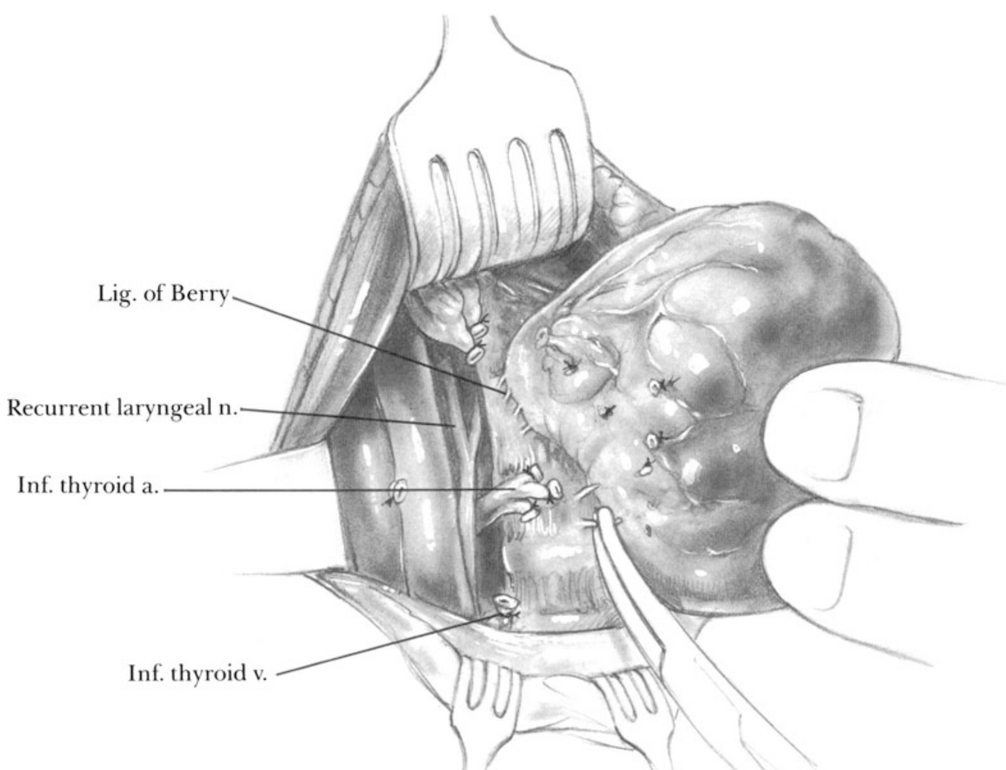


Fig. 96–13

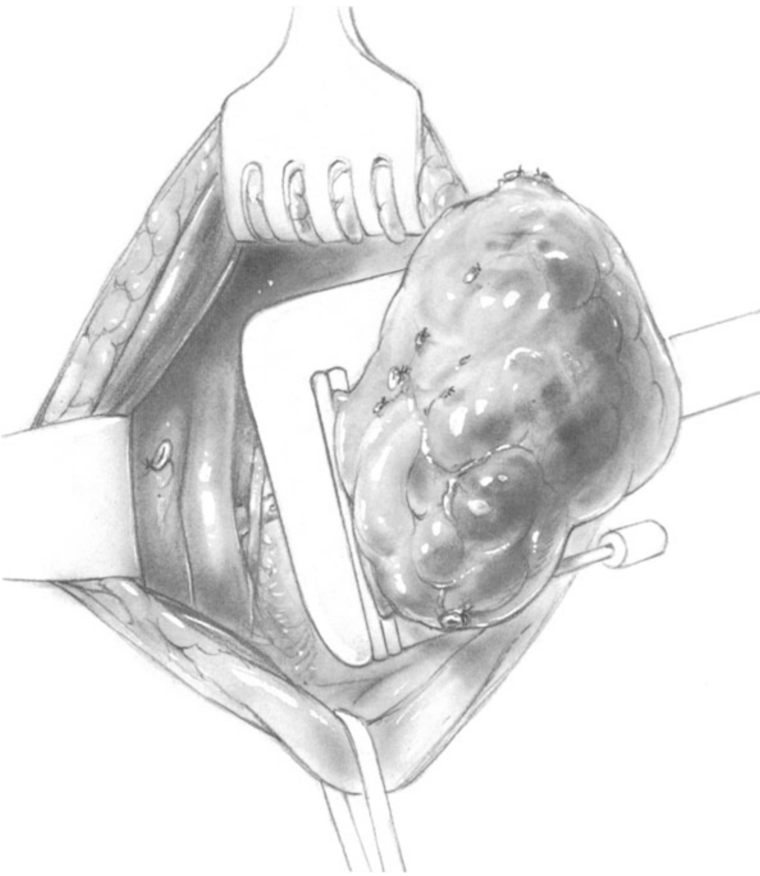


Fig. 96–14

Fig. 96–16

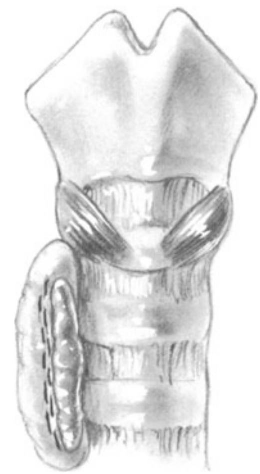


Fig. 96–17

3.5-mm staples as seen in **Fig. 96–14**. Then divide the isthmus with a scalpel leaving the left lobe of the thyroid in place as seen in **Fig. 96–15**.

As you irrigate the operative field with saline and obtain *complete* hemostasis by ligatures and electrocoagulation, always keep in view the recurrent nerve and the parathyroid glands.

Partial Thyroid Lobectomy

On some occasions, what appears to be an obviously benign lesion will occupy a small portion of the

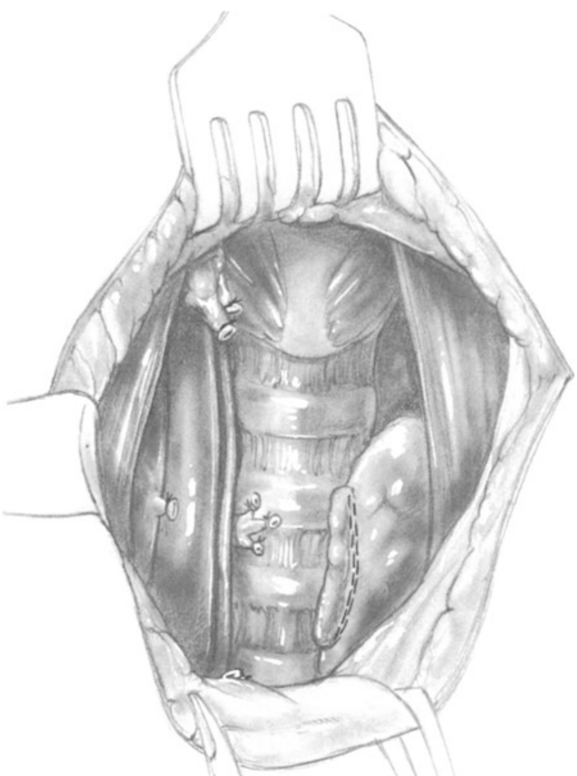


Fig. 96–15

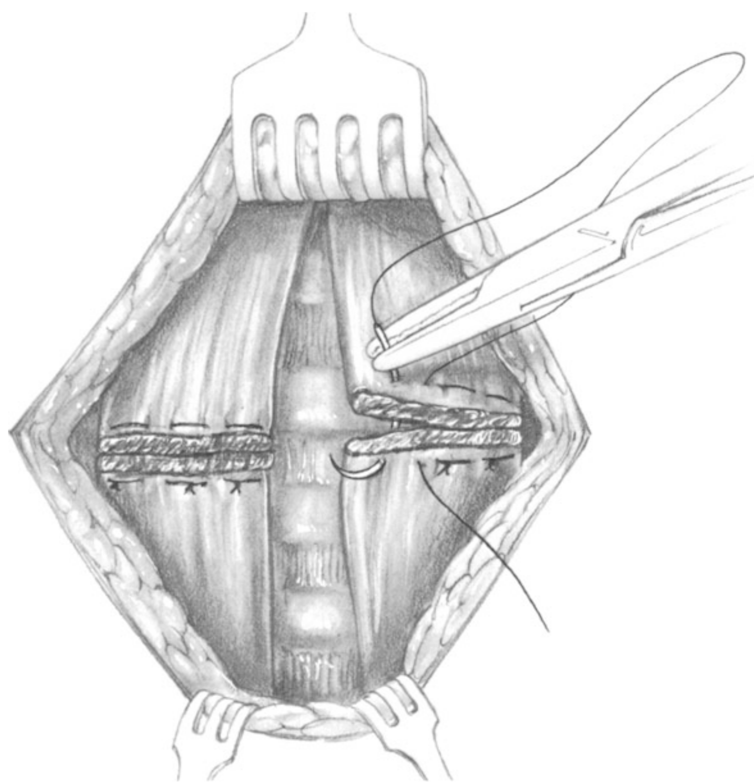


Fig. 96–18

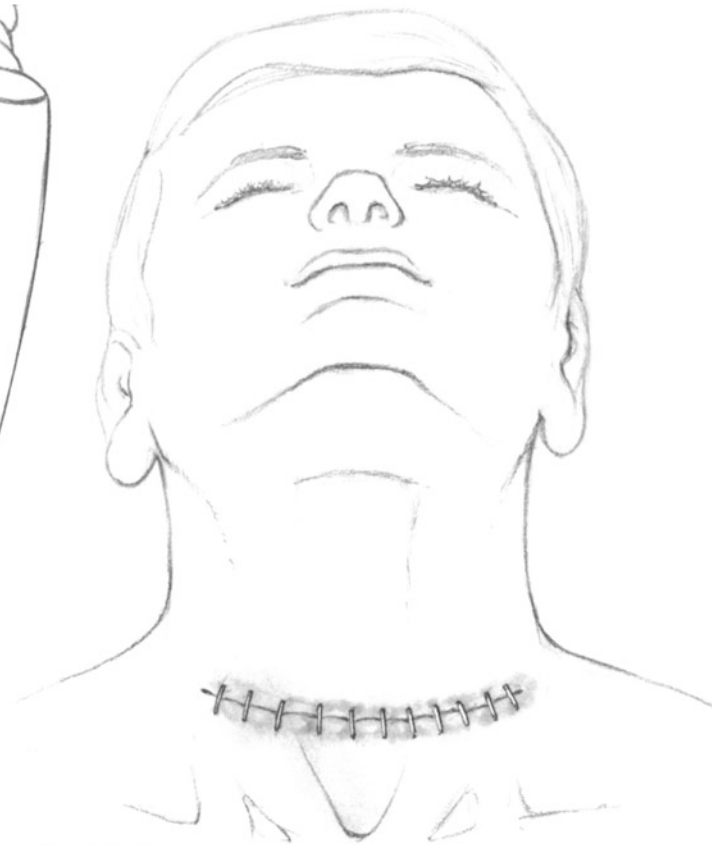


Fig. 96–20

Fig. 96–19

thyroid gland. Under these conditions, local excision or partial lobectomy may be indicated. The stapling device is sometimes useful under these conditions. **Fig. 96–16** illustrates removal of the lower half of the right thyroid lobe, a stapling device having been used first to close and control bleeding from the remaining segment of thyroid. Remember that *identification* and *preservation* of the recurrent nerve must be achieved early in the dissection. If the gland is fairly thick, use 4.8-mm staples.

For benign lesions of the isthmus, one can dissect the isthmus away from the trachea and apply the stapling device to the junction between the isthmus and the adjacent thyroid lobes (**Fig. 96–17**).

Closure

In the unusual situation where the strap muscles have been transected, resuture these two muscles by means of interrupted mattress sutures of 2–0 PG as illustrated in **Fig. 96–18**. In other cases, simply suture the right and left strap muscles together loosely with interrupted 4–0 PG sutures. We rarely drain thyroidectomy cases. Hemostasis should be *perfect* before the operation is terminated. It is not safe to depend on a drain to evacuate blood clots.

After the strap muscles have been reapproximated, suture the divided platysma muscle together using interrupted 5–0 Vicryl. Close the skin by means of carefully applied skin staples (**Figs. 96–19 and 96–20**) or interrupted fine nylon.

Postoperative Care

In patients with Graves' disease, carefully monitor vital signs in order to detect early evidence of a *thyroid storm*. Those patients who were prepared for operation with propranolol will require treatment with this medication for 7–10 days following operation.

Carefully observe the patient's neck for signs of swelling or ecchymosis. Active *bleeding* in the bed of the excised thyroid gland can rapidly compress the trachea and cause respiratory obstruction, especially if the bleeding is due to a major artery. Under rare circumstances, it may be necessary to remove all of the sutures in the skin and the strap muscles in order to release the blood clot at the patient's bedside. In most cases, evacuate the blood clot in the operating room. After the removal of a very large goiter, one may occasionally observe the gradual swelling of the tissues of the neck due to slow venous bleeding that infiltrates the tissues and may produce respiratory distress by laryngeal edema. This type of patient requires orotracheal intubation as well as evacuation of the clot in the operating room. It is rare that an exploration or a tracheostomy must be done at the patient's bedside.

Following bilateral thyroid lobectomy, check for *hypocalcemia* by measuring the serum calcium level until the patient is discharged. Observe for the signs of paresthesia of the extremities or face, symptoms that generally appear when the calcium drops below a level of 7–8 mg/dl. Treat the symptoms with intravenous calcium gluconate, 1 gram of a 10% solution several times a day. Give oral calcium carbonate tablets, 2–4 grams per day, as required to maintain the serum calcium level. If calcium alone does not control the symptoms, administer vitamin D, 50,000–100,000 units a day by mouth. The milder forms of hypocalcemia following thyroid surgery will probably be transient because it is caused by minor trauma to the parathyroid glands. Severe postoperative hypoparathyroidism is often permanent in nature.

The patient who has undergone trauma or laceration of both recurrent laryngeal nerves may develop a complete *airway obstruction* requiring prompt endotracheal intubation and then tracheotomy. This complication should be extremely rare.

Postoperative Complications

Hematoma with possible tracheal compression and respiratory distress may occur.

There may be *injury to the recurrent laryngeal nerve*. If unilateral, this generally produces some degree of hoarseness and weakness of voice. As mentioned above, bilateral recurrent nerve damage causes bilateral vocal cord paralysis and marked narrowing of the glottis with respiratory obstruction, which often requires immediate tracheotomy. The airway may later be improved by an arytenoidectomy. Postoperative hoarseness may be also due to transient vocal cord edema or vocal cord injury due to the endotracheal tube used for anesthesia.

External laryngeal nerve injury may result in the patient being unable to utter high-pitched sounds.

Hypoparathyroidism, transient or permanent, results from inadvertent removal or trauma to several of the parathyroid glands. If during operation it is noted that one or more parathyroid glands have been removed, slice these into segments 1 mm by 1 mm each. Then transplant them into a muscle of the forearm or the neck. If the fragments are sufficiently small, satisfactory function may develop. Transient hypoparathyroidism lasting as long as several months may result from manipulation of the parathyroid glands without permanent damage.

Thyroid storm may develop following thyroidectomy for Graves' disease, especially if the preoperative preparation has not been adequate. This condition is characterized by fever, severe tachycardia, mental confusion, delirium, and restlessness. Rarely seen in the present era, thyroid storm may be treated by adequate doses of propylthiouracil and intravenous sodium iodide, as well as propranolol, 2 mg intravenously, with electrocardiographic control, followed by 10–40 mg by mouth several times a day. A patient with a high fever should be placed on a hypothermic blanket.

Hypothyroidism may occur following bilateral subtotal thyroidectomy. Although many surgeons believe that after an interval of 1–2 years following thyroidectomy the thyroid hormone secretion continues at a stable rate, other observers contend that, like radioactive iodine, thyroidectomy may induce hypothyroidism many years after operation. Consequently, these patients should be checked for thyroid function at intervals of 1–2 years for an indefinite period of time.

References

Attie JN. Feasibility of total thyroidectomy in the treatment of thyroid carcinoma. Am J Surg 1979;138:555.

Becker FO, Economou SG, Southwick HW. Adult thyroid cancer after head and neck irradiation in infancy and childhood. Ann Intern Med 1975;83:347.

Block MA. Surgery of thyroid nodules and malignancy. Curr Probl Surg 1983;20:137.

Block MA, Dailey GE, Robb JA. Thyroid nodules indeterminate by needle biopsy. Am J Surg 1983;146:72.

Blum M, Rothschild M. Improved non-operative diagnosis of the solitary "cold" thyroid nodule: surgical selection based on risk factors and three months of suppression. JAMA 1980;243:242.

Cady B, Sedgewick CE, Meissner WA et al. Changing clinical pathology, therapeutic, and survival patterns in differentiated thyroid carcinoma. Ann Surg 1976; 184:541.

Cady B, Sedgewick CE, Meissner WA et al. Risk factor analysis in differentiated thyroid cancer. Cancer 1979; 43:810.

Clark OH. Total thyroidectomy: the treatment of choice for patients with differentiated thyroid cancer. Ann Surg 1982;196:361.

Clark RL, White SC, Russell WD. Total thyroidectomy for cancer of the thyroid: significance of intraglandular dissemination. Ann Surg 1959;149:858.

Dobyns BM, Sheline GE, Workman JB. Malignant and benign neoplasms of the thyroid in patients treated for hyperthyroidism: a report of the cooperative thyrotoxicosis therapy follow-up study. J Clin Endocrinol 1974; 38:976.

Mazzaferri EL, Young RL, Oertel JE et al. Papillary thyroid carcinoma: the impact of therapy in 576 patients. Medicine 1977;56:171.

Paloyan E. Operation for the irradiated gland for possible thyroid carcinoma: criteria, technique, and results. In: DeGroot LJ, (ed) Radiation—associated thyroid carcinoma. New York: Grune and Stratton; 1977.

Rosen IR, Wallace C, Strawbridge HG et al. Reevaluation of needle aspiration cytology in detection of thyroid cancer. Surgery 1981;90:747.

Tollefson HR, Shah JP, Huvos AG. Papillary carcinoma of the thyroid: recurrence in the thyroid gland after initial surgical treatment. Am J Surg 1972;124:97.

Wanebo HJ, Andrews W, Kaiser DL. Thyroid cancer: some basic considerations. Am J Surg 1981;142:472.

Wells SA Jr, Ross AJ, Dale JK et al. Transplantation of the parathyroid glands: current status. Surg Clin North Am 1979;59:167.

Woolner LB, Beahrs OH, Black BM. Thyroid carcinoma: general considerations and follow-up data on 1,181 cases. In: Young S, Inman DR (eds) Thyroid neoplasia. London: Academic Press; 1968.

97 Cricothyroidotomy

Concept: Which Kind of Emergency Airway?

When a hospitalized patient requires the establishment of an airway in the upper respiratory tract under emergency conditions, the first priority is to achieve endotracheal intubation, generally through the mouth, with a laryngoscope. In situations where endotracheal intubation cannot be established with great rapidity, an immediate cricothyroidotomy or tracheotomy is indicated. Of these two procedures, we agree with Boyd, Romita, Conlan, and associates that cricothyroidotomy has many advantages over tracheotomy under emergency conditions. The cricothyroid membrane is situated directly under the skin with no intervening tissues, such as muscle and the thyroid isthmus, which are encountered during tracheotomy. Cricothyroidotomy is easily learned and can be performed very rapidly with minimal risk. It involves an incision in the membrane between the lower border of the thyroid cartilage and the cricoid cartilage for purposes of tracheal intubation. Utilized under proper conditions, it has been demonstrated to be safe in a series of 655 cases reported by Brantigan and Grow (1976) and in another series of 147 cases reported by Boyd and associates.

Although the older literature contains many warnings that cricothyroidotomy is followed by many complications such as glottic or subglottic stenosis, both Boyd and associates and Brantigan and Grow (1982) did not encounter this complication when cricothyroidotomy was the initial procedure used for upper airway obstruction. On the other hand, patients who have been maintained on mechanical ventilation with endotracheal intubation for more than 7 days and who have then undergone cricothyroidotomy, have sustained an unacceptable incidence of subglottic stenosis. Presumably, prolonged intubation with secondary ulceration and inflammation of the larynx, followed by cricothyroidotomy, combine to cause permanent damage to the subglottic region. Patients with acute inflammation of the epiglottis or vocal cords due to infection or external trauma also should not undergo cricothyroidotomy, except possibly as a temporary lifesaving measure. On the other hand, Boyd and associates and Brantigan and Grow (1982) have found that maintaining a patient on a mechanical ventilator for many weeks following intubation via cricothyroidotomy appears to produce no permanent damage, provided the patient was not orally intubated for more than 7 days prior to the cricothyroidotomy.

Indications

Establishing an emergency airway when oral or nasal endotracheal intubation cannot be achieved

Under elective conditions the cricothyroid route is suitable for tracheal intubation, provided (1) the patient has not been orally or nasally intubated for a period of more than 7 days and (2) there is no preexisting infection or external trauma of the larynx.

Preoperative Care

Like tracheotomy, cricothyroidotomy is simpler to perform in a patient who has already been orally intubated. However, many cricothyroidotomy procedures are performed under emergency conditions where no preoperative preparation is possible.

Pitfalls and Danger Points

Making Erroneous Incision in Thyrohyoid Membrane

A dangerous error, occasionally performed by a neophyte under conditions of excitement, is to make the incision *above* the thyroid cartilage in the thyrohyoid membrane instead of *below* the thyroid cartilage in the cricothyroid region. This erroneous incision may result in serious damage to the structures of the larynx. In learning to do this operation, remember that the incision is made at the lower border of the thyroid cartilage between the thyroid and the cricoid cartilages.

Failure to Control Subcutaneous Bleeding

Occasionally a vein in the subcutaneous space is transected. The veins should be either ligated or electrocoagulated; otherwise, postoperative bleeding may occur.

Operative Strategy

Because cricothyroidotomy is often performed in an emergency situation, local infiltration of the skin over the cricothyroid membrane is the anesthetic usually employed. In desperate situations, of course, no anesthesia is necessary.

Since the most dangerous error is making the incision in the wrong place, the surgeon should avoid this error by grasping the lateral margins of the thyroid cartilage between the thumb and the middle finger of his left hand, using the tip of his index finger to palpate the space between the lower margin of the thyroid cartilage and the upper margin of the cricoid. With this maneuver, one can pinpoint accurately the proper site for the incision. Under conditions of desperate emergency in the field without instruments, it is possible to perform this procedure with a sharp penknife by inserting the tip of the blade through the skin and the cricothyroid membrane with one motion. Then twist the blade 70°–90° to provide a temporary airway until some type of tube can be inserted into the trachea.

Operative Technique

Incision

Place a folded sheet under the patient's shoulders to elevate them 4–8 cm above the table level. This extends the neck somewhat. After the usual skin preparation, grasp the lateral margin of the thyroid cartilage between the thumb and the middle finger of the left hand. Palpate the cricothyroid space accurately with the tip of the index finger. Then infiltrate the line of the incision with local anesthesia. Make a transverse incision in the cricothyroid space, about 2 cm in length. Carry the incision down to the cricothyroid membrane. Occlude any bleeding points with ligatures or electrocoagulation. Use a scalpel with a No. 15 blade to stab the cricothyroid membrane (**Figs. 97–1 and 97–2**). Enlarge the

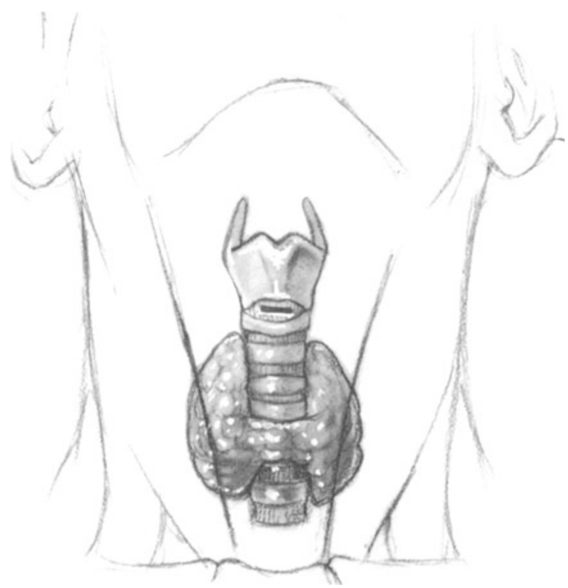


Fig. 97–2

Fig. 97–1

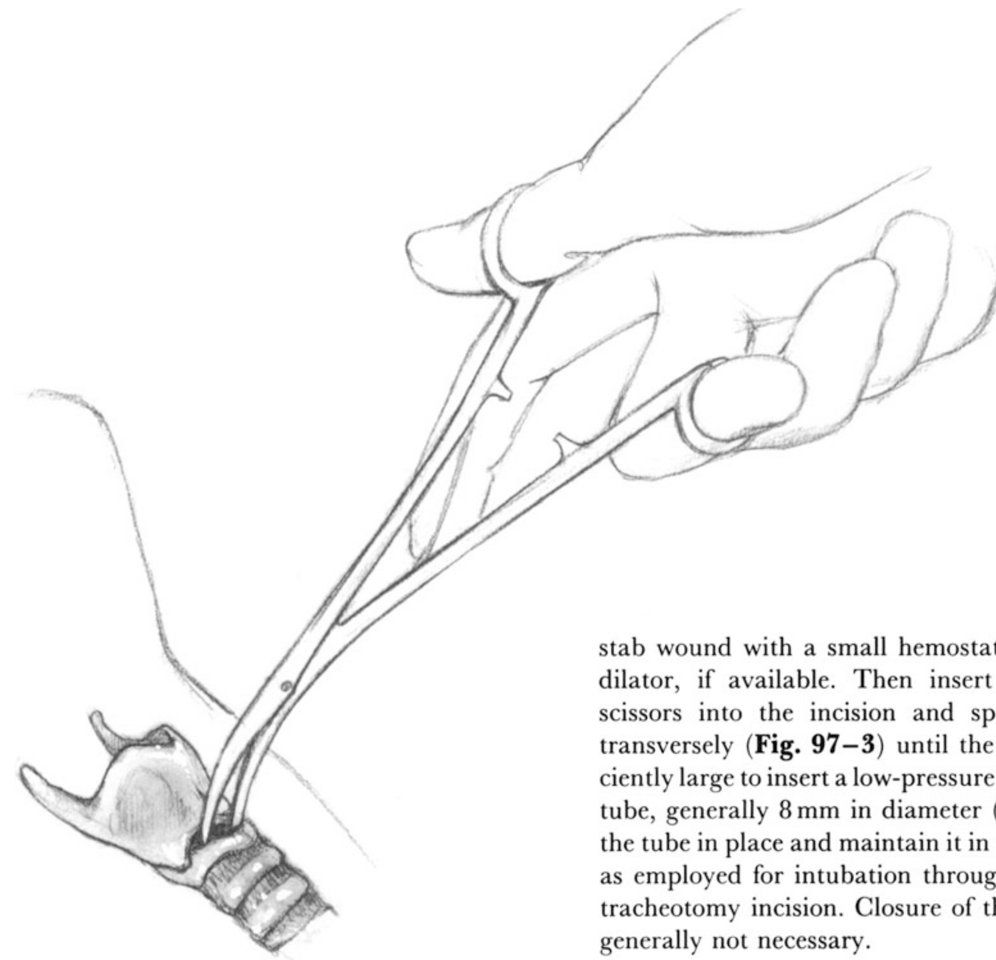


Fig. 97–3

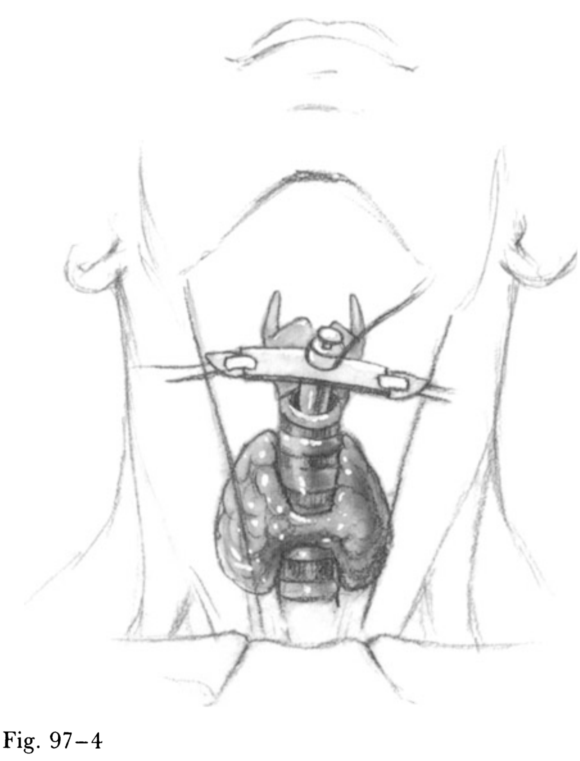


Fig. 97–4

stab wound with a small hemostat or a Trousseau dilator, if available. Then insert a heavy Mayo scissors into the incision and spread the tissues transversely (**Fig. 97–3**) until the opening is sufficiently large to insert a low-pressure cuff tracheotomy tube, generally 8 mm in diameter (**Fig. 97–4**). Fix the tube in place and maintain it in the same manner as employed for intubation through the traditional tracheotomy incision. Closure of the skin wound is generally not necessary.

Postoperative Care

(See Chap. 98.)

Postoperative Complications

Peristomal bleeding

Transient hoarseness

Infection, cellutitis

Subglottic stenosis has not been seen unless the patient had undergone preoperative endotracheal intubation for more than 7 days or had an inflammatory condition of the larynx prior to operation.

References

Boyd AD, Romita M, Conlan A et al. A clinical evaluation of cricothyroidotomy. Surg Gynecol Obstet 1979;149: 365.

Brantigan CO, Grow JB. Cricothyroidotomy: elective use in respiratory problems requiring tracheotomy. J Thorac Cardiovasc Surg 1976;71:72.

Brantigan CO, Grow JB. Subglottic stenosis after cricothyroidotomy. Surgery 1982;91:217.

98 Tracheotomy

Concept: When to Do a Tracheotomy

As mentioned in Chap. 97, tracheotomy is not the optimal operation for use in emergency situations in the absence of adequate light, instruments, and suction apparatus. Under these conditions, orotracheal intubation or cricothyroidotomy are far better procedures.

At one time tracheotomy was frequently employed in patients with pulmonary disease in order to improve respiratory function by reducing the dead space and by providing a direct route to the trachea to facilitate aspiration of excessive bronchial secretions. At present, improved methods of pulmonary physiotherapy have reduced the necessity to perform tracheotomy to facilitate tracheal suctioning; efficient nursing management of orotracheal tubes in patients on mechanical ventilators has made it unnecessary to perform a tracheotomy in these patients if their need for assisted ventilation does not exceed 1–3 weeks' duration. This requires meticulous suctioning of the trachea and the use of a low-pressure cuff on the endotracheal tube. As a result of all these developments, the present primary usefulness of the tracheotomy arises in patients who require it for the *long-term* maintenance of an airway.

Indications

Organic upper airway obstruction
Radical oropharyngeal or thyroid surgery
Severe laryngeal trauma
Long-term ventilatory support

Preoperative Care

Pass an oral or nasal endotracheal tube preoperatively whenever possible.

Pitfalls and Danger Points

Injury during surgery to cricoid or first tracheal ring
Inadequate hemostasis
Asphyxia

Operative Strategy

Because most tracheotomy operations are performed with the orotracheal or nasotracheal tube in place, inhalation anesthesia is the agent most commonly employed. Local anesthesia is also quite satisfactory in most patients.

With an indwelling endotracheal tube in place, the risk of anoxia during tracheotomy is virtually eliminated. If for some reason an endotracheal tube is not in place, be certain the hemostasis is adequate prior to opening the trachea. Otherwise, blood may pour into the tracheal stoma, obstructing the airway. An adequate suction apparatus should always be available during tracheotomy. This is one reason why a cricothyroidotomy is a better operation during an emergency situation when an endotracheal tube has not been passed.

If the incision in the trachea is made in the area of the 1st ring or the cricoid cartilage, there is great risk that a subglottic stenosis will occur after the tracheotomy tube has been removed. It should be recognized that the opening in the trachea, made by the tracheotomy tube, heals by cicatrization, incurring the risk that a mild narrowing of the trachea will occur at the site of the tracheotomy. If this occurs in the subglottic region, corrective therapy will be extremely difficult. For this reason, take every precaution to avoid incising or injuring the 1st ring or cricoid cartilage.

A very low tracheotomy incision, for instance in the 4th ring, may also entail an unnecessary risk for the patient. This is true because inserting a tracheotomy tube low down in the trachea may cause erosion of the innominate artery due to pressure exerted by the tip of the tube. This complication has on occasion resulted in massive hemorrhage into the trachea with prompt asphyxiation of the patient. This risk is especially applicable in children where the innominate artery is relatively close to the tracheotomy site.

Operative Technique

Endotracheal Tube

Virtually all patients should have an endotracheal tube in place prior to undergoing tracheotomy.

Incision and Exposure

Position the patient with a folded sheet beneath the shoulders so that the neck is extended.

Although some surgeons believe that a horizontal skin incision produces a better scar, the generally preferred incision is a vertical one beginning at the level of the cricoid and continuing in a caudal direction for about 4–5 cm. Carry the incision through the subcutaneous fat and the platysma muscle directly over the midline of the trachea, exposing the sternohyoid muscles. Achieve complete hemostasis with electrocautery and PG ligatures. Now elevate the strap muscles and make a vertical incision down the midline separating these two muscles. Carry the incision down to the upper trachea and expose and divide the capsule of the thyroid gland. Clamp, divide, and ligate all veins in this vicinity. Identify the thyroid isthmus. This bridge of tissue crosses the trachea generally in the vicinity of the 3rd tracheal ring (**Figs. 98–1 and 98–2**).

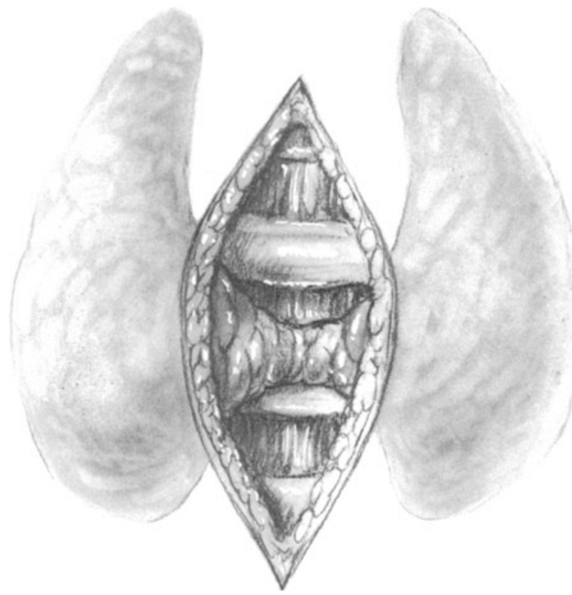


Fig. 98–2

Identifying the Tracheal Rings

Clearly visualize the cricoid cartilage and the first tracheal ring. Preserve these two structures from injury. Occasionally it may be possible to retract the thyroid isthmus in a cephalad direction to expose the 2nd and 3rd tracheal rings. However, in most cases, it will be necessary to elevate the thyroid isthmus from the trachea by sliding Metzenbaum scissors beneath the isthmus and elevating it. Then divide the isthmus between clamps and insert suture-ligatures to maintain complete hemostasis. This will clearly reveal the identity of the 2nd and 3rd tracheal rings (**Fig. 98–3**).

Opening the Trachea

Check that hemostasis is complete. Also, check that the suction apparatus is functioning.

In some cases incising only the 2nd ring will provide an adequate tracheotomy opening, but generally it will be necessary to incise both the 2nd and

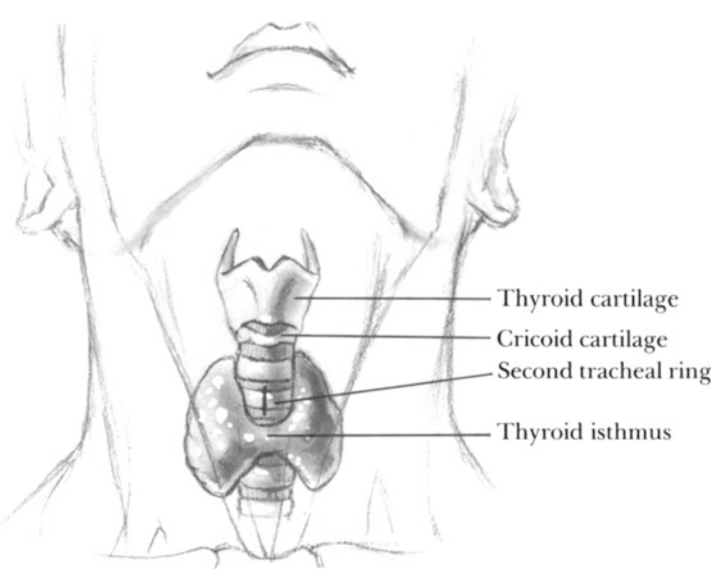


Fig. 98–1

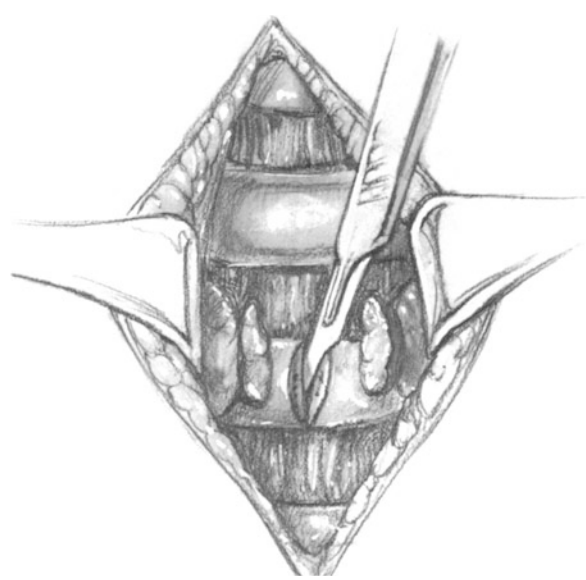


Fig. 98–3

3rd rings. This procedure is facilitated by inserting a single hook retractor to elevate the upper portion of the 2nd ring. Insert a scalpel with a No. 15 blade to incise the membrane transversely just above the 2nd ring. Then divide the 2nd ring with the scalpel (Fig. 98–3) and also the 3rd ring if necessary. Never divide the 1st ring or the cricoid cartilage.

Inserting Tracheotomy Tube

Retract the edges of the trachea by inserting either a hemostat, two small hook retractors, or a Trousseau 3-prong retractor (**Fig. 98–4**). Since most tracheotomy operations will require the insertion of a tube with a large balloon cuff for mechanical ventilation, be certain to apply a water-soluble lubricant to the tip of the tracheotomy tube and cuff. Then insert the tube into the tracheal incision (**Fig. 98–5**) while the anesthesiologist extracts the nasotracheal tube. Insert a suction catheter into the tracheotomy tube and aspirate mucous from the bronchial tree. Attach an oxygen line to the tracheotomy tube if necessary.

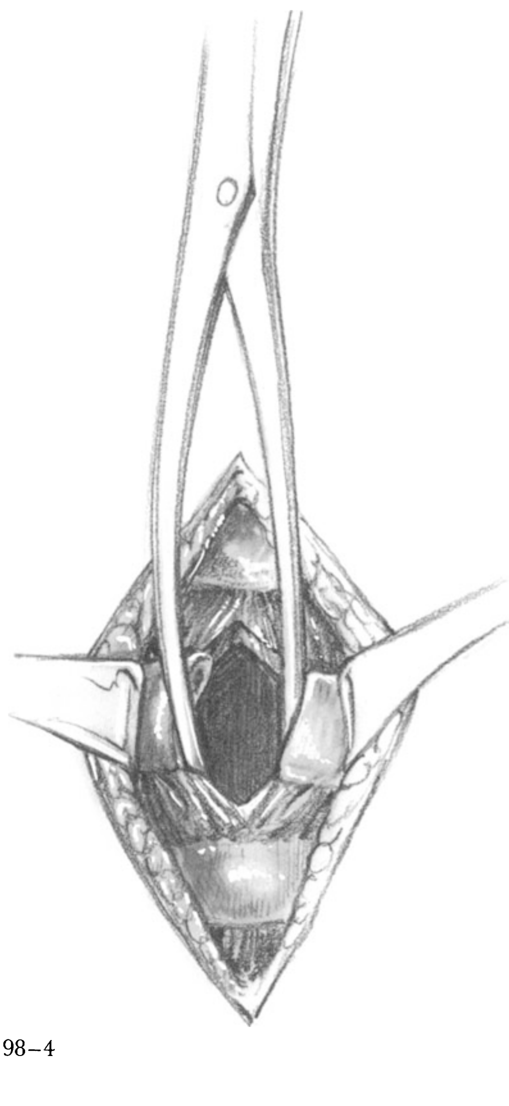


Fig. 98–4

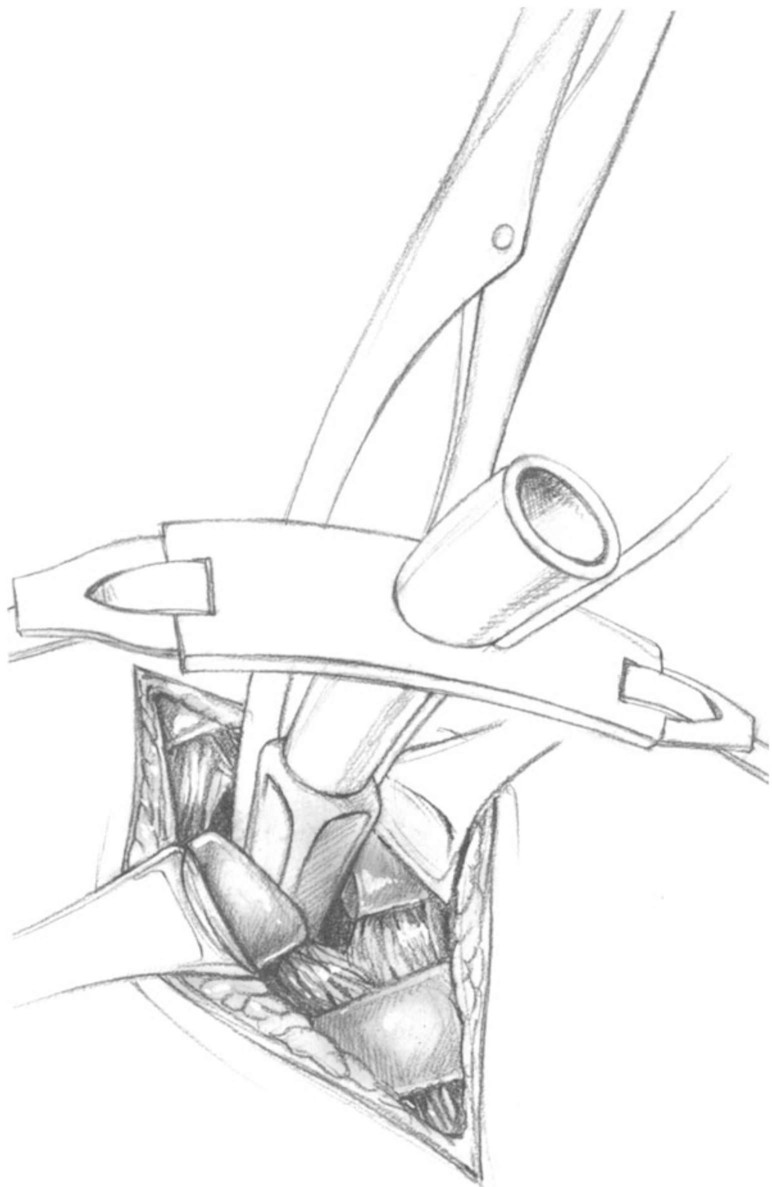


Fig. 98–5

Closure

Reapproximate the sternohyoid muscles in the midline with interrupted 4–0 PG sutures. Insert several additional sutures to reapproximate the platysma muscle. Then close the skin *loosely* with interrupted 4–0 nylon sutures. Suture the tracheotomy tube to the skin in two places. As soon as practicable, tie the cotton tapes together in the back of the patient's neck to guarantee fixation of the tracheotomy tube.

Postoperative Care

Humidified air is necessary to prevent crusting of secretions and eventual obstruction of the tracheotomy tube.

Use light-weight swivel connectors to attach the tracheotomy tube to the ventilator to avoid unnecessary pressure on the trachea at the stoma.

If the tracheotomy tube has to be changed within the first one or two postoperative weeks, be certain to have instruments available for instant endotracheal intubation or emergency cricothyroidotomy if difficulty is encountered in reinserting a tracheotomy tube. Remember, the track between the skin and the tracheal stoma will not be established for a variable number of days after the operation. Therefore, locating the tracheal stoma deep in the neck may sometimes be extremely difficult. This is a procedure not to be performed by an inexperienced resident.

To improve the exposure of the trachea in the neck, hyperextend the patient's head by placing a rolled-up sheet under his shoulders. In order to help maintain the track of the tracheotomy tube, place the patient in a recumbent position with a sheet or sandbag beneath the shoulders. This will extend the head and neck, bringing the tracheal stoma closer to the skin incision. Only with the patient in this position should the old tracheotomy tube be removed and replaced. Never attempt this maneuver during the first two postoperative weeks with the patient in a sitting position.

Postoperative Complications

Hemorrhage following tracheotomy may occur as a result of the surgeon's having failed to ligate the bleeding points in the wound. This will become manifest by bleeding around the tracheotomy tube. A far more serious hemorrhage may occur late in the postoperative period, the result of either the tip of the tracheotomy tube or the balloon cuff eroding through the anterior wall or the trachea into the innominate artery. This is a life-threatening complication manifested by arterial bleeding into the trachea. Emergency management of this condition depends on temporarily controlling the bleeding by inflating the balloon cuff. If inflating the cuff around the tracheotomy tube does not promptly control the bleeding, then remove it and immediately insert an orotracheal tube. Inflating the cuff of the orotracheal tube may then occlude the fistula from the trachea to the innominate artery. Emergency resection of the innominate artery with suture of both ends may be necessary for definitive repair of the fistula with resection also of the damaged trachea in some cases.

Subcutaneous emphysema may be avoided if the tissues are not sutured too snugly against the tracheotomy tube. There may be some air leakage between the trachea and the tracheotomy tube. If this air has access to the outside, subcutaneous emphysema will not occur.

Wound infection

Pneumothorax (rare)

Accidental displacement of tracheotomy tube

Stenosis may occur sometime after the tracheotomy tube has been removed. This complication may take place either at the tracheal stoma or in the area of the trachea occluded by the balloon cuff. Strictures at the stoma level may be minimized by making the incision in the trachea as small as possible. Constrictions lower in the trachea have been virtually eliminated by the large-volume, low-pressure balloon cuffs. If a patient who has undergone a period of mechanical ventilation with a tracheal tube ever develops signs of an upper airway obstruction (stridor or wheezing or shortness of breath), a stricture of the trachea should be strongly suspected.

A lateral X ray of the neck will disclose an upper tracheal stricture, while an oblique chest X ray should identify lower tracheal lesions. Tracheal resection and anastomosis may be necessary for serious strictures. A granuloma may be resected through a bronchoscope utilizing the laser in some cases.

Miscellaneous

99 Drainage of Subphrenic Abscess

Concept: Etiology and Modern Management of Subphrenic Abscess

Etiology

Although subphrenic abscesses may arise from primary infections of the biliary tract, the appendix, or the colon, in the great majority of cases subphrenic sepsis follows a previous abdominal operation. In DeCosse, Poulin, Fox, and Condon's study of 52 patients in whom subphrenic sepsis followed previous surgery, 22 of them developed abscesses subsequent to operations on the stomach and 11 of them, abscesses after biliary tract surgery. Other causes of subphrenic abscesses included surgery for trauma in 7 patients and colon operations in another 7 cases. These authors felt that postoperative bleeding was a common contributing cause in their series of subphrenic abscesses, many of which were, in fact, infected hematomas. Inadvertent splenectomy was another postoperative complication associated with left-sided subphrenic sepsis following gastric surgery.

Diagnosis

Clinical Assessment

Only about two-thirds of the patients with subphrenic abscesses demonstrate a typical clinical picture of fever, localized pain or tenderness, leucocytosis, and ipsilateral pleural effusion on chest X ray. In the *early* stages, many patients manifest few of the above manifestations. Consequently, recent abvances in radiographic and other types of body imaging have been most welcome.

Nuclear, Sonographic, and CT Scanning Assessments

Although sonography has been of some value in identifying subphrenic sepsis, the CT scan is proving to be by far the most accurate method of identifying an abdominal abscess. The accuracy of computed tomography is so impressive, that it is cost effective to perform this study on any patient who has an unexplained persistent fever following abdominal surgery.

Percutaneous Catheter Drainage of Subphrenic Abscess

With the aid of the CT scanning device and ultrasonography, Johnson, Gerzof, Robbins et al. were successful in draining 89% of subphrenic or other abdominal abscesses by means of catheters inserted via the percutaneous route. Their indications for using percutaneous drainage included: (1) a well-established unilocular fluid collection having the various CT and ultrasound signs of an abscess; (2) a safe percutaneous access route; (3) a joint evaluation by the surgical and radiology services; and (4) an operative backup for any complication or failure. Percutaneous drainage was considered to be especially indicated if, in addition to meeting the above criteria, the patient was an exceptionally poor surgical risk. All patients were observed for a minimum of 6 months to detect recurrent abscesses. In the same institution, 12 patients underwent surgical drainage for subphrenic abscess. Of these, 4 patients suffered from inadequate drainage; all told, 5 patients died of sepsis.

These authors stated that computed tomography "has become our method of choice to identify and follow . . . intraabdominal sepsis." It should be emphasized that abscesses having many loculations may not be suitable for this technique. In many cases, it will be an inadequate method of curing an abscess that communicates with the intestinal or biliary tract. Similar successful results were described by Mandel, Boyd, Jaques, and associates who reported on 24 of their own patients and also collected reports of 252 cases from the world literature.

If computed tomography detects a subphrenic abscess in its early stages, before the abscess wall has become fibrotic and rigid, drainage by surgery or percutaneous catheter will permit the abscess to collapse. Consequently, the drain or catheter may be removed at a relatively early date. Otherwise, when the abscess wall is rigid, drainage must be continued until the CT scan or a Hypaque sinogram X ray demonstrates that the abscess cavity has disappeared.

Almost all subphrenic abscesses can be successfully treated by percutaneous catheter drainage.

Surgical Approach

Posterior (12th-Rib Excision) Approach

At one time, removing the 12th rib and entering the "subphrenic" space from the posterior approach was popular. However, anatomical studies by Boyd and by DeCosse and associates demonstrated that the bare area of the right lobe of the liver is located on its posterior surface. For this reason, there is no significant space caudal to the bare area between the right lobe of the liver and the diaphragm. The only space that can be approached efficiently via the bed of the 12th rib is the right *subhepatic* space. In order to drain a right suprahepatic subphrenic abscess through the bed of the 12th rib, the surgeon would have to divide the triangular ligament and penetrate the bare area of the liver. Exposure from the 12th rib approach is hardly adequate for this dissection. Consequently, only a right posterior subhepatic abscess can properly be approached through the bed of the 12th rib. In the report of DeCosse and associates, failure to achieve adequate drainage was noted in 12 of the 15 cases in which the posterior approach was used to the subphrenic space.

For purposes of this discussion, we have adopted the classification of Boyd with a slight modification. On the right side there is a single suprahepatic subphrenic space and a right infrahepatic space. On the left there is a subphrenic space. The left infrahepatic space can be divided into two spaces: the posterior infrahepatic space, which constitutes the lesser sac; and the left anterior infrahepatic space, which is situated anterior to the stomach.

Lateral and Subcostal Extraperitoneal Approach

DeCosse and associates modified the subcostal extraperitoneal approach of Clairmont and Ranzi by extending it in a lateral direction as far as the tip of the 11th rib. The layers of the abdominal wall are divided down to the peritoneum. Then the surgeon's hand dissects the peritoneum away from the diaphragm until the abscess is reached. The lateral extraperitoneal approach may also be used in the treatment of a right posterior infrahepatic abscess. DeCosse and associates were successful in draining left subphrenic as well as left posterior infrahepatic abscesses in the lesser sac through the subcostal or lateral extraperitoneal approach. The lesser sac abscesses were reached by dissecting the peritoneum away from the upper pole of the kidney. The right suprahepatic subphrenic abscess is easily approached through an anterior (subcostal) extraperitoneal approach. An abscess in the left anterior infrahepatic space is best approached by performing a laparotomy.

Laparotomy

Halasz as well as Dineen and McSherry advocated draining subphrenic abscesses by a transperitoneal route. Although it is true that, thanks to modern antibiotics, there is no great risk of spreading the infection by draining an abscess transperitoneally instead of extraserously, no one can doubt that exploring the abdomen 2–3 weeks following major surgery is more difficult and more hazardous than is draining the abscess by an extraserous route. Prior to the achievement of diagnostic accuracy with computed tomography, there was a considerable risk that the patient might have an abscess in more than one location. Under these conditions, an extraperitoneal operation might overlook the second or third abscess. When a CT scan demonstrates a *solitary* right or left subphrenic abscess, or a right posterior infrahepatic abscess, we prefer to attempt drainage by the extraserous approach because the operation is safe and relatively simple. If this procedure fails to eliminate the signs of sepsis, a laparotomy should be performed. However, this discussion may be hypothetical because almost all of the subphrenic abscesses, in accessible locations like the above, are effectively managed by the insertion of percutaneous drainage catheters with CT guidance. In patients suspected of having a lesser sac abscess, a peripancreatic, or a left anterior infrahepatic abscess and in those suspected of having an anastomotic leak with multiple intermesenteric abscesses, laparotomy is mandatory.

Indications

It is true that in the early stages of the development of a subphrenic abscess, there probably is a stage of cellulitis that can successfully be treated with antibiotics. However, in the vast majority of patients who have symptoms of sepsis, it is too late for treatment by antibiotics alone by the time the diagnosis of a subphrenic abscess is made. Prompt institution of drainage is thus indicated, either by the percutaneous route or by surgery.

Preoperative Care

Therapeutic doses of appropriate antibiotics should be administered. Until the culture report is available, we believe the patient should receive an aminoglycoside, clindamycin, and ampicillin intravenously because in most cases the causative organisms will respond to these agents. Other antibiotic regimens that include various combinations of a third- or fourth-generation cephalosporin and metronidazole are also acceptable.

Whereas the older diagnostic workup for a subphrenic abscess depended on the abdominal and chest X ray together with a liver-lung nuclear scan, at this time the best single diagnostic procedure to localize a subphrenic abscess is computed tomography.

Nasogastic tube

Pitfalls and Danger Points

Failure to locate and adequately drain all loculations and multiple abscesses

Injuring the spleen, liver, or hollow viscus

Operative Strategy

Extraserous Approach

Dissection in the extraserous preperitoneal or retroperitoneal plane is generally simple if the surgeon enters the proper plane by incising the transversalis fascia but not the peritoneum. The incision should be made long enough to admit the surgeon's hand. Then blunt dissection will separate the peritoneum from the undersurface of the diaphragm until an area of induration is reached. This represents the abscess. Generally blunt dissection with a finger will permit entry into the abscess. Although DeCosse and associates have successfully drained abscesses in the posterior right subhepatic space and in the lesser sac by the extraserous approach, we usually prefer a laparotomy to accomplish drainage of these two spaces.

When an extraserous approach has failed to reveal an abscess, it is generally simple to lengthen the incision in the abdominal wall transversely, converting it to a subcostal incision. Then incise the peritoneum and continue the exploration for the abscess transperitoneally. Alternatively, a second vertical incision may be made in the midline of the abdomen for further exploration.

Laparotomy

When the transperitoneal approach has been elected, we prefer a midline incision, especially if there is suspicion of an anastomotic leak or an abscess located within the folds or the small bowel mesentery. If the exploration of the subphrenic, subhepatic, and lesser sac spaces does not reveal the source of the patient's sepsis, it may be necessary to free the entire small bowel and the pelvis in order to positively rule out an abdominal abscess.

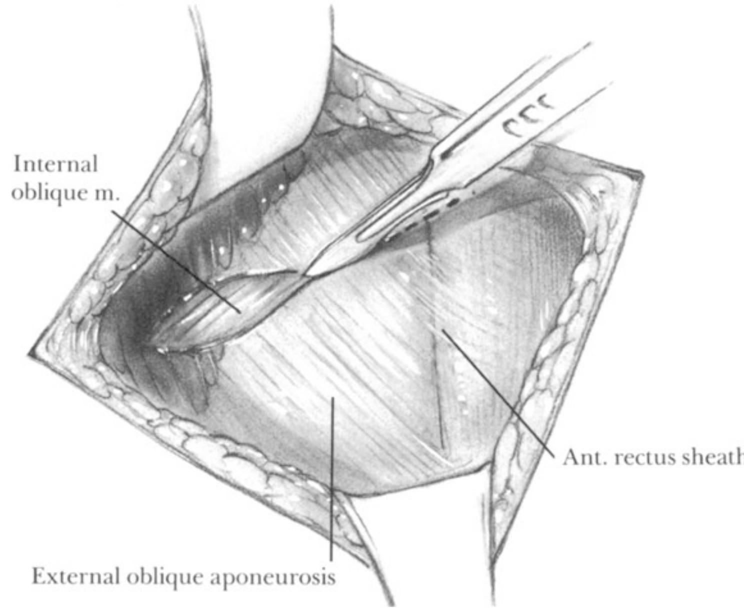


Fig. 99–1

Operative Technique—Extraserous Subcostal Drainage of Right Subphrenic Abscess

Incision and Exposure

Make a 10–12 cm incision, beginning near the tip of the right 11th rib and continue medially parallel to the costal margin. Carry the incision through the external oblique muscle and aponeurosis (**Fig. 99–1**). Generally, the internal oblique muscle (**Fig. 99–2**)

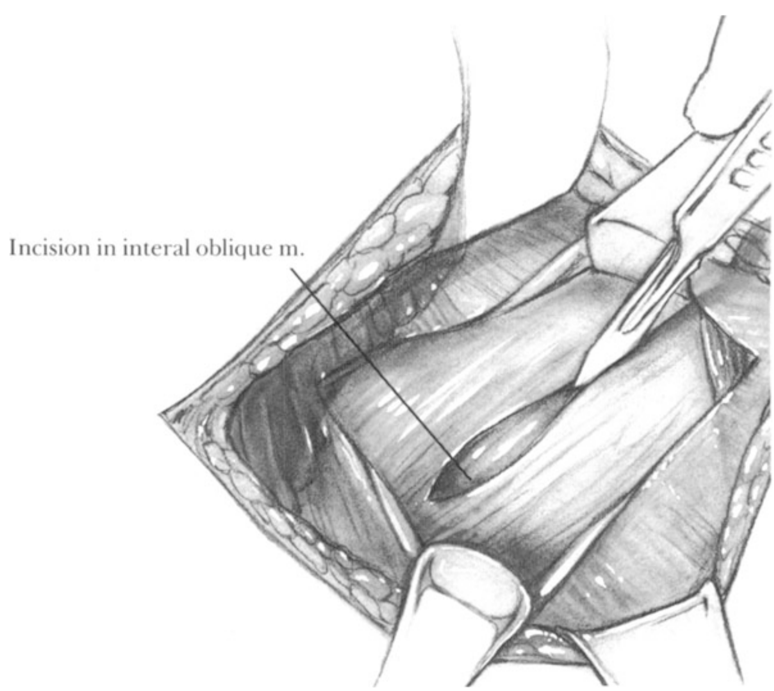


Fig. 99–2

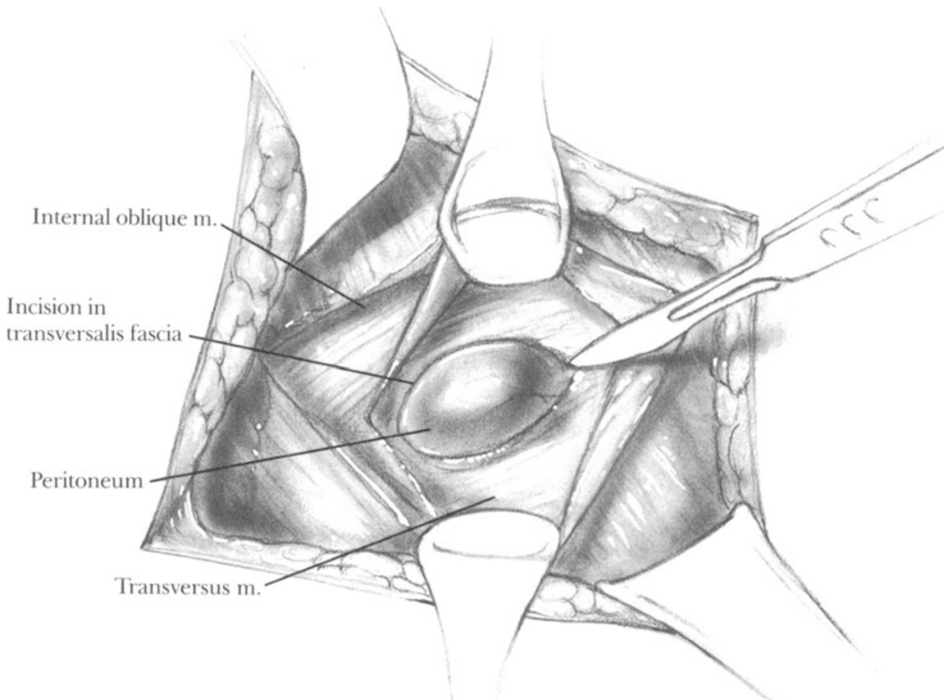


Fig. 99–3

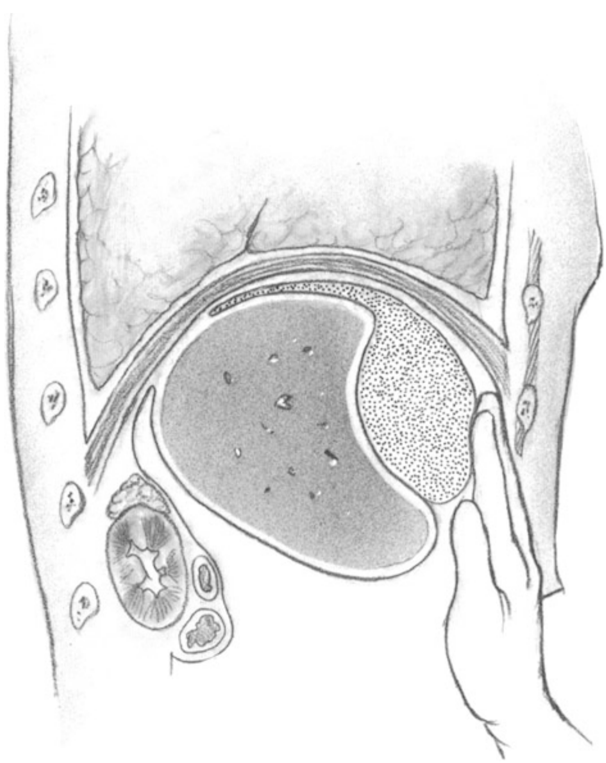


Fig. 99–4

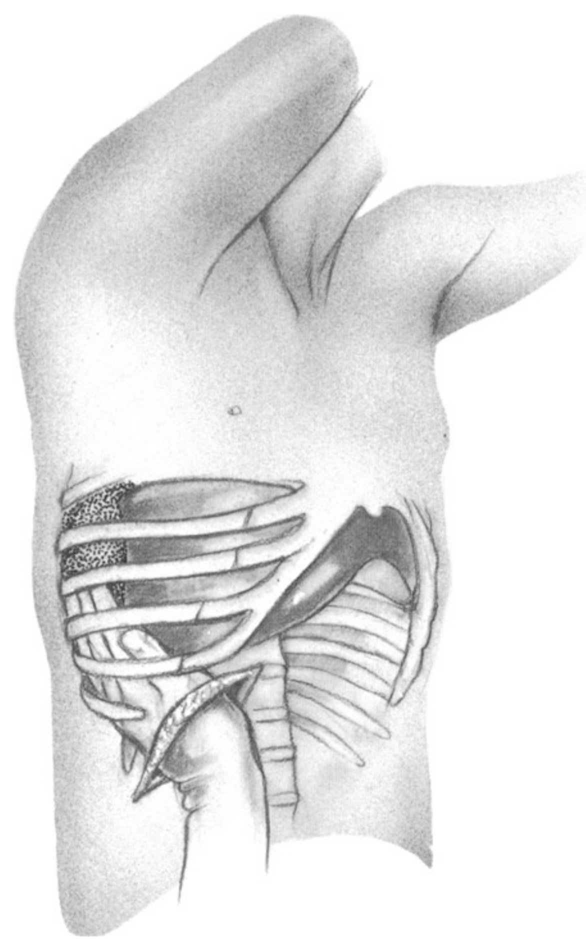


Fig. 99–5

can be separated along the line of its fibers. It will usually be necessary to divide the 9th intercostal nerve. Then transect the transversus muscle with the electrocautery. If necessary, the incision may be continued through the lateral quarter of the rectus muscle.

Identify the transversalis fascia and carefully divide it with a scalpel (**Fig. 99–3**) revealing the underlying peritoneal membrane. Use a gauze sponge on a sponge-holder to dissect the peritoneum away from the transversalis fascia. Continue the dissection upward by inserting the hand to further separate the peritoneum from the undersurface of the diaphragm until the dome of the liver is reached (**Fig. 99–4**).

A right posterior infrahepatic abscess can be reached by the extraserous approach if the peritoneum is dissected laterally (**Fig. 99–5**) until the fat overlying Gerota's fascia is encountered. This is swept away from the posterolateral peritoneal envelope. The abscess will then be encountered medial and superior to the upper pole of the right kidney. On the left side a posterior infrahepatic or lesser sac abscess can be approached in a similar fashion by dissecting the posterolateral peritoneum away from the fat over Gerota's capsule. The abscess will be encountered medial to the upper pole of the left kidney.

Drainage and Closure

After exposing an area of induration in one of the subphrenic spaces, the abscess may be entered by inserting a fingertip or the tip of a blunt Kelly Hemostat. Open the abscess cavity widely and irrigate out the purulent material after obtaining a sample for routine and anaerobic cultures (**Fig. 99–6**).

If an abscess has been drained in its early stages before its walls have become rigid, evacuating the pus will permit the abscess cavity to collapse and disappear. In cases of this type it is necessary to insert only a single suction drain and a single large latex drain. These drains may be brought out through the

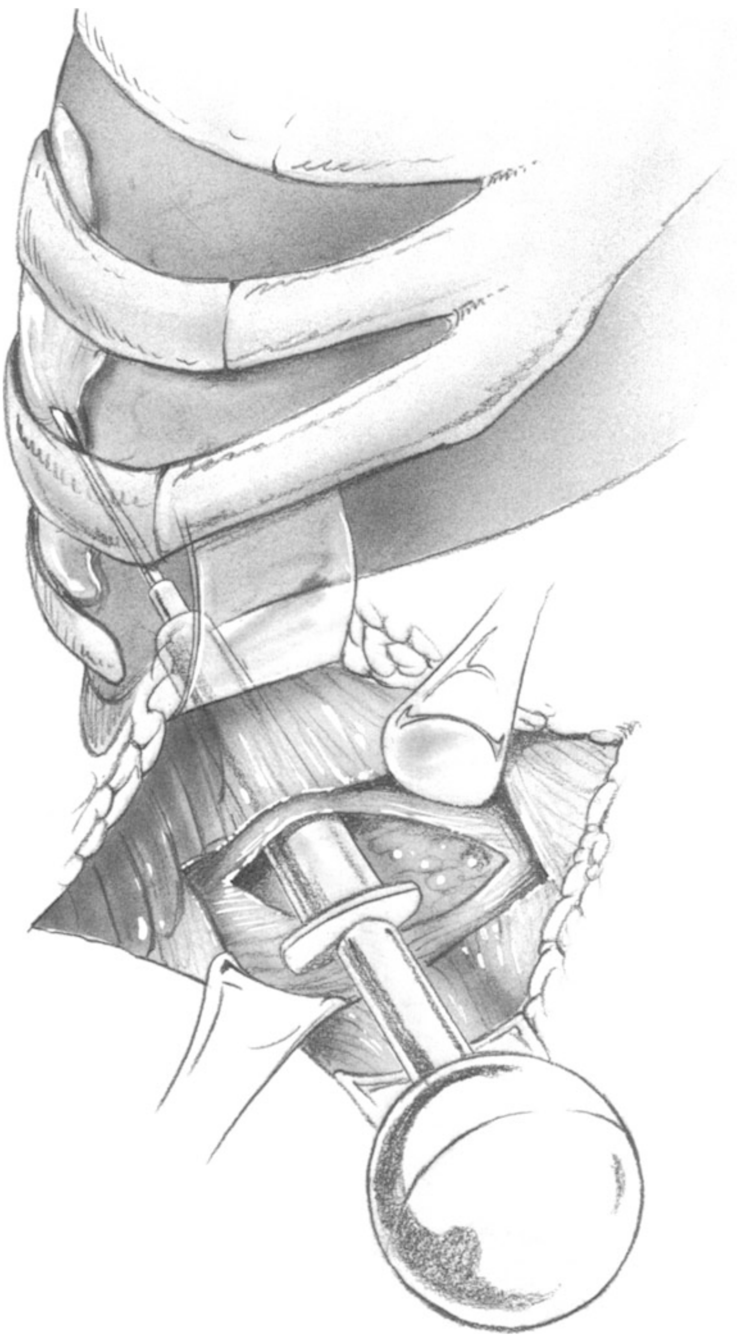


Fig. 99–6

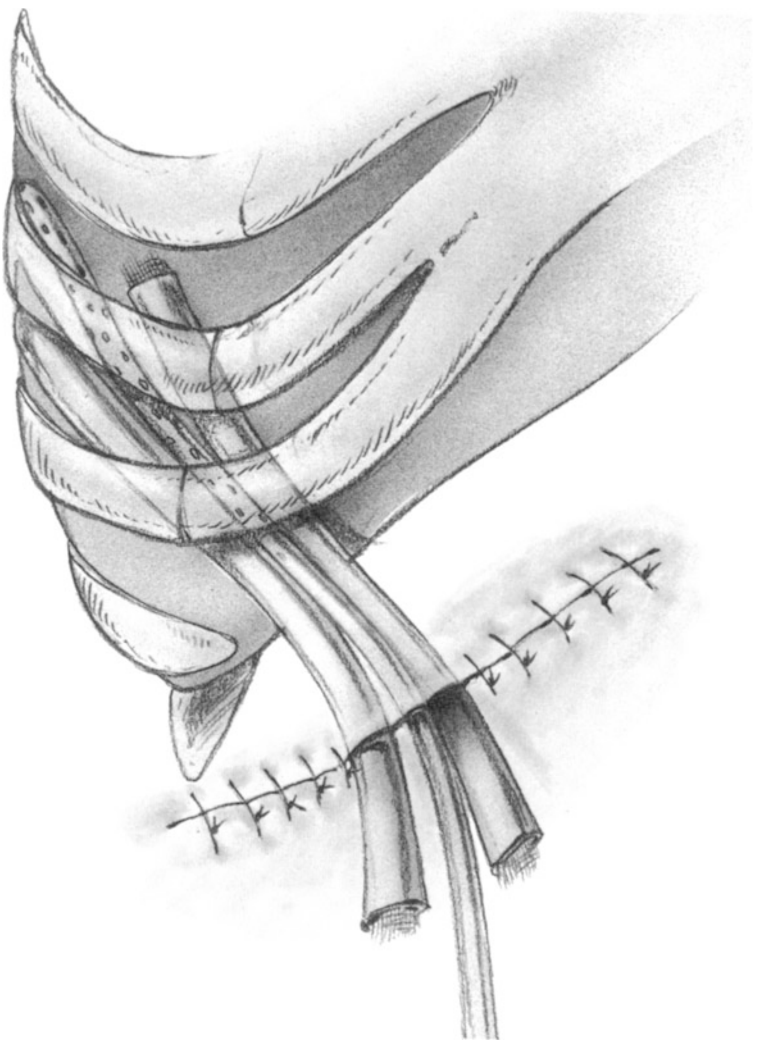


Fig. 99–7

incision (**Fig. 99–7**) (or through a stab wound). Close the remainder of the abdominal wall incision so that one finger may be inserted into the abdominal cavity alongside the drains. Although many surgeons prefer to sew the skin closed after this operation, we believe that the skin and the subcutaneous tissue should be lightly packed with a strip of moistened gauze and left unsutured. Several untied interrupted nylon skin sutures may be inserted, in anticipation of a delayed secondary closure at the bedside 4–7 days following operation. If the patient has a large subphrenic abscess with rigid walls that do not collapse after evacuating the pus, insert two suction drains and 3–4 large latex drains, anticipating that the drains may have to be left in for a number of weeks before the abscess cavity collapses or fills with granulation tissue.

Operative Technique—Laparotomy for Subphrenic and Abdominal Abscesses

Incision and Exposure

When draining an accurately localized right infrahepatic abscess a right lateral subcostal incision is suitable. Left anterior infrahepatic and lesser sac abscesses, suprahepatic abscesses, and most other abdominal abscesses are better drained through midline incisions. If the patient has had a recent operation through a midline incision, try to enter the abdomen by extending the previous midline incision into a virginal area of the abdominal wall so that one is less likely to encounter densely adherent bowel when opening the peritoneum. After the abdomen is opened, identify the falciform ligament and peritoneum. Dissect these two structures away from all the underlying bowel and omentum, first on the right side and then on the left. After this has been accomplished, pass a hand over the liver to explore the suprahepatic and then the infrahepatic spaces.

Divide the avascular portion of the gastrohepatic ligament and enter the lesser sac behind the lesser curvature of the stomach. If this approach has been obliterated by previous surgery or adhesions, enter the lesser sac by dividing the omentum along the greater curvature and expose the posterior wall of the stomach and the anterior surface of the pancreas. Identify the right and left paracolic spaces and expose the pelvic cavity since both are likely locations of abscesses, especially in patients suffering ruptured appendicitis or diverticulitis. Finally, if it is necessary to rule out the possibility of an interloop abscess, the surgeon will have to patiently free the entire length of small intestine and its mesentery.

Perform a needle catheter jejunostomy in all patients not likely to resume oral nutrition early in the postoperative course.

Drainage and Closure

When a long midline incision has been used, drains should be brought out through suitable stab wounds. Although large sump drains are suitable for subphrenic abscesses, there is a considerable risk of creating a colocutaneous or enterocutaneous fistula if a large plastic drain remains in contract with a segment of bowel for period of time exceeding 2 weeks. Consequently, it may be preferrable to use soft Silastic sump drains or latex Penrose drains rather than a more rigid type of drain.

Close the midline incision by the modified Smead-Jones technique (Chap. 5) using No. 1 PDS sutures to the abdominal wall. Insert vertical mattress sutures of 3–0 interrupted nylon about 2 cm apart into the skin but do not tie any of these sutures for 4–8 days.

Postoperative Care

Continue therapeutic doses of suitable antibiotics, guided by Gram stain studies taken in the operating room and by bacterial culture results. Antibiotics will be required for a minimum of 7–10 days in patients undergoing surgery for a subphrenic abscess.

If early feeding cannot be tolerated by the patient, initiate jejunostomy tube feeding.

If the abscess cavity was not rigid and its walls collapsed after the pus was evacuated, remove the drains after 10–14 days. If there is any question about a residual cavity, inject sterile Hypaque or other iodinated aqueous contrast medium through the sump drain to perform a sinogram X ray. If there is any cavity remaining, leave at least one of the drains in place until the cavity has been eliminated, as demonstrated by an X-ray study.

If the patient has a large abscess cavity with rigid walls, and thick pus, consider the advantages of irrigating the abscess daily through one of the sump catheters with a dilute antibiotic solution.

Postoperative Complications

Residual or recurrent abscess

Overlooked abscess

Colocutaneous of enterocutaneous fistual

Hematoma secondary to hepatic or splenic operative trauma

References

Boyd DP. The subphrenic spaces and the emperor's new robes. N Engl J Med 1966;275:911.

Clairmont P, Ranzi E. Kasuistischer Beitrag zür operativen Behandlung des subphrenischen Abszesses. Wien Klin Wochenschr 1905;18:653.

DeCosse JJ, Poulin TL, Fox PS et al. Subphrenic abscesses. Surg Gynecol Obstet 1974;138:841.

Dineen P, McSherry CK. Subdiaphragmatic abscess. Ann Surg 1962;155:506.

Halasz NA. Subphrenic abscess. JAMA 1970;214:724.

Johnson WC, Gerzof SG, Robbins AH et al. Treatment of abdominal abscesses. Ann Surg 1981;194:510.

Mandel SR, Boyd D, Jaques PF et al. Drainage of hepatic, intraabdominal, and mediastinal abscesses guided by computerized axial tomography; successful alternative to open drainage. Am J Surg 1983;145:120.

Appendixes

A Some Mechanical Basics of Operative Technique

Rare is the novice who has the inborn talent to accomplish all the mechanical manipulation in surgery with no more thought or analysis than the natural athlete gives to hitting a ball. Most surgeons in training can gain a great deal from analyzing such basics of surgery as foot position, hand and arm motion, and the efficient use of instruments.

In considering the mechanics discussed here, remember that underlying all aspects of surgical technique are the fundamental principles articulated by Halsted, who emphasized that the surgeon must minimize trauma to tissues by using gentle technique. Halsted also stressed the importance of maintaining hemostasis and asepsis.

Bear in mind that this text has been written from the vantage point of the right-handed surgeon. Left-handed surgeons should of course reverse the instructions where appropriate.

Importance of Surgeon's Foot and Body Position

For every activity involving the use of hands and arms, there is a body stance that allows the greatest efficiency of execution. For example, the right-handed professional who uses a baseball bat, a tennis racket, a wood chisel, or a golf club places the left foot forward, the right foot 30-50 cm to the rear, and directs the right arm and hand motion toward the left foot. And for the greatest efficiency in sewing, the surgeon assumes a body position such that the point of the needle is aimed toward the left foot. This stance allows the shoulder, arm, and wrist to occupy positions that are free of strain. It permits the surgeon to perceive proprioceptive sensations as the needle moves through the tissues. Only in this way can the surgeon "feel" the depth of the suture bite. Combining this proprioceptive sense with visual monitoring of the depth of the needle bite is the best way to assure consistency in suturing. Because accuracy in grasping submucosa with the suture is one of the most important factors in the proper construction of an intestinal anastomosis, the surgeon must make every effort to perfect this skill.

Fig. A-1 illustrates the proper foot position of the surgeon who is inserting Lembert sutures in the construction of an anastomosis situated at right angles to the long axis of the body. If the surgeon were to insert sutures of the Halsted type instead, they would require one forehand pass with a needle holder, followed by a second pass with the same strand of suture material, using a backhand motion; there should be no alteration of foot position. To insert sutures backhand, the needle should be directed toward the surgeon's right foot. Similarly, cutting by scalpel is properly performed with a backhand motion directed toward the surgeon's right foot (**Fig. A-2**). In using scissors, however, the point of the scissors should be directed toward the surgeon's *left* foot.

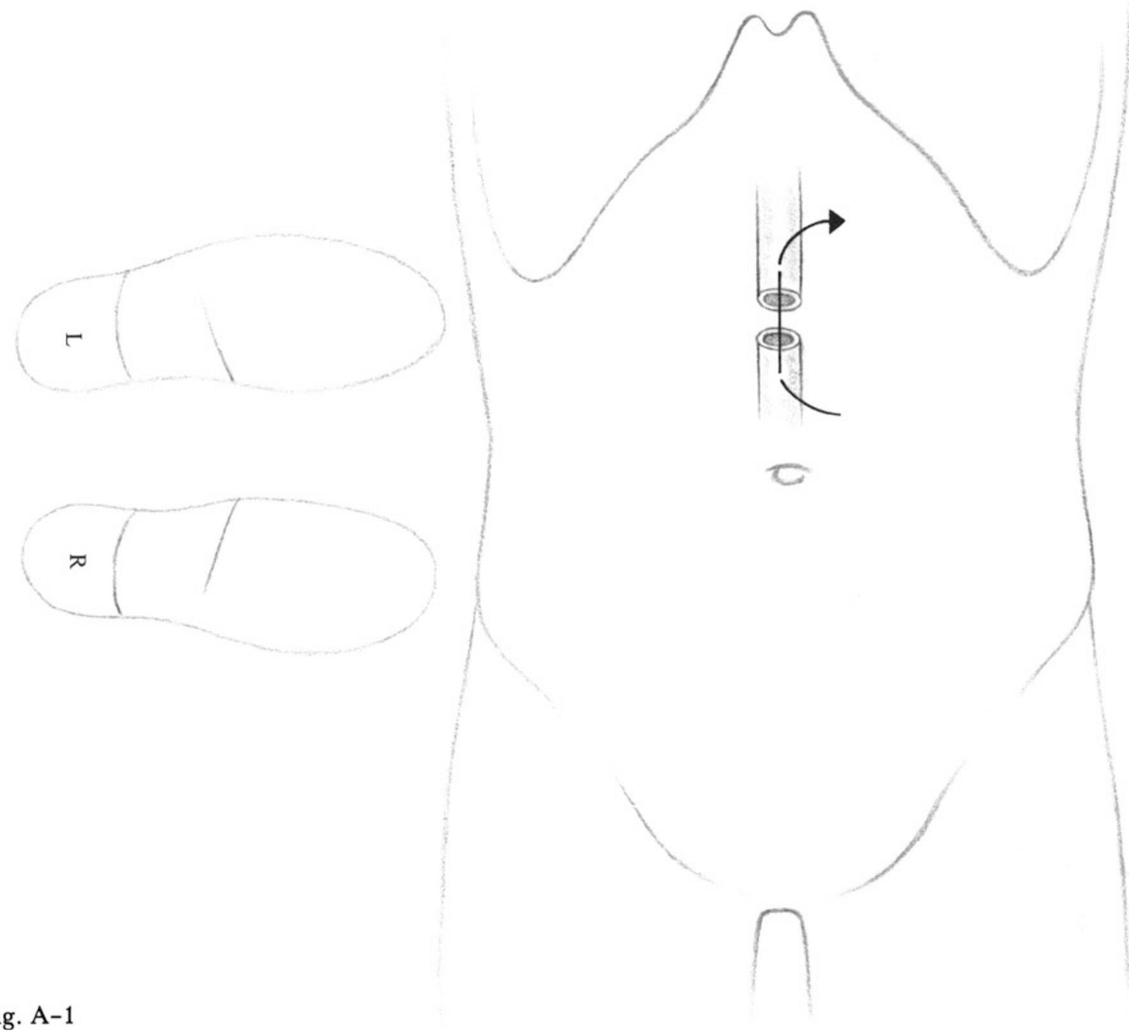


Fig. A-1

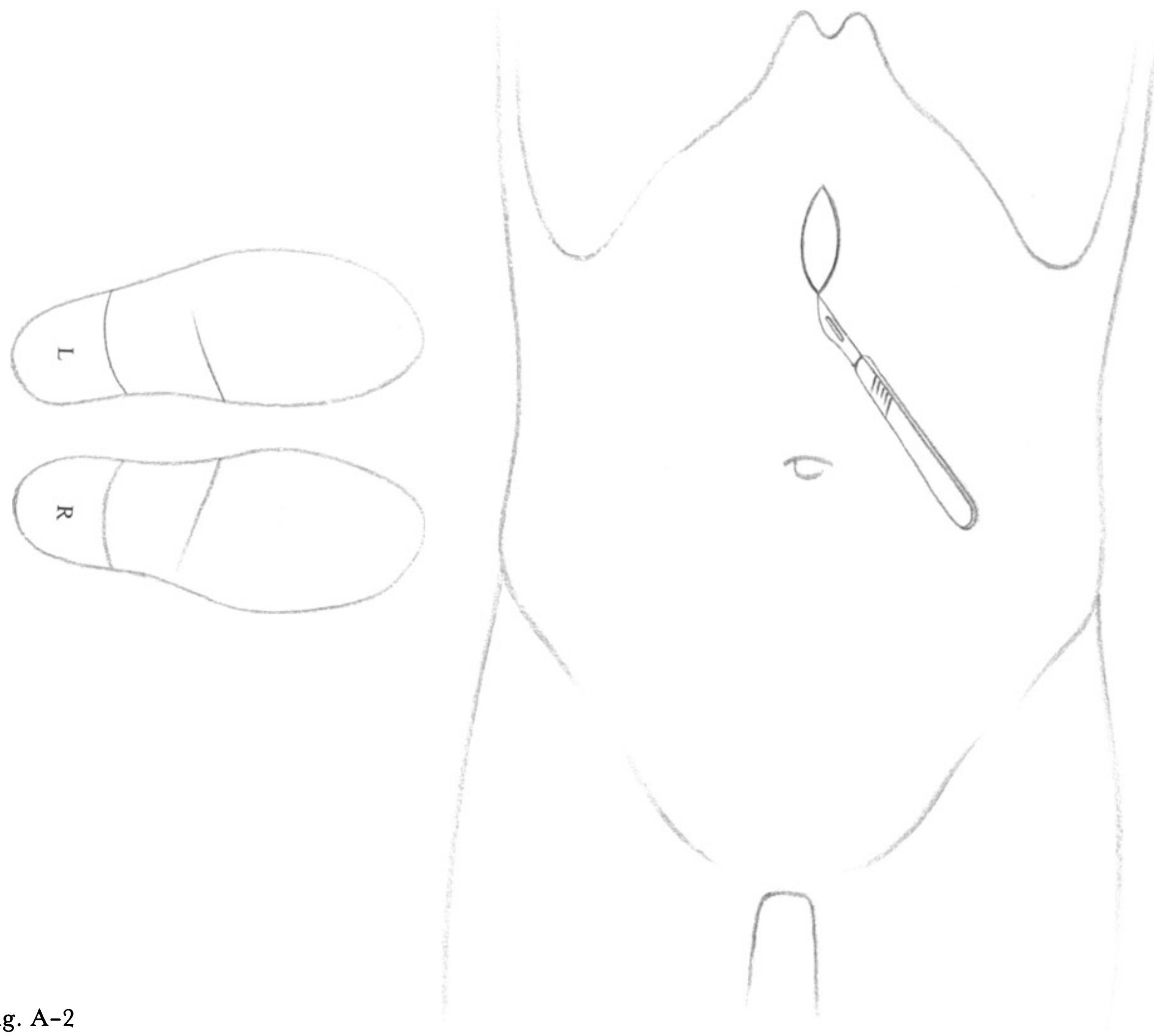


Fig. A-2

The proper foot position for inserting Lembert sutures in an anastomosis oriented in a line parallel to the long axis of the body is shown in **Fig. A-3**.

Some surgeons do not have a highly developed proprioceptive sense when they use the backhand suture. Therefore, whenever it is feasible they should avoid this maneuver in seromuscular suturing. This is almost always possible if the surgeon rearranges the direction of the anastomosis or assumes a body stance that permits optimal forehand suturing.

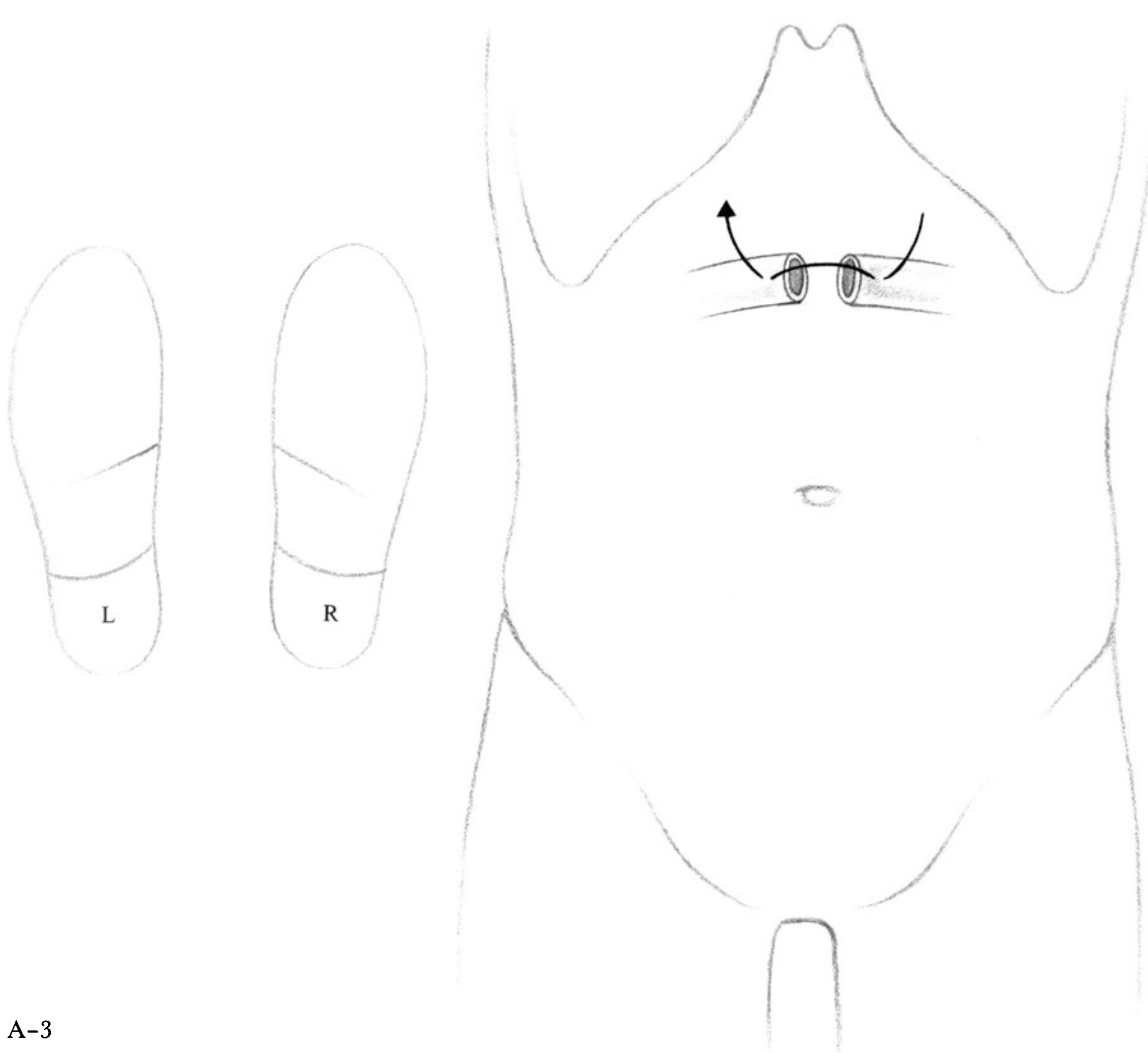


Fig. A-3

The method of changing body position so that all sutures can be placed with a forehand motion is illustrated in **Fig. A-4**. It shows Cushing sutures being inserted into an esophagogastric anastomosis, with the surgeon standing on the left side of the patient. When the needle is passed through the gastric wall from the patient's left to right, the surgeon's left foot is planted close to the operating table along the *left*

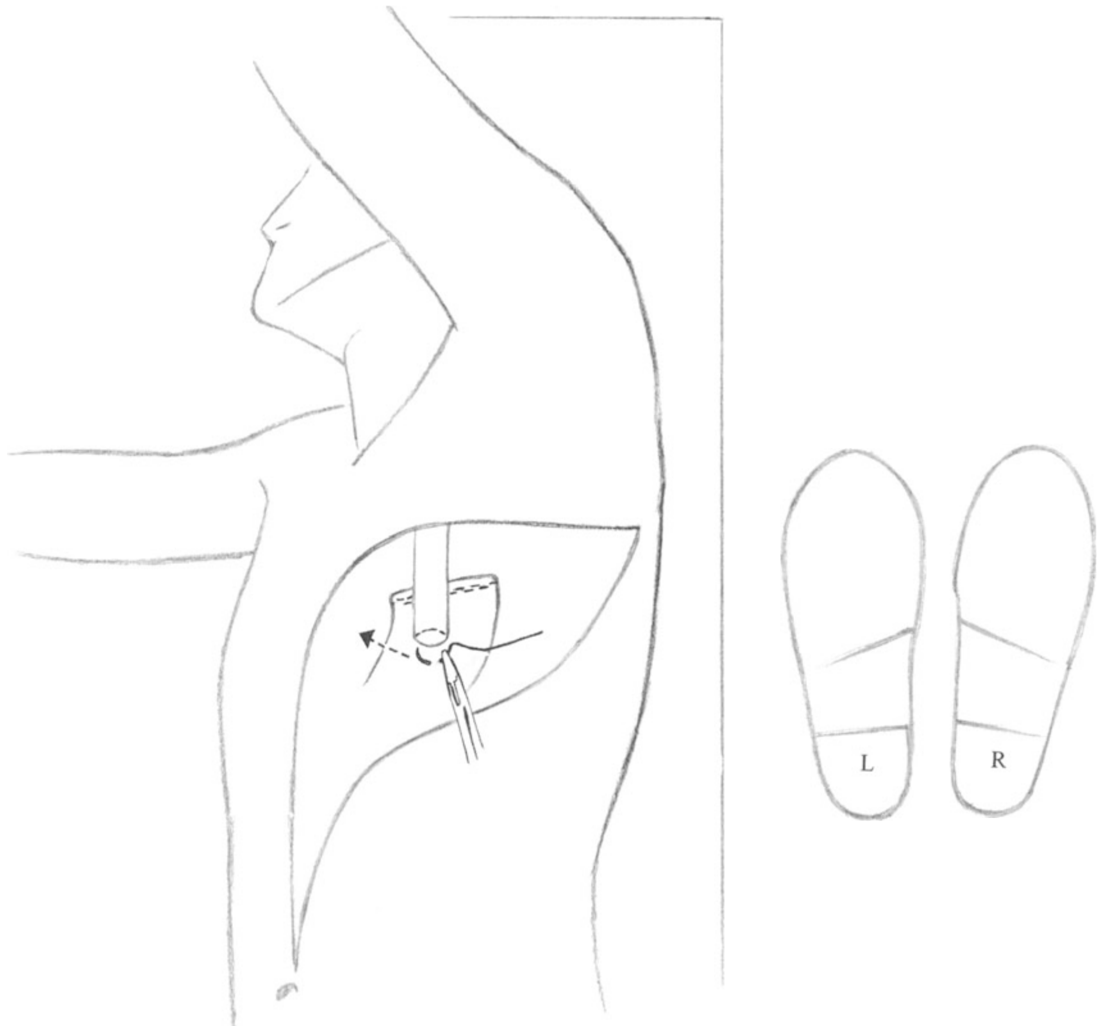


Fig. A-4

side of the patient's abdomen. The surgeon's right foot is placed more laterally. When the suture is passed from the patient's right to left, on the posterior aspect of the esophageal wall, the surgeon's right foot is placed alongside the operating table. The surgeon's body faces toward the patient's feet and the surgeon's left foot is somewhat lateral to the right foot (**Fig. A-5**). This directs the point of the needle toward the surgeon's left foot at all times.

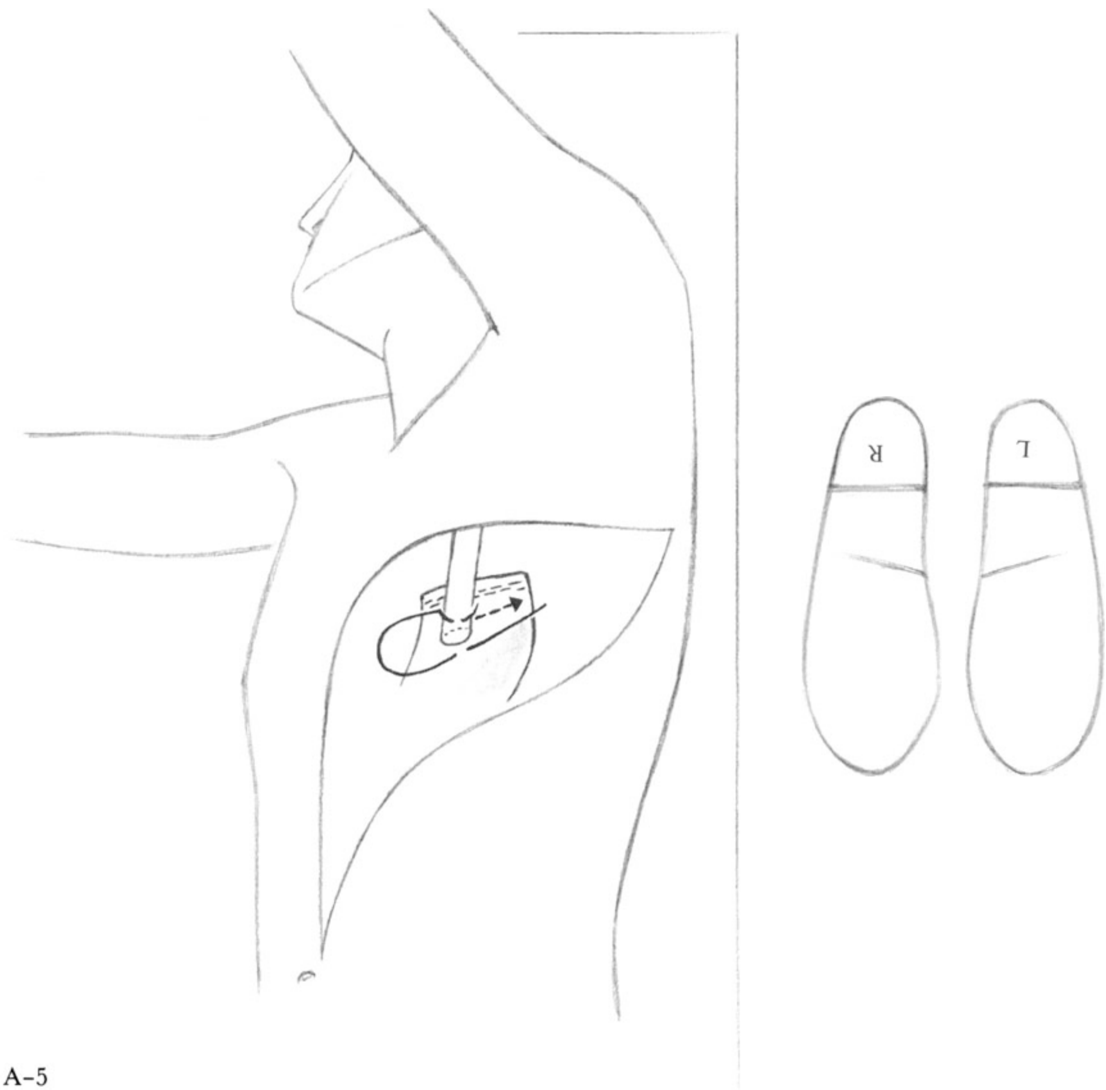


Fig. A-5

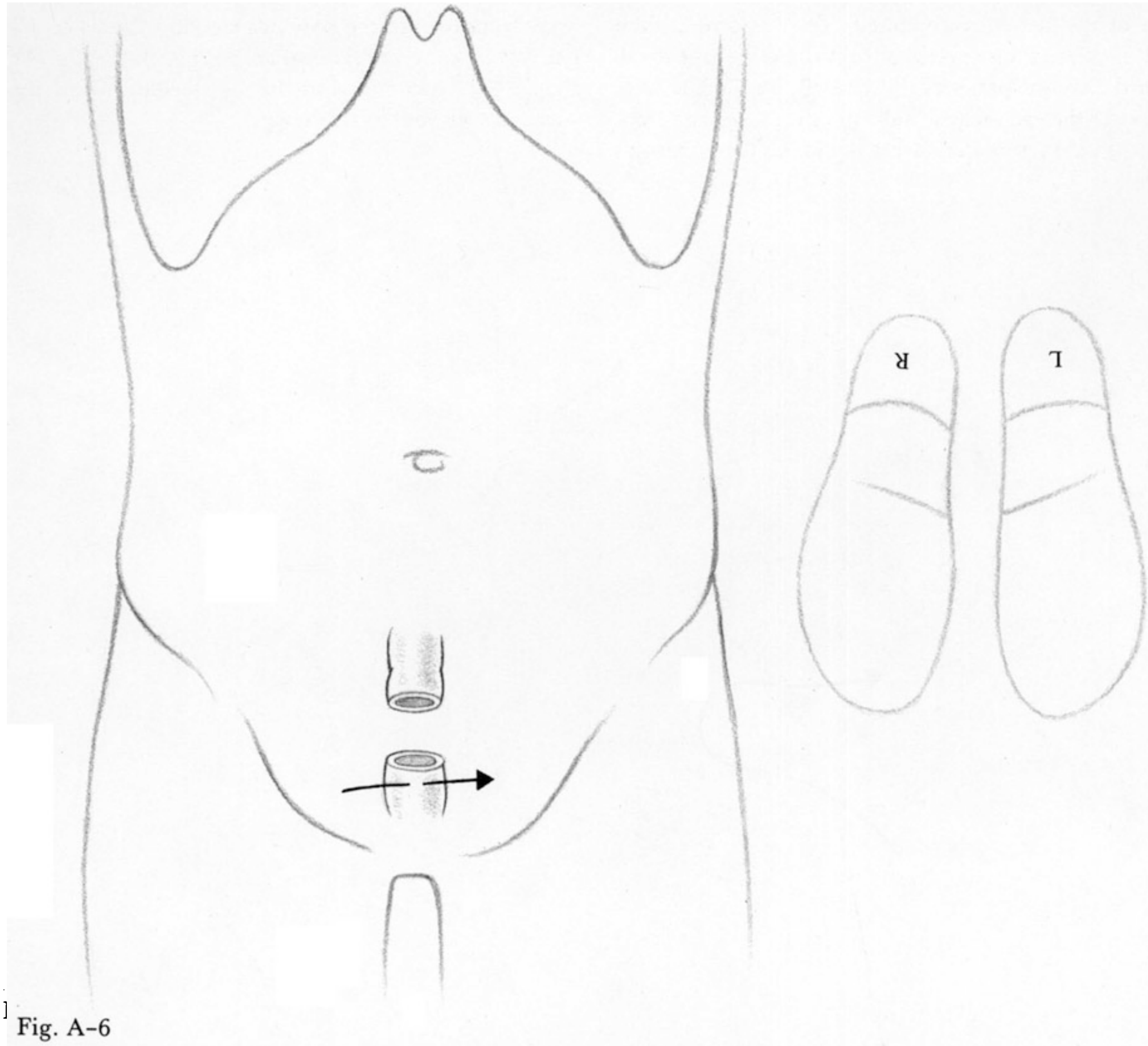


Fig. A-6

A similar change in body stance is illustrated in **Figs. A-6 and A-7**, where Cushing sutures are being inserted into a low-lying colorectal anastomosis. Of course, if the surgeon chose to use the Lembert-type suture in either an esophagogastrostomy or a coloproctostomy, a single stance would be efficient for the entire anastomosis.

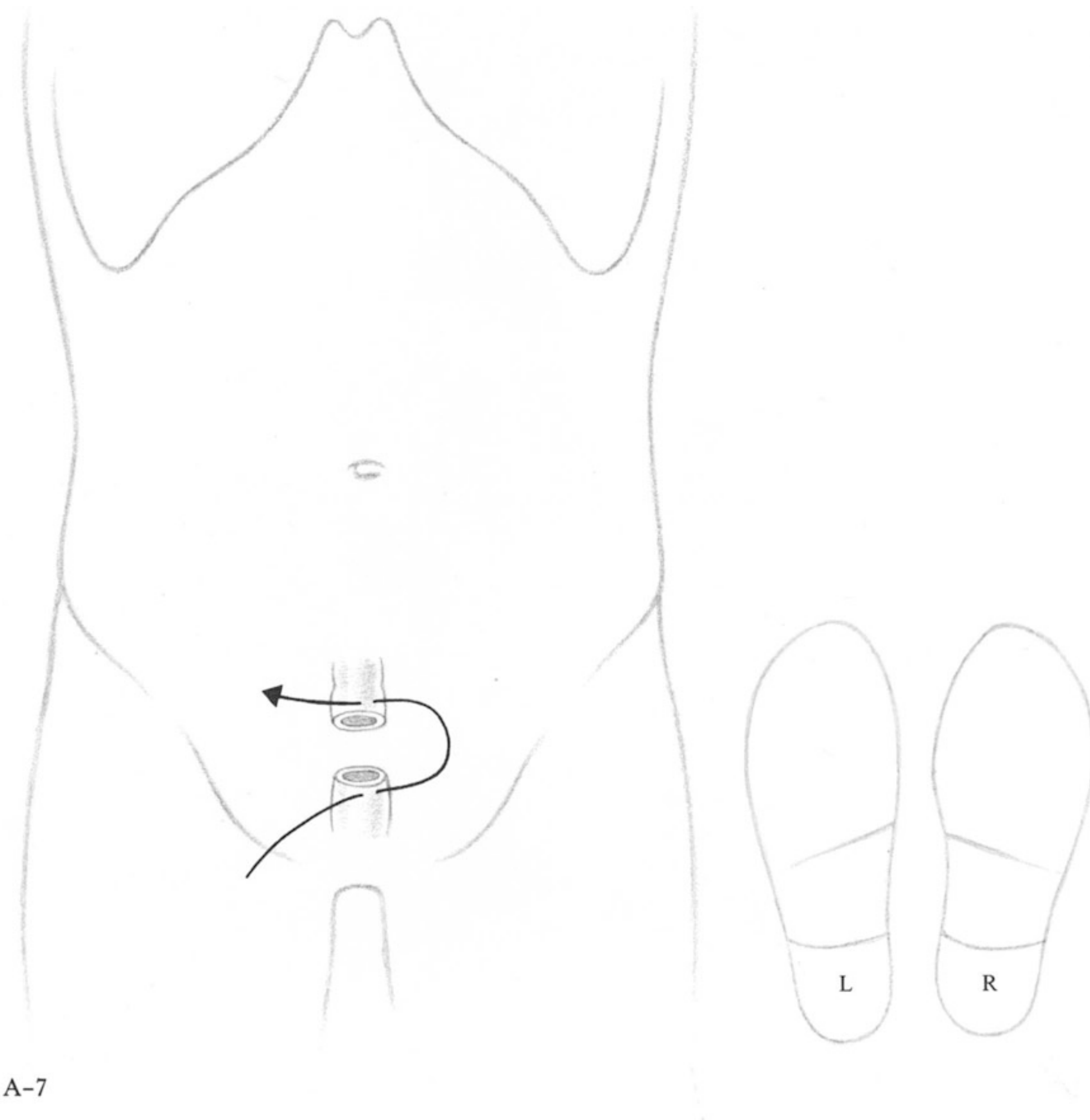


Fig. A-7

Figs. A-8 and A-9 illustrate the insertion of Lembert sutures for the final layer of a gastrojejunal anastomosis, showing the foot position of the surgeon who is standing on the patient's right side as compared with a position on the patient's left.

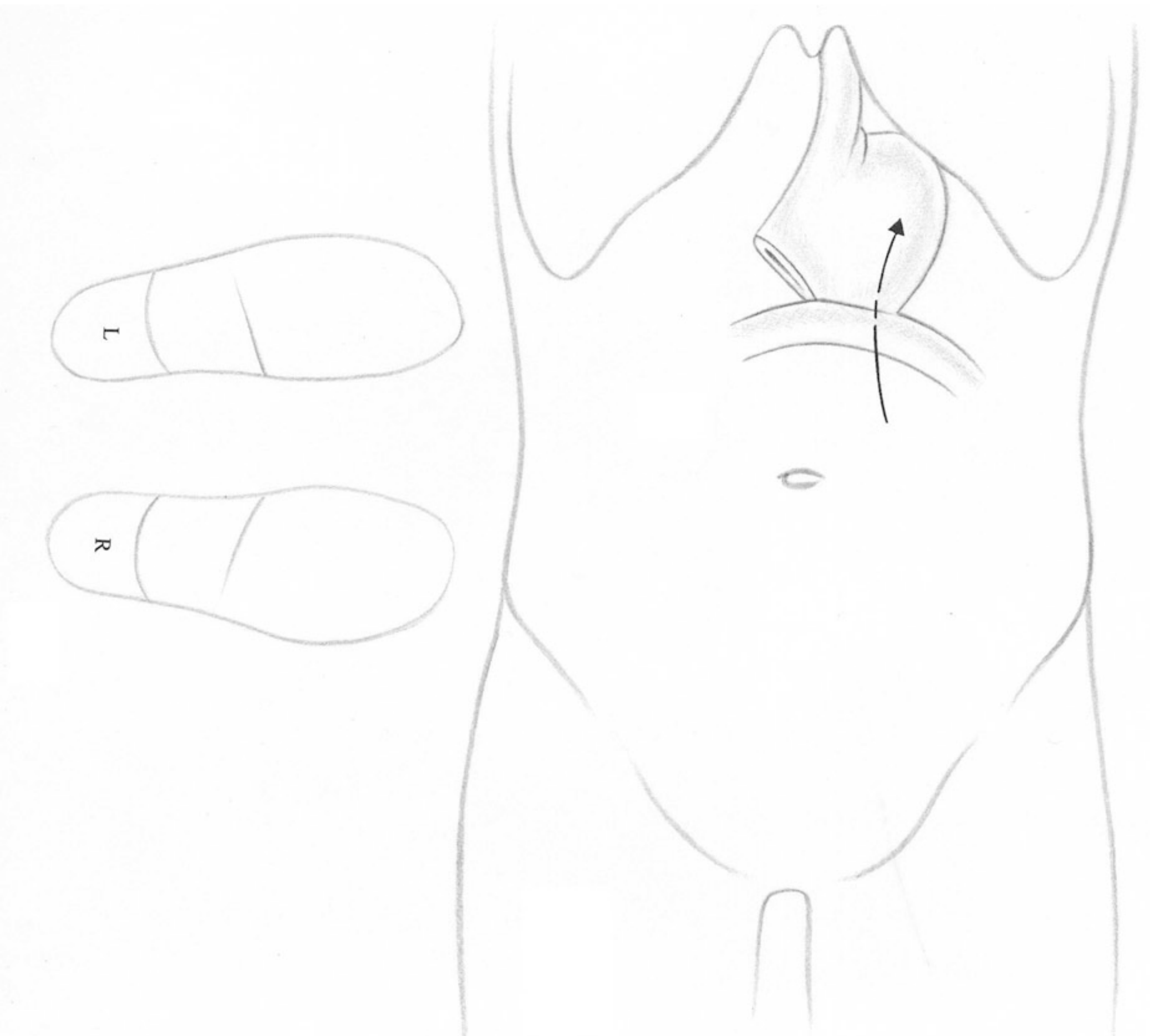


Fig. A-8

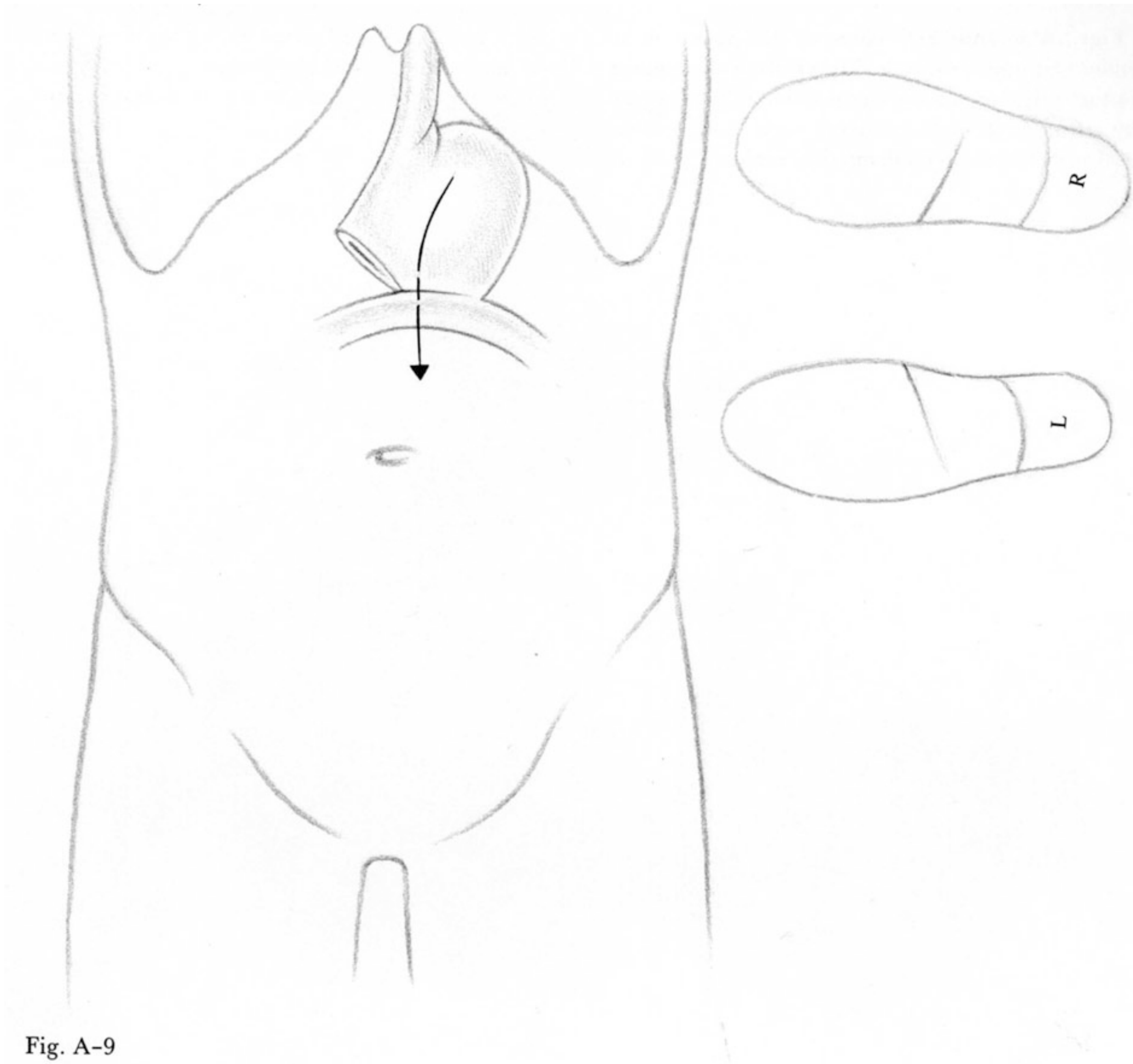


Fig. A-9

Fig. A-10 illustrates closure of an upper vertical midline abdominal incision. **Fig. A-11** shows a lower midline incision with the surgeon standing at the patient's right side.

Though it is true that some surgeons are able to accomplish effective suturing in spite of awkward or strained body and hand positions, it must be emphasized that in surgery, as in athletics, good form is an essential ingredient in producing consistently superior performance.

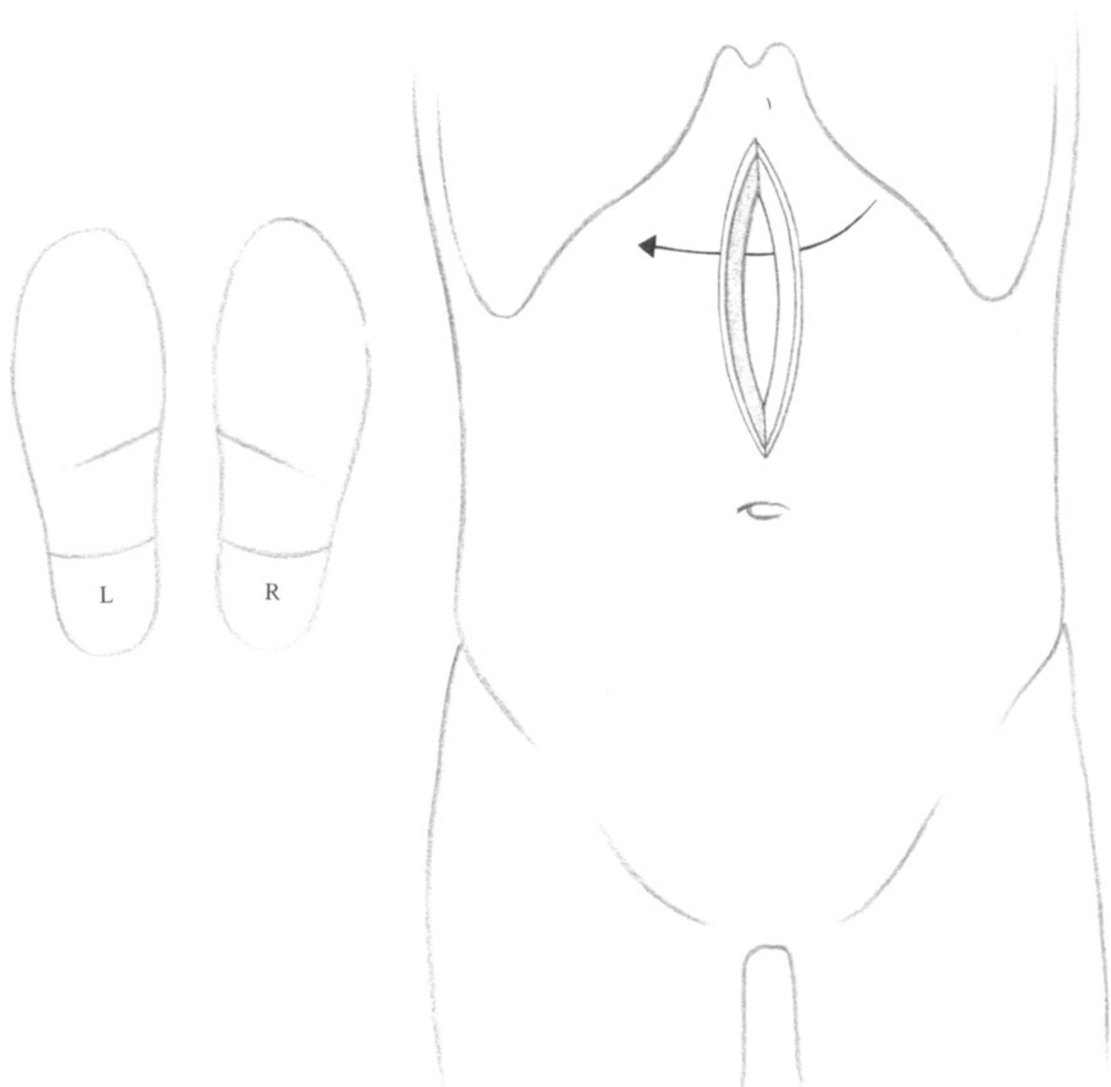


Fig. A-10

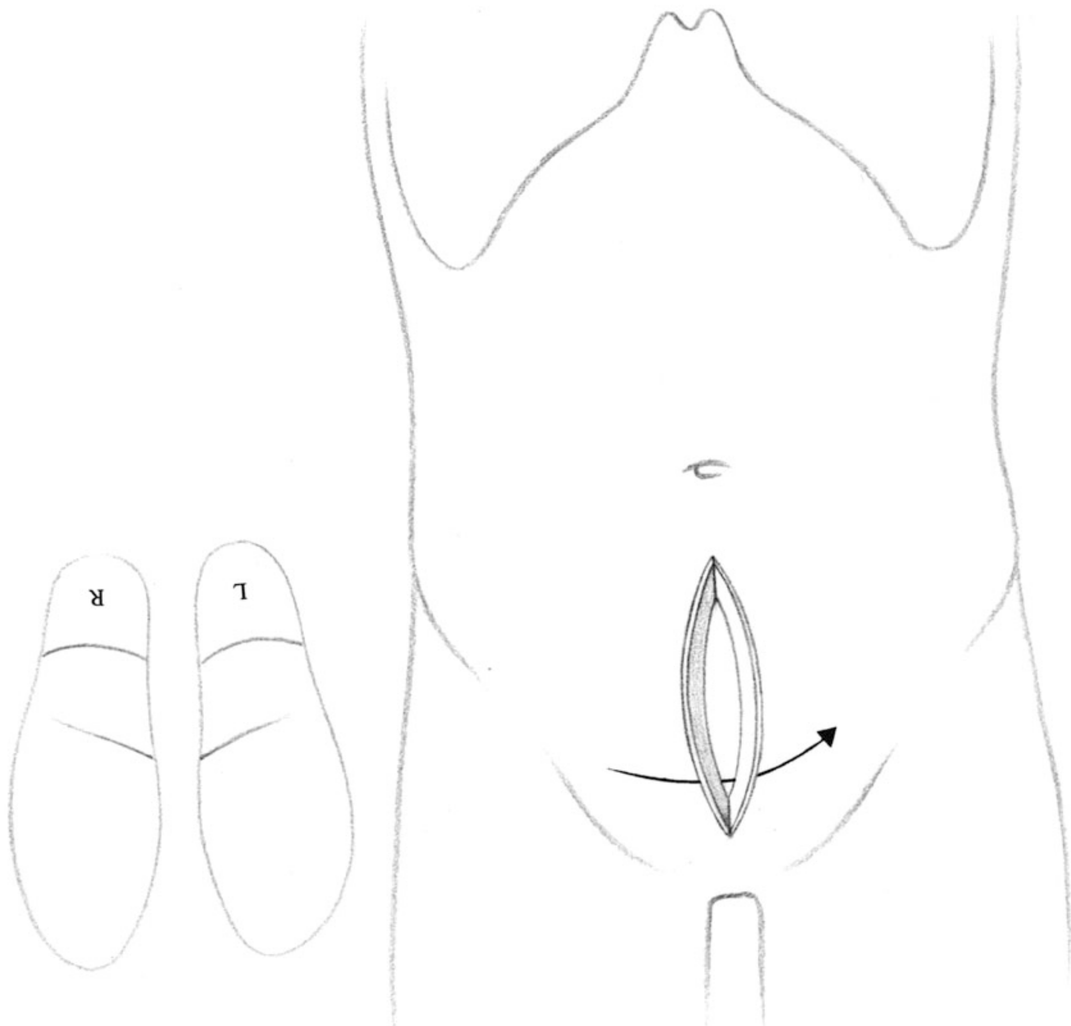


Fig. A-11

Use of Instruments

With rare exceptions, all surgical instruments used in soft tissue dissection should be held with fingertip pressure; they should not be held in a tight vise-like grip. The loose grip is essential if the surgeon is to perceive proprioceptive sensations as the instrument is applied to the tissue. This requirement applies whether the instrument used is a scalpel, forceps, needle-holder, or scissors.

Scalpel

When making the initial scalpel incision in the skin, the surgeon can minimize tissue trauma by the use of a bold stroke through the skin and subcutaneous fat. This does indeed require a firm grip. In most other situations, however, the scalpel should be held gently between the thumb on one side of the handle and the other fingers on the opposite side. Long, deliberate strokes with the scalpel are preferred. Generally, cutting is best done with the belly of the scalpel blade. This enables the surgeon to control the depth of the incision by feel as well as by eye. The scalpel is a particularly effective instrument when broad surface areas are to be dissected, as in radical mastectomy or inguinal lymphadenectomy.

In situations such as an attempt to define the fascial ring surrounding an incisional hernia, the surgeon can clear overlying adherent fat rapidly from broad areas of fascia by using a scalpel. The efficiency of knife dissection is greatly enhanced when the tissues being incised are kept in a state of tension;

this can be brought about by traction between the surgeon's left hand and countertraction by the first assistant.

The surgeon must always be alert to observe the nuances of anatomy revealed by each scalpel stroke, especially if a structure appears in an unexpected location. This is not possible if the surgeon is in the habit of making rapid little chopstrokes with the scalpel, like a woodpecker. Rapid, frenzied motions do not afford sufficient time for the surgeon's brain to register and analyze the observations made during the dissection. Nor do they allow sufficient time for feedback to control the hand motions. Slow, definitive, long sweeping strokes with the scalpel make the most rapid progress and allow enough time to permit the activation of cerebral control mechanisms and prevent unnecessary damage.

Metzenbaum Scissors

The round-tipped Metzenbaum scissors is a valuable instrument because it serves a number of essential functions. The closed Metzenbaum is an excellent tool for dissection. It may be inserted behind adhesions or ligaments to elevate and delineate planes of dissection before dividing them. Properly held, with the ring finger and thumb in the two orifices and the index finger and middle finger extended along the handle, *this instrument serves as an extension of the hand in detecting sensations* and in providing the surgeon with information concerning the density, pliability, and thickness of the tissue being dissected. As with other instruments, this proprioceptive function is enhanced if the hand grasps the instrument gently.

The Electrocautery as a Cutting Device

Some surgeons prefer to use the electrocautery, set for the "cutting" current, for such maneuvers as elevating the skin flaps during mastectomy or incising subcutaneous fat. Transecting fat with a cutting current makes hemostasis only partially effective, but tissue trauma is minimal. If the current is set for "coagulation," considerable heat may be generated, causing the fat to boil. Madden et al. and Cruse and Foord have observed that the incidence of wound infections is doubled. On the other hand, the transection of muscle bellies, as for instance in the subcostal or thoracic incision, may be accomplished efficiently when the electrocoagulator is set for "coagulation" or "blend" current. This provides good hemostasis and appears not to injure the patient significantly. Occasionally, the peritoneum and ligaments in the paracolic gutters become somewhat vascular secondary to inflammation. The electrocoagulator can be used to divide these structures.

In many areas, such as the neck, breast, and abdominal wall, it is feasible to cut with the electrocautery set for "cutting." To divide a small blood vessel, change the switch from "cutting" to "coagulation" and occlude the isolated blood vessel by electrocautery. Carefully performed, this sequence of dissection seems not to be damaging. If the incidence of wound infections, hematoma, or local edema is increased by using this technique, the surgeon is overcoagulating the tissues and not isolating the blood vessels effectively.

Forceps

Care must be taken to avoid unnecessary trauma when applying forceps to body tissues. As with other instruments, hold the forceps gently. It is surprising how little force need be applied when holding the bowel with a pair of forceps while inserting a suture. If the imprint of the forceps appears upon the wall of the bowel after the forceps have been removed, this is a clear warning that excessive force has been applied in grasping the tissue.

With the goal of avoiding unnecessary trauma, in selecting forceps recognize immediately that the "smooth" as well as the "mouse-toothed" forceps are contraindicated when handling delicate tissue. Applied to the bowel, the smooth forceps requires excessive compression to avoid slipping. In this situation a DeBakey-type forceps does not require excessive compression to prevent the tissue from slipping from the jaws of the forceps. For more delicate dissection, the Brown-Adson type forceps is even more suitable. This instrument contains many tiny interdigitating teeth, which allow the surgeon to hold delicate tissues with *minimal* force.

Needle-holder

It should be obvious that when a curved needle is used it must be inserted with a circular motion to avoid a tear at the site of the needle's point of entry into the tissue. What is required is a rotatory motion of the surgeon's wrist which, in turn, is aided by proper body stance and a relaxed shoulder and elbow position. Stability is enhanced if the elbow can be kept close to the body. Many novices tend to ignore the need for this rotatory wrist motion, especially when the suture line is in a poorly accessible anatomical location. They tend to insert a curved needle with a purely horizontal motion of the needle-holder, thus causing excessive injury at the entrance hole.

Using the same hand grip throughout the suturing sequence enhances the surgeon's capacity to detect proprioceptive impulses from the needle-holder. It is difficult to sense the depth of the needle bite accurately if some of the time the surgeon's fingers are in the orifices of the instrument's handle and at other times are not. For gastrointestinal suturing, where proprioception is of great importance, we prefer a grip with the thumb in one orifice and the ring finger in the other, steadying the handle with the extended index and middle fingers.

While most suturing is accomplished using a needle-holder with a straight shaft, some situations require a needle-holder whose shaft is angled or curved. This is so, for example, in the low colorectal and in some esophagogastric anastomoses. In both instances inserting the suture with a smooth rotatory motion may not be possible unless a curved needle-holder like the Stratte or Finochietto is used (see Fig. D-18).

Hemostat

Ideally, the hemostat should be applied to a vessel just behind the point of bleeding, and the bite of tissue should be no larger than the diameter of the vessel. Obtaining hemostasis may *seem* to take less time if large bites of tissue are grasped by large hemostats than if small, accurate bites are taken. On the other hand, with small bites *many* bleeding points can be rapidly controlled by electrocoagulation rather than ligature, a technique that is especially helpful in operations such as those for radical mastectomy.

Whenever possible, small Halsted or Crile hemostats should be employed. The choice between straight- and curve-tipped hemostats is a matter of personal preference, as either may be applied with equal accuracy. For deeper vessels, such as the cystic artery, Adson clamps provide greater length of handle combined with delicate jaws.

Occasionally it is more efficient to use a single, large Kelly hemostat to grasp a large pedicle containing a number of vascular branches than to cause additional bleeding by dissecting each small branch away from the pedicle. An example is the ligation of the left gastric artery–coronary vein pedicle along the lesser curvature of the stomach during gastric resection. A right-angled Mixter clamp is useful for obtaining hemostasis in the thoracic cavity and when dividing the vascular tissue around the lower rectum during the course of anterior resection.

In all cases the preferred hand grip for holding hemostats is identical with that for holding the needle-holder and scissors. When the hemostat has a curved tip, the instrument should be held so that the tip curves in the same direction in which the surgeon's fingers flex.

References

Cruse PJ, Foord R. A five-year prospective study of 23,649 surgical wounds. Arch Surg 1973; 107:206.

Madden JE et al. Studies in the management of the contaminated wound, IV. Resistance to infection of surgical wounds made by knife, electrosurgery, and laser. Am J Surg 1970; 119:222.

B Dissecting and Sewing

The Art of Dissecting Planes

Of all the skills involved in the craft of surgery, perhaps the single most important is the discovery, delineation, and separation of anatomical planes. When this is skillfully accomplished, there is scant blood loss and tissue trauma is minimal. The delicacy and speed with which dissection is accomplished can mark the difference between the master surgeon and the tyro.

Of all the instruments available to expedite the discovery and delineation of tissue planes, none is better than the surgeon's *left index finger*. (References here are again to right-handed surgeons.) This digit gets insinuated behind the lateral duodenal ligament in the performance of the Kocher maneuver, behind the renocolic ligament during colon resection, and behind the gastrophrenic ligament in the performance of a gastric fundoplication. These structures can then be divided very rapidly, for the underlying left index finger is visible through the transparent tissue. Dissection of all these structures by other techniques not only is more time-consuming, it is frequently more traumatic and produces more blood loss.

In identifying adhesions between the bowel and peritoneum, the left index finger can often be passed behind the adhesion. This maneuver can produce gentle traction on the tissue to be incised. If the finger is visible through the adhesion it can aid dissection.

If there is insufficient space for the insertion of the surgeon's left index finger, often the *Metzenbaum scissors*, with the blades closed, can serve the same function when inserted underneath an adhesion for delineation and division. This maneuver is also useful in incising the adventitia of the auxillary vein during a mastectomy. To do this, the closed Metzenbaum scissors is inserted between the adventitia and the vein itself; then it is withdrawn, the blades are opened, and one blade is inserted beneath the adventitia; finally, the jaws of the scissors are closed and the tissue divided. This maneuver gets repeated until the entire adventitia anterior to the vein has been divided.

In many situations a closed blunt-tip right-angle *Mixter clamp* may be used the same way as a Metzenbaum scissors for the dissection and delineation of anatomical structures. Identification and skeletonization of the inferior mesenteric artery or the cystic artery and delineation of the circular muscle of the esophagus during cardiomyotomy are just some of the uses to which this instrument can be put.

The *scalpel* is the instrument of choice when developing a plane that is not a natural one, such as in elevating skin flaps over the breast. When the scalpel is held at a 45° angle to the direction of the incision (**Fig. B-1**), it is also quite useful in clearing fascia of overlying fat.

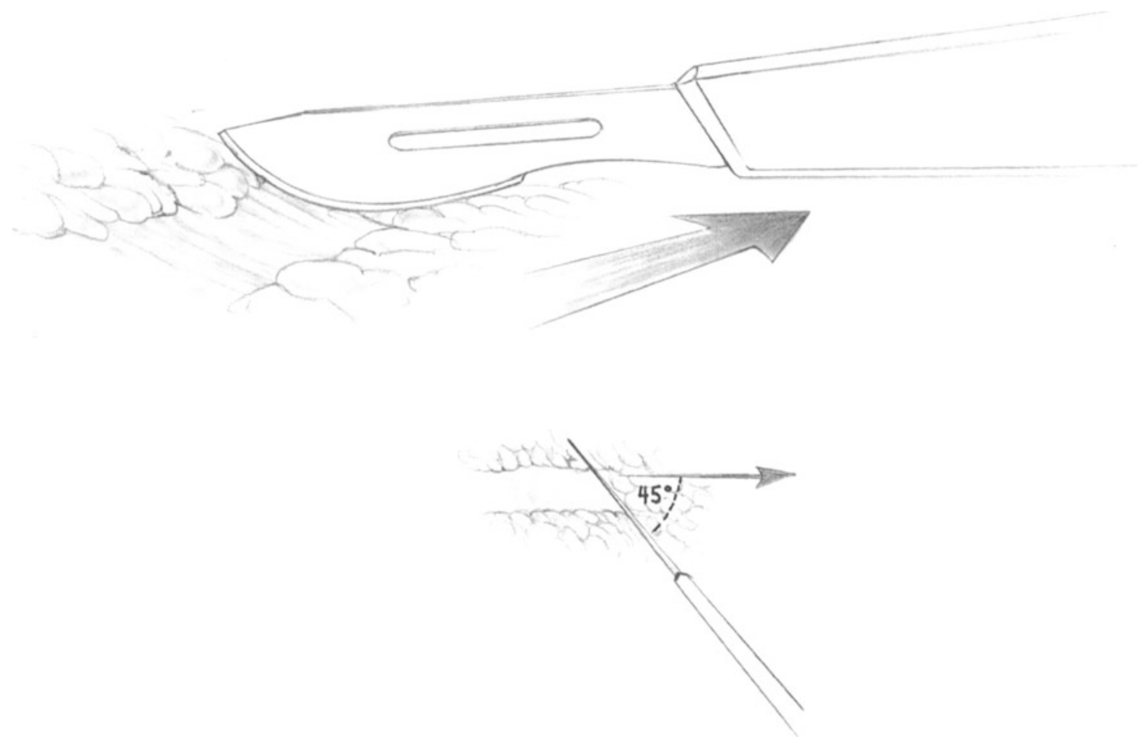


Fig. B-1

More important, when the surgeon must cope with advanced pathological changes involving dense scar tissue, such as may exist when elevating the posterior wall of the duodenum in the vicinity of a penetrating duodenal ulcer, the scalpel is the only instrument that will divide the dense scar accurately until the natural plane of cleavage between the duodenum and pancreas is reached, beyond the diseased tissue.

The *peanut sponge* (Kutner dissector), a small, 1.5-cm gauze sponge grasped in a long hemostat, is an appropriate device to separate fat and areolar tissue from anatomical structures. It should not be used to tear tissues while making a plane. After the peritoneum overlying the cystic duct and artery has been incised, the peanut sponge can separate peritoneum and fat from the underlying duct and artery. It is useful for the elevation of a thyroid lobe from its capsule. After sharp dissection has exposed the major arteries during the course of a colon resection, the peanut sponge is able to skeletonize the vessels and sweep the lymphatic and areolar tissue toward the specimen.

A folded 10 cm × 10 cm *gauze square* grasped in a sponge holder has occasional application in sweeping perirenal fat from the posterior aspect of the peritoneum in lumbar sympathectomy. It is useful also in separating the posterior wall of the stomach from peripancreatic filmy peritoneal attachments. Because the use of a large sponge does not permit anatomical precision, small veins may be torn in this type of gross dissection; therefore the sponge's applicability should be limited to avascular planes.

The surgeon who wants to perform accurate dissections is greatly aided by a *talent for quickly recognizing tissues and structures* as they are revealed by the scalpel or scissors. A truly alert surgeon can make a prompt evaluation of the structural characteristics of a nerve, blood vessel, ureter, or common bile duct, so that each is identifiable at a glance, even before the structure is thoroughly exposed. This requires an intimate knowledge of anatomy, so that the surgeon knows *exactly where each structure will appear*, even before it has been revealed by dissection.

Sewing Technique

Use of Needle-holder

Smooth rotatory wrist action and the surgeon's awareness of what it feels like when a needle penetrates the submucosa of the bowel are important when suturing with a typical half-circle needle on a needle-holder. (Also see Appendix A.)

Selection of Needle: Straight or Curved?

Most surgeons prefer to place seromuscular sutures into the gastrointestinal tract with a fine half-curved needle in a needle-holder. However, for those who wish to learn the technique it is possible to accomplish the same seromuscular bite with a straight needle held between thumb and fingers. This is done by first angling the needle toward the lumen of the bowel at a 45° angle. After penetrating the submucosa the needle direction is abruptly changed to an outward direction away from the lumen.

It is in the insertion of the mucosal layer of sutures that the straight needle demonstrates its distinct superiority. The needle should be directed at a right angle to the long axis of the bowel and passed directly through the entire wall in a single thrusting motion. The first assistant should then grasp the tip of the needle with a straight hemostat, pull it through, and hand it back to the surgeon, who will then be prepared to insert the next stitch in the continuous layer. Considerable time can be saved by avoiding the need to reposition the needle in a needle-holder at each step.

The needle selected for any use should have the least possible thickness commensurate with adequate strength to achieve its purpose.

Size of Bite

The width of the tissue enclosed in the typical seromuscular suture will vary between 4 and 6 mm, depending on the thickness and consistency of the tissue involved. Hypertrophied gastric wall requires a larger bite than the normally thin colon. When closing the abdominal wall by our version of the Smead-Jones closure, a bite of abdominal wall 3 cm wide is appropriate, as this stitch serves as a buried "retention" suture and must resist considerable muscle pull without tearing out.

Distance between Sutures

The distance between bites in the typical approximation of the seromuscular layer with interrupted Lembert sutures is 5 mm. When continuous mucosal or other sutures are used, the width of the bites and the distance apart should be approximately the same as those specified for interrupted stitches.

After one layer of sutures has been inserted, the surgeon should use the forceps in order tentatively to test the optimal degree of inversion that will permit the second layer to be inserted without tension (see Figs. 24-26a and 24-26b).

Size of Suture Material

As there must never be any tension on an anastomosis in the gastrointestinal tract, it is not necessary to use suture material heavier than 4-0. Failure of healing is often due to tearing of a stitch through the tissue and almost never to a broken suture. When two layers of sutures are used for an anastomosis in the GI tract, the inner layer should be 5-0 Vicryl. This layer provides immediate and accurate approximation of the mucosa and, in some instances, hemostasis. Therefore, this layer of suture material need not persist more than 4-6 days before it is absorbed. In esophagogastric anastomoses, interrupted 4-0 PG should be used for the inner layer, which has the additional function of contributing strength to the anastomosis. For this purpose, slower absorption is desirable.

When taking large bites of tissue that has considerable tensile strength, such as in the Smead-Jones closure of the abdominal wall, heavier suture material is indicated. Here, 1-0 PDS is suitable. Obviously, the size of the suture material must be proportional to the strength of the tissues into which it is inserted and to the strain it has to sustain.

Continuous versus Interrupted Sutures

An end-to-end anastomosis of the GI tract should be done with interrupted seromuscular sutures in order to avoid the possibility that the purse-string effect of the continuous stitch will narrow the lumen. A continuous suture of 5-0 Vicryl is permissible in the mucosal layer if it is inserted with care to avoid narrowing. When an anastomosis is large, as in gastrojejunostomy, the use of two continuous layers of PG appears to be quite safe.

In performing inguinal hernia repair by the Shouldice technique, we have found multiple layers of continuous 3-0 Tevdek to be satisfactory.

How Tight the Knot?

If the knot on a suture approximating the seromuscular coats of two segments of intestine is tied so tightly as to cause ischemic necrosis, an anastomotic leak may follow. This is especially likely if the stitch has been placed erroneously through the entire wall of the bowel into the lumen. Since considerable edema follows the construction of an anastomosis, knots should be tied with only sufficient tension to provide apposition of the two seromuscular coats. Caution must be exercised when tying suture material such as silk or Prolene, which are slippery enough so that each knot may have the effect of a noose that is repeatedly tightened with the tying of each additional knot. Nylon sutures also evidence excessive slippage; even when the first knot has been applied with proper tension, each succeeding knot often produces further constriction. When nylon sutures in the skin have been tied with too much tension, marked edema, redness, and cross-hatching can be seen at the site of each stitch. The same ill effects occur when intestinal sutures are made too tight, but the result is of course not visible to the surgeon.

Catching Both Walls of Intestine with One Pass of the Needle-holder

Most surgeons who insert seromuscular sutures to approximate two segments of intestine were taught to insert the Lembert suture through the intestine on one side of the anastomosis. Then they pick up the needle with the needle-holder to take another Lembert stitch in the opposite wall of the bowel. Occasionally, under ideal conditions, it is possible to pass a needle of proper length through one side of the intestine and then, without removing the needle-holder, pass the needle through the opposite wall before pulling the thread through.

The danger in performing this shortcut is that one may traumatize the entrance wound made on the side of the intestine through which the needle was first inserted. This can happen as the surgeon moves the needle and the intestinal wall in a lateral direction to bring it closer to the opposing intestine, thus making a small tear at the entrance hole (**Fig. B-2**). With proper technique this shortcut can be accomplished without undue trauma. After the needle has been passed through the first segment of intestine, the surgeon should avoid any *lateral* movement of the needle-holder. Instead, the surgeon should *gently* pick up the opposing segment of intestine with a forceps and bring this bowel to the needle. Then, with a purely *rotatory* motion of the wrist, the surgeon should allow the needle to penetrate the second side (**Fig. B-3**). If the surgeon remains conscious of the need to avoid trauma and uses a rotatory maneuver, there are situations in which this technique is acceptable and efficient.

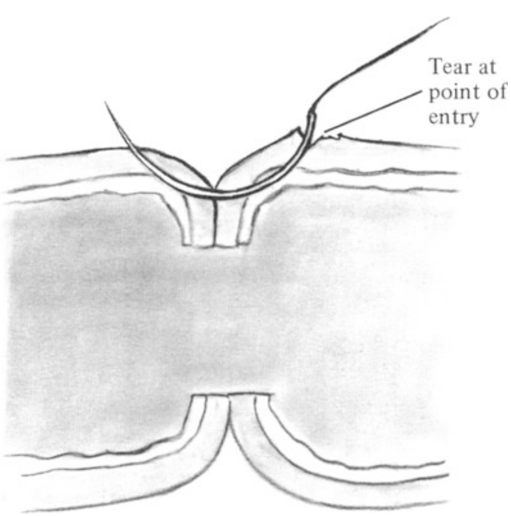


Fig. B-2

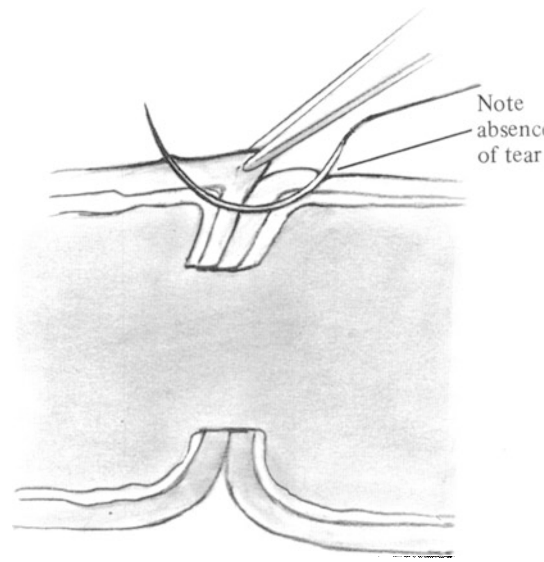


Fig. B-3

Types of Stitches

Simple Everting Skin Stitch

In closing skin, eversion of the edges is desired. Consequently, the wrist should be pronated and the needle inserted so that the deeper portion of the bite will be slightly wider than the superficial portion (**Fig. B-4**). When this stitch is tied, the edges will be everted (**Fig. B-5**).

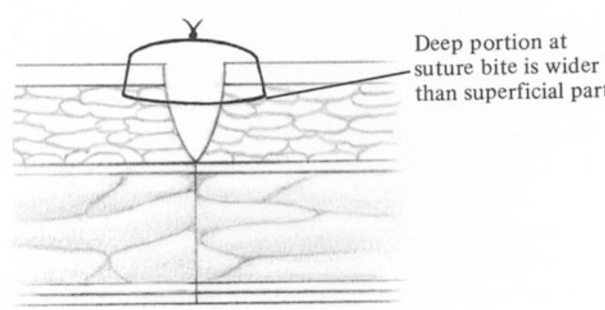


Fig. B-4

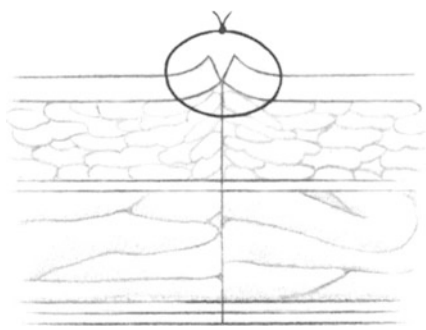


Fig. B-5

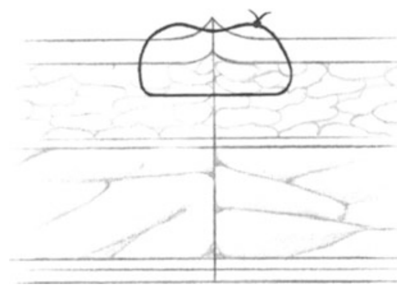


Fig. B-7

Vertical Mattress (Stewart) Stitch

In the classic Stewart method of skin suturing, eversion is guaranteed by the nature of the vertical mattress stitch (**Figs. B-6 and B-7**). Neither of these two types of skin sutures should be tied with excessive tension if cross-hatching is to be avoided.

Continuous Subcuticular Stitch

In the continuous subcuticular stitch 4-0 PG may be employed on an atraumatic, curved, or straight cutting needle. With practice the surgeon may insert it rapidly and get a good cosmetic result (**Fig. B-8**). Because it is absorbable there are no sutures to be removed postoperatively. If preferred, continuous 3-0 nylon may be used, with lead shot fixing the stitch at its points of origin and termination. This stitch should not be removed for 10-14 days following the operation. If the nylon stitch is longer than 7-8 cm, it may break during the attempt at its removal.

Skin Staples

The new stapling devices developed by the U.S. Surgical and the Ethicon companies have made the Michel clips obsolete. The new staples can be applied with force just sufficient to achieve approximation without producing cross-hatching of the skin. They also obtain good cosmetic results. Depending upon the thickness of the skin and the underlying structures, staples may be placed 5-10 mm apart (**Fig. B-9**).

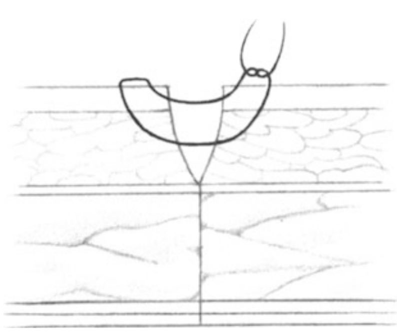


Fig. B-6

Simple Interrupted Fascial Stitch

In the traditional abdominal closure, the fascia is closed by interrupted simple stitches, which catch 8-10 mm of tissue with each bite, as shown in **Fig. B-10**. Except for its use in the McBurney and Pfannenstiel incisions, this type of abdominal wall closure should be considered obsolete (see Chap. 5).

Continuous Simple Over-and-Over Stitch

Fig. B-11 illustrates the simple over-and-over continuous stitch which frequently is used for closure of the peritoneum and is sometimes applied to the mucosal layer of bowel anastomoses.

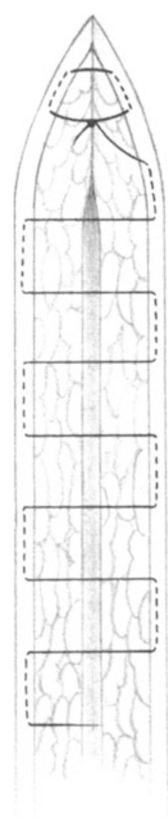


Fig. B-8

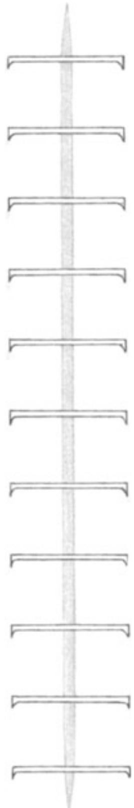


Fig. B-9

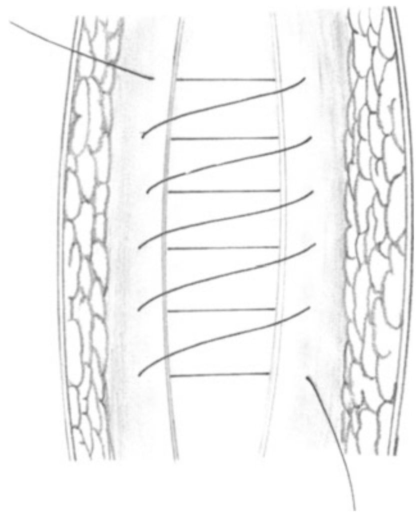


Fig. B-11

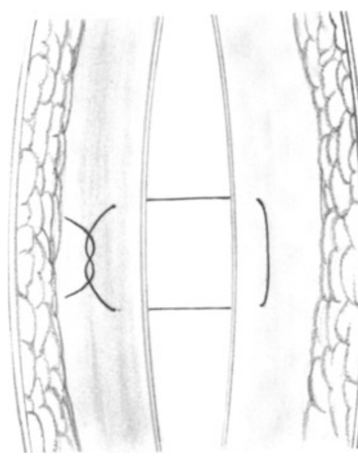


Fig. B-12

Horizontal Mattress Stitch

The mattress suture is used to close fascia and, sometimes, for ventral hernia repair (**Fig. B-12**). It can also serve as a hemostatic stitch.

Smead-Jones Stitch

The Smead-Jones stitch is well suited for the closure of major abdominal incisions. It is, in essence, a buried "retention" suture, for it encompasses all the layers of the abdominal wall, except the skin, in its large loop. The large loop is followed by a small loop,

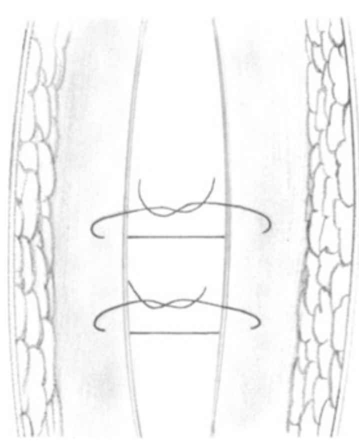


Fig. B-10

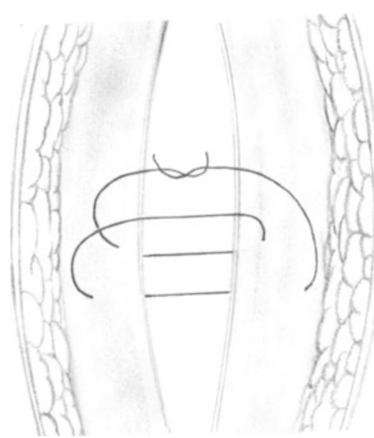


Fig. B-13

which catches only 4-5 mm of linea alba on each side (**Fig. B-13**). The purpose of this small loop is to orient the abdominal wall in perfect apposition. It is described in detail in Chap. 5. Its dimensions are diagrammed in **Fig. B-14**.

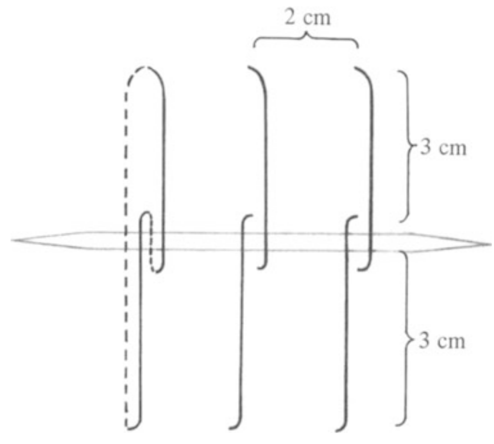


Fig. B-14

Fig. B-15

Hemostatic Figure-of-Eight Stitch

The classic hemostatic stitch, the figure-of-eight, for the occlusion of a bleeding vessel that has retracted into muscle or similar tissue is illustrated in **Fig. B-15**.

Seromucosal Bowel Stitch

In recent years bowel anastomoses that employ one layer of sutures have become acceptable. An effective method of accomplishing both inversion and approximation simultaneously is by the use of what we have called the seromucosal stitch (**Fig. B-16**). This is an inverting stitch that catches the seromuscular and submucosal layer as well as a small amount of mucosa. When properly applied, it produces a slight inversion of the mucosal layer as well as approximation. It is not necessary to pass this stitch deeper than the submucosal layer.

If this stitch is passed into the lumen before emerging from the mucosal layer, it is identical with that described by Gambee, whose technique was at one time applied to the one-layer closure of the Heinecke-Mikulicz pyloroplasty. Used either in an interrupted or in continuous fashion, it is an excellent alternative to the Connell stitch for the inversion of the anterior mucosal layer of a two-layer bowel anastomosis. When used for the construction of a single-layer intestinal anastomosis, it should, of course, be done only in interrupted fashion.

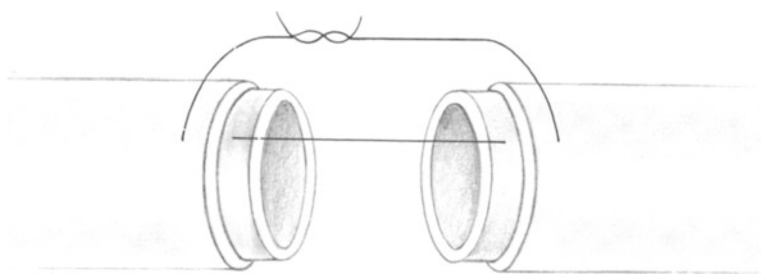


Fig. B-16

Lembert Stitch

Perhaps the most widely used technique for the approximation of the seromuscular layer of a bowel or gastric anastomosis is the Lembert stitch (**Fig. B-17**). This catches about 5 mm of tissue, including a bite of submucosa, and emerges 1-2 mm proximal to the cut edge of the serosa. This stitch also has been used for one-layer intestinal anastomoses. Under proper circumstances, it may be applied in a continuous fashion.

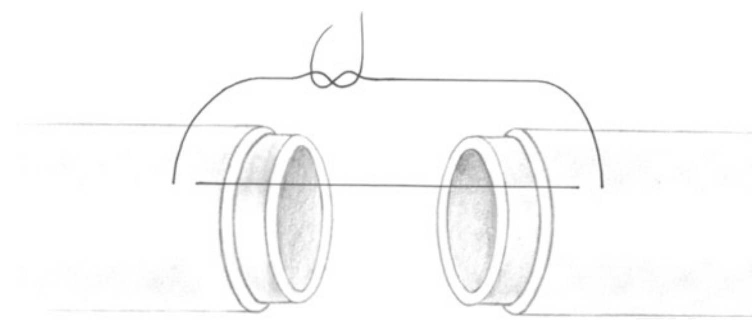


Fig. B-17

Cushing Stitch

The Cushing stitch is similar to the Lembert stitch, except that it is inserted parallel to the cut edge of the bowel, 2-4 mm from the cut edge. It should catch about 5 mm of the bowel, including the submucosa. It is especially applicable for seromuscular approximation in anastomoses in poorly accessible locations, such as the low colorectal anastomosis. The interrupted Cushing technique is illustrated in **Fig. B-18a**. When used as a continuous stitch (**Fig. B-18b**),

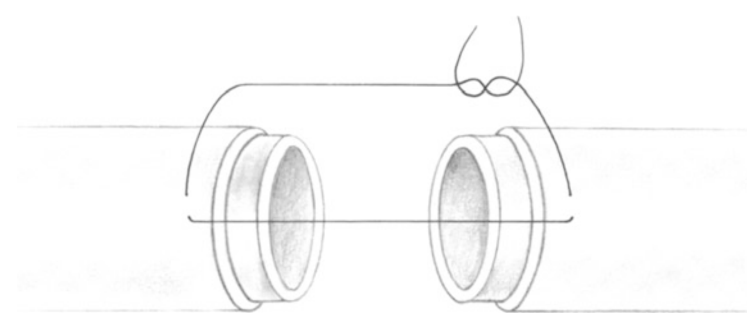


Fig. B-18a

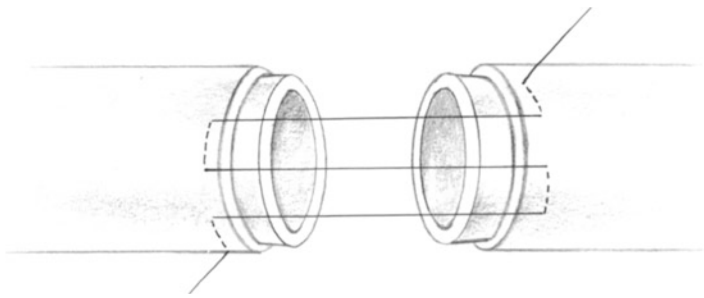


Fig. B-18b

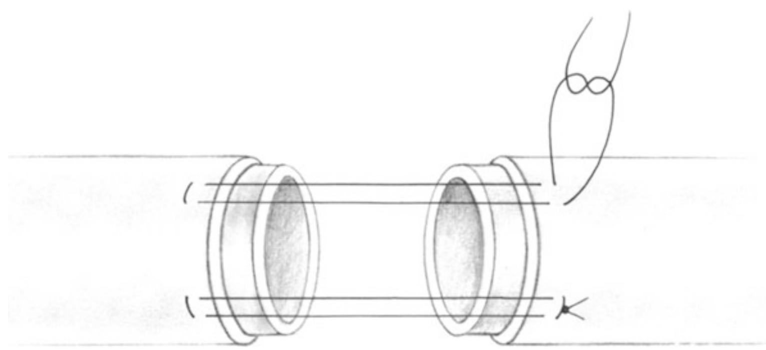


Fig. B-19

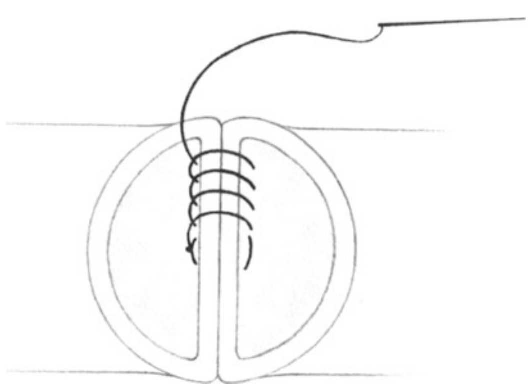


Fig. B-20

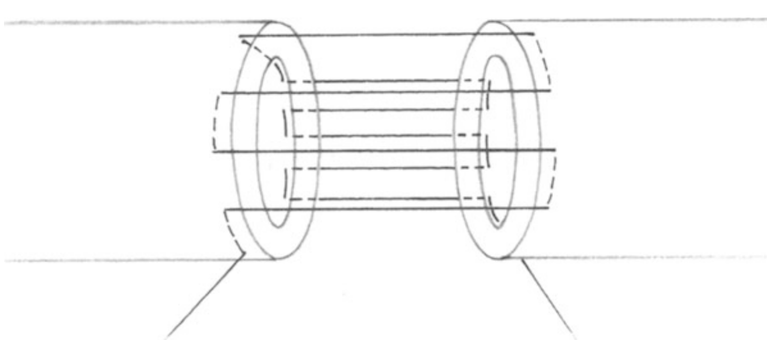


Fig. B-21

the Cushing is a good alternative to the Connell stitch for inverting the anterior mucosal layer of an anastomosis. The main difference between the Connell (see Fig. B-21) and a continuous Cushing suture is that the former penetrates into the lumen of the bowel while the latter passes only to the depth of the submucosal layer. The continuous Cushing suture is also much easier and more efficient to accomplish than the Connell.

Halsted Stitch

The Halsted stitch (**Fig. B-19**) also provides excellent seromuscular approximation in a bowel anastomosis. It shares with the Cushing stitch the danger that when tied with excessive tension, it will cause strangulation of a larger bite of tissue than will the Lembert suture.

Continuous Locked Stitch

Fig. B-20 illustrates the approximation of the posterior mucosal layer of a bowel anastomosis with a continuous locked stitch. This stitch assures hemostasis as well as approximation. When hemostasis is not a problem, some surgeons prefer to close this layer with a simple over-and-over continuous stitch (Fig. B-11).

Connell Stitch

In 1892 Connell reported that he had devised a way to perform a *one-layer* end-to-end anastomosis of the bowel. For many decades his stitch has been used as the method of inverting the anterior mucosal layer of a *two-layer* bowel anastomosis. The stitch goes from the serosa through all the layers of intestine into the lumen (**Fig. B-21**), comes out through all the layers on the same side, and passes over to the opposite segment of the bowel, where the same sequence takes place.

Because it forms a loop on the mucosa, the Connell stitch is moderately hemostatic. One should not depend entirely on it for hemostasis, however. As the bowel is inverted, intraluminal bleeding does not remain visible to the surgeon, and may go undetected. Rather than rely on the Connell stitch, it is preferable to ligate the bleeding points on the anterior surface of the bowel with fine catgut, or else to occlude the bleeding points with accurate electrocoagulation. If hemostasis has been achieved in this manner, the Connell technique is not the optimal method of inverting the anterior layer of mucosa in performing bowel anastomosis, as it is more cumbersome than either the seromucosal suture (Fig. B-16) or a continuous Cushing stitch (Fig. B-18b).

Technique of Successive Bisection

The technique that we have named "successive bisection" assures consistently accurate intestinal anastomoses, especially when the diameters of the two segments are not identical. As illustrated in **Fig. B-22**, the first stitch is inserted at the antimesenteric border and the second stitch at the mesenteric border. The third is then inserted at a point that exactly bisects the entire layer. The fourth stitch bisects the distance between the first and third stitches. This pattern is repeated until the anastomotic layer is complete (**Fig. B-23**).

Types of Intestinal Anastomoses

One Layer or Two Layers?

Although there are abundant data confirming that an intestinal anastomosis can be performed safely with either one layer or two layers of sutures, there is, to our knowledge, no consistent body of randomized data conclusively demonstrating the superiority of one or the other in humans. It is obvious that the one-layer anastomosis does not turn in as much intestine and, consequently, has a larger lumen than the two-layer. However, in the absence of postoperative leakage, obstruction at the anastomotic site is rare except, perhaps, when the esophagus is involved. It does seem reasonable, though, to assume that if the seromuscular layer sutured by the surgeon suffers from some minor imperfection, then the mucosal sutures may compensate for the imperfection and prevent leakage. While we have experienced good results with one-layer techniques, we recommend in teaching residents, that every surgeon master the standard two-layer technique before considering the other.

End-to-End or End-to-Side?

In most situations, the end-to-end technique is quite satisfactory for joining two segments of bowel. If there is some disparity in diameter, a *Cheatle slit* should be performed on the antimesenteric border of the narrower segment of intestine to enable the two diameters to match each other (**Figs. B-24 and B-25**). In case there is a large disparity in the two diameters, more than 1.5–2 cm, the end-to-side anastomosis has advantages, provided that the anastomosis is not constructed in a manner that permits a blind loop to develop. If the end-to-side anastomosis is placed within 1 cm of the closed end of the intestine, the blind-loop syndrome will not occur. Closing the end of the segment of bowel by suturing requires extra time, but a stapled closure of the bowel end can be accomplished in a matter of seconds and in our experience appears to be just as safe as suturing.

There are two instances in which the end-to-side anastomosis is clearly superior to the end-to-end. One is in an esophagograstic anastomosis following esophagogastrectomy. We have reported that in this procedure the incidences of leakage, postoperative stenosis, and mortality are distinctly less with the

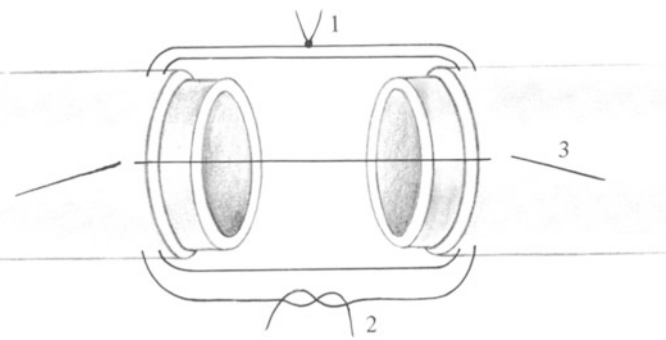


Fig. B-22

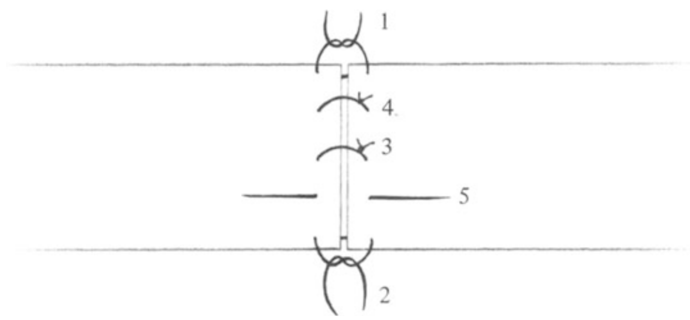


Fig. B-23

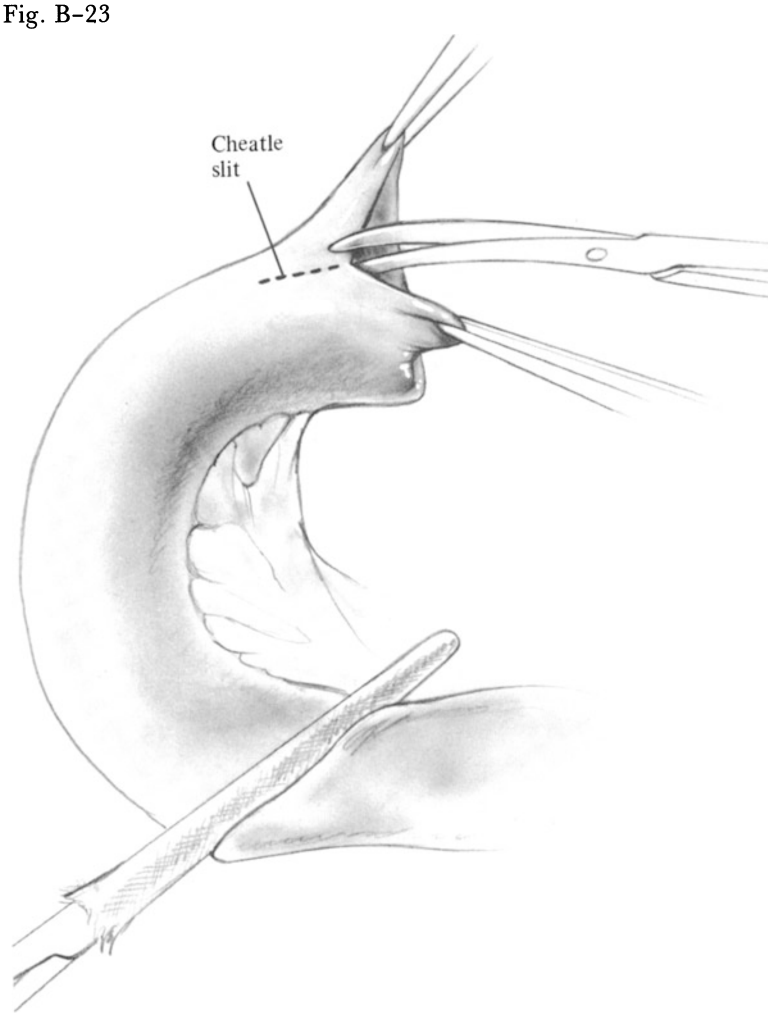


Fig. B-24

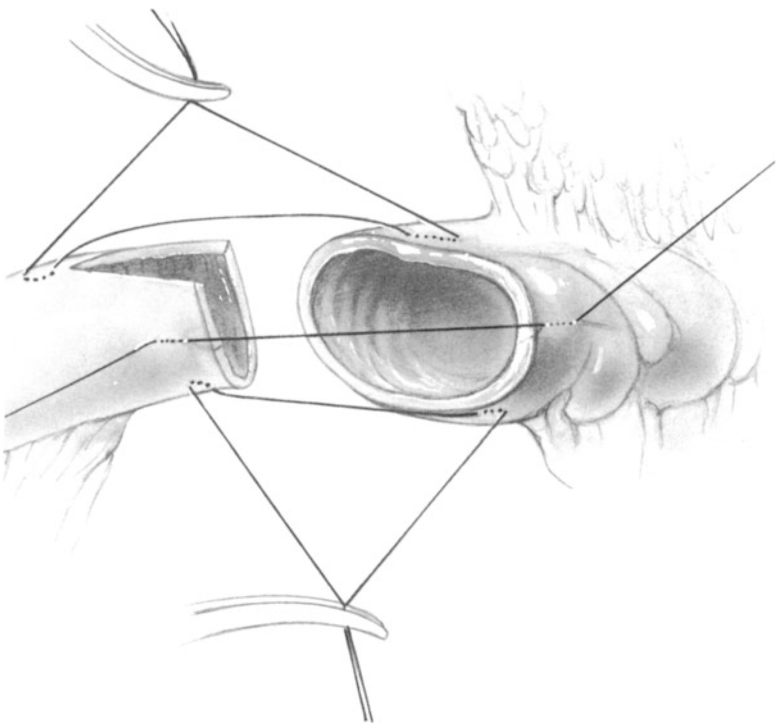


Fig. B-25

end-to-side technique. This is probably true also for an esophagojejunal anastomosis. The second instance is in the low colorectal anastomosis. In this procedure the ampulla of the rectum is often much larger in diameter than the descending colon. Zollinger and Sheppard have reported that the use of the side-to-end Baker technique has virtually eliminated the incidence of postoperative stenosis and leakage. This is confirmed by our experience.

Sutured or Stapled Anastomosis?

A review of 472 stapled suture lines performed at the Booth Memorial Medical Center over a 4-year period, and reported by Chassin, demonstrated that the incidence of anastomosis-related complications following stapling was identical to that following sutured anastomoses done over the same period of time by the same surgical staff (see Chap. 4). It was noted, however, that the stapled group contained a much higher incidence of emergency operations, sepsis, bowel gangrene, intestinal obstruction, and carcinomatosis than did the sutured group. When done by surgeons whose techniques are sophisticated, stapling and suturing can achieve equally good results.

Types of Suture Material

Absorbable

Plain Catgut

Plain catgut is not commonly used in modern surgery. Although its rapidity of absorption might seem to be an advantage, this rapidity is the result of an intense inflammatory reaction that produces enzymes for the digestion of the organic material. Plain catgut is acceptable for ligating bleeding points in the subcutaneous tissues and not for very much else.

Chromic Catgut

Chromic catgut has the advantage of a smooth surface, which permits it to be drawn through delicate tissues with minimal friction. It may be depended upon to last for about a week and is suitable only when such rapid absorption is desirable. It is completely contraindicated in the vicinity of the pancreas, where proteolytic enzymes produce premature absorption, and in the closure of abdominal incisions and hernia repair, where it does not hold the tissues long enough for adequate healing to occur. Chromic catgut is useful for the approximation of the mucosal layer in a two-layer anastomosis of the bowel. For this purpose, size 4-0 is suitable. Bear in mind that wound infection will increase the rapidity of catgut digestion.

Polyglycolic Synthetics

Polyglycolic synthetic sutures (PG), such as Dexon or Vicryl, are far superior to catgut because the rate at which they are absorbed is much slower. Even after 15 days, about 20% of the tensile strength remains. Digestion of the polyglycolic sutures is by hydrolysis. Consequently, the proteolytic enzymes in an area of infection have no effect on the rate of absorption of the polyglycolics. Also, the inflammatory reaction they incite is mild as compared with catgut. Their chief drawback is that their surface is somewhat rougher than catgut, which may traumatize tissues slightly when the PG suture material is drawn through the wall of the intestine. This characteristic also *makes the tying of secure knots somewhat more difficult* than with catgut. However, these appear to be minor disadvantages, and these products have for many purposes made catgut an obsolete suture material.

Nonabsorbable

Natural Nonabsorbables

Natural nonabsorbable sutures, such as silk and cotton, have enjoyed a long period of popularity among surgeons the world over. They have the advantage of easy handling and secure knot tying. Once the knots are set, slippage is rare. On the other hand, they produce more inflammatory reaction in tissue than do the monofilament materials (stainless steel, Prolene) or even the braided synthetics. Silk and cotton, although classified as nonabsorbable, do indeed disintegrate in the tissues over a long period of time, whereas the synthetic materials appear to be truly nonabsorbable. In spite of these disadvantages, silk and cotton have maintained worldwide popularity mainly because of their ease of handling and surgeons' long familiarity with them. Because there are no clear-cut data at this time demonstrating that anastomoses performed with synthetic suture material have fewer complications than those performed with silk or cotton, it is not yet necessary for the surgeon to abandon the natural nonabsorbables if he or she can handle them with greater skill. With the exception of the monofilaments, a major disadvantage of nonabsorbable sutures is the formation of chronic draining sinuses and suture granulomas. This is especially marked when material larger than size 3-0 is used in the anterior abdominal fascia or in the subcutaneous tissue.

Synthetic Nonabsorbable Braids

Synthetic braided sutures include those made of Dacron polyester, such as Mersilene, Ticron (Dacron coated with silicone), Tevdek (Dacron coated with Teflon), and Ethibond (Dacron with butilated coating). Braided nylon (Surgilon or Nurolon) is popular in the United Kingdom. All these braided synthetic materials require four or five knots for secure closure, compared to the three required of silk and cotton.

Synthetic Nonabsorbable Monofilaments

Monofilament synthetics like nylon and Prolene are so slippery that as many as 6-7 knots may be required. They and monofilament stainless steel are the least reactive of all the products available. For this reason, 2-0 or 0 Prolene has been used by some surgeons for the Smead-Jones abdominal closure in the hope of eliminating suture sinuses. Because of the large number of knots, this hope has not been realized, but the sinuses have turned out to be fewer than when nonabsorbable braided materials are used. Prolene size 4-0 on atraumatic needles has been used for the seromuscular layer of intestinal anastomoses. Both Prolene and various braided polyester sutures have achieved great popularity in vascular surgery.

Monofilament Stainless Steel Wire

Monofilament stainless steel wire has many characteristics of the ideal suture material; however, it is

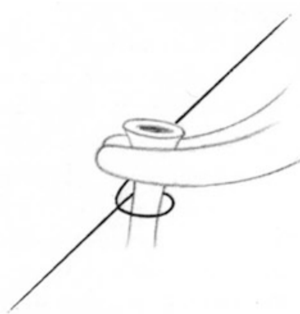


Fig. B-26a

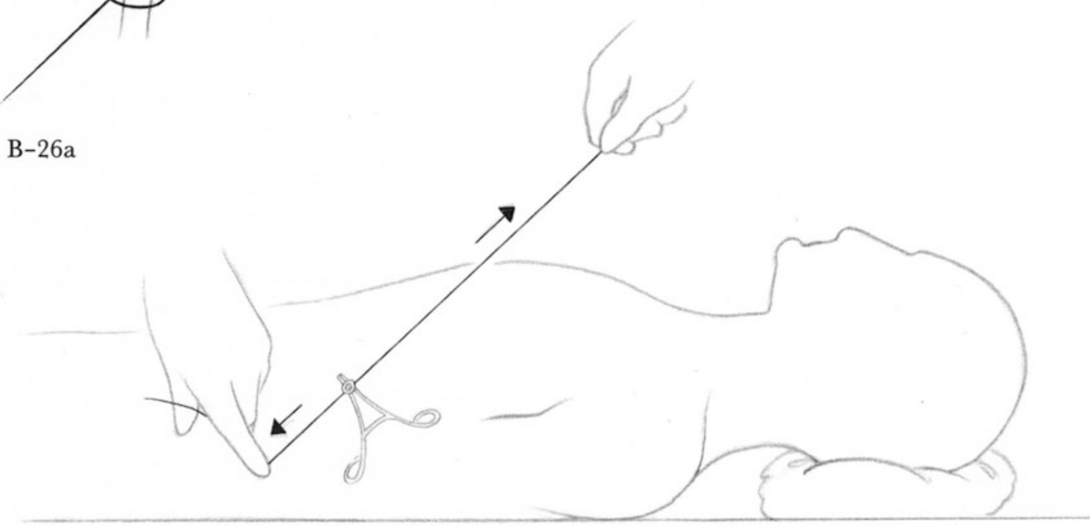


Fig. B-26b

difficult to tie. Also, when it has been used for closure of the abdominal wall, patients occasionally have complained of pain at the site of a knot or of a broken suture. True suture sinuses and suture granulomas have been extremely rare when monofilament stainless steel has been used—no more than 1 in 300 cases. Size 5-0 monofilament wire has been used by Belsey and Skinner for one-layer esophagogastric anastomoses and by Trimpi for colon anastomoses. Three square throws are adequate for a secure knot in tying this material. If steel wire in the form of a *braid* is used, the incidence of suture sinuses is not less than experienced with braided silk.

Knot-Tying Technique

The "three-point technique" of tying knots is very important in ligating blood vessels. This means that the surgeon's left hand grasping one end of the ligature, the vessel being ligated, and the surgeon's right hand grasping the opposite end of the ligature are positioned in a straight line, as illustrated in **Figs. B-26a and B-26b**. If this is not the case, as the surgeon's hands draw apart in tightening the knot they exert traction against the vessel. In tying deep bleeding points, this traction tears the vessel at the point of ligature and exacerbates bleeding. In tying a deep structure, such as the cystic artery, the surgeon's left index finger should draw the deep end of the ligature deep to the artery so that the left index finger, the cystic artery, and the surgeon's right hand always form a straight line.

When using silk, three square throws provide adequate security. With PG, four throws are necessary. With the various coated polyester sutures, four or five knots must be tied. In using the synthetic materials, many prefer the "surgeon's knot" (**Fig. B-27**) as a first throw.

For heavy monofilament suture material like 0 or 1 Prolene we have used a modification of a fisherman's 3-1-2 knot. First, make a triple throw "surgeon's knot" (**Fig. B-28a**). Then square it with a single throw (**Fig. B-28b**). Complete the knot with the usual double throw "surgeon's knot" (**Fig. B-28c**). This seems to hold without slipping.

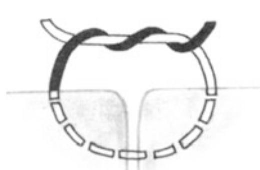


Fig. B-27

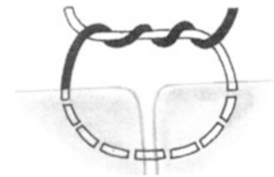


Fig. B-28a

Fig. B-28b

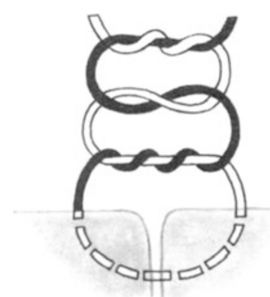


Fig. B-28c

When tying a knot in a deep or poorly accessible location, it is vital that the two-hand technique of tying be used. For superficial bleeding points in the skin and subcutaneous tissues, either one- or two-hand knots are efficacious.

References

Chassin JL. Esophagogastrectomy: data favoring end-to-side anastomosis. Ann Surg 1978; 188:22.

Connell ME. An experimental contribution looking to an improved technique in enterorrhaphy whereby the number of knots is reduced to two or even one. Med Record 1982; 42:335.

Zollinger RM, Sheppard MH. Carcinoma of the rectum and the rectosigmoid. Arch Surg 1971; 102:335.

C Control of Bleeding

Techniques of Achieving Hemostasis

Hemostat and Ligature

A hemostat of the proper length and design is a suitable instrument for occluding most bleeding vessels. This is followed by a ligature of a size compatible with the diameter of the vessel. As demanded by the situation, hemostats the size of a Halsted, Crile, Adson, Kelly, or Mixter may be indicated (see Glossary).

As for the ligature material, surgeons trained in the Halsted tradition have long preferred fine silk because it is less reactive than catgut and eliminates the danger of premature absorption. The advantage of silk and cotton has diminished with the advent of the polyglycolic synthetic absorbable ligatures. The disadvantage of nonabsorbable ligatures is that they may incite the information of a suture granuloma or suture sinus. It is possible for a sinus to occur after the use of silk deep in the abdomen, although this is rare. Granulomatous nodules have occasionally been palpated on rectal examination following the use of silk in deep pelvic surgery. Since the polyglycolic materials have low reactivity and slow absorption, they are ideal materials for routine ligatures, if the surgeon has learned to tie secure knots using this material.

The need to ligate a large artery in the presence of an abscess or pancreatitis creates a unique situation. A ligature of braided nonabsorbable material is a foreign body that can readily harbor bacteria in its interstices. When it does, often it erodes into the artery at the site of the ligature and produces hemorrhage. The risk of this type of hemorrhage can be reduced by using heavy polyglycolic absorbable or monofilament (Prolene or PDS) ligature material.

In summary, PG ties are useful for most routine ligatures. Silk provides greater security in tying major vessels such as the left gastric or inferior mesenteric artery. When the mesentery of the sigmoid colon is being divided in the treatment of perforated diverticulitis, use 2–0 PG to ligate the vessels. If the splenic artery is being divided and ligated during the resection of a pseudocyst of the pancreas, use a 2–0 ligature of Prolene.

Ligature-passer

In ligating large vessels such as the inferior mesenteric, the ileocolic, or left gastric, it is convenient to pass a blunt-tip right-angle Mixter clamp behind the vessel. The blunt tip of the clamp separates the adventitia of the artery from the surrounding tissue. Preferably, at least 1.5 cm of vessel should be dissected free. When this has been done, use a ligature-passer, which consists of a long hemostat holding the 2–0 silk ligature, to feed the thread into the jaws of the open Mixter clamp. Then draw the ligature behind the vessel and tie it. Pass the Mixter clamp behind the vessel again, feed a second ligature into its jaws, and ligate the distal portion of the vessel. Divide the vessel, leaving a 1-cm stump distal to the proximal tie and about 0.5 cm on the specimen side. Leaving a long stump of vessel distal to a single tie of 2–0 silk prevents the ligature from slipping off, even when it is subjected to the continuous pounding of arterial pulse waves.

Suture-ligature

Two simple ligatures of 2–0 silk placed about 3 mm apart, with a free 1-cm stump distal to the ligatures, assure hemostasis when ligating the large arteries encountered in gastrointestinal surgery. If there is not a sufficient length of artery to meet these conditions, a 2–0 silk ligature supplemented by the insertion of a transfixion suture-ligature that pierces the center of the artery 3 mm distal to the simple ligature is almost as good as a free 1-cm stump of artery.

Another type of suture-ligature is used in tissue into which a vessel has retracted. This may occur on the surface of the pancreas, where attempts at grasping a retracted vessel with hemostats can be much more traumatic than a small figure-of-eight suture of atraumatic 4–0 silk. The same figure-of-eight suture-ligature technique is valuable when a vessel has retracted into a mesentery thickened by obesity or Crohn's disease.

Hemoclip

Metallic clips offer a secure and expedient method of obtaining hemostasis, provided proper application of this technique is accomplished. Hemoclips are applicable *only* when the *entire circumference* of a vessel is visible, preferably *before* the vessel has been lacerated. Applying a clip inaccurately often results in incomplete occlusion of the vessel and continued bleeding, following which the presence of the metal clip obstructs the use of a hemostat or a suture-ligature in the same area. Attempts to remove the clip from a thin-walled vein may increase the rate of bleeding.

When Hemoclips are applied in an area where subsequent steps in the operation require blunt dissection or vigorous retraction — such as in performing a Kocher maneuver — the subsequent surgical maneuvers often dislodge the clips and lacerate the vessels, producing annoying hemorrhage.

Another maneuver that should never be performed is the application of clips in the general area from which blood is oozing, in the hope this will somehow catch the bleeder. Again it must be emphasized that unless a bleeding vessel can be clearly visualized, applying a Hemoclip is counterproductive.

In the absence of these contraindications, the use of Hemoclips is a desirable technique, as for instance in the mediastinum during esophageal dissection, or in the retroperitoneal area during colon resection.

Coagulation by Electrocautery

Electrocoagulation is a valuable and rapid means of achieving hemostasis, provided that certain contraindications are observed. Vessels that have an external diameter larger than 2–3 mm should not be electrocoagulated. Just as with Hemoclips, any tissue that will be subjected to blunt dissection or retraction may not be suitable for electrocautery, as the friction often wipes away the coagulum, causing bleeding to resume.

In the presence of fat, such as in the subcutis or in the breast, bleeding points should not be electrocoagulated unless a discrete blood vessel has been identified. Otherwise, electrocoagulation in the general area of a bleeder surrounded by fat boils the fat and causes more extensive tissue insult than is necessary. This happens because fat is a poorer conductor of electricity than is muscle or vascular tissue.

When many subcutaneous bleeding points are subjected to electrocoagulation, the extensive tissue insult may contribute to wound infection. Cruse noticed a doubled incidence of wound infection in operations done with the electrocautery as compared with those accomplished with a cold knife and hemostats. Very likely this was the result of excessive tissue trauma the electrocautery causes in the fatty layer.

Extensive use of electrocoagulation in muscle tissue, as in opening large incisions in the throacic cavity, appears to have no deleterious effects. In doing mastectomies we have used electrocoagulation to control all of the bleeding points except for the branches of the auxillary vein. These are divided after applying Hemoclips. There have been only rare instances of postoperative bleeding in a large series of mastectomies.

In summary, with the exception of fatty tissue and tissues subject to blunt dissection and strong retraction, electrocoagulation of identified vessels is both rapid and effective.

The careful and accurate application of electrocoagulation permits the achievement of complete hemostasis in areas such as the gallbladder bed, the chest wall, and the retroperitoneal tissues, where many tiny veins may continue to ooze even after a period of gauze compression. Individual ligation of each of these innumerable small bleeding points would be time-consuming.

Physicochemical Methods

Gauze Pack

The physical application of a large, moist gauze pad has been employed for many decades to control diffuse venous oozing. It enhances the clotting mechanism because pressure slows down the loss of blood while the interstices of the gauze help form a framework for the deposition of fibrin. Unfortunately, after the gauze pack is removed, bleeding sometimes resumes.

Oxidized Cellulose

Oxidized regenerated cellulose in the form of gauze (Surgicel) or cottonoid (Oxycel) offers the same advantages as a gauze pack. They may be applied in a thin layer to an oozing surface such as a liver or spleen from which the capsule has been avulsed. Pressure on the cellulose should be applied by an overlying gauze pack. After 10–15 minutes, the gauze pack should be removed and the oxidized cellulose left behind. Used in a thin layer over viable surfaces, the cellulose should undergo uncomplicated absorption. If a wad of cellulose is stuffed into a crack in the liver, however, failure of total absorption and abscess formation may result. Oxidized cellulose is more suitable for surface bleeding than for the control of hemorrhage in a deep crevice.

Avitene

Avitene (microfibrillar collagen) is claimed to be even more effective than oxidized cellulose. It comes in powdered form to be sprinkled on a bleeding surface. Any moisture on instruments or gloves that come into contact with Avitene causes the Avitene to stick to the moist instrument rather than the bleeding surface. If blood oozes through the layer of Avitene, another layer should be applied and pressure exerted over it. When flat surfaces of a denuded spleen or gallbladder bed are oozing, oxidized cellulose seems equally effective as Avitene, and at one-twentieth the cost. Avitene is better for irregular surfaces because it is a powder.

Microfibrillar collagen and oxidized cellulose are extremely valuable when some portion of the splenic capsule has been avulsed during a vagotomy or splenic flexure mobilization. In most cases a splenectomy can be avoided by the use of these substances, occasionally supplemented by the use of sutures.

Control of Hemorrhage, Temporary

In the course of operating, the equanimity of the surgeon is jarred occasionally by a sudden hemorrhage caused by the inadvertent laceration of a large blood vessel. One should have clearly in mind a sequence of steps to execute in such an event, aimed first at temporary control of the bleeding in preparation for definitive steps later. The sequence should go something like this:

1) Finger pressure. The simplest step, especially useful in controlling bleeding from an artery, is the simple application of a fingertip to the bleeding point. In the case of a large vein, such as the auxillary or vena cava, pinching the laceration between thumb and index finger is sometimes effective.

2) Elevation of the structure by placing the hand behind it. If step (1) is not applicable, sometimes the left hand may be placed behind a structure such as the hepatoduodenal ligament to control bleeding from the cystic artery or the pancreas or portal vein for bleeding in that area. This may bring temporary control.

3) Compression by hand pressure or gauze-pad pressure. Large lacerations of the liver may be temporarily controlled by compressing this organ between two hands while the patient is being resuscitated. Massive venous bleeding from the presacral space can be controlled by the application of a large gauze pad.

4) Satinsky clamp. When direct pressure is not effective, a partially occluding Satinsky-type vascular clamp may be used to control the laceration of a large vessel.

5) Proximal and distal control. Sometimes, even temporary control of hemorrhage is impossible without proximal and distal occlusion of the vessel. This may involve the aorta or vena cava in some cases. Preferably, vascular clamps should be used, but in their absence umbilical tape is a satisfactory temporary substitute. The aorta may even be clamped in a suprarenal position for 15–20 minutes if no other means of hemostasis is effective. This safe period may be lengthened if iced sterile saline is poured over the kidneys to reduce their metabolic requirements.

Control of Hemorrhage, Definitive

Once temporary control of hemorrhage has been obtained, the surgeon should reassess the strategic situation. The field should be cleared of all instruments and hemostats not relevant to the major problem at hand. If additional exposure is needed, plans should be outlined immediately to accomplish this by extending the incision or by repositioning gauze pads or retractors. Optimal light and suction lines should be obtained. Arrangements should be made with the blood bank for adequate support of the patient. Additional personnel should be recruited as necessary. Dr. Frank C. Spencer, chairman of the department of surgery at New York University, has emphasized that one competent individual must be assigned to "bookkeeping." This individual's only duty should be to keep track of the volume of blood lost as well as the rate of at which it is replaced, and to report this to the operating surgeon at frequent intervals. Otherwise, the surgeon and the anesthesiologist may become so involved with the task at hand that they may make inadequate provision for resuscitating the patient.

After all these steps have been completed and the patient's condition has been stabilized, the surgeon can then convert the measures for temporary control of hemorrhage into maneuvers to assure permanent control. This generally involves the application of a partially occluding Satinsky-type clamp to the vessel or the achievement of proximal and distal control with vascular clamps, so that the laceration can be sutured in a definitive fashion with a continuous suture of atraumatic Tevdek or Prolene. No surgeon should undertake to perform major surgery unless he or she has had training and experience in the suturing of large arteries and veins.

D Glossary

Adaptic Non-Adhering Dressing.

J & J Products
New Brunswick, New Jersey 08903

Atraumatic suture. Suture material permanently swaged into the end of a disposable needle so as to eliminate the usual double thickness of thread encountered when suture material is threaded through the eye of a needle (see Fig. D-18).

Avitene (microfibrillar collagen hemostat). An absorbable powdery substance that attracts platelets to its fibrils, triggering thrombus formation.

Med Chem Products, Inc.
Woburn, Massachusetts 01801

Baker tube, Bardic. A plastic tube, 108 cm in length, with an inflatable balloon near its tip which can be manipulated down the small bowel for suction decompression (see Chap. 32).

C. R. Bard
111 Spring Street
Murray Hill, New Jersey 07974

Baker tube, Nyhus-Nelson modification.

Bissell Medical Products
P. O. Box 1338
Chicago, Illinois 60690

Burhenne Soft Steerable Catheter System. A device for extracting retained common bile duct stones via the drain tract remaining after removing the T-tube.

Medi Tech Division
Cooper Scientific
372 Main Street
Watertown, Massachusetts 02172

Catheter, Angiocath Intravenous Placement Unit. A plastic catheter introduced over a needle.

Deseret
Sandy, Utah 84070

Catheter, Cholangiogram, Laparoscopic Cholecystectomy Arrow-Karlan

Arrow International
3000 Bernville Road
Reading, Pennsylvania 19605

Catheter, Cholangiogram, Taut

Taut
2571 Kaneville Court
Geneva, Illinois 60134

Catheter, Foley. A double-lumen indwelling bladder catheter. The narrower of the two lumens leads to an inflatable balloon at the catheter tip.

Catheter, Swan-Ganz. A balloon-tipped transvenous catheter used to measure pulmonary artery wedge pressure.

Cheatle slit. An incision on the antimesenteric side of the open end of the intestine, designed to increase the circumference of the lumen so that an end-to-end anastomosis can be constructed between it and intestine of a larger diameter (see Figs. B-24 and B-25).

Contrast media, radiographic

1. Conray; iothalamate meglumine. Aqueous radiopaque iodinated medium useful in cholangiography.
2. Gastrografin; diatrizoate meglumine and diatrizoate sodium solution. Aqueous radiopaque iodinated medium for radiographic visualization of the gastrointestinal tract.

Drain, closed-suction. A fenestrated plastic tube attached to a sterile plastic container which exerts suction after the container is manually compressed. The system is closed to assure sterility (see Fig. D-11).

1. Hemovac-Snyder drain
   Zimmer
   727 North Detroit Street
   Warsaw, Indiana 46580

2. Jackson-Pratt drain
   V. Mueller
   6600 W. Tuohy Avenue
   Chicago, Illinois 60648

Drain, sump. A fenestrated plastic or rubber tube attached to continuous suction. A second channel admits air into the tip of the catheter to prevent tissue being drawn up against the suction vents and occluding them (see Fig. D–11).

1. Shirley sump
   H. W. Andersen Products
   45 E. Main Street
   Oyster Bay, New York 11771
2. Saratoga sump
   Sherwood Medical Industries
   1831 Olive Street
   St. Louis, Missouri 63103

Drugs

1. Immodium; loperamide hydrochloride; Janssen
2. Lomotil; diphenoxylate hydrochloride; Searle
3. Metamucil; psyllium hydrophilic mucilloid; Searle
4. Senokot-S; senna concentrate and docusate sodium; Purdue Frederick

Elastic sleeve. Sleeve made to order according to measurements of the individual patient's arm circumference at various levels.

Jobst
Box 653
Toledo, Ohio 43694

Gelfoam. Absorbable gelatin sponge, useful to induce hemostasis by direct contact with a bleeding surface.

Upjohn
Kalamazoo, Michigan 49001

Gomco Thermotic drainage pump. A device which provides intermittent suction at low pressure (either 90 mm or 120 mm of mercury) suitable for sump drains or nasogastric tubes.

Gomco
828 E. Ferry Street
Buffalo, New York 14211

Hartmann operation. See Chap. 51.

Hemoclip. A V-shaped metal clip whose jaws are forced together around a blood vessel for hemostasis.

Linvatec
Box 12600
Research Triangle Park, North Carolina 27709

This clip is also manufactured by Ethicon under the name Ligaclip and by U.S. Surgical Corporation under the name Surgiclip.

Hemorrhoid Banding Instrument, McGivney Type. An effective device to apply a tight rubber band to internal hemorrhoids.

Ford Dixon
P.O. Box 35704
Dallas, Texas 75235

Hypaque (diatrizoate sodium). An iodinated aqueous contrast medium used instead of barium when performing radiographic contrast enemas or esophagrams in the early postoperative period.

Intestinal bag, Vi-Drape. A sterile 45 × 45 cm plastic bag to contain the small intestine during surgery on the colon.

Med/Surg, Parke-Davis
Park Plaza, P.O. Box 1506
Greenwood, South Carolina 29646

Legs rests, Allen

Allen Medical Systems
Richmond Road
Bedford Heights, Ohio 44146

Legs rests, Lloyd-Davies. Used to support the legs and thighs in abduction and in mild flexion for low anterior resection by EEA stapling and abdominal-perineal proctosigmoidectomy (see Fig. D–15).

Downs Surgical
2500 Park Central Boulevard
Decatur, Georgia 30035

Maloney bougies. Mercury-weighted bougies with tapered tips useful in dilating esophageal strictures.

Narco Pilling
Delaware Drive
Fort Washington, Pennsylvania 19034

Mesh, polypropylene. Plastic mesh useful in repair of large hernias.

1. Marlex Mesh
   Bard Implants Div.
   Box M
   Billerica, Massachusetts 01821
2. Prolene Mesh
   Ethicon
   Somerville, New Jersey 08876

Mucous fistula. When bowel has been resected but an anastomosis is contraindicated, the proximal segment of intestine is brought out as an enterostomy and the distal cut end of intestine is exteriorized through a stab wound and is called a "mucous fistula" (see Chap. 51).

Needle Biopsy, Travenol/Tru-Cut

Travenol Lab
Deerfield, Illinois 60015

Oxycel. An oxidized cellulose hemostatic agent which comes in pledget (cotton-type) form and in pads and strips (gauze-type).

Becton Dickinson Acute Care
Franklin Lake, New Jersey 07417

Perioperative antibiotics. Antibiotics administered prior to operation so that adequate blood and tissue concentrations will be achieved to combat intraoperative bacterial contamination. Additional doses are given if necessary during the operation to maintain therapeutic levels for the duration of the surgery (see Chap. 2).

Pleur-evac. Disposable sterile plastic device that provides constant negative pressure to catheter inserted into thoracic cavity following thoractomy.

Krale Division of Deknatel
110 Jericho Turnpike
Floral Park, New York 11001

Pump, Infusion, Pressure. A pump that compresses a 1-liter bag of saline solution during choledochoscopy.

Sorenson Research
P.O. Box 15588
Salt Lake City, Utah 84115

Retractor, "chain." This device utilizes a sterile chain attached to a lithotomy stirrup to elevate and retract either the left or right costal margin or the sternum (see Fig. D-19).

Retractor, Thompson. Multiple-purpose retractor set that attaches to operating room table. Various components permit rigid retraction for many abdominal, thoracic, or rectal operations (see Fig. D-24).

Thompson Surgical Instruments
P.O. Box 1051
Traverse City, Michigan 49685

Retractor, Upper Hand. This retractor is attached to the operating table by a steel bridge. It elevates and draws the sternum or costal margin in a cephalad direction (see Fig. D-25).

Hepco Inc.
Box 5200
Kansas City, Missouri 64112

Silastic. A silicone material useful for draining tubes because it has low tissue reactivity.

Dow Corning
P.O. Box 1M
Midland, Michigan 48640

Stomahesive peristomal covering. A thin wafer that lies between the peristomal skin and the faceplate of an ileostomy or colostomy appliance and is designed to protect the peristomal skin from digestive juices.

E. R. Squibb
P.O. Box 2013
New Brunswick, New Jersey 08903

Stitches

Lembert	(see Fig. B-17)
Cushing	(see Fig. B-18)
Halsted	(see Fig. B-19)
Seromucosal	(see Fig. B-16)
Smead-Jones	(see Fig. B-13)
Connell	(see Fig. B-21)

Staplers. See Chap. 4 and Figs. D-29 through D-35.

Auto Suture
U.S. Surgical Corporation
Connecticut 06902

Steri-Strip. Sterile paper adhesive tape.

Surgical Products Div. 3M
St. Paul, Minnesota 55144

Successive bisection. A term used to describe a sequence of inserting anastomotic sutures that will compensate for a minor disparity in the diameters of the two segments of intestine (see Figs. B-22 and B-23).

Surgicel (absorbable hemostat). A "cloth" composed of oxidized regenerated cellulose used adjunctively to assist in control of capillary and venous bleeding; absorbable if used in one or two thicknesses over flat surfaces.

Surgikos (Johnson & Johnson)
2500 Arbrook Boulevard
Arlington, Massachusetts 76010

Suture material

Dermalon—monofilament nylon (Davis and Geck, American Cyanamid, 1 Casper Street, Danbury, Connecticut)
Ethibond—braided Dacron polyester with butilated coating (Ethicon, P.O. Box 151, Somerville, New Jersey 08876
Ethilon—monofilament nylon (Ethicon)
Mersilene—braided Dacron polyester (Ethicon)
Nurolon—braided nylon (Ethicon)
PDS—Polydiaxanone, synthetic monofilament absorbable suture; slowest rate of absorption of currently available suture materials (Ethicon)
PG—polyglycolic acid, Dexon (Davis and Geck)
—polyglactin, Vicryl (Ethicon)
Prolene—monofilament polypropylene (Ethicon)
Surgilene—monofilament polypropylene (Davis and Geck)
Surgilon—braided nylon coated with silicone (Davis and Geck)
Tevdek—braided Dacron polyester coated with Teflon polytetrafluorethylene (Deknatel, 110 Jericho Turnpike, Floral Park, New York 11001)
Thumbtack—titanium hemorrhagic occluder pin with applicator (Cat. No. CR 1007, Surgin Co., 1000 Richfield Road, Placentia, California 92670)
Ticron—braided Dacron polyester coated with silicon (Davis and Geck)
Vicryl—Polyglactin, synthetic absorbable suture material (Ethicon)

Umbilical tape. Narrow woven cotton tape that comes in widths of from 3 to 10 mm. Useful in ligating the umbilical cord of the newborn infant and in occluding the lumen of the small or large intestine.

Vesseloop. A narrow ribbon (0.9 × 1.5 mm cross section) of siliconized rubber useful in tagging structures like the ureter for later identification in pelvic surgery.

Medgeneral
10800 Lyndale Avenue South
Minneapolis, Minnesota 55420

Wound protector, Vi-Drape. A sterile plastic drape designed to protect the subcutaneous fat from contamination by intestinal content during abdominal surgery (see Figs. 2-1 and 2-2).

Med/Surg, Parke-Davis
Park Plaza, P.O. Box 1506
Greenwood, South Carolina 29646

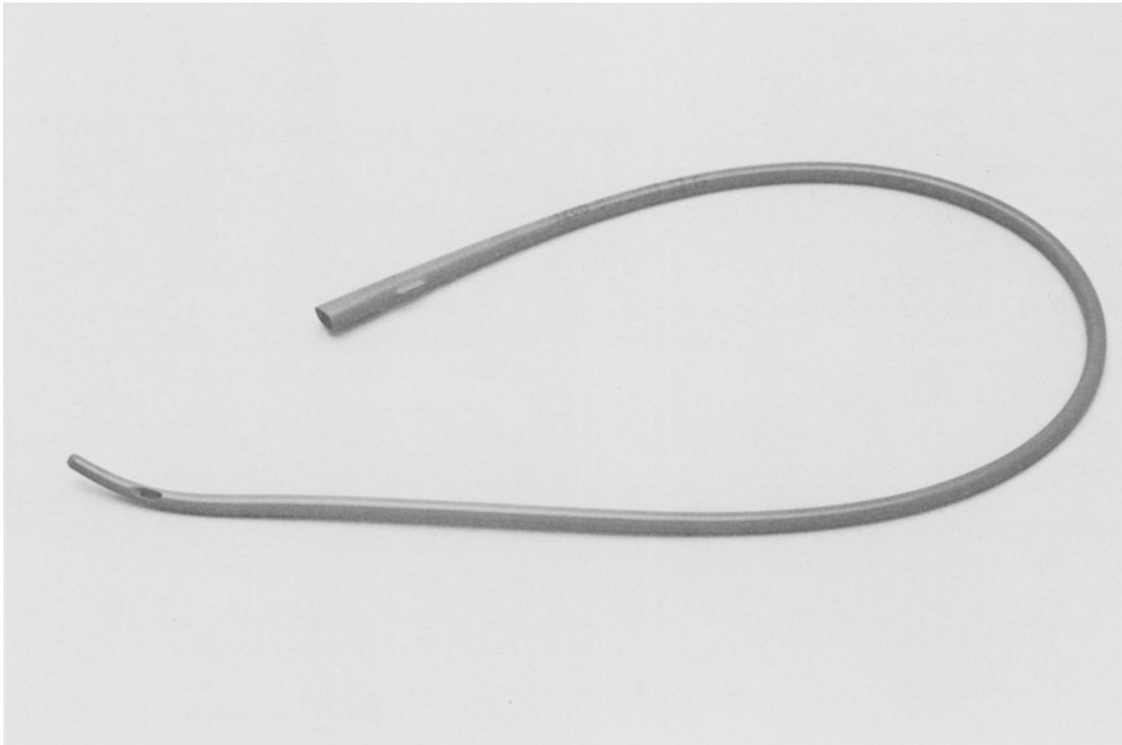


Fig. D-1 Catheter, Coudé-tip.

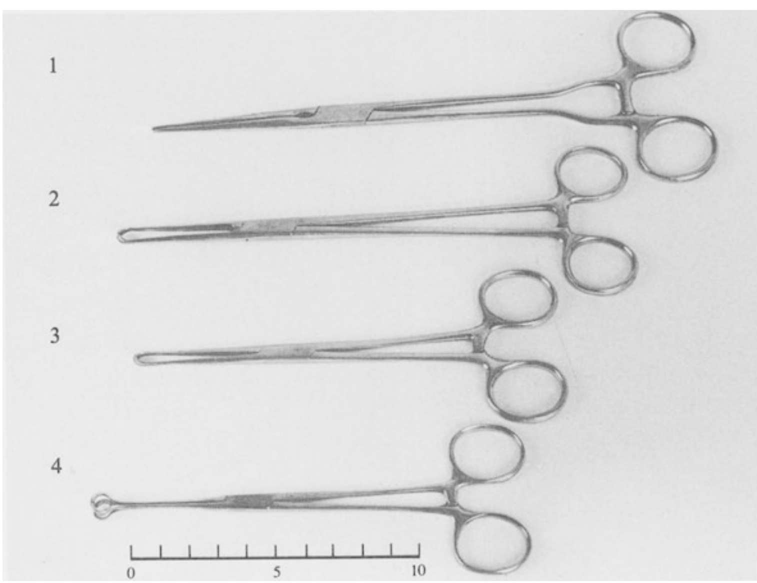


Fig. D-2 Clamps—Allen (1), Allis (2 and 3), and Babcock (4).

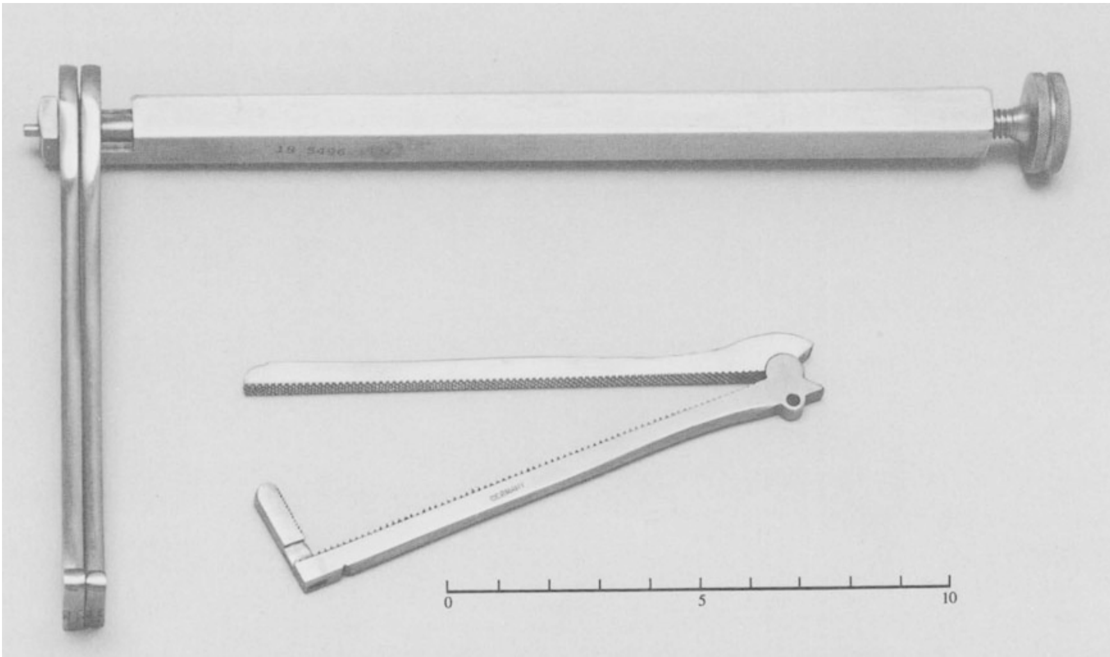


Fig. D-3 Clamp—DeMartel.

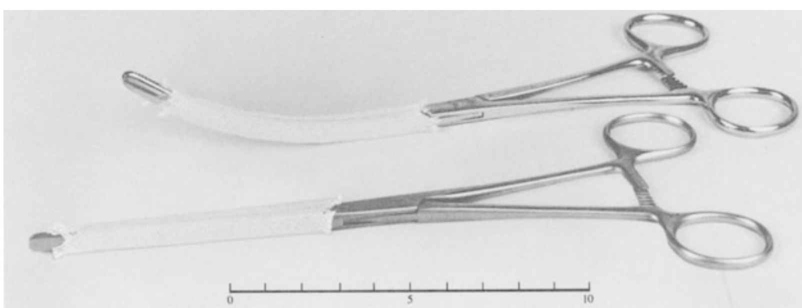


Fig. D-4 Clamps—Doyen Non-Crushing Intestinal, linen-shod.

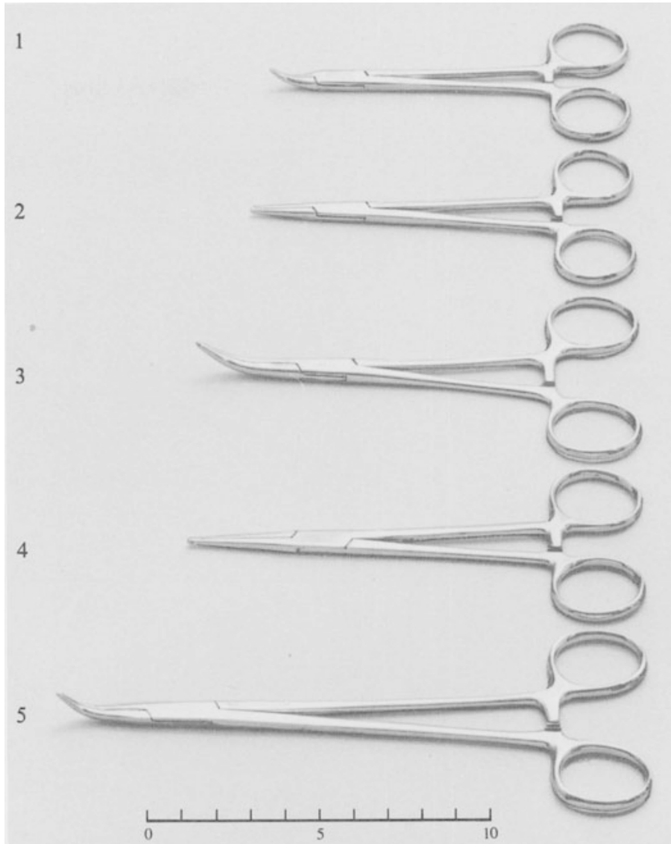


Fig. D-5 Clamps, hemostatic—Halsted (1 and 2), Crile (3 and 4), and Adson (Tonsil) (5).

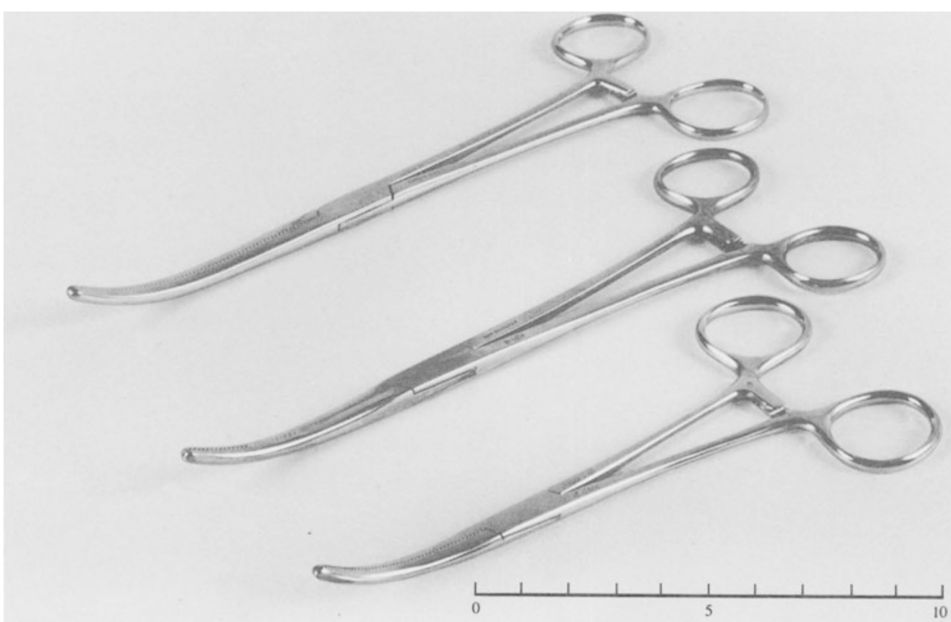


Fig. D-6 Clamps, hemostatic—Kelly.

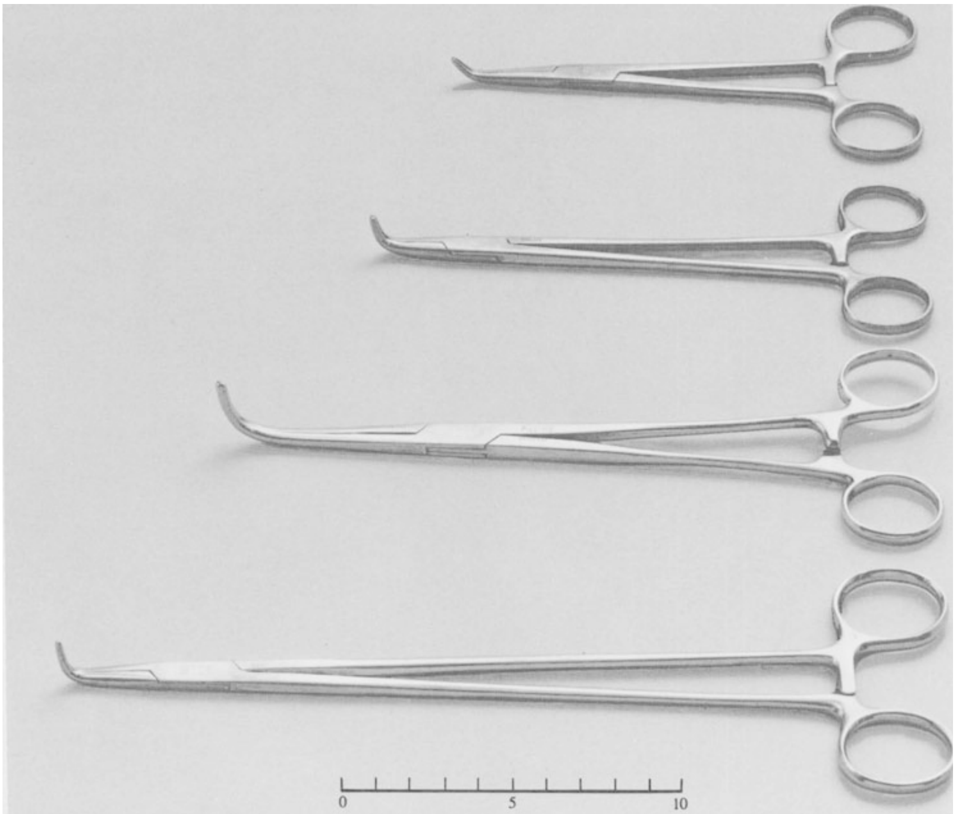


Fig. D-7

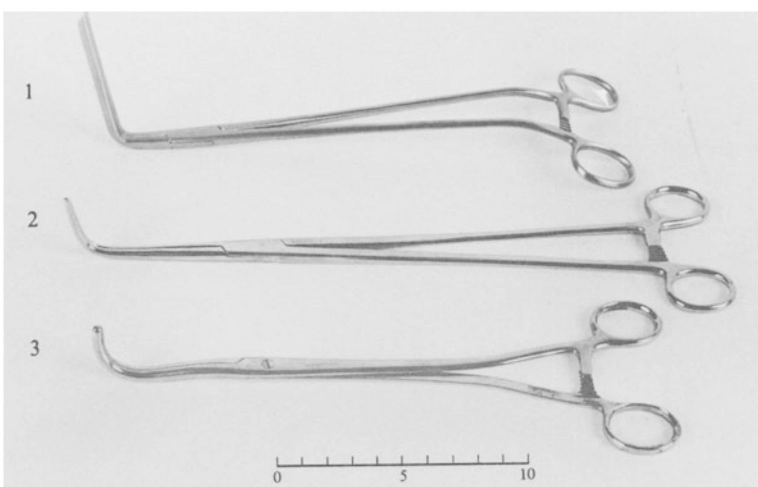


Fig. D-8 Clamps—Kidney Right Angle (1), Bronchus (2), and Moynihan (3).

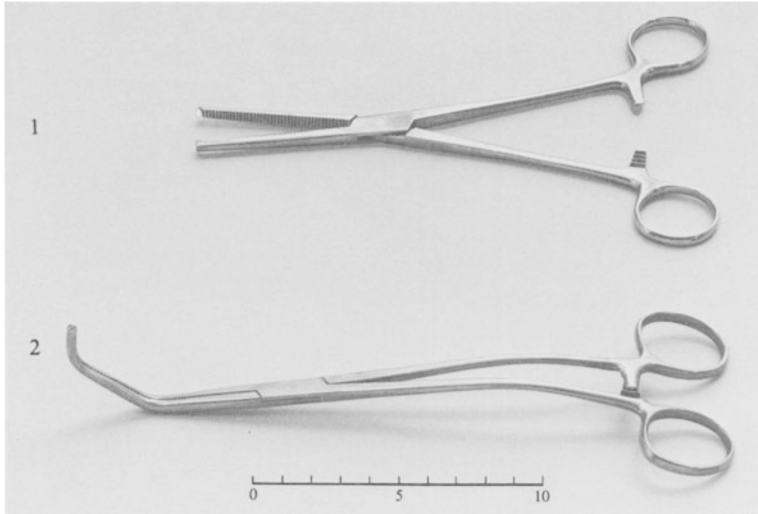


Fig. D-9 Clamps—Kocher (1) and Satinsky (2).

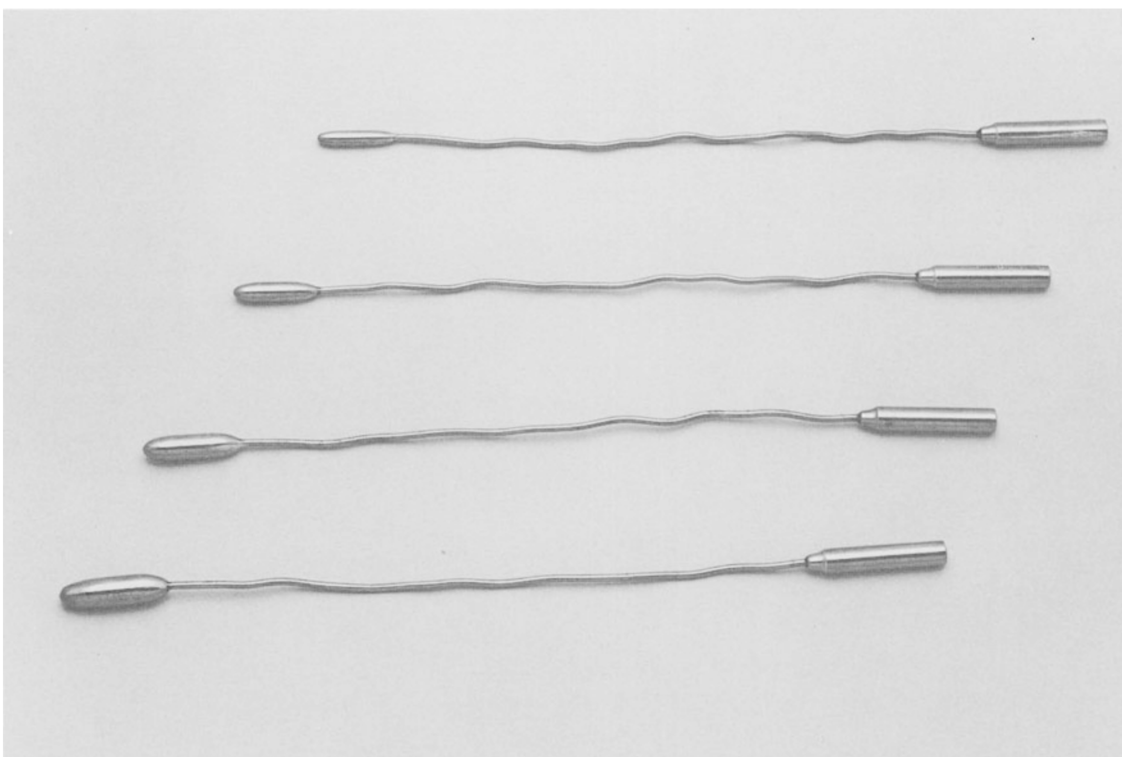


Fig. D-10 Dilators, Bakes.

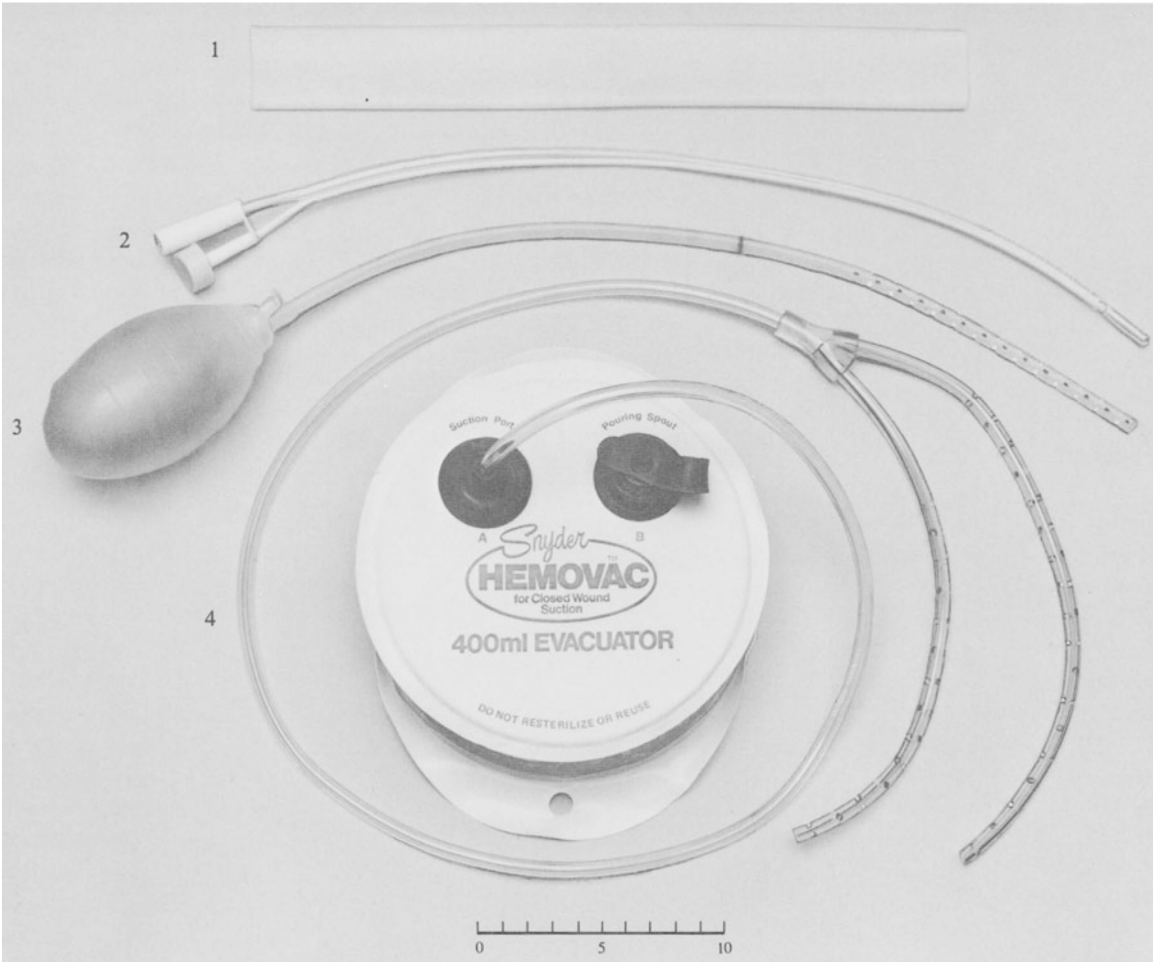


Fig. D-11 Drains—Latex (1), sump, Shirley (2), closed-suction, Jackson-Pratt (3), and Hemovac (4).

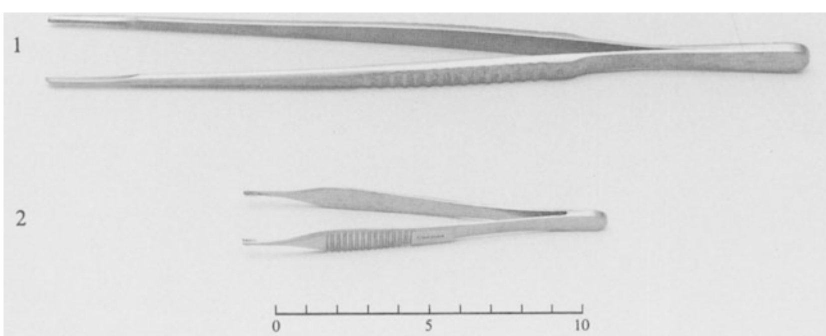


Fig. D-12 Forceps—Debakey (1) and Brown-Adson (2).

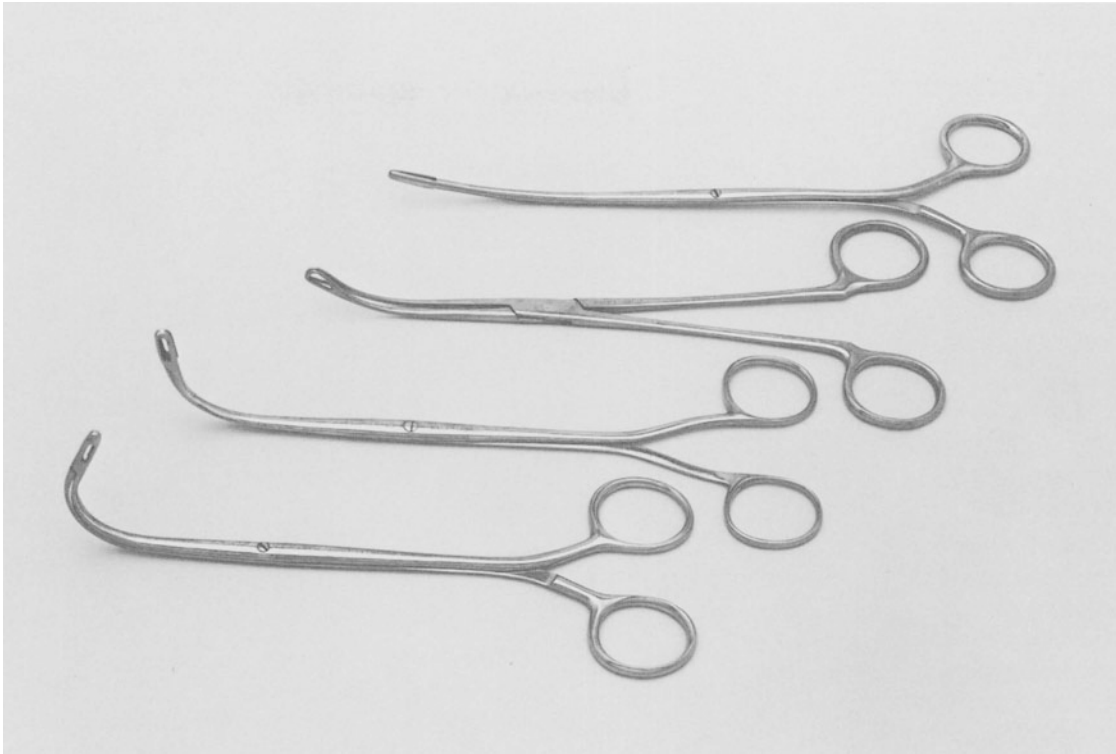


Fig. D-13 Forceps, Gallstone (Randall).

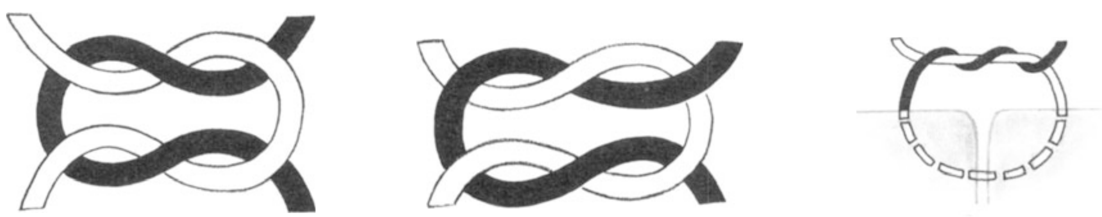


Fig. D-14 Knots — square (1), Grannee (2), and surgeon's (3).

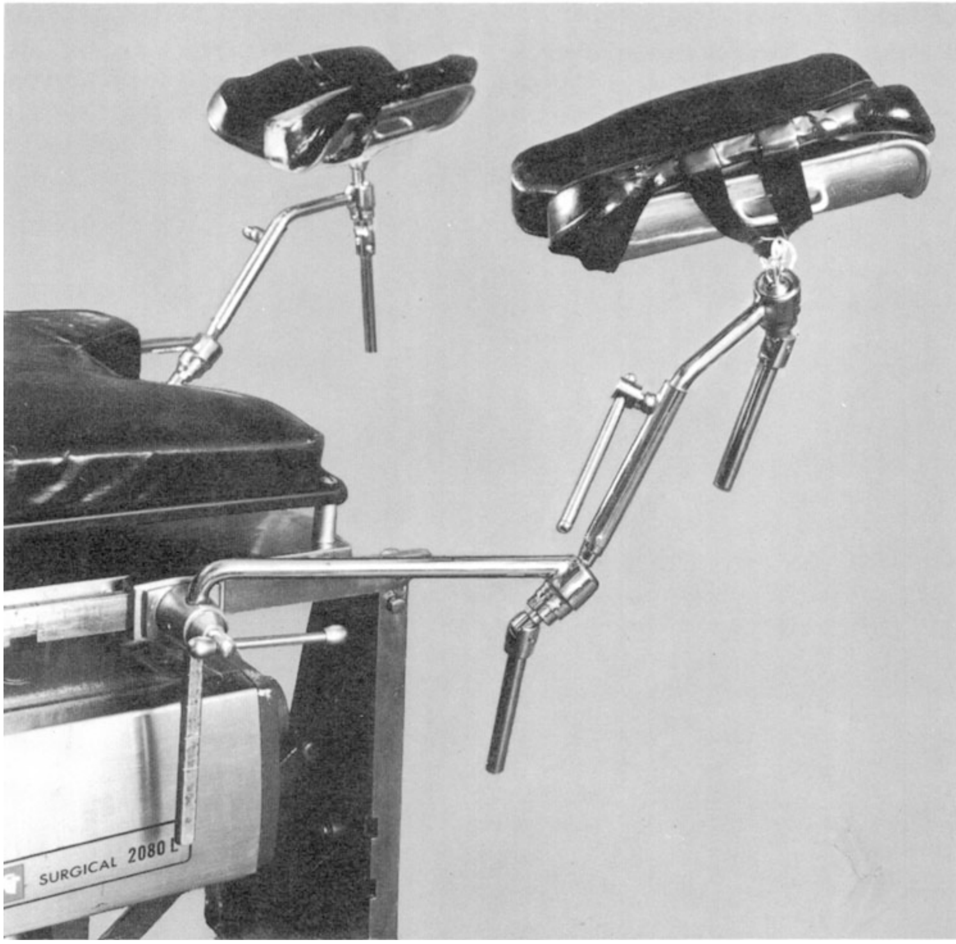


Fig. D–15 Lloyd-Davies leg rests.

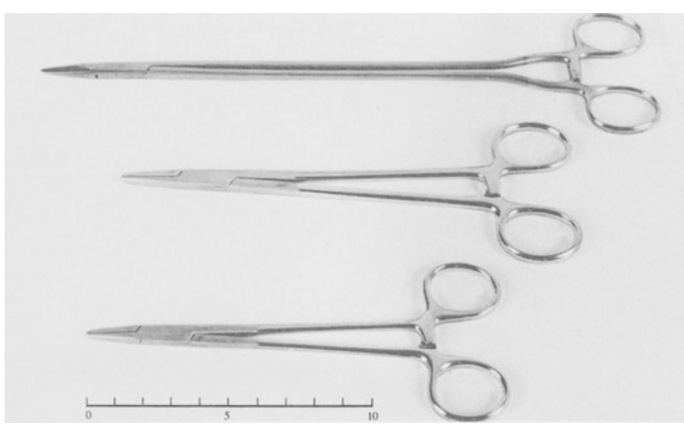


Fig. D–16 Needle-holders, straight.

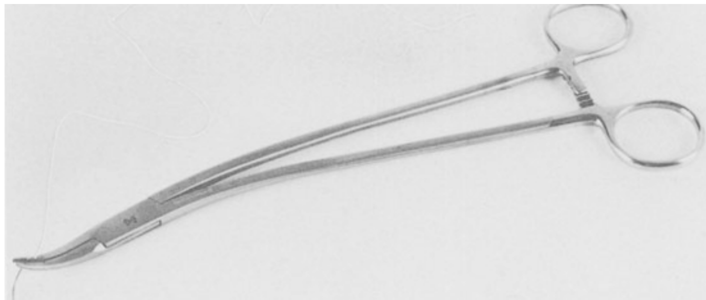


Fig. D–17 Needle-holder, Stratte.

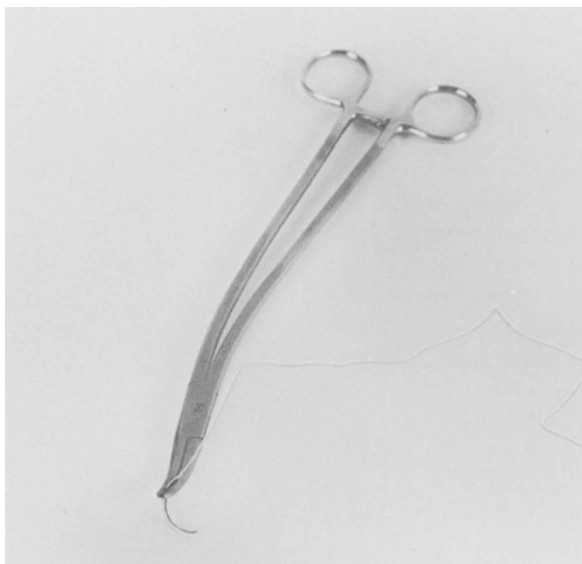


Fig. D–18 Needle-holder, Stratte, grasping an atraumatic suture.

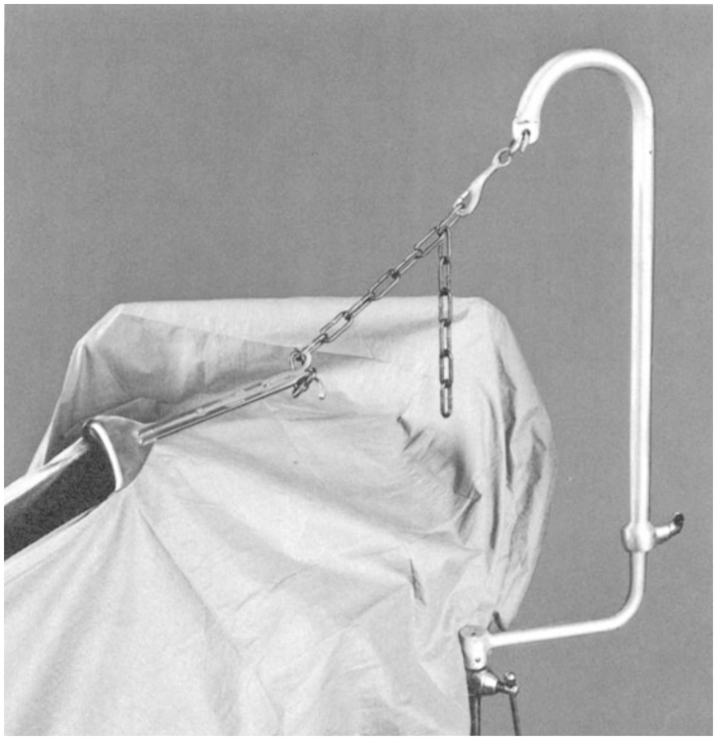


Fig. D-19 Retractor—"chain."

Fig. D-20 Retractor, Gelpi.

Fig. D-21 Retractors, Hill-Ferguson.

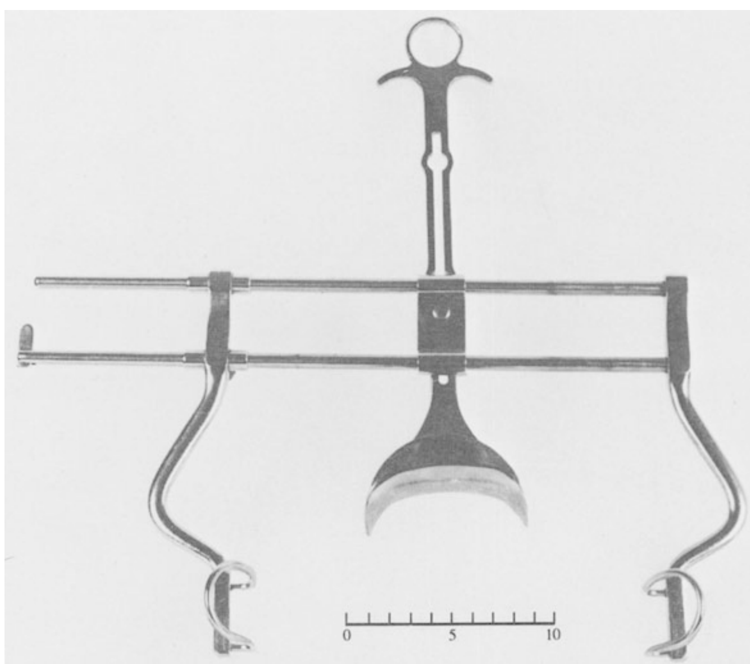


Fig. D-22 Retractor, self-retaining—Balfour.

Fig. D-23 Retractor, self-retaining—Farr.

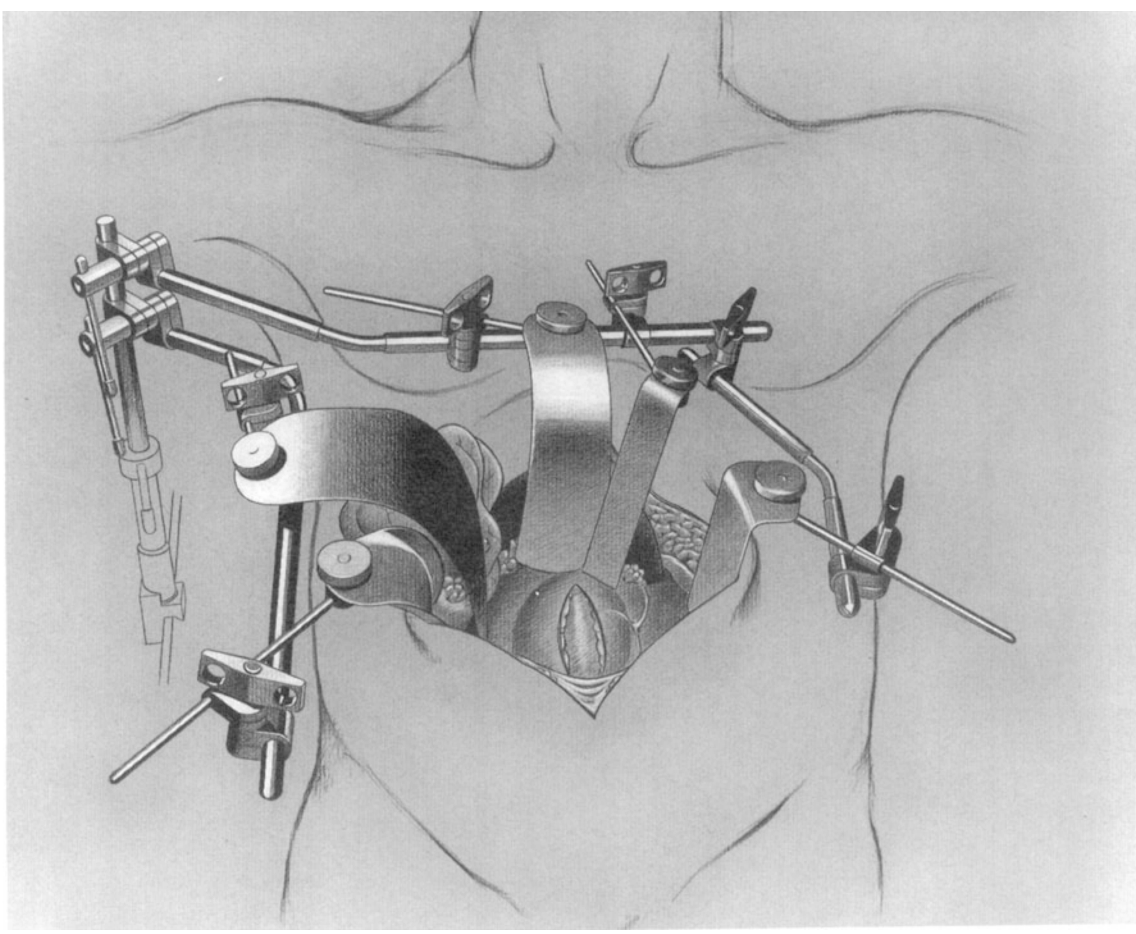


Fig. D-24 Retractor, Thompson.

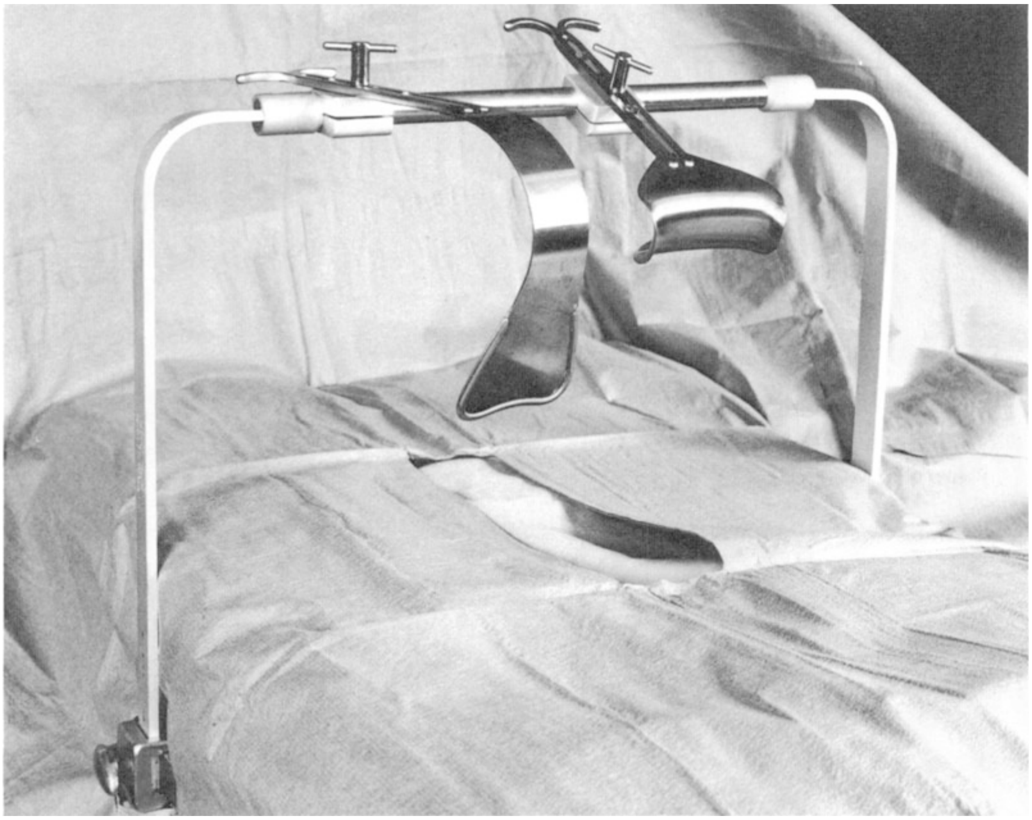


Fig. D-25 Retractor — Upper Hand.

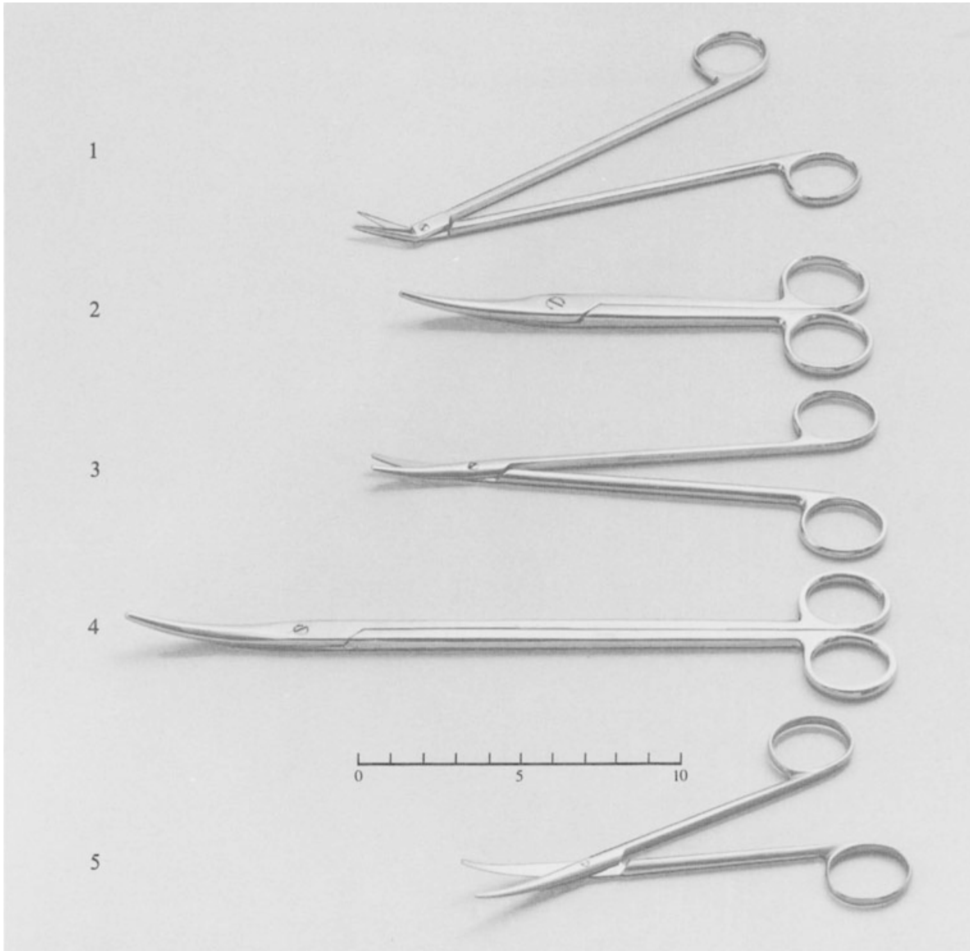


Fig. D–26 Scissors – Potts (1), Mayo (2), and Metzenbaum (3, 4, and 5).

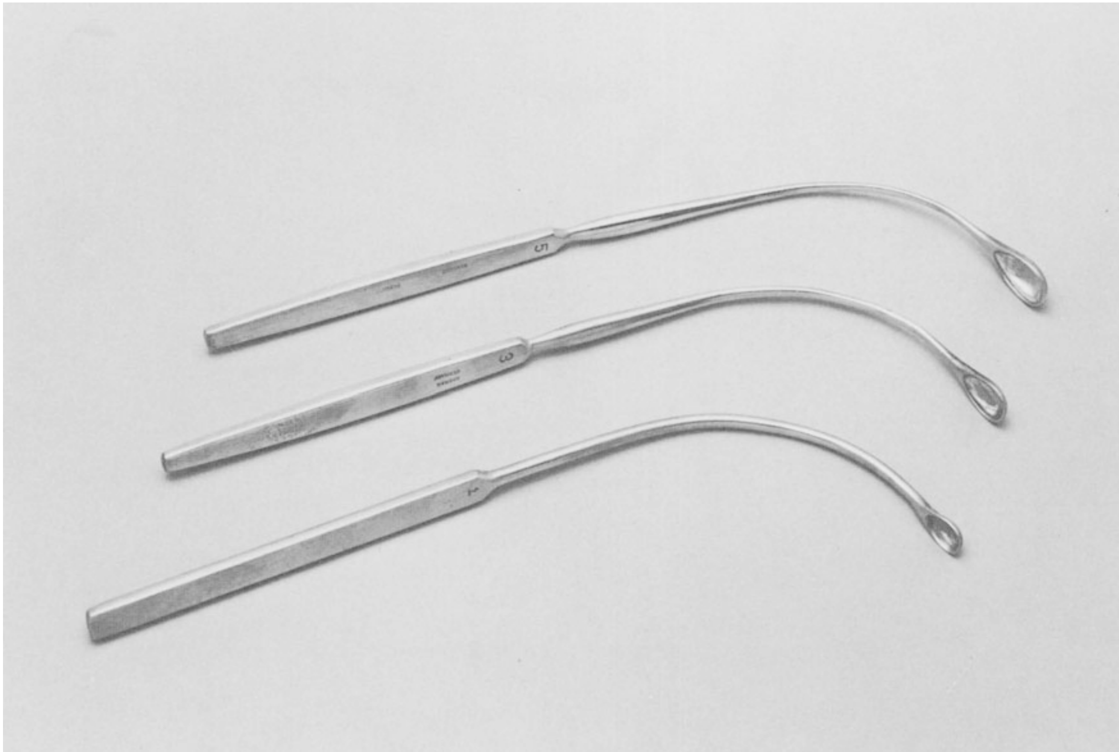


Fig. D-27 Scoops, Pituitary.

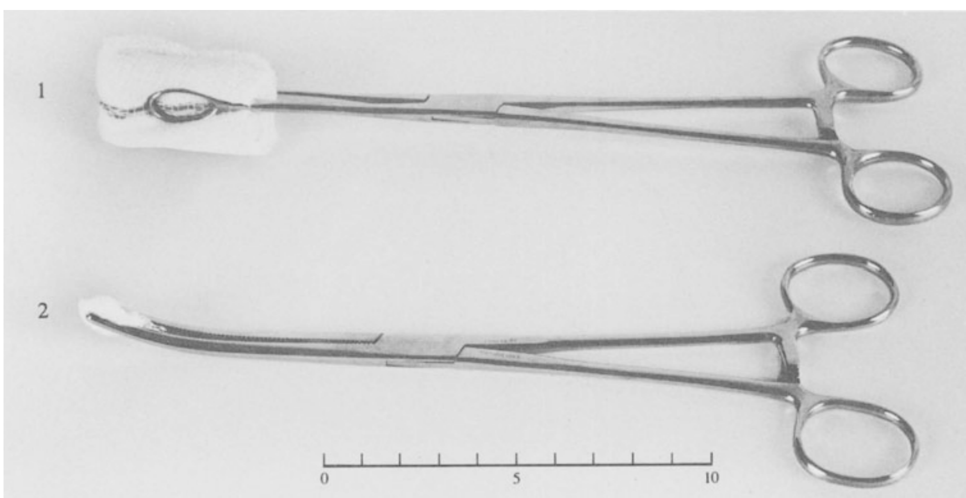


Fig. D-28 Sponge-holder with 10 × 10 cm gauze square (1); peanut-sponge (Kuttner) dissector (2).

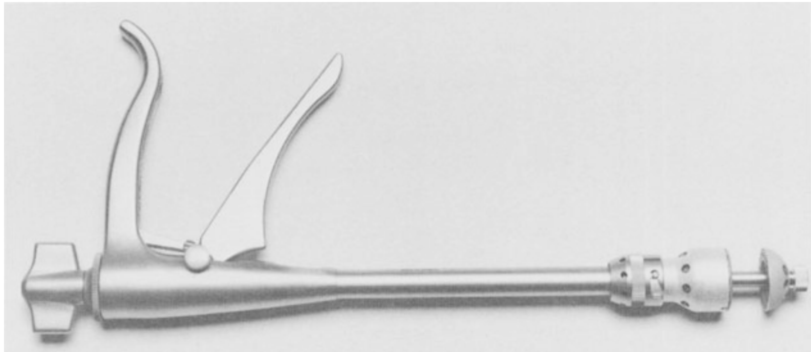


Fig. D–29 Stapler, Auto Suture, EEA.

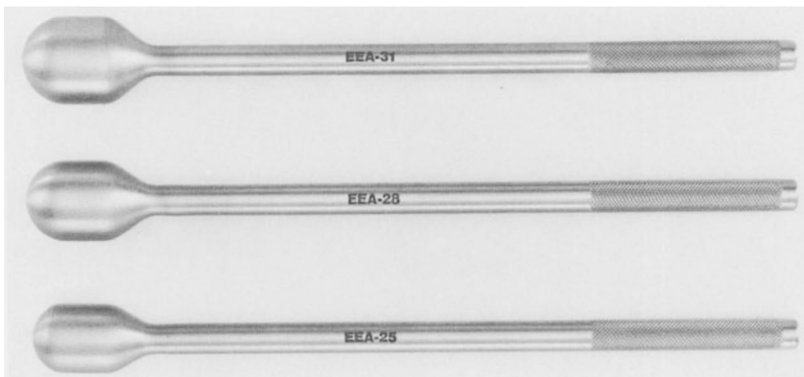


Fig. D–30 Stapler, Auto Suture, EEA sizers.

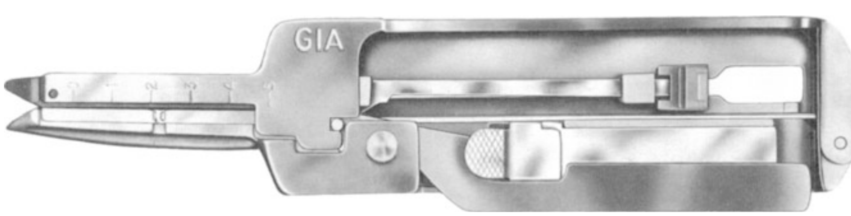


Fig. D–31 Stapler, Auto Suture, GIA.

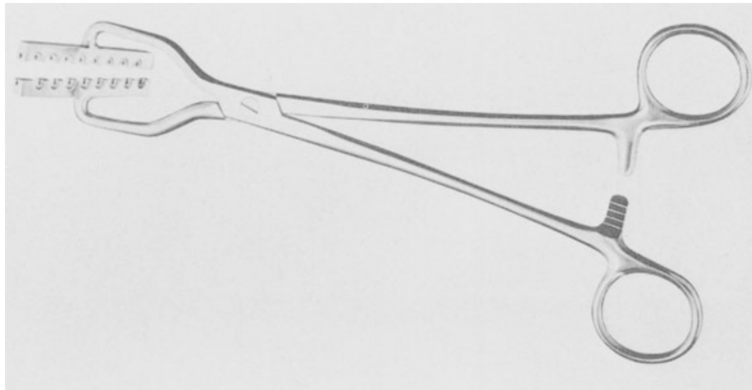


Fig. D-32 Stapler, Auto Suture, purse-string instrument.

Fig. D-33 Stapler, Auto Suture, skin stapler.

Fig. D-34 Stapler, Auto Suture, TA-55.

Fig. D-35 Stapler, Auto Suture, TA-90.

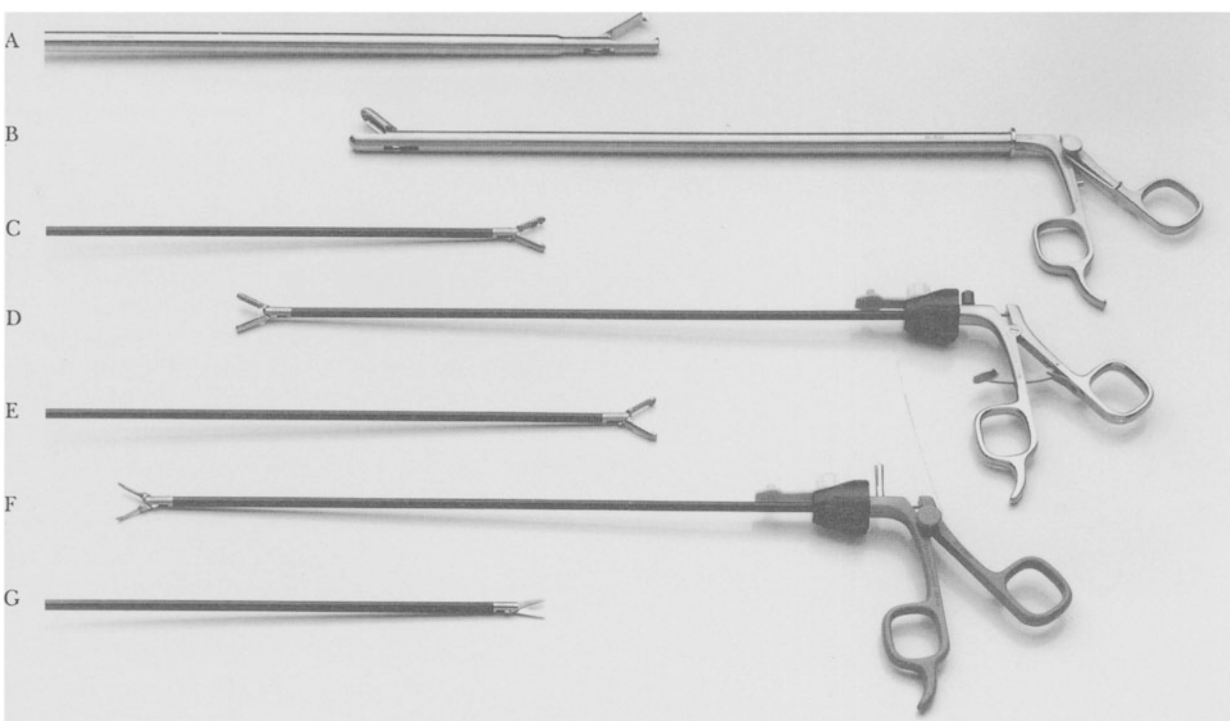


Fig. D-36 Videoscopic (laparoscopic) cholecystectomy instruments. A-Claw to grasp and remove gallbladder from the abdominal cavity. B-Large-mouth stone forceps. C, D, E, F, G-Various shapes of grasping and dissecting forceps.

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