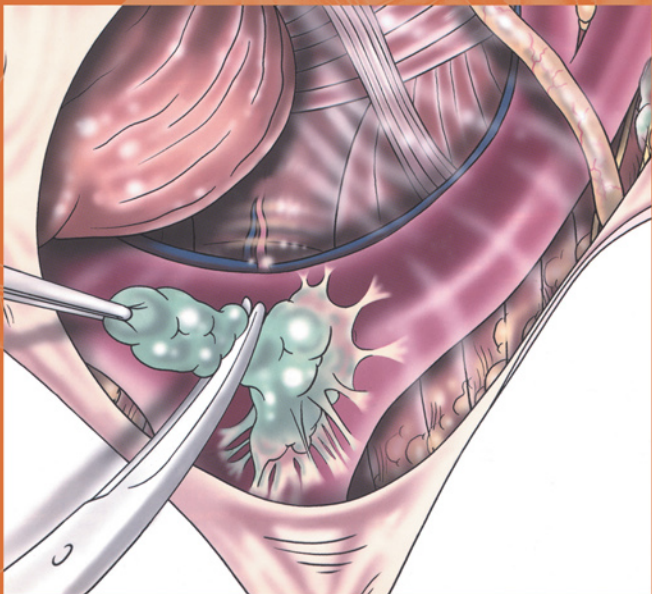
An Atlas of Gynecologic Oncology

Investigation and Surgery



J Richard Smith, Giuseppe Del Priore
John Curtin and John M Monaghan

MARTIN DUNITZ

An Atlas of **Gynecologic Oncology**

To Mr Tom Lewis and Dr Bruce A Barron, whose friendship was responsible for bringing the editors together

JRS

To my family—from the smallest latest joyous addition, to the oldest and wisest, some departed, and in the center of them all, my wife, Men-Jean Lee

GDP

An Atlas of **Gynecologic Oncology**

Edited by

J Richard Smith,
MB ChB, MD, FRCOG
Consultant and Honorary Senior Lecturer in Gynaecology
Co-Director of Gynaecologic Oncology
Imperial College School of Medicine
Chelsea and Westminster Hospital
London, UK
Visiting Associate Professor of Gynecology
New York University School of Medicine
New York, USA

Giuseppe Del Priore
MD, MPH, FACOG
Chief of Gynecologic Oncology
Bellevue Hospital
Assistant Director of Gynecological Oncology
New York University School of Medicine
New York, USA

John Curtin,
FACOG, MD
Gynecologist/Oncologist
Department of Gynecological Oncology
Memorial Sloan-Kettering Hospital
New York, USA

John M Monaghan
MB ChB, FRCS(Ed), FRCOG
Senior Lecturer in Gynaecological Oncology
University of Newcastle upon Tyne
Northern Gynaecological Oncology Centre
Queen Elizabeth Hospital
Gateshead, UK

With artwork by **Dee McLean**
Joanna Cameron

Martin Dunitz

First published in the United Kingdom in 2001
by Martin Dunitz Ltd, The Livery House,
7–9 Pratt Street, London NW1 0AE

This edition published in the Taylor & Francis e-Library, 2005.

A CIP record for this book is available from the British Library.

ISBN 0-203-41954-5 Master e-book ISBN

ISBN 0-203-44478-7 (Adobe eReader Format)
ISBN 1 85317 490 4 (Print Edition)

Distributed in the United States by:

Blackwell Science Inc.

Commerce Place, 350 Main Street

Maiden, MA 02148, USA

Tel: 1–800–215–1000

Distributed in Canada by:

Login Brothers Book Company

324 Salteaux Crescent

Winnipeg, Manitoba, R3J 3T2

Canada

Tel: 204–224–4068

Distributed in Brazil by:

Ernesto Reichmann Distribuidora de Livros, Ltda

Rue Coronel Marques 335, Tatuape 03440–000

São Paulo

Brazil

Composition by Scribe Design, Gillingham, Kent

Contents

Contributors

Richard R Barakat MD
Gynecology Service
Department of Surgery
Memorial Sloan-Kettering Cancer Center
1275 York Avenue
New York, NY 10021, USA
Mark Bower, PHD, MRCP
Department of Medical Oncology
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Deborah CM Boyle, MB ChB, DFFP
Department of Obstetrics and Gynaecology
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Jane Bridges, MB chB, MRCOG
Department of Obstetrics and Gynaecology
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Carmel J Cohen, MD
Gynecologic Oncology
Obstetrics, Gynecology and Reproductive Science
Mount Sinai Medical Center
One Gustave L Levy Place
New York, NY 10029–6574, USA
Peter G Cordeiro, MD, FACS

Plastic and Reconstructive Surgery Service
Memorial Sloan-Kettering Cancer Center
1275 York Avenue
New York, NY 10021, USA
David J Corless, MD, FRCS
Department of Surgery
Leighton Hospital
Middlewich Road
Crewe CW1 4QJ, UK
Jonathan A Cosin, MD
Obstetrics, Gynecology and Women's Health
University of Minnesota Medical School
Box 395
420 Delaware Street SE
Minneapolis, MN 55455, USA
John Curtin, MD, FACOG
Department of Gynecological Oncology
Memorial Sloan-Kettering Hospital
1275 York Avenue
New York, NY 10021, USA
Daniel Dargent MD
Gynécologic Obstétrique
Hôpital Edouard Herriot
Place d'Arsonval
F-69437 Lyon Cedex 03, France
Peter A Davis, MA, MChir, FRCS
Department of Surgery
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Giuseppe Del Priore, MD, MPH
Gynecologic Oncology
New York University Medical Center
550 First Avenue
New York, NY 10016, USA
Jeffrey M Fowler, MD
Division of Gynecologic Oncology
Ohio State University College of Medicine
1654 Upham Drive, 5th Floor Means Hall

Columbus, OH 43210, USA
Jeremiah Healy, MA, MRCP, FRCR
Department of Imaging
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Paul Hilton, MD, FRCOG
Department of Gynaecology
Royal Victoria Infirmary
Newcastle upon Tyne NE1 4LP, UK
Michael Höckel, MD, PhD
Universitätsfrauenklinik
Triersches Institut
Philipp-Rosenthal-Strasse 55
D-04103 Leipzig, Germany
Karl A Illig MD
Division of Vascular Surgery
University of Rochester Medical Center
601 Elmwood Avenue, Box 652
Rochester, NY 14642, USA
Ian J Jacobs, MD, MRCOG
Department of Gynaecological Oncology
St Bartholomew's Hospital
London EC1A 7BE, UK
Andrew Lawson, FANZCA, FFARACS, FFARCSI, DA
Magill Department of Anaesthesia
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Charles Levenback MD
Gynecologic Oncology
MD Anderson Cancer Center
University of Texas
1515 Holcombe Boulevard
Houston, Texas 77030, USA
Werner Lichtenegger MD
Universitätsklinikum Charité
Medizinische Fakultät der Humboldt-Universität
Augustenburger Platz 1

D-13353 Berlin, Germany
Roland Matthews, MD
Division of Gynecologic Oncology
Department of Obstetrics and Gynecology
State University of New York Science Center
450 Clarkson Avenue
Box 24
Brooklyn, NY 11203, USA
Usha Menon, MD, MRCOG
Department of Gynaecological Oncology
St Bartholomew’s Hospital
London EC1A 7BE, UK
John Monaghan MBChB, FRCS(Ed), FRCOG
Northern Gynaecological Oncology Centre
Queen Elizabeth Hospital
Sheriff Hill
Gateshead, Tyne and Wear NE9 6SX, UK
Farr R Nezhat, MD
Obstetrics and Gynecology
1176 Fifth Avenue, Suite 1
New York, NY 10029, USA
David Oram, FRCOG, DObst RCOG
Department of Gynaecological Oncology
St Bartholomew’s Hospital
London EC1A 7BE, UK
Kenneth Ouriel, MD
Vascular Surgery, Desk S61
The Cleveland Clinic Foundation
9500 Euclid Avenue
Cleveland, OH 44195, USA
Simon Padley, BSC, MRCP, FRCR
Department of Imaging
Chelsea and Westminster Hospital
369 Fulham Road
London SW 10 9NH, UK
Marie Plante, MD
Gynecology Service
L’Hôtel-Dieu de Québec
Laval University

11 côte du Palais
Quebec City, Quebec, Canada G1R 2J6
Michel Roy, MD
Gynecology Service
L'Hôtel-Dieu de Québec
Laval University
11 côte du Palais
Quebec City, Quebec, Canada G1R 2J6
Michael Seckl, PhD, MRCP
Medical Oncology
Hammersmith Hospital
Du Cane Road
London W12 OHS, UK
Eileen M Segreti, MD, FACOG
Gynecologic Oncology
Department of Obstetrics and Gynecology
Medical College of Virginia
Virginia Commonwealth University
Richmond, VA 23298–0034, USA
J Richard Smith, MBChB, MD, FRCOG
Department of Obstetrics and Gynaecology
Chelsea and Westminster Hospital
369 Fulham Road
London SW10 9NH, UK
Laszlo Ungars MD
Department of Obstetrics and Gynecology
St Stephen's Hospital
3 Hazmam Street
Second District
Budapest 1025, Hungary

Acknowledgments

Mr Smith would like to thank Mrs Christine Pietraszewska, Dr Charles J Lockwood, Chief of Obstetrics and Gynecology at NYU Medical Center and Professor PJ Steer, Professor of Obstetrics at Chelsea and Westminster Hospital.

Dr Del Priore would like to thank Dr Charles J Lockwood for providing an academic environment where this and other projects could flourish.

Preface

This book has been written primarily for postgraduates involved in the surgical management of gynaecological malignancy: this includes both trainers and trainees. It is pictorial in nature and includes a full description of the majority of investigative and surgical procedures required in the repertoire of the gynaecological oncologist.

The book is intended to fill a gap in gynaecological sections of both your own collection and your library The bulk of the text relates to surgery and gives clear written and pictorial instruction. These chapters have been written by well-known and respected surgeons and their fellows, all of whom are authorities on their subjects. The book is very much an international collaboration, with authors from the USA, the UK, France and Germany.

Whilst there are a plethora of practical texts relating to general gynaecology, there are few specific to gynaecological oncology; of these, this is the only one to be produced in colour and to include an investigative section.

The investigative chapters pull together investigations performed by ourselves and by colleagues from other disciplines, the sections on computed tomography, magnetic resonance imaging, cystoscopy and stenting being previously accessible only in radiological or urological texts. The chapter on genetic and other screening methods for ovarian cancer provides insight into a rapidly expanding area within the subspecialty.

This text is not disease-based, and so no chapter relates specifically to endometrial cancer. Approaches to this malignancy differ, but all the possible radical elements of treatment (eg, nodal dissection, laparoscopically assisted vaginal hysterectomy, etc) are included in chapters here.

The text is deliberately short, with only essential references and further reading. Much emphasis is placed on the illustrations, all the work of one team of artists to maintain clarity and continuity of presentation. The radiological and endoscopic sections include photographs with line drawings to aid clarity.

This book is therefore very much designed as a practical guide to investigation and surgery—a ‘cook book’. We hope you, the reader, will obtain as much from reading it as we have derived from producing it.

J Richard Smith
Giuseppe Del Priore
John Curtin
John M Monaghan

1
Introduction

J Richard Smith

Giuseppe Del Priore

This chapter reviews three specific areas relevant to virtually all surgical procedures and surgeons, namely infection prophylaxis, deep venous thrombosis prophylaxis and universal precautions: the latter facilitate the protection both of surgeons and their assistants, both medical and nursing, and of patients.

Infection prophylaxis

Most gynaecology units now routinely use antibiotic prophylaxis prior to major surgery. In the absence of such prophylaxis, abdominal hysterectomy is complicated by infection in up to 14% of patients, and following vaginal hysterectomy, infection rates of up to 38% have been reported (Sweet and Gibbs 1990). This results in much morbidity, increased length of hospital stay, increased prescribing of antibiotics and a large financial burden. The risk factors for postoperative infection are shown in Table 1. By its very nature, oncological surgery carries greater risks of infection than routine gynaecological surgery, owing to the length of the procedures and increased blood loss.

Table 1 Risk factors for postoperative infection

1.	Hospital stay for more than 72 hours before surgery
2.	Prior exposure to antimicrobial agents in the immediate preoperative period
3.	Morbid obesity
4.	Chronic illness, e.g. hypertension, diabetes
5.	History of repeated infection
6.	Prolonged operative procedure (>3 hours)
7.	Blood loss in excess of 1500 ml

It is difficult to compare many of the studies on prophylaxis, as diagnosis and antibiotic regimens are not standardized. However, there seems to be general agreement that approximately 50% of infections are prevented in this way and that the potential dangers of increased microbial resistance do not justify withholding prophylaxis. Prophylaxis is thought to work by reducing, but not eradicating, vaginal flora. The antibiotic used, its dose and the duration of therapy do not appear to influence results. It is therefore suggested that short courses of antibiotics should be used, involving a maximum of three doses. First-generation cephalosporins, broad-spectrum penicillins and/or metronidazole are all reasonable choices on grounds of efficacy and cost. Antibiotic prophylaxis should not detract from good surgical technique, with an emphasis on strict asepsis, limitation of trauma and good haemostasis. This should be coupled with adequate drainage of body cavities, where particularly blood and also lymph are likely to pool postoperatively.

Prevention and treatment of thromboembolic disease

Thromboembolic disease (TED) is a significant cause of morbidity and mortality in gynaecologic oncology patients. If sensitive methods of detection are employed and no preventive measures are taken, at least 20% and as many as 70% of gynaecologic cancer patients may have some evidence of thrombosis. In certain situations, such as with a long-term indwelling venous catheter of the upper extremity, nearly all patients will have some degree of TED, though it may not be clinically significant. On the other hand, lower extremity TED has a much more certain and clinically significant natural history. Venous thromboses below the knee may spread to the upper leg in approximately 10–30% of cases or resolve spontaneously in approximately 30%. Once the disease has reached the proximal leg, the risk of pulmonary embolism (PE) increases from less than 5% for isolated below-the-knee TED, to up to 50% for proximal TED. The mortality rate for an undiagnosed PE is high. Up to two-thirds of patients who die from pulmonary embolism do so in the first 30 minutes after diagnosis. Early recognition and effective treatment can reduce this mortality; however, postoperative TED is still a leading cause of death in gynaecologic oncology patients. Despite the considerable data on the consequences of TED, only one-third of hospitalized high-risk patients receive appropriate prophylaxis.

Prevention and risk assessment

Patients may be considered for prevention of TED based on their clinical risk category. Laboratory tests such as euglobulin lysis time do correlate with the risk of TED but are no more helpful than clinical risk assessment in selecting patients for prophylaxis. Low-risk patients are young (less than 40 years old), undergoing short operative procedures (less than 1 hour) and do not have coexisting morbid conditions such as malignancy or obesity that would elevate the risk of TED. Moderate-risk patients include those undergoing longer procedures, older or obese patients, and patients having pelvic surgery. High-risk patients include otherwise moderate-risk patients who have cancer and those with a previous history of TED. Positioning for vaginal surgery lowers the risk of TED when compared with the abdominal approach.

All patients should have some form of TED prevention. Low-risk patients, with an incidence of approximately 3% for TED, may be adequately protected with early ambulation, elevation of the foot of the bed, and graduated compression stockings. ‘Early ambulation’ has been defined by some investigators as walking around the nursing station at least three times within the first 24 hours. Graduated compression stockings are readily available; however, ensuring their proper application and size can be difficult. Obese patients may suffer from a ‘tourniquet’ effect if the stocking rolls off the thigh; this may actually increase the risk of TED, not prevent it.

Moderate-risk patients include the majority of general gynaecology patients and have an approximate 10–40% chance of developing TED. These patients should receive the same measures as low-risk patients with the addition of low-dose unfractionated low molecular weight heparin (LMWH), 5000 units subcutaneously twice a day. An alternative to the administration of heparin is the application of pneumatic compression devices to the lower extremities. High-risk category patients require even more measures owing to the estimated 40–70% risk of TED.

The vast majority of gynaecologic oncology cases will fall into the high-risk category. Standard unfractionated heparin (UH) is ineffective in these cases in low doses, such as 5000 units twice daily. If given three times daily, UH is effective but no better than pneumatic calf compression. Unfortunately, more frequent dosing is associated with significantly more wound haematoma formation and blood transfusions. It also requires additional nursing and pharmacy personnel time, and is more uncomfortable for the patient. These may be some of the reasons why only a minority of surgeons regularly use UH prophylaxis. Unfortunately, although compression devices are effective in gynaecologic oncology patients, the devices are somewhat cumbersome, and are disliked by patients and nursing staff. In fact, improper application of the devices occurs in approximately 50% of patients on routine inpatient nursing stations. Compression devices are also contraindicated in patients with significant peripheral vascular disease.

The LMWHs have many potential advantages over the previously cited alternatives. These include excellent bioavailability, allowing for single daily dosing. This reduces nursing effort and therefore cost, and may be better accepted by the patient. This form of prophylaxis is also associated with less thrombocytopenia and postoperative bleeding. Patients with UH-associated thrombocytopenia will usually tolerate LMWH without difficulty. In summary, in extremely high-risk patients such as gynaecologic patients, LMWH may be more efficacious, more cost-effective and less toxic than the alternatives.

Many other agents have been tried in an attempt to overcome the imperfections of existing options. All have limitations and are not used routinely; however, all are effective to some degree and may be appropriate in highly selected patients. Some of these agents include aspirin, warfarin and high molecular weight dextran. In comparison with LMWH, aspirin results in more bleeding complications and is less effective than the heparin in preventing TED. Warfarin has a prophylactic effect similar to aspirin, but again is less effective than heparin and is associated with a higher risk of complications and requires more intensive monitoring. Dextrans are effective but have been associated with rare cases of allergic reactions. Other complications reported include fluid overload and nephrotoxicity. Further research to avoid some of these limitations may improve the therapeutic value of these alternatives.

The duration of prophylaxis has traditionally been limited to the duration of hospital stay. In many older studies, when health care was less cost-conscious, this may have been several days to weeks. Lengths of stay are now much shorter and as a result, so is the duration of TED preventive measures. Even before this forced change in clinical practice, it was recognized that a significant minority of TED either developed or was diagnosed long after discharge from the hospital. The optimal duration of prophylaxis is still not known and depends on the method used. For instance, patients should be instructed to walk every day once discharged from the hospital. Similarly, graduated compression stockings may be worn after surgery until discharge with little risk and possibly some benefit. Some authors also advocate compression stockings to be worn at home following discharge. However, pharmacologic therapies have side effects, may require some training (e.g. self or nurse injections) and are associated with considerable cost in both monitoring and potential toxicity. For these reasons, the optimal method and duration of TED prophylaxis following discharge have not been determined.

The agents discussed above are all designed to prevent TED and thereby reduce the risk of developing a clinically significant pulmonary embolism. When these methods are used properly, most patients will not develop TED and therefore will be at low risk for a pulmonary embolism. However, it is not uncommon for a gynaecologic oncology patient to present with TED as the first manifestation of disease; for instance, it is the presenting symptom in up to 10% of ovarian cancer patients. In these patients, and in those who develop TED despite appropriate prophylaxis, something must be done to prevent the progression to a potentially fatal pulmonary embolism. This becomes especially difficult if the patient requires surgical treatment for the malignancy. One common management technique for these difficult situations is mechanical inferior vena cava interruption. This can be accomplished preoperatively with peripheral venous access and interventional radiologic techniques. Care must be taken to delineate the extent of the clot so that no attempt is made to pass the filtering device through an occluded vein. If peripheral caval interruption is not possible, a vena caval clip may be applied intraoperatively However, large pelvic masses, not uncommon in gynaecologic cancer patients, may prevent access. Additional problems with vena caval interruption include migration of the device, complete occlusion of the cava, perforation and infection. In preoperative cases where the patient cannot have a filter or clip placed, one option is the discontinuation of intravenous UH 1 hour before the perioperative period, with resumption approximately 6 hours after completion of the surgery. Most patients will do well with this technique, but they are still vulnerable to intraoperative pulmonary embolisms. Another pharmacologic option may include the preoperative lysis of the thrombus with thrombolytic agents such as urokinase followed by resumption of standard prophylactic measures. Oral anticoagulation is used after caval interruption, if not contraindicated, to prevent post-thrombotic venous stasis of the lower extremity. Therefore, mechanical devices, while reducing perioperative pulmonary emboli, do not obviate the need for long-term anticoagulation.

Diagnosis

Given the imperfection of prophylaxis and the high risk of TED in gynaecologic oncology patients, all physicians caring for these women should be familiar with the treatment and diagnosis of TED including pulmonary embolism. Fewer than one-third of patients with TED of the lower extremity will present with the classic symptoms of unilateral oedema, pain and venous distension. Homan's sign, calf pain with dorsiflexion of the foot, is also unreliable and is seen in less than half of patients with TED. Calf TED occurs bilaterally in approximately 40% of cases and is more common on the left (40%) than on the right (20%). Only a high index of suspicion and objective testing can correctly identify patients with TED.

In high-risk patients with a high baseline prevalence of TED, sensitive but nonspecific tests are useful owing to their high positive predictive value. To exclude disease in these same high-risk patients, repeat testing on subsequent days or more sensitive techniques are needed. Noninvasive diagnostic testing should always be considered before interventional techniques including venography and arteriography. Lower extremity Doppler and real-time two-dimensional ultrasonography scans are fairly sensitive (85%) and specific (>95%) for TED. If results are positive in high-risk patients, including those with symptoms suggestive of pulmonary embolism, no further testing is indicated and therapy may be initiated. Ventilation-perfusion scans may be used similarly in patients in whom pulmonary embolism is suspected. If the scan indicates an intermediate or high probability of PE, treatment is usually advisable. In patients at higher risk for haemorrhagic complications, such as during the immediate postoperative period where there is residual tumour, confirmatory tests may be indicated before therapy. Pulmonary arteriography may be indicated in this setting, although magnetic resonance arteriography or venography is rapidly becoming the test of choice.

Treatment

If there is no contraindication to anticoagulation, therapy should be started as soon as the diagnosis of TED is made. Outcomes are correlated with the time it takes to achieve therapeutic anticoagulation, so the fastest means available should be employed. Low molecular weight heparin has an advantage over UH in that a single daily dose of approximately 175 units/kg subcutaneously will be therapeutic almost immediately. Unfractionated heparin may require approximately 24 hours and repeated blood testing before becoming therapeutic. Treatment with warfarin can be started once the anticoagulation effect of either heparin is realized. With UH, this may be as early as day 1, although 2–3 days of therapy may be needed before anticoagulation is achieved. With LMWH, warfarin can be started within a few hours, and definitely on the same day. Either heparin should be continued until the warfarin has achieved an International Normalized Ratio (INR) of 2–3. Anti-coagulation with warfarin should continue for at least 3 months. Patients with recurrent TED or persistent precipitating events, e.g. vessel compression by tumour, may need indefinite anticoagulation.

Disseminated cancer and chemotherapy will unavoidably increase the risk of complications from anticoagulation. Cancer patients who have nutritional deficits, organ damage and unknown metastatic sites are particularly vulnerable. Chemotherapeutic agents alter the metabolism of anticoagulants through their effect on liver and renal function, making dosing more difficult. Chemotherapeutic drugs may also share similar toxicities with anticoagulants and thereby worsen haemorrhagic complications from thrombocytopenia and anaemia. For these reasons, treatment of TED may not be desired by the patient nor recommended by her physician in all situations. Thrombosis restricted to the calf may be followed with frequent ultrasonograms in such situations, although the decision to treat is controversial and thus a matter for clinical judgement.

Infection control*

There is increasing awareness of the risks of transmission of blood-borne pathogens from surgeon to patient and vice versa during surgical practice. These risks have been highlighted by the publicity surrounding human immunodeficiency virus (HIV), but are generally greater from other pathogens including hepatitis B virus (HBV). Infection with hepatitis C virus (HCV) also poses a risk of transmission from patient to surgeon. The prevalence of these viral infections varies widely with different populations, and this exerts an influence on the surgeon’s risk, as does the number of needlestick (or sharps) injuries sustained and the surgeon’s immune status. The risks of transmission of these viruses and their subsequent pathogenicity are discussed below. The necessity for universal precautions in surgical practice need not affect overmuch operator acceptability or cost.

Antenatal anonymous surveys have shown a seroprevalence of HIV in metropolitan areas of the UK to be as high as 0.26% (Goldberg et al 1992). Seroprevalence data of women undergoing gynaecological or general surgical procedures are not currently available, but an unlinked anonymous survey of 32 796 London hospital inpatients aged 16–49 years from specialties not usually dealing with illness related to HIV infection has found a seroprevalence of 0.2% (Newton and Hall 1993).

The risk of acquiring HIV from a single needlestick injury from an infected patient is in the region of 0. 10% to 0.36% (Shanson 1992, Ippolito et al. 1993). However, using mathematical models to predict lifetime risks of acquiring the infection in a population with a low HIV seroprevalence (0.35%), it has been suggested that 0.26% of surgeons would seroconvert during their working lives (Howard 1990). If the seroprevalence of HIV infection in surgical patients were as high as 5%, then the estimated 30-year risk of HIV seroconversion for the surgeon might be as high as 6%, depending on the number and type of injuries sustained (Lowenfels et al 1989).

Intact skin and mucous membranes are thought to be effective barriers against HIV Only a very few cases of transmission via skin contamination are known to have occurred, and these health-care workers had severe dermatitis and did not observe barrier precautions when exposed to HIV infected blood (Centers for Disease Control 1987) Aerosol transmission of HIV is not known to occur, and the principal risks are related to injuries sustained from hollow-bore needles, suture needles and lacerations from other sharp instruments. Infectivity is determined by the volume of the inoculum and the viral load within it: thus a hollow-bore needlestick injury carries greater risk than injury from a suture needle. Prior to highly active antiretroviral therapy, infection with HIV results in the acquired immune deficiency syndrome (AIDS) in 50% of patients over a 12-year period and has a long-term mortality approaching 100%. For HIV seropositive surgeons, further operative practice involving insertion of the fingers into the body cavity is precluded owing to the potential risk of doctor-to-patient transmission: for gynaecological surgeons, this encompasses virtually their entire surgical practice, with the exception of simple laparoscopic and hysteroscopic procedures. At present there is no vaccine available to prevent infection with HIV. Should needlestick injury occur, the injured area should be squeezed in an attempt to expel any inoculum, and the hands should be thoroughly washed. There is now good evidence that after exposure prophylactic zidovudine (azidothymidine, AZT) reduces transmission by 79% (Centers for Disease Control 1996). Most occupational health departments now advise their health-care workers to commence treatment within 1 hour of injury with multiple therapy including AZT, indinivir and a pro tease inhibitor, e.g. 3TC (lamivudine). This type of regimen may well reduce the risks of seroconversion further.

Intraoperative transmission of HBV occurs more readily than with HIV, and exposure of skin or mucous membrane to blood from a hepatitis B e antigen (HBeAg) carrier involves a highly significant risk of transmission for those who are not immune. The risk of seroconversion following an accidental inoculation with blood from an HBeAg carrier, in the absence of immunity, is in the order of 35% (Bradbeer 1986). Hepatitis B surface antigen (HBsAg) is found in 0.5–1% of patients in inner cities and in 0.1% of patients in rural areas and blood donors. Given a needlestick rate of 5% per operation, the risk of acquiring the virus in a surgical lifetime is potentially high. Prior to the introduction of HBV vaccination an estimated 40% of American surgeons became infected at some point in their careers, with 4% becoming carriers. Acute infection with HBV is associated with the development of fulminant hepatitis in approximately 1% of individuals. Carriers may go on to develop chronic liver damage, cirrhosis or hepatocellular carcinoma, carrying an overall mortality of approximately 40%.

Transmission of HBV from infected health-care workers to patients is rare but well documented. Welch et al (1989) reported a case of an infected gynaecologist who transmitted HBV to 20 of his patients; the operations carrying greatest risk of infection were hysterectomy (10/42) and caesarean section (10/51). In view of this risk government guidelines in most countries stipulate that surgeons should be immune to HBV, either through natural immunity or vaccination, the exceptions being staff who fail to respond to the vaccine (5–10%) and those who are found to be HBsAg positive in the absence of 'e' antigenaemia ([UK] Advisory Group on Hepatitis 1993). In the UK, the USA and other countries this is a statutory obligation. Those who fail to respond to vaccination should receive hepatitis B immunoglobulin following needlestick injury where the patient is HBV positive.

Hepatitis C virus, the commonest cause of non-A non-B hepatitis in the developed world, is also known to be spread by blood contamination. Routine screening for antibodies amongst blood donors in the UK has shown that 0.05% were seropositive in 1991; many of these were seemingly healthy asymptomatic carriers. However, as many as 85% of injecting drug users may be seropositive. Antibodies to HCV were detected in 4.3% of 599 pregnant women screened anonymously in a North American inner city (Silverman et al 1993). In the UK, infection with HCV is second only to alcohol as a cause of cirrhosis, chronic liver disease and hepatocellular carcinoma, although the clinical course in seemingly healthy individuals is unclear.

A recent anonymous seroprevalence study of staff at an inner London teaching hospital reported that infection with HCV was no higher than that previously seen in blood donors. The seroprevalence was no different for workers involved with direct clinical exposure (medical and nursing staff) compared with those

---

* This section is adapted from *Br J Gynaecol Obstet* (1995) **102**:439–41.

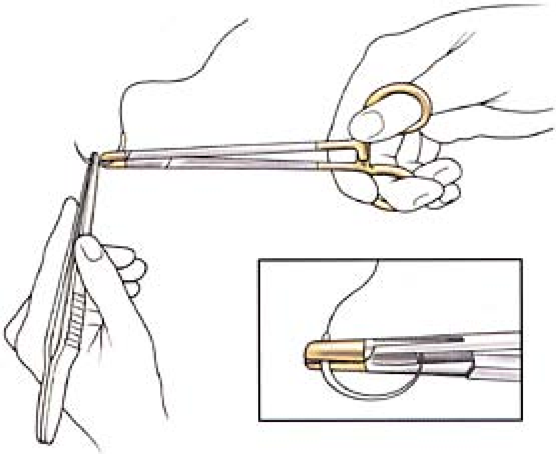


Figure 1

Safety needle holder

at risk of indirect clinical exposure (laboratory and ancillary staff) (Zuckerman et al 1994). However, these findings should not lead to complacency. From epidemiological data, it would appear that HCV infection is less contagious than HBV, but more so than HIV The possibility of HCV infection should be considered in the event of needlestick injury. Immunization and postexposure prophylaxis are not available for those exposed to HCV.

Prevention of blood-borne infection

Some surgeons have advocated preoperative screening of patients for HIV infection. They argue that patients shown to be infected should be treated as high-risk, while the remaining patients would be labelled as low-risk, with the consequent development of a two-tier infection control policy. However, such an approach is fraught with political, ethical, logistical and financial implications and, furthermore, wrongly assumes that infected patients can always be identified by serological testing. The universal precautions suggested below are practicable, and effectively minimize the intraoperative infection risk of both surgeon and patient. These precautions are based on the procedure rather than the perceived risk status of the patient. As discussed above, the greatest risk of contracting a blood-borne pathogen is from needlestick injury. Vaginal hysterectomy has been shown to have the highest rate (10%) of needlestick injury of any surgical procedure (Tokars et al 1991). Glove puncture has been used as a measure of skin contamination and a reflection of needlestick injury; the highest rate of glove puncture reported in any surgical procedure was 55% at caesarean section (Smith and Grant 1990). Double gloving has shown a 6-fold diminution in inner glove puncture rate, and anecdotally appears to result in a reduction in needlestick injury, but it is uncomfortable, particularly during protracted procedures, making it unsuitable for many gynaecologic oncological operations. Blunt-tipped needles, such as the Protec Point (Davis & Geck, Gosport, UK) and Ethiguard (Ethicon, Edinburgh, UK), appear to reduce the rate of glove puncture, and one of the authors (JRS) has never sustained a needlestick injury in 8 years of continuously using these needles. The newer needles are capable of penetrating the majority of tissues including uterine muscle, vaginal vault, cervix, peritoneum and rectus sheath. They are unsuitable for bowel and bladder surgery and do not penetrate skin, but they have been used subcutaneously for abdominal wound closure. Abdominal skin closure can also be safely undertaken with the use of staples. This is particularly important since it has been shown that 5% of glove punctures occurred during this stage of the procedure (Smith and Grant 1990). Just under half of punctures occur in the right hand (Smith and Grant 1990)—a surprising finding considering that most surgeons are right-handed and therefore grasp the needleholder with the dominant hand. Injury appears to occur during knot tying, and a safety needleholder with provision for guarding the needle tip at this stage and when returning the needle to

Table 2 Risk factors for transmission of blood-borne pathogens during surgical practice

1.	Prolonged surgical procedure
2.	Heavy blood loss
3.	Operating within a confined space, e.g. pelvis or vagina
4.	Poor lighting
5.	Guiding the needle by feel

the scrub nurse is now available (Thomas et al 1995) (Figure 1). The use of a kidney dish for passing scalpels between staff should also be encouraged, as should safe needle and blade disposal in hands-free surgical sharps boxes. Blades or needles that have fallen on the floor should be retrieved with a magnet prior to disposal. Blunt towel clips are also available to prevent injury while draping. Reusable self-adhesive drapes are available, as are disposable self-adhesive drapes with a surrounding bag to prevent gross contamination.

Skin and mucous membrane contamination should be avoided by the use of masks and waterproof gowns. Spectacles or other protective eyewear should be worn to prevent contamination by facial splashes of blood and other body fluids.

The risks and safety measures discussed above are summarized in Tables 2 and 3. Table 2 demonstrates that oncological surgery carries the greatest risk

Table 3 Simple precautions available to reduce needlestick injury

1.	Blunt-tipped needles: available from Davis & Geck (Protec Point) and Ethicon (Ethiguard needle)
2.	Staple guns for skin closure: available from Autosuture and Ethicon Endosurgery
3.	Staples for bowel anastomosis: available from Autosuture and Ethicon Endosurgery
4.	Safety needleholders: available from Femcare (Nottingham, UK) and Avalon (Burlington, VT, USA)
5.	Spectacles/protective eyewear
6.	Magnet for picking up sharps
7.	Hands-free disposable sharps boxes for needles and blades
8.	Blunt towel clips
9.	Self-adhesive drapes

These measures are summarized in an educational video produced by the TV Unit at Imperial College School of Medicine, Charing Cross Hospital, St Dunstan's Road, London W6 8RP, UK.

within gynaecological practice. However, the simple and relatively cheap procedures and precautions suggested in Table 3 can reduce the risk for both surgeon and patient to extremely low levels.

Bibliography

Advisory Group on Hepatitis (1993) *Protecting health care workers and patients from hepatitis B.*HMSO: London.

Bradbeer C (1986) AIDS-epidemiology and screening. *Med Internal* **2:**1241–6.

Centers for Disease Control (1987) Update: human immunodeficiency virus infection in health care workers exposed to blood of infected patients. *MMWR* **36:**285–9.

Goldberg DJ, MacKinnon H, Smith R et al (1992) Prevalence of HIV among childbearing women and women having termination of pregnancy: multidisciplinary steering group study. *Br Med J* **304:**1082–5.

Howard RJ (1990) Human immunodeficiency virus testing and the risk to the surgeon of acquiring HIV. *Surg Gynaecol Obstet* **171:**22–6.

Ippolito G, Puro V and De Carli G (1993) The risk of occupational human immunodeficiency virus infection in health care workers: The Italian Study Group on occupational risk of HIV infection. *Arch Intern Med* **153:**1451–8.

Lowenfels AB, Worsmer GP and Jain R (1989) Frequency of puncture injuries in surgeons and estimated risk of HIV infection. *Arch Surg* **124:**1284–6.

Newton L and Hall SM (1993) Unlinked anonymous monitoring of HIV prevalence in England and Wales: 1990–1992. *Common Dis Rep* **3:**1–16.

Shanson DC (1992) Risk to surgeons and patients from HIV and hepatitis: guidelines on precautions and management of exposure to blood or body fluids. (Joint Working Party of the Hospital Infection Society and the Surgical Infection Study Group). *Br Med J* **305:**1337–43.

Silverman NS, Jenkin BK, Wu C et al (1993) Hepatitis C virus in pregnancy: seroprevalence and risk factors for infection. *Am J Obstet Gynecol* **169:**583–7.

Smith JR and Grant JM (1990) The incidence of glove puncture during caesarean section. *J Obstet Gynaecol* **10:** 317–18.

Sweet RL, Gibbs RS (1990) *Infectious diseases of the female genital tract,* 2nd edn. Williams & Wilkins: Baltimore.

Thomas PB, Falder S, Jolly M et al (1995) The role of blunt-tipped needles and a new needle-holder in reducing needlestick injury. *J Obstet Gynaecol* **15:**336–8.

Tokars J, Bell D, Marcus R et al (1991) Percutaneous injuries during surgical procedures (Abstract). *VII International Conference on AIDS*, Florence, Italy.

Welch J, Webster M, Tilzey AJ et al (1989) Hepatitis B infections after gynaecological surgery. *Lancet* **i:**205–7.

West DJ (1984) The risk of hepatitis B among health care professionals in the United States: a review. *Am J Sci* **287:** 26–33.

Zuckerman J, Clewley G, Griffiths P and Cockroft A (1994) Prevalence of hepatitis C antibodies in clinical health-care workers. *Lancet* **343:**1618–20.

2
Anatomy

Werner Lichtenegger

Giuseppe Del Priore

Introduction

Physicians are familiar with general human anatomy and expert in their own regions of specialization. Since gynecologic oncologists are often called upon to perform unique and sometimes infrequent procedures in a variety of regions, a review of the different anatomic areas can be helpful. Of course, gynecologic oncologists will usually be operating in the pelvis or called upon as a consultant to other pelvic surgeons. Therefore, a detailed understanding of pelvic anatomy is essential.

The pelvic fascia and pelvic spaces

Within the space lined by the pelvic fascia lies a mass of subserous tissue which as a whole is termed the tela urogenitalis (Figure 1). The tissue has various functions. It forms the fascia of the pelvic viscera as well as denser tissues conducting blood vessels and nerves from the pelvic wall. Between the pelvic wall, the uterus and the denser tissue lie spaces that are filled with loose connective tissues. These spaces can be opened easily. The anatomic nomenclature includes many different interpretations of the connective tissue structures in the pelvis. These terms include endopelvic fascia, intrapelvic fascia and connective tissue body, neurovascular plate, corpus intrapelvinum, parametrium and broad ligament, and hypogastric sheets. The mass of the connective tissue body originates at the pelvic wall and runs in a transverse direction to the uterus and the vagina. Before reaching it, it gives off one connective tissue sheet to the rectum and one to the bladder. These structures can be distinguished as the uterovaginal pillar, the bladder pillar and the rectal pillar. In a transverse section of the pelvis it resembles a horizontal letter Y, the base of which originates at the pelvic wall and which follows the pelvic axis. The body of the corpus intrapelvinum can originate only from the posterior ascending field of the arcus. Pernkopf took this into account in describing what he called the ‘frontal dissepiment’ as meaning the pelvic wall at the posterior part of the arcus (Figure 2).

A confluence of this connective tissue from the side-wall to the uterus is called the *cardinal ligament* (Figure 3). This is the strongest thickening of the pelvic fascia between the pelvic wall and the uterus. It emits the rectal pillar and the bladder pillar. Only the parametrium actually reaches the supravaginal part of the cervix and therefore the uterus. The paracolpium, the part of the uterovaginal pillar below the level of the ureter, reaches the vagina and the cervix at the level of the vaginal fornix.

The *bladder pillar* from the abdominal view stretches from the body of the corpus intrapelvinum to the bladder. Viewed from the vagina, the distal pillar—which also lies in a sagittal plane—rises to the bladder. The sagittal bladder pillar is also called the vesicouterine ligament. The part of the ligament covering the

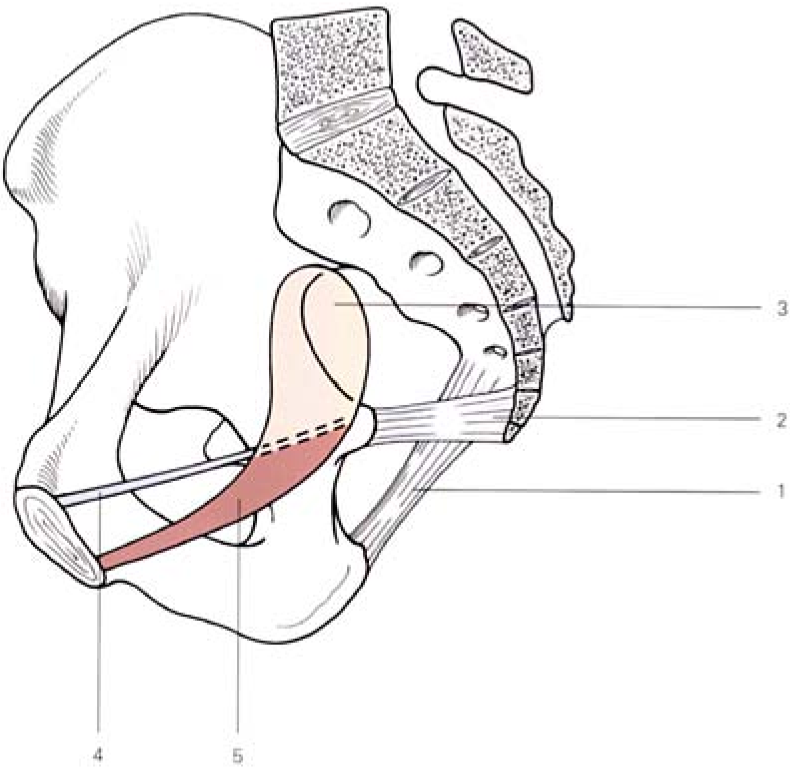


Figure 1

1 Ischiosacral ligament

2 Sacrospinous ligament

3 Origin of cropus intrapelvicum at lateral pelvic side-wall

4 Arcus tendineus levatoris ani

5 Arcus tendineus fasciae pelvis

ureter (the ureteral roof) forms the upper limit of the paracystium. Loose connective tissue lies between the uterus and the wall of the canal of the ureter. This tissue contains the blood supply and has been called the mesoureter.

The *rectal pillar* (uterosacral) spans the distance from the dorsal of the cardinal ligament to the sacrum. The upper portion represents the sagittal rectal pillar. The sagittal rectal pillar does not lie in a sagittal plane, but deviates far laterally to accommodate the pouch of Douglas. This brings it very close to the pelvic wall. The rectouterine ligament splits into an anterior leaf which emits the rectal fascia and a posterior leaf which reaches the sacrum at the level of anterior sacral foramina II–IV. The insertion at the sacrum can extend upward beyond the sacral promontory (Figures 3 and 4).

The *paravesical space* is limited medially by the vesical fascia and the bladder pillar which enters it. Laterally it reaches to the parietal pelvic fascia and medially and anteriorly it merges into the prevesical space. The major pelvic vessels lie in the lateral margin. Posteriorly it is limited by the body of the corpus intrapelvinum and the uterine artery in the cardinal ligament. The roof of the paravesical and prevesical

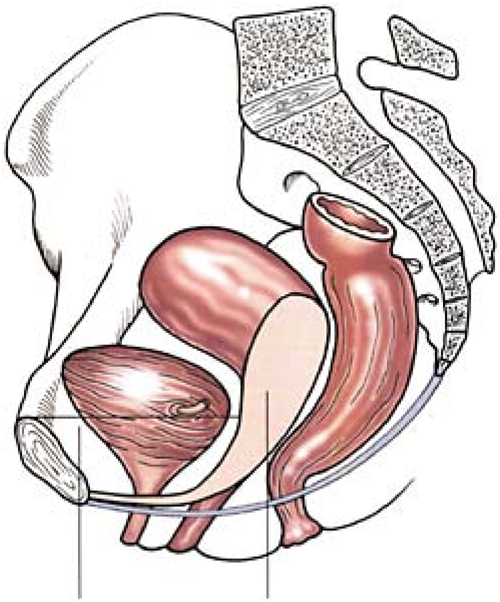


Figure 2

1 Corpus intrapelvicum

2 Arcus tendineus levatoris ani

space is formed by the vesico-umbilical fascia, which forms a vertical plane at the anterior abdominal wall at the horizontal plane in the pelvis.

The *pararectal space* is limited medially by the rectal fascia and the rectal pillar and laterally by the parietal pelvic fascia. After being opened from the abdomen, the pararectal space is narrow, because the rectal pillar lies close to the pelvic wall. The space is best demonstrated by pulling the uterus anteriorly so that the rectal pillar is lifted off the pelvic wall. The retrorectal/presacral space lies behind the rectum and is limited by rectal fascia and the parietal pelvic fascia. The retrorectal space is separated from the pararectal spaces by the part of the rectal pillar that joins the pelvic sacral foramina II–IV.

Between the vaginal and rectal fascia lies the *recto-vaginal space*. It reaches caudally to the centrum tendinum. Superiorly it is limited by the peritoneum of the pouch of Douglas. Laterally the space is limited by the rectal pillars.

The *vesicocervical* and *vaginal spaces* are limited by the vesical fascia and the cervix. They reach the peritoneum and are inferiorly separated by the septum supravaginale. The *vesicovaginal space* reaches caudally the origin of the urethra and lies between the bladder pillars.

Vascular supply

Most vessels that are encountered during oncologic procedures can be interrupted without consequence owing to a rich collateral circulation (Figures 5, 6, 7). However, whenever possible, vessels should be spared to promote healing and optimize chemotherapy and radiation therapy treatments. Certain vessels, such as the superior mesenteric artery, can never be interrupted without reanastomosis. Care must be

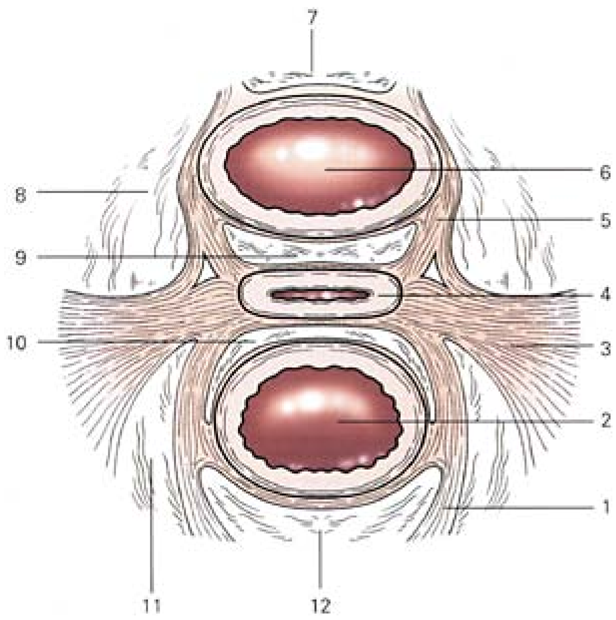


Figure 3

1 Uterosacral ligament

2 Rectum

3 Cardinal ligament

4 Vagina

5 Bladder pillar

6 Urinary bladder

7 Prevesical space

8 Paravesical space

9 Vesicovaginal space

10 Rectovaginal space

11 Pararectal space

12 Retrorectal space

exercised around these structures, as blood vessels are not entirely consistent in their course or points of origin.

Some helpful guidelines for locating these vessels include bony, cutaneous and muscle relationships. For instance, the aortic bifurcation often occurs over the fourth lumbar vertebra which, in thin individuals is at the level of the umbilicus. The renal vessels originate around the second lumbar vertebra. The gonadal arteries arise just inferiorly to these at the third lumbar vertebral body, around the level of the third part of the duodenum. The duodenum is also helpful in identifying the superior mesenteric artery, which leaves the

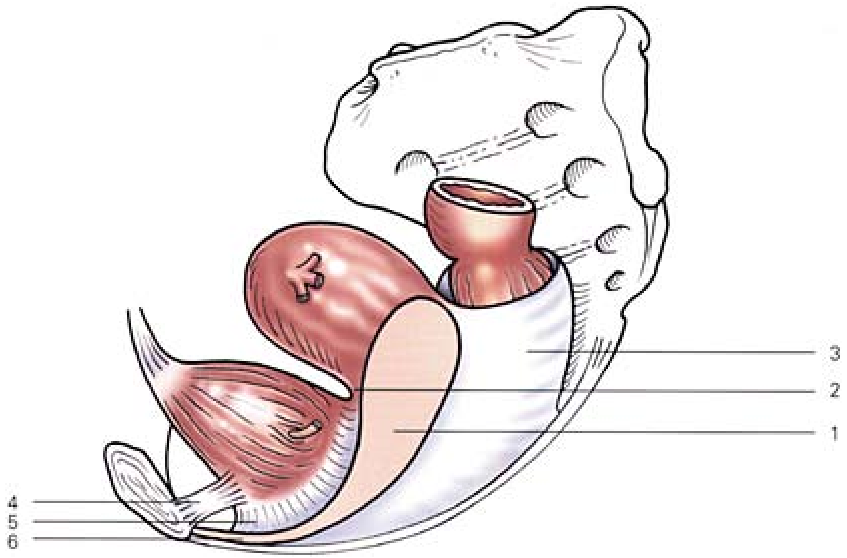


Figure 4

1 Origin of connective tissue, detached at lateral pelvic wall

2 Cardinal ligament

3 Uterosacral ligament

4 Pubovesical ligament

5 Laterovesical ligament

6 Arcus tendineus fasciae pelvis

aorta immediately cephalad to the third part, and the inferior mesenteric artery, which leaves the aorta just caudad to this same duodenal section. The gonadal veins, on the other hand, are asymmetric, with the left vein emptying into the left renal vein.

Lymphatic drainage parallels the course of the venous blood supply. However, drainage is not always as straightforward as the blood supply. Lymph node metastases can obstruct flow and lead to retrograde metastases, which appear to skip regional chains. For instance, some uterine fundal cancers can have isolated para-aortic lymph node spread.

Nerve supply

There are few procedures that require the dissection of nerves in gynecologic oncology. Nevertheless, the general course and function of many nerves should be known in order to avoid injury to them and minimize surgical complications (Figure 8). The larger nerves are sometimes used as landmarks during surgical dissections: for instance, the obturator nerve may serve as the near-to-inferior border of the pelvic lymphadenectomy and the phrenic nerve as the posterior border of the scalene node dissection.

At the very beginning of a surgical procedure, the nervous system anatomy should be considered in the proper positioning of the patient to avoid injury. For instance, because laparoscopy requires that the surgeon be further cephalad than during the same procedure done by laparotomy, both arms should be tucked at the

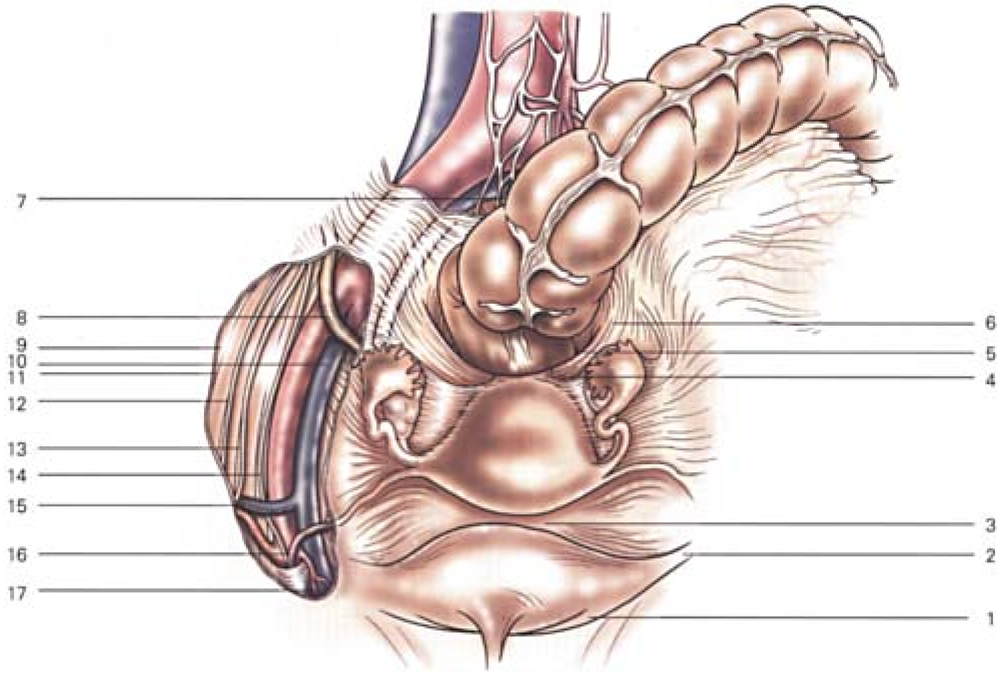


Figure 5

1 Paravesical fossa

2 Transverse vesical fold

3 Uterovesical pouch

4 Rectovesical pouch

5 Sacrogenital fold of uterosacral ligament

6 Pararectal fossa

7 Superior hypogastric plexus

8 Ureter

9 Psoas muscle

10 Internal iliac artery

11 Iliohypogastric nerve

12 Ilioinguinal nerve

13 Lateral femoral cutaneous nerve

14 Genitofemoral nerve

15 Circumflex iliac artery

16 Round ligament inserting into internal inguinal ring

17 Inferior epigastric artery

patient's side to avoid excessive superior traction on the brachial plexus by the surgeon leaning on the

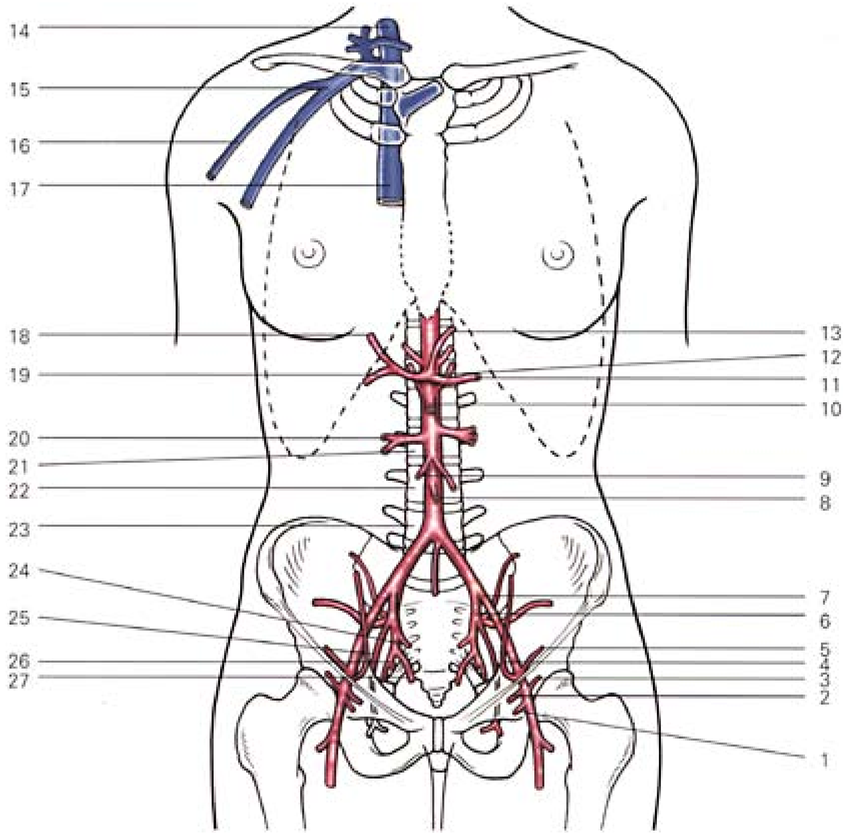


Figure 6

1 External pudendal artery
2 Superficial epigastric artery
3 Superficial circumflex iliac artery
4 Inferior epigastric artery
5 Deep circumflex iliac artery
6 Internal iliac artery
7 External iliac artery
8 Inferior mesenteric artery
9 Gonadal artery
10 Superior mesenteric artery
11 Splenic artery
12 Coliac trunk
13 Left gastric artery
14 Internal jugular vein
15 Subclavian vein
16 Cephalic vein
17 SVC
18 Hepatic artery
19 Gastroduodenal artery
20 Renal artery
21 L2
22 L3
23 L4
24 Inferior rectal artery
25 Obturator artery
26 Internal pudendal artery
27 Uterine artery

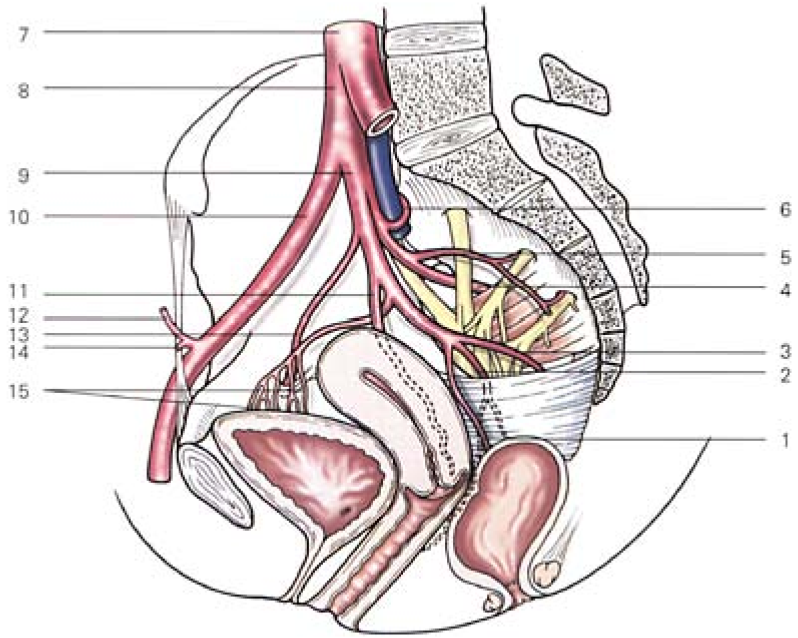


Figure 7

1 Middle rectal artery

2 Internal pudendal artery

3 Inferior gluteal artery

4 Superior gluteal artery

5 Lateral sacral artery

6 Iliolumbar artery

7 Aorta

8 Common iliac artery

9 Internal iliac artery

10 External iliac artery

11 Uterine artery

12 Circumflex liliac artery

13 Obturator artery

14 Inferior epigastric artery

15 Superior vesical

extended arm. During vaginal procedures, an assistant unfamiliar with the course of the femoral nerve might rest an arm on the patient's medial anterior thigh and compress the femoral nerve. This nerve may also be injured by an abdominal retractor placed too deeply over the psoas muscle. Finally, some of the

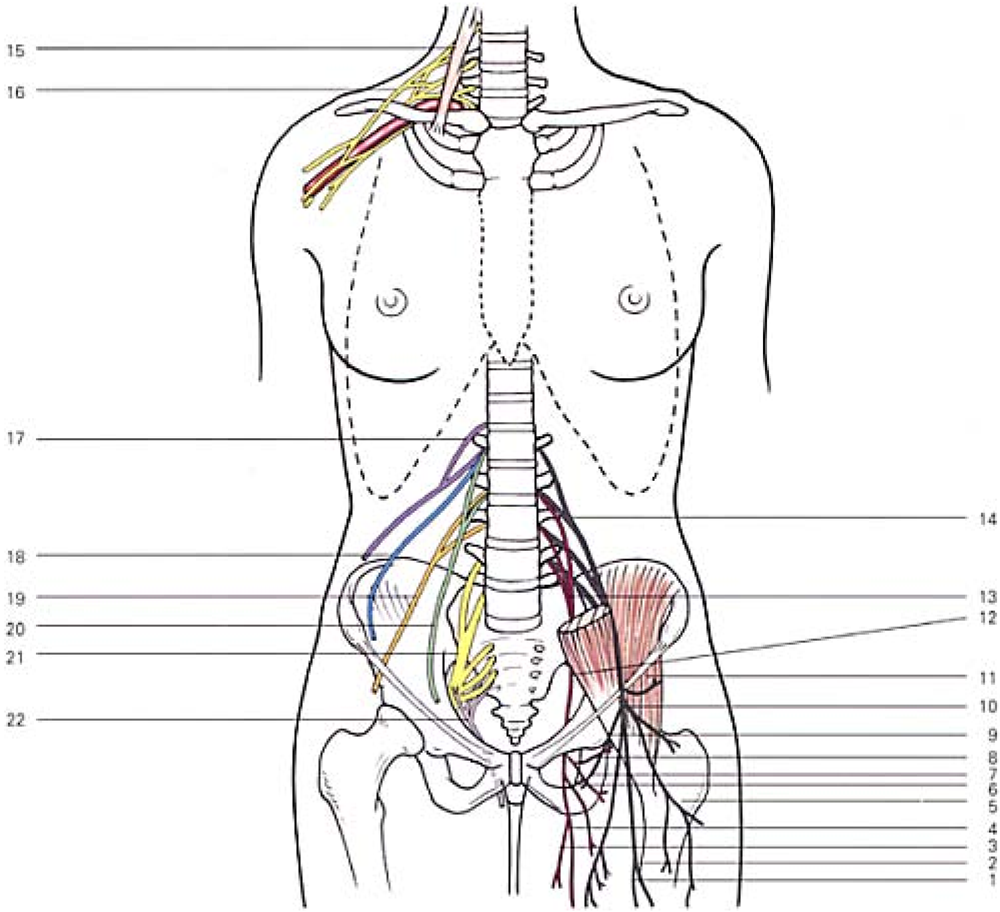


Figure 8

1 Articularis genus nerve
2 Vastus intermedius nerve
3 Gracialis nerve
4 Adductor magnus nerve
5 Vastus lateralis nerve
6 Adductor longus nerve
7 Adductor brevis nerve
8 Pectineus nerve
9 Obturator externus nerve
10 Sartorius nerve
11 Rectus femoris nerve
12 Obturator nerve near fossa
13 Obturator nerve
14 Femoral nerve
15 Scalene muscle
16 Brachial plexus
17 Iliohypogastric nerve
18 Ilioinguinal nerve
19 Lateral cutaneous fenoral
20 Genitofemoral nerve
21 Sciatic nerve
22 Pudendal nerve

smaller nerves, such as the genital femoral nerve, may be transected during the removal of suspicious lymph nodes.

Femoral nerve injury results in decreased hip flexion and leg extension due to the loss of the iliacus, rectus femoris, vastus lateralis, intermedius and medialis, and sartorius muscle function. Injury to the obturator nerve results in loss of leg adduction and pronation from loss of the adductor brevis, longus and magnus, as well as obturator externus and gracilis muscle innervation. The sciatic nerve is not usually injured during surgical procedures but can be compromised by cervical cancer spread to the lateral pelvic wall, causing significant pain. Pain, secondary to cancer or postoperative, can be controlled in the pelvis by regional anesthetic blockade of the dorsal nerve roots of T10, T11, and T12 to the uterus tubes and ovary, and S2, S3 and S4 to the remaining genital structures (see Chapter 22).

Muscles

Many of the cutaneous landmarks used in planning gynecologic surgery are made up of the borders of the superficial muscles (Figures 9 and 10). In some of the reconstructive procedures discussed in this book, the muscles are the primary focus of the procedure. For the most part, however, they are structures to be retracted or transected. Nevertheless, they are helpful in identifying related anatomical structures, and therefore should be familiar to the operating surgeon.

One useful relationship is that between the rectus abdominis muscle and the epigastric vessels. When performing laparoscopy, it is best to place the lateral trocars completely lateral to these muscles to be sure of avoiding the epigastric vessels. This also makes operating easier by keeping the instruments as far apart as possible. It is this relationship with the 1epigastrics that makes the rectus an ideal vascular pedicle flap for reconstructive procedures. The gracilis muscle is also a suitable pedicle flap, but because it is more variable, the rectus is preferred for perineal reconstruction.

The muscles of the abdominal cavity are infrequently involved in either the disease process or the operative procedure in gynecologic oncology. However, they do serve as borders for lymph node dissections. For instance, the middle of the psoas muscle marks the lateral extent of the pelvic lymphadenectomy and the internal obturator muscle does the same for the obturator space lymphadenectomy. The muscles of the proximal lower extremity are similarly used as landmarks in the inguinofemoral dissection (see Figures 3–5, Chapter 15). During a scalene node biopsy, the dissection is carried to the surface of the scalenus anterior muscle between the sternocleidomastoid and the trapezius muscles (Figures 9, 10).

Bony and cutaneous landmarks

Bony and cutaneous landmarks are sometimes overlooked by junior operating surgeons in their eagerness to enter the abdomen (see Figure 9). However, more experienced surgical oncologists will recognize their value in planning successful gynecologic oncology procedures. For instance, gaining central venous access always begins with determination of the location of the distal third of the clavicle or the heads of the sternocleidomastoid muscle. Vascular access may also be achieved through a cephalic vein cut-down. This vein is identified by the cutaneous border of the deltoid and pectoralis major muscles. These same landmarks are also useful in initiating a scalene node biopsy. An inguinal node dissection may be performed through different incisions as long as the operator recognizes the relationship of the nodes to the inguinal ligament. Tube thoracostomy and thoracentesis require recognition of the location of the inferior scapula at the seventh and eighth ribs. Finally, although the soft tissue dimensions of the patient are important, the truly

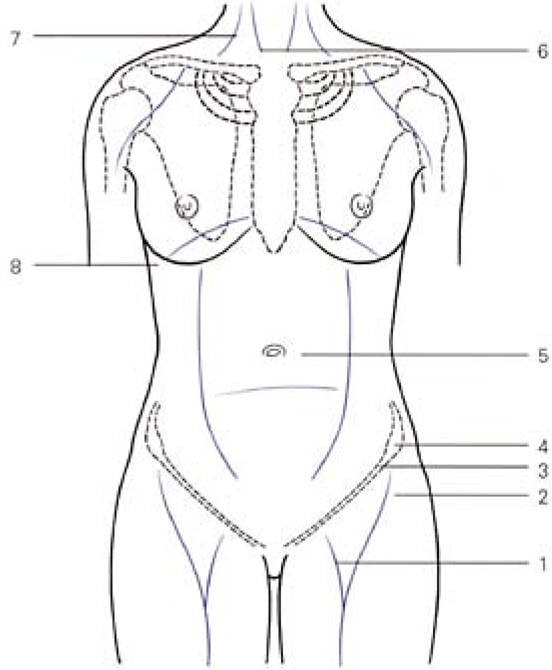


Figure 9

1 Adductor longus groove
2 Sartorius muscle groove
3 Inguinal ligament
4 Anterior superior iliac spine
5 Level of L4/L5 vertebral bodies
6 Sternal head
Clavicular head } sternocleidomastoid muscle
7
8 Seventh rib

limiting factor for most patients is the bony confines of the operative field. For instance, a large patient may have a wide and shallow pelvis, making her an acceptable candidate for a radical hysterectomy. This may be determined before the incision by noting the distance between the anterior iliac crests in relation to the distance from the crest to the ischial tubercle. Similarly, for vaginal procedures, emphasis should be placed on the distance between the ischial tubercles and the angle of the pubic arch. The best way of assessing the patient preoperatively is by recognizing the significance of the bony and cutaneous landmarks of the operative field.

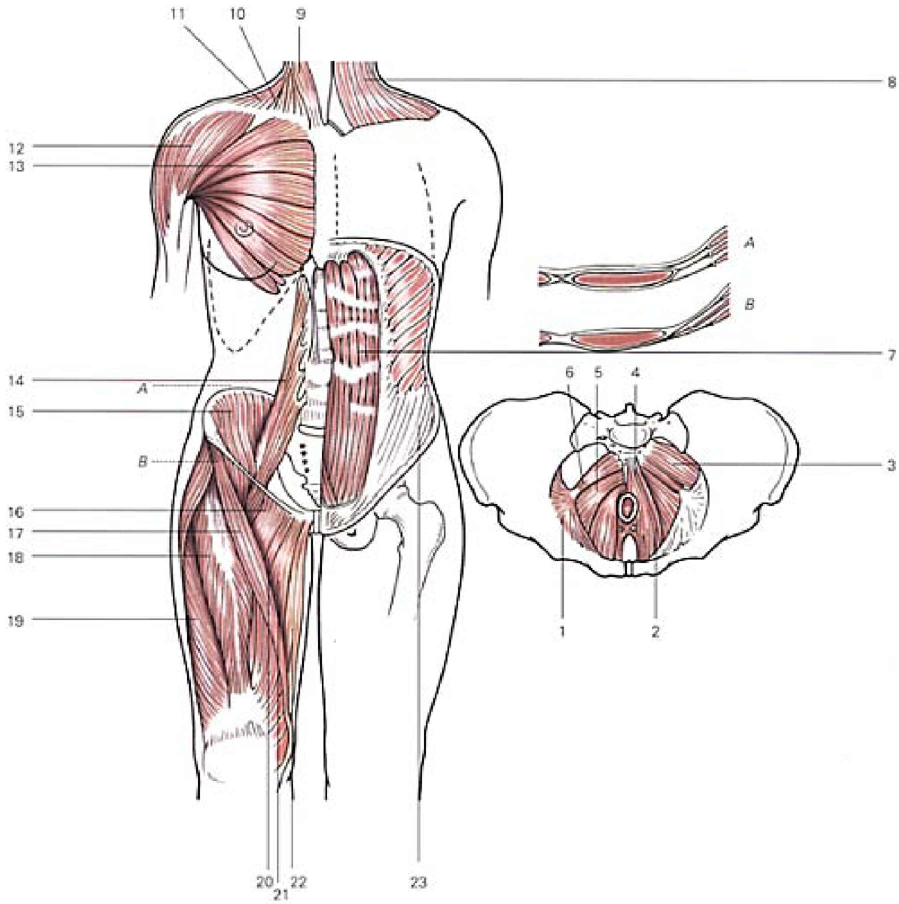


Figure 10

A Transverse level, umbilicus

B Transverse level, arcuate line

1 Obturator internus

2 Puborectalis

3 Piriformis

4 Pubococcygeal muscle

5 Iliococcygeal muscle

6 Coccygeus

7 Rectus abdominis

8 Platysmus

9 Sternocleidomastoid muscle

10 Anterior scalene muscle

11 Trapezius

11 Trapezius

12 Deltoid

13 Pectoralis major

14 Psoas

15 Iliacus

16 Pectineus

17 Sartorius

18 Rectus femoris

19 Adductor brevis

20 Adductor longus

21 Vastus lateralis

22 Gracilis

23 Anterior superior iliac spine

Bibliography

Amreich I (1958) Zusammenhänge zwischen normaler und chirurgischer Anatomie des Beckenbindegewebes der Frau , *Klin Med* **13:**443.
Pernkopf E (1943) *Topographische Anatomie des Menscben*, 2nd edn, Berlin: Urban and Schwarzenberg.
Richter K (1985) Spezielle Gynäkologie 1. In: Ober KG, Thomsen K, eds, *Gynäkologie und Gerburtsbilfe*, vol. III/1, 2nd edn, Stuttgart: Thieme.
Richter K, Frick H (1985) Die Anatomie des Fascia pelvis visceralis aus didaktischer Sicht, *Geburtshilfe Frauenbeilkd* **45:**275.

3
Tumour markers

Usha Menon

Ian J Jacobs

Since the description of Bence Jones proteins well over a century ago, a variety of substances have been investigated as potential tumour markers. However, the term ‘tumour marker’ remains ill defined. Broadly it can be taken to mean any change that indicates the presence of cancer. In this context, morphological change in exfoliated cervical cells is one of the leading tumour markers in clinical use. Colposcopy uses nuclear density changes and neovascularization as tumour markers, while colour flow Doppler focuses on the latter. The rapid growth of molecular biology techniques, flow cytometry and chromosomal analysis will in the future greatly add to the tests available for detection and monitoring of malignant tumours. However, this review is restricted to serum tumour markers, i.e. biological substances produced by malignant tumours which enter the circulation in detectable amounts.

Tumour markers can be broadly classified into tumour-specific antigens and tumour-associated antigens. The idiotypes of immunoglobulins of B cell tumours and certain neoantigens of virus-induced tumours are two examples of strictly tumour-specific antigens. The vast majority of tumour markers are in reality tumour-associated antigens. In many cases, they were initially described as being highly tumour-specific, but subsequent studies have revealed their presence in multiple cancers and in normal adult or fetal tissues.

On the basis of size, tumour-associated antigens can be divided into low molecular weight tumour markers (mol.wt_r<1000) and macromolecular tumour antigens (Suresh 1996). The former include some nucleosides, lipid-associated sialic acid, polyamines and other metabolites. However, the macromolecular tumour markers form the largest subgroup and have been most useful in the clinical management of cancer. They can be enzymes, hormones, receptors, growth factors, biological response modifiers or glycoconjugates.

Ideally, tumour markers should be tumour-specific, produced in sufficient amounts to allow detection of minimal disease, and should quantitatively reflect tumour burden. This would enable their use in screening, diagnosis, monitoring response to therapy and detecting recurrence during follow-up. For each use, the value of the marker depends heavily on two parameters—sensitivity and specificity—which must be well established before the marker is adopted into routine clinical practice. Very few tumour markers fulfil these criteria, the main limitation being lack of specificity.

Ovarian and fallopian tube cancers

Epithelial ovarian cancers represent the bulk of ovarian malignancies and numerous serum tumour markers have been investigated in the context of screening, prognosis and monitoring of response and recurrence. The best known among them is cancer antigen 125 (CA125).

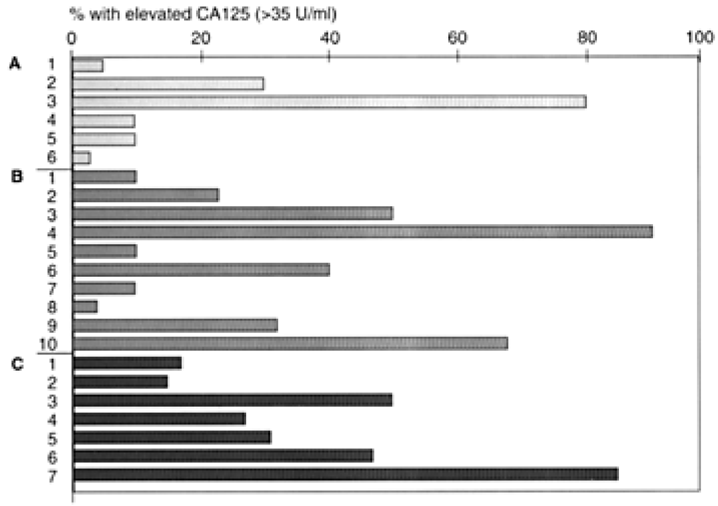


Figure 1

Causes of elevated serum levels of CA125.

A, healthy: 1 premenopausal, 2 menstruation, 3 1st trimester of pregnancy, 4 2nd trimester, 5 3rd trimester, 6 postmenopausal.

B, benign disease: 1 endometriosis grade I, 2 grade II, 3 grade III, 4 grade IV, 5 benign cysts, 6 acute pelvic inflammatory disease, 7 fibroids, 8 chronic pancreatitis, 9 acute pancreatitis, 10 cirrhosis.

C, malignant disease: 1 breast, 2 colon, 3 pancreas, 4 lung, 5 stomach, 6 liver, 7 ovary.

CA125

Cancer antigen 125 is an antigenic determinant on a high molecular weight glycoprotein recognized by the murine monoclonal antibody OC125, which was raised using an ovarian cancer cell line as an immunogen (Bast et al 1981). It is expressed by amnion and coelomic epithelium during fetal development. In the adult, it is found in structures derived from coelomic epithelium (the mesothelial cells of the pleura, pericardium and peritoneum) and in tubal, endometrial and endocervical epithelium. Curiously, the surface epithelium of normal fetal and adult ovaries do not express the determinant, except for inclusion cysts, areas of metaplasia and papillary excrescences (Kabawat et al 1983).

The CA125 antigen is still poorly characterized. Cross-inhibition experiments with 26 different monoclonal antibodies have revealed that this antigen carries two major antigenic domains classified as A, the domain binding monoclonal antibody OC125, and B, a domain binding monoclonal antibody M11 (Nustad et al 1996). Immunoassays for quantitation of serum CA125 levels are now usually based on a heterologous assay (CA125 II) with two different monoclonal antibodies (M11 and OC125), replacing the original homologous assay done with monoclonal antibody OC125 alone. The CA125 II assay is sensitive and reliable for measuring serum CA125, and fully retains the cut-off values of 35 U/ml and 65 U/ml that were defined with the original CA125 immunoradiometric assay (Kenemans et al 1993).

The serum value of 35 U/ml, representing 1% of healthy female donors, is widely accepted as the upper limit of normal (Bast et al 1983). It should be noted that this is an arbitrary cut-off which may not be ideal for some applications of CA125. For example, in postmenopausal women or in patients after hysterectomy

CA125 levels tend to be lower than in the general population, and lower cut-off points may be more appropriate (Alagoz et al 1994, Bon et al 1996). Approximately 83% of patients with epithelial ovarian cancer will have CA125 levels greater than 35 U/ml (Bast et al 1983, Canney et al 1984). Unfortunately only 50% of patients with stage I disease have elevated levels, while raised levels are found in over 90% of patients with more advanced disease (Jacobs and Bast 1989). The incidence of CA125 elevation is lower in mucinous, clear cell and borderline tumours (Vergote et al 1987, Jacobs and Bast 1989, Tamakoshi et al 1996). Elevation of serum CA125 levels may also be associated with other malignancies (pancreas, breast, colon, lung) and with benign and physiological states, including pregnancy, endometriosis and menstruation (Jacobs and Bast 1989) (Figure 1). Many of these nonmalignant conditions are not found in postmenopausal women, thereby improving the diagnostic accuracy of an elevated level in this population.

Screening

The role of CA125 in screening for early-stage ovarian cancer is currently under investigation. Like ultrasonography, CA125 measurement does not have sufficient sensitivity or specificity to be a suitable screening test when used in isolation. However, there is good evidence that a multimodal strategy combining CA125 assessment with pelvic ultrasonography in postmenopausal women can achieve encouraging specificity (99.9%), positive predictive value (26.8%) and sensitivity (78.6%) (Jacobs et al 1993). CA125 elevation in apparently healthy postmenopausal women is a powerful predictor of ovarian cancer risk (Jacobs et al 1996). Improvements to the sensitivity of CA125 assay in screening have been achieved by the development of an algorithm which incorporates both the absolute level and rate of rise of CA125 with time (Skates et al 1995, Skates et al 1996). The results of screening studies currently in progress in the UK and in the USA may finally answer the question of the impact of early intervention on ovarian cancer mortality in the general population.

In women with strong evidence of a hereditary predisposition to ovarian cancer, screening using serum CA125 and ultrasound is frequently advocated. This management has yet to be validated scientifically and can be problematic since this population often includes premenopausal women who are more likely than the postmenopausal population to have false positive CA125 and ultrasound abnormalities. In two screening programmes involving 983 women with a family history of ovarian cancer, CA125 was elevated (35 U/ml or more) in 11% of cases. No case of invasive ovarian cancer was detected (Muto et al 1993, Karlan et al 1993). Women in the high-risk population who request screening should be counselled about the current lack of evidence for the efficacy of both CA125 and ultrasound screening and the associated risk of false positive results. Many will still opt for screening despite understanding the risks and limitations.

Differential diagnosis of an adnexal mass

Serum CA125 is of value in the differential diagnosis of benign and malignant adnexal masses, particularly in postmenopausal women. Einhorn et al (1986) measured CA125 levels preoperatively in 100 women undergoing diagnostic laparotomy for palpable adnexal masses, 23 of whom were subsequently found to have a malignancy. Using a cut-off of 35 U/ml, serum CA125 measurements had a sensitivity for malignant disease of 78%, a specificity of 95% and a positive predictive value of 82%. Jacobs et al (1990) combined serum CA125 with ovarian ultrasound and menopausal status to calculate a risk of malignancy index (RMI). Patients with an elevated RMI score had, on average, 42 times the background risk of ovarian cancer. The RMI has subsequently been validated in a prospective study (Tingulstad et al 1996). Numerous studies have since shown that in women with a pelvic mass, determination of CA125 in addition to clinical examination and ultrasonography improves the positive predictive value for ovarian cancer (Curtin et al 1994, Parker et al 1994a, Maggino et al 1994).

Prognosis

In ovarian malignancy, whilst preoperative serum CA125 levels are related to tumour stage, load and histologic grade, initial studies did not find them to be an independent prognostic factor (Makar et al 1992, Venesmaa et al 1994, Scholl et al 1994). Two more recent studies have questioned this view. A retrospective analysis of 114 consecutive patients with epithelial ovarian cancer (Parker et al 1994b) concluded that high serum CA125 levels and low serum albumin levels at diagnosis can be used to identify poor prognostic subgroups, independent of stage. In another retrospective analysis (Nagele et al 1995) the traditional prognostic factors and CA125 levels (cut-off value 65 U/ml) were studied in 201 patients with FIGO stage I invasive epithelial ovarian cancer, treated in five centres during 1984–93. Multivariate analysis identified preoperative CA125 levels as the most powerful prognostic factor for survival, the risk of dying of disease being 6 times higher in patients with CA125 elevation.

Postoperative CA125 levels and measurements taken during chemotherapy have been found to be significant prognostic indicators. It is important to state here that in the immediate postoperative period CA125 levels can be elevated as a result of abdominal surgery (Yedema et al 1993a) and measurements should be postponed until just before chemotherapy is begun. The 5-year survival rate was 75% in 22 patients with a CA125 level below 50 U/ml measured 4 weeks after debulking surgery compared to 10% in 33 patients with a serum CA125 level over 50 U/ml (Davidson et al 1991). Postoperative CA125 levels greater than 35 U/ml in women with no residual disease and 65 U/ml in those with residual disease were found to be independent prognostic factors in 687 patients with invasive epithelial ovarian cancer (Makar et al 1992). A CA125 prognostic score composed of two CA125 values, one determined preoperatively and the other 1 month after surgery, has been described: patients with lower scores had significantly better prognosis than patients with high scores (Rosen et al 1990).

During primary chemotherapy, it is now well documented that serum CA125 half-life (the time for CA125 levels to decline by 50%) is an independent prognostic factor both for the achievement of complete remission and for survival in patients with advanced epithelial ovarian cancer (Yedema et al 1993b, Rosman et al 1994, Gadducci et al 1995a). A CA125 half-life of 20 days is commonly used (Van der Burg et al 1988, Hawkins et al 1989b, Yedema et al 1993a). CA125 levels prior to the third course of chemotherapy predicted survival status at 12 months with an overall accuracy of 93% in 50 patients with advanced epithelial ovarian cancer (Redman et al 1990), a finding confirmed by other researchers (Makar et al 1993a, Gadducci et al 1995a). The slope of the CA125 exponential regression curve was demonstrated to be an independent prognostic indicator of survival in patients with a CA125 positive ovarian carcinoma (Buller et al 1996).

Serum CA125 levels at relapse of invasive epithelial ovarian cancer are also useful in evaluation prognosis. Patients with serum CA125 levels of 35 U/ml or less at relapse had a better prognosis than those with higher values. Among patients with serum CA125 levels higher than 35 U/ml, no difference in survival was observed. On multivariate analysis, the independent prognostic factors for survival were histologic type and serum CA125 level (Makar et al 1993b).

Monitoring response to treatment

Serum CA125 levels reflect progression or regression of disease in more than 90% of patients with ovarian cancer who have elevated preoperative levels (Bast et al 1983, Hawkins et al 1989a). This has led to wide application of CA125 measurements in monitoring clinical course and response to chemotherapy in women with epithelial ovarian cancer (Hempling et al 1993). Several studies have found an elevated CA125 level prior to second-look laparotomy to be a good indicator of persistent disease. However, the overall accuracy is limited to 62–88% as values lower than 35U/ml do not exclude active disease (Jacobs and Bast 1989, Fioretti et al 1992). In patients with advanced-stage epithelial ovarian cancer, 92% of 13 patients with serum CA125 values of 20–35 U/ml and 49% of 82 patients with serum CA125 values less than 20 U/ml had residual tumour at second-look laparotomy (Gallion et al 1992). The decrease in the use of second-look laparotomy over the past few years to determine response is largely due to the lack of impact of this procedure on survival rather than the growing use of less invasive scanning techniques or CA125 assay to determine disease status (Fisken et al 1991). Absolute values of CA125 should probably not be used as the sole criterion to determine clinical response and evaluate chemotherapeutic efficacy (Morgan et al 1995).

The pattern of CA125 fluctuations with time provides more useful information than an arbitrary cut-off level in the detection of residual tumour. The odds of achieving complete remission during initial chemotherapy have been reported as 15% and 67% respectively for patients with stage III or IV ovarian cancer who had a serum CA125 half-life of more than 20 days or less than 20 days respectively (Hawkins et al 1989b). The rate of CA125 decline calculated using an exponential regression model has been shown to be an accurate predictor of therapeutic response (Buller et al 1992). Another powerful indicator of response to chemotherapy has been serum CA125 levels prior to the third course of chemotherapy (Makar et al 1993a, Gadducci et al 1995a). It has been suggested that in women with a CA125 half-life of over 20 days and an elevated level at the start of the third course of chemotherapy, a change of treatment regimen should be considered (De Bruijn et al 1997). A more precise mathematical definition using strict CA125 criteria to evaluate response has been developed (Rustin et al 1996a).

Detecting recurrence

Among patients with elevated antigen levels at diagnosis, clinical detection of recurrence was preceded by serum CA125 elevation in 94% of 15 patients (Fioretti et al 1992). Using serial CA125 levels in 255 patients undergoing first-line chemotherapy for ovarian cancer a confirmed rise of serum CA125 levels to more than twice the upper limit of normal predicted tumour relapse with a sensitivity of 84% and a false positive rate of less than 2% (Rustin et al 1996b). A median lead time prior to clinical progression of 63–99 days was demonstrated between marker detection of disease progression and clinically apparent progressive disease (Rustin et al 1996a, Cruickshank et al 1991). The value of marker lead time depends ultimately on the patient's remaining therapeutic options. The influence on survival of therapeutic intervention at preclinical diagnosis of relapse remains to be tested in a randomized controlled trial.

Combination with other markers

Tumour-associated trypsin inhibitor (TATI) or one of the gastrointestinal mucin markers, CA19–9, CA72.4 or carcinoembryonic antigen, are good supplements to CA125 in mucinous ovarian cancer. In patients with nonmucinous tumours, the addition of other serum markers to CA125 sometimes improves the diagnostic sensitivity but in general the effect is small (De Bruijn et al 1997). Table 1 summarizes the current role of CA125 as a tumour marker in ovarian malignancy.

Carcinoembryonic antigen

Carcinoembryonic antigen (CEA) was detected in 1965 with heterosera from rabbits immunized with a colonic carcinoma (Gold and Freedmen 1965). It is an oncofetal antigen found in small amounts in adult colon. Elevated levels are associated with colon and pancreatic carcinoma. Levels are also raised in benign diseases of the liver, gastrointestinal tract and lung, and in smokers. In tissue studies on ovarian malignancies, it is expressed in most endometrioid and Brenner tumours and in areas of intestinal differentiation in mucinous tumours. Unlike CA125, it is not expressed in normal and inflammatory conditions of the adnexa. Serum CEA levels are elevated in 25–50% of women with ovarian cancer. While there is some

Table 1 Summary of the role of CA125 as a tumor marker in eipthelial ovarian cancer

		Prognostic indicator			
Screening	*Differential diagnosis*	*Initial serum levels*	*Postoperative serum levels*	*Monitoring response to treatment*	*Detection of recurrence*
General population: use should be limited to trials with CA125 as part of a multimodal strategy	Significant contribution, especially in postmenopausal women	Role uncertain	Established as an independent prognostic indicator	Reflects clinical course in >90% of CA125 positive tumours	Detects recurrence with a sensitivity of 84–94% and a false positive rate of <2%
Was not found to be an independent prognostic indicator in previous studies but two more recent publications have refuted this					
Criteria used include: 1. CA125 >50U/ml 4 weeks after surgery 2. CA125 score using pre- and postoperative values 3. CA125 level prior to third course of chemotherapy 4. Slope of CA125 exponential regression curve	Serial rather then absolute values should be used				

		Prognostic indicator			
Screening	*Differential diagnosis*	*Initial serum levels*	*Postoperative serum levels*	*Monitoring response to treatment*	*Detection of recurrence*
As part of the risk of malignancy index a sensitivity of 71–85% with a specificity of 96–97% is achieved (positive predictive value 89%)	Median lead time compared to clinical diagnosis of recurrence is 60–99 days				
High-risk population: annual screening with CA125 and ultrasound is widely advocated but is not yet validated	Criteria used include: 1. Half-life—20 days is the most often used cut-off 2. Level prior to third course of chemotherapy 3. Slope of CA125 exponential regression curve 4. Strict definitions using 50% and 75% reductions from preoperative values				

correlation with disease state, this is less satisfactory than that obtained with the other described markers (Onsrud 1991).

Alpha-fetoprotein

Alpha-fetoprotein (AFP) is an oncofetal glycoprotein produced by the fetal yolk sac, liver and upper gastrointestinal tract. Elevated levels are seen in pregnancy and in benign liver disease. Serum levels are raised in most patients with liver tumours and in some with gastric, pancreatic, colon and bronchogenic malignancies (Onsrud 1991). In women with endodermal sinus tumours and embryonal carcinomas, AFP is a reliable marker for monitoring response to therapy and detecting recurrences (Chow et al 1996, Zalel et al 1996). It also accurately predicts the presence of yolk sac elements in mixed germ-cell tumours (Olt et al 1990). On univariate analysis, serum AFP levels over 1000 ng/ml together with age over 22 years and histological grading were the major prognostic factors in a series of 43 patients with ovarian and extragonadal malignant germ-cell tumours (Mayordomo et al 1994).

Human chorionic gonadotrophin

Human chorionic gonadotrophin (HCG) is synthesized in pregnancy by the syncytiotrophoblast. It is a glycoprotein hormone made up of two dissimilar, noncovalently linked subunits, α and β. Tumour production of HCG is accompanied by varying degrees of release of the free subunits into the circulation. In patients with gestational trophoblastic disease (hydatidiform mole, invasive mole and choriocarcinoma), HCG level is elevated in virtually all cases and serves as an ideal tumour marker. There is close correlation between HCG levels and tumour burden and clinical management decisions are based almost solely on the level of the marker. This hormone can also be found in the serum of patients with non-trophoblastic cancers. Although gynaecological malignancies are prominent in this group, the sensitivity is below that of other markers in current use except in germ-cell tumours with a chorionic component (Mann et al 1993).

A more promising approach is the measurement of HCG and its metabolic fragments in the urine. Urinary β-core or urinary gonadotrophin fragment (UGF) is a mixture of human chorionic gonadotrophin, free β-subunit and its fragments. It has been found to be a general stage-dependent marker for gynaecological cancers. Levels were found to be elevated in 56–84% of patients with ovarian cancer (Kinugasa et al 1995, Cole et al 1996). In the former study, a combination of urinary β-core and serum CA125 detected all 45 patients with ovarian cancer. False positive elevations were found in 1.5% of 65 women at high risk for ovarian cancer who participated in a early ovarian cancer detection programme at Yale University (Schwartz et al 1991).

Inhibin and related peptides

Inhibin and activin are structurally related dimeric proteins which were first isolated from ovarian follicular fluid on the basis of their ability to modulate pituitary follicle stimulating hormone secretion. They are members of a larger group of diverse proteins, the transforming growth factor-β superfamily that is involved in cell growth and differentiation. Inhibin is a heterodimeric glycoprotein composed of a common α-subunit and one of two β-subunits, resulting in inhibin A (αβA) and inhibin B (αβB), for which specific immunoassays are now available. The serum also contains immunoreactive forms of the α-subunit which are not attached to the β-subunit, the most abundant of which is believed to be pro-αC and pro-αN-αC. These precursor forms of inhibin are measured using the pro-αC assay. The initial Monash assay detects immunoreactive inhibin, which includes a range of inhibin-related peptides in addition to biologically active inhibin dimers.

In 1989 Lappohn et al studied 9 women with granulosa cell tumours and found serum immunoreactive inhibin concentrations to be elevated. Numerous studies have since confirmed elevation of serum inhibin in ovarian sex cord/stromal tumours and established their role in the differential diagnosis and surveillance of these malignancies (Jobling et al 1994, Cooke et al 1995, Boggess et al 1997). Bioactive dimeric inhibins A and B are the major molecular forms detected (Yamashita et al 1997, Petraglia et al 1998). Antimüllerian hormone or müllerian inhibitory factor is another member of the transforming growth factor-β superfamily that is being investigated as a marker for granulosa cell tumour (Rey et al 1996, Silverman and Gitelman 1996, Petraglia et al 1998).

In epithelial ovarian cancers, the role of these peptides remains to be defined. Using the initial non-specific Monash assay, elevated serum inhibin levels have been reported in 25–90% of women with epithelial ovarian cancers (Healy et al 1993, Blaakaer et al 1993, Phocas et al 1996). More recently, using specific immunoassays that measure bioactive dimeric inhibin A, elevated serum levels have been found in 5–31% of women with epithelial ovarian cancers (Lambert-Messerlian et al 1997, Burger et al 1996, Cooke et al 1995). Mucinous ovarian cancers are most likely to be associated with raised inhibin levels (Cooke et al

1995, Burger et al 1996). Overall the emerging picture is that dimeric inhibin A and B levels are not informative in epithelial ovarian cancer. There is growing evidence that pro-αC is the most commonly elevated of the inhibin-related peptides (Lambert-Messerlian et al 1997, Burger et al 1998) and combining pro-αC with CA125 may increase the sensitivity for detection of epithelial ovarian cancer (Seifer and Schneyer 1997, Lambert-Messerlian et al 1997).

Activin is a dimer of the two β-subunits of inhibin and exists as activin A (βAβA), activin B (βBβB) and activin AB (βAβB). Serum activin A has been found to be significantly elevated in epithelial ovarian cancers (Welt et al 1997, Petraglia et al 1998) with the highest levels detected in undifferentiated tumours. Preliminary data suggest that there is a poor correlation of activin with the clinical course of the disease (Petraglia et al 1998).

In conclusion, functional inhibin is secreted by most ovarian granulosa cell tumours and may be superior to oestradiol in determining response to therapy and predicting recurrence. Dimeric inhibin A and B levels are probably not informative in epithelial ovarian cancer but a more detailed analysis of pro-αC is needed before its exact role can be defined.

Oestrogen and androgen

Oestrogen secretion is associated with granulosa cell tumours. Since it is difficult to assess the malignant potential of granulosa cell tumours using histology, serial oestradiol levels are of significant value in monitoring these patients after surgery. Androgen levels are elevated in women with Sertoli-Leydig cell tumours.

Cytokines

Cytokines are soluble mediator substances which are produced by cells and exercise a specific effect on other target cells. Cytokines have assumed increasing importance in tumour biology with the demonstration that many can be produced by cancer cells and influence the malignant process both positively and negatively (Michiel and Oppenheim 1992). It is clear that cytokines do not fulfil the classical criteria for tumour markers: they are invariably produced by nonmalignant tissue, may be elevated in a number of pathological conditions, are not specific for one cell type and in the malignant scenario are often produced by the surrounding tissue in response to the tumour rather than by the tumour itself. Despite this, measurements of cytokines and their soluble receptors may provide valuable clinical information regarding prognosis and response to treatment.

Most of the cytokine markers are at an early stage of evaluation and in some cases studies have produced conflicting results. Serum interleukin 6 (IL-6) levels may have a role in predicting prognosis in women with ovarian cancer while IL-2R, a truncated soluble form of interleukin 2 receptor, may be useful as an adjunctive tool to CA125 in the differential diagnosis of adnexal masses. Although serum tumour necrosis factor (TNF) levels are significantly higher in patients with epithelial ovarian cancer than in those with benign ovarian disease, its measurement seems to be of limited clinical value. However, the two soluble receptors of TNF (sTNF-R) may be more useful. Elevated serum levels of sTNF-R were more sensitive indicators of primary ovarian malignancy and better predictors of active disease in patients with recurrent ovarian cancer than CA125 (Whicher and Banks 1995).

Serum macrophage colony-stimulating factor (M-CSF or CSF-1) is the most important of the cytokines to be studied so far, in the context of ovarian cancers. It appears to be a marker with high specificity for ovarian malignancy. It is produced constitutively by normal as well as neoplastic ovarian epithelium (Lidor et al 1993). Levels were significantly elevated in 61–64% of patients with ovarian cancer compared with 6–7% of patients with benign ovarian tumours. Elevation of M-CSF was related to stage of disease and was independent of histologic type (Suzuki et al 1993, Suzuki et al 1995). The importance of M-CSF and its receptor (encoded by the c-*fms* proto-oncogene) in epithelial ovarian cancer has now been recognized, with overexpression of M-CSF denoting poor prognosis. In a Cox proportional hazards model, serum M-CSF but not CA125 was significantly associated with outcome following adjustment for stage, grade and degree of surgical clearance (Scholl et al 1994). In patients with advanced disease, M-CSF levels in ascitic fluid below a critical cut-off value were associated with longer overall survival and were better predictors of survival than any other prognostic factor except zero residual disease after cytoreduction (Price et al 1993). The other area where the role of M-CSF as a tumour marker warrants further study is in ovarian cancer screening. When M-CSF was assayed along with CA125, it was found that 66 of 69 patients with ovarian cancer (96%) had high serum levels of M-CSF and/or CA125 values (Suzuki et al 1993). At least one of the serum markers was elevated in 98% of patients with stage I ovarian cancer when M-CSF was measured together with serum CA125 and another marker, OVX1 (Woolas et al 1993).

Cytokeratins

Cytokeratins are intermediate filaments that are part of the cytoskeleton of all epithelial cells. They are specific markers of epithelial differentiation and, interestingly, they continue to be expressed by epithelial cells after malignant transformation. In contrast to Cytokeratins themselves, fragments of Cytokeratins are soluble in the serum and therefore can be detected and measured with the aid of monoclonal antibodies. They are currently being studied as tumour markers in various malignancies.

Tissue polypeptide-specific antigen

Tissue polypeptide-specific (TPS) antigen is a new proliferation marker closely related to the tumour marker tissue polypeptide antigen. It is recognized by a monoclonal antibody raised against the M3 epitope on cytokeratin 18. It was elevated in 50–77% of ovarian cancers studied, with a specificity of 84–85% (Shabana and Onsrud 1994, Salman et al 1995, Sliutz et al 1995). The TPS assay did not add to the diagnostic value of serum CA125 in ovarian cancer (Shabana and Onsrud 1994). No correlation between marker levels and survival was found. However, serial measurement of TPS was of value in follow-up of patients (Shabana and Onsrud 1994, Salman et al 1995). There was improved detection of recurrent disease when CA125 was used in combination with TPS, especially in those patients who had elevated serum TPS prior to therapy (Sliutz et al 1995).

CYFRA 21–1

CYFRA 21–1 is a soluble serum fragment of cytokeratin 19. In a retrospective study, CYFRA 21–1 was measured along with the tumour markers CA72–4, CASA and the established marker CA125 II in stored serum obtained from 72 women with ovarian cancer at primary diagnosis. Measurement of CYFRA 21–1 had a sensitivity of 44% which was similar to that obtained by the other markers: CA125 II 47%; CA72–4 47%; CASA 31%. The sensitivity of CYFRA 21–1 was 33% in serous ovarian cancer and 36% in mucinous ovarian cancer (Hasholzner et al 1994, 1996). A study in Japan measured CYFRA 21–1 together with CA125 and squamous carcinoma antigen initially in 102 healthy Japanese women to set the reference value and then in 94 women with benign gynaecological disease and 141 women with malignant disease (Inaba et al 1995). The respective positivity rates for CYFRA 21–1 and CA125 were 64% and 77% in ovarian malignancy, while they were 4 and 31% in benign ovarian masses. As a marker, CYFRA 21–1 had an accuracy of 61% in diagnosing ovarian malignancy, which was higher than that of CA125 (53%). The positive predictive value (PPV) of CYFRA 21–1 for ovarian cancer of 94% was significantly higher than the PPV of 69% achieved with CA125. The potential usefulness of CYFRA 21–1 as a tumour marker for ovarian malignancy needs to be explored further before any firm conclusions can be drawn.

Tumour-associated trypsin inhibitor

In ovarian cancer patients elevated levels of a 6 kDa polypeptide, the tumour-associated trypsin inhibitor (TATI), have been detected in both urine and serum. When used as a single marker in 180 patients with epithelial ovarian cancer and 214 women with benign pelvic pathology, serum TATI achieved a lower sensitivity (63%) and specificity (72%) than CA125 (>35 U/ml). A combination of the two markers increased the sensitivity to 91% but the specificity decreased to 65%. However, the use of TATI was clearly superior in diagnosing mucinous adenocarcinoma of the ovaries, the rate of true positive findings being 64% compared with 50% for CA125. Unlike CA125, TATI levels correlated well with tumour grade. While CA125 remains the single tumour marker of choice in the diagnosis of malignant epithelial ovarian cancer, TATI appears to be a possible complementary marker with a higher sensitivity in cases of poorly differentiated and mucinous carcinoma (Peters-Engl et al 1995). It may also have a role to play in predicting prognosis. When assayed prior to surgery in 66 patients with stage III and IV ovarian cancer, serum TATI levels were elevated in 41%. These women had a 5-year cumulative survival rate of 8%, whereas the survival rate was 45% in the 39 patients with normal preoperative TATI values. In contrast, the preoperative CA125 levels in these women did not predict survival. In multivariate analysis which included age, stage, histological grade and preoperative TATI and CA125 levels, patients with elevated preoperative TATI levels had a 2.3-fold relative risk of death compared with patients with normal preoperative levels. Thus, preoperative determination of serum TATI may have a place in the pretreatment evaluation of patients with advanced ovarian cancer (Venesmaa et al 1994).

Other serum markers

Multiple serum markers have been assessed in isolation and in various combinations in women with ovarian cancer, both in the context of screening and in assessing prognosis and monitoring response and recurrence. The most significant finding is that in women with ovarian cancer, no single agent or combination has emerged as having a clear clinical advantage over CA125, except in specific tumour subtypes such as germ-cell tumours with yolk sac or chorionic elements and granulosa cell tumours (Table 2).

Endometrial cancers

There are no serum tumour markers with a well-established role in clinical management of endometrial cancer. Serum CA125 levels are elevated in 10–27% of patients with endometrial carcinoma (Patsner et al 1990, Takeshima et al 1994, Hakala et al 1995). In two series of 42 and 148 women, respectively, with endometrial cancer (Gadducci et al 1990, Tomas et al 1990), the incidence of elevated serum CA125 levels was significantly greater in advanced-stage disease (63–67%) than in early-stage disease (10–19%). Thus CA125 measurement prior to surgery may be useful in predicting the presence of extrauterine and metastatic spread. Serum CA125 levels may have a role in surveillance following treatment of patients with early-stage endometrial carcinoma, but may be falsely elevated in the presence of severe radiation injury. Isolated recurrences in the vagina do not cause elevation, while distant metastasis normally does.

Among the general tumour markers for gynaecological malignancy, CYFRA 21–1 was found to be elevated in 52% of endometrial malignancies (Inaba et al 1995) and urinary β-core or UGF levels were elevated in 38–48% of samples from women with endometrial carcinoma (Kinugasa et al 1995, Cole et al 1996).

Cervical cancers

Screening for cervical cancer uses exfoliative cytology and currently there are no serological markers being explored in this context. However, in assessing

Table 2 Role of current tumour markers in ovarian cancer

Ovarian cancers	*Screening*	*Differential diagnosis*	*Prognostic indicator*	*Monitoring response to*	*Detection of recurrence treatment*
Epithelial cancers	CA125 as part of a multimodal strategy *M-CSF *CYFRA 21–1 *CA72–4	CA125 *CA72–4 *TATI *CYFRA 21–1 *Inhibin pro-α C *IL-2R–conflicting evidence *GAT	CA125—Preoperative levels: conflicting evidence. Postoperative levels: independent prognostic indicator *TATI *M-CSF *IL-6–conflicting evidence *Inhibin—high levels associated with good response *IAP *CASA+CA125	CA125 *TPA+CA125 *Soluble receptors of TNF *Tetranectin *CASA	CA125 *TPA *Soluble receptors of TNF *TPS *Tetranectin
Germ-cell tumours		AFP—tumours with yolk sac elements HCG—tumours with chorionic elements	AFP	AFP—tumours with yolk sac elements HCG—tumours with chorionic elements	AFP—tumours with yolk sac elements HCG—tumours with chorionic elements
Sex cord stromal tumours		*Inhibin, oestradiol in granulosa tumours		*Inhibin in granulosa tumours	*Inhibin, oestradiol in granulosa tumours

*Potential role. Not yet used in routine clinical practice.

prognosis, monitoring response to therapy and detecting recurrence, a variety of tumour markers are being investigated. The main ones are squamous cell carcinoma antigen, tissue polypeptide antigen, CEA and CYFRA 21–1.

Squamous cell carcinoma antigen

In 1977 Kato and Torigoe isolated the tumour antigen TA-4 from a cervical squamous cell carcinoma. Squamous cell carcinoma antigen (SCC) is one of 14 subfractions of tumour antigen TA-4. Elevated serum levels were found in 57–65% of women with primary squamous cell carcinoma of the cervix (Lozza et al 1997, Ngan et al 1996). The release into the circulation is independent of local tissue content as high antigen concentrations are found in the cytosol of normal cervical squamous epithelia, but in these cases serum levels are always in the normal range (Crombach et al 1989). The antigen is, however, not specific for cervical squamous cell carcinoma. Elevated serum levels are also found in other squamous cell cancers of the head and neck, oesophagus and lung and adenocarcinoma of the uterus, ovary and lung. Levels of SCC can also be raised in skin diseases such as psoriasis and eczema (Duk et al 1989a).

The SCC antigen is probably a marker of cellular differentiation of squamous cells, as the incidence of elevated serum levels is higher in women with well-differentiated (78%) and moderately differentiated carcinomas (67%) than in those with poorly differentiated tumours (38%) (Crombach et al 1989). Levels of SCC before treatment correlate with stage, tumour volume, lymph node status and blood vessel invasion (Scambia 1994, Duk et al 1996, Bolger et al 1997, Massuger et al 1997). However, the prognostic significance of pretreatment SCC measurements remains uncertain and needs further exploration. Preoperative SCC levels were not an independent prognostic factor in multivariate analysis in three studies involving a total of 829 patients with cervical carcinoma (Gaarenstroom et al 1995, Ngan et al 1996, Bolger et al 1997). In contrast, two studies of 102 and 653 women, respectively, treated for cervical cancer (Scambia et al 1994, Duk et al 1996), found that initial SCC levels were a significant prognostic indicator of survival after controlling for lesion size, grade, vascular invasion, depth of stromal infiltration and lymph node status. Even in node negative patients, the risk of recurrence was three times higher if the SCC level was elevated before therapy (Duk et al 1996).

In SCC positive patients, serial SCC determinations correlated with the clinical course in 72% of women (Gocze et al 1994), with levels decreasing with effective therapy (Pectasides et al 1994). Normalization of elevated levels was associated with a complete response (Rose et al 1993) and an elevated post-treatment serum SCC level was associated with a poor survival rate (Bonfrer et al 1997). In patients affected by recurrent carcinoma, a raised SCC level was found in 50–71% of cases, with a lead time ranging from 0 to 12 months (Rose et al 1993, Lozza et al 1997).

Tissue polypeptide antigen

Serum tissue polypeptide antigen (TPA) has been found to be elevated in 40–50% of women with squamous cell carcinoma of the cervix (Ferdeghini et al 1994, Ngan et al 1996). Serum levels were related to stage, grade of differentiation and prognosis. However, after adjusting for tumour stage and size, pretreatment serum TPA levels were not found to be predictive of survival in patients with cervical cancer (Gaarenstroom et al 1995, Sproston et al 1995, Ngan et al 1996, Bonfrer et al 1997).

CYFRA 21–1

Elevated levels of CYFRA 21–1 were initially detected in patients with squamous cell carcinoma of the lung. This led to their investigation in squamous cell carcinoma of the cervix. Elevated levels were found in 14% of controls, 35% of patients with stage Ib-IIa squamous cell carcinoma of the cervix and 64% of patients with stage IIb-IV squamous cell carcinoma of the cervix (Tsai et al, 1996). Although CYFRA 21–1 level was related to tumour stage and size in patients with cervical cancer (Bonfrer et al 1994) and there was a positive correlation with SCC (Nasu et al 1996, Kainz et al 1995), it was less sensitive and specific than SCC in detecting squamous cell carcinoma of the cervix (Ferdeghini et al 1993, Ferdeghini et al 1994, Tsai et al, 1996). In cervical adenocarcinoma, CYFRA 21–1 was elevated in 63% of patients (Ferdeghini et al 1993c). Its role in the management of patients with cervical cancer needs further investigation.

CA125 and CEA

Serum CA125 level is elevated in only 13–21% of women with squamous cell carcinoma (Tomas et al 1991, Gocze et al 1994). However, in cervical adenocarcinoma, it is a better tumour marker then SCC (Duk et al 1989b). Levels of CA125 were found to be raised in 6 of 19 patients (32%) with cervical adenocarcinoma while SCC values were abnormal in only 2 (11%) (Tomas et al 1991). In another study, all 5 patients with cervical adenocarcinoma had normal SCC levels, but CA125 levels were elevated in 3 of the 5 cases (Gocze et al 1994). The combination of CA19.9 and CA125 was particularly useful with a sensitivity of 60% for cervical adenocarcinoma. The addition of CEA to the combination increased sensitivity to 70% (Borras et al 1995). When levels were elevated, serum CA125 was found to be an important prognostic factor and an indicator of tumour virulence (Duk et al 1990, Avall-Lundqvist et al 1992). Serial measurements of CA125 can be used in the evaluation of response to chemotherapy, with levels falling in 83% of women with previously untreated cervical carcinoma who responded to chemotherapy (Leminen et al 1992). In progressive disease, very high serum CA125, SCC and CEA levels were found in patients with adenosquamous tumours, whereas patients with adenocarcinoma demonstrated only high CA125 levels (Duk et al 1989b).

Carcinoembryonic antigen is less useful in cervical cancers and has been reported to have an overall sensitivity of 15% and a specificity of 90% in 334 patients with squamous cell carcinomas and 18 patients with adenocarcinomas (Lam et al 1992). However, the positive rate of CEA was significantly higher among patients with cervical adenocarcinoma than in those with squamous cell malignancy.

For squamous cell carcinoma of the cervix, SCC remains the best available marker and is a potential tool for monitoring the efficacy of treatment in advanced and recurrent disease. CA125 is useful in cervical adenocarcinoma. The evidence available so far does not justify the routine measurement of multiple markers.

Vulval and vaginal cancers

Tumours of the vulva and vagina are rare and there are few studies of circulating markers in these conditions. Tissue polypeptide-specific antigen has been shown to be elevated in 80% of vulvovaginal cancers (Salman et al 1995), while SCC levels were elevated in 43% of patients with vulval or vaginal cancer (Nam et al 1990). A study of urinary core fragment of the β-subunit of HCG in 50 patients with vulvovaginal malignancy (Carter et al 1995) found that the sensitivity of β-core was only 38%, but 90% of patients with elevated levels died within 24 months when compared to 32% of those with normal levels. For both, patients at initial presentation and those with recurrent disease, there was a highly significant difference in the survival curve between those with elevated β-core levels and those with normal levels. Rising urinary gonadotrophin fragment levels at an earlier clinic visit predicted recurrence in 4 of 7 patients who developed recurrent tumour (Nam et al 1990). While the numbers are small, the data suggest that for lower genital tract cancer the measurement of urinary β-core may be valuable as a prognostic indicator, allowing a more informed approach to treatment and follow-up.

Conclusion

The potential use of the described markers is hampered by the fact that the production of most markers is neither confined to the malignant tumour cell nor connected to the malignant phenotype. Notwithstanding, HCG has emerged as an ideal tumour marker in gestational trophoblastic disease. Of the ever-increasing number of other serological markers being studied in the context of gynaecological malignancies, especially ovarian epithelial cancers, no tumour marker has yet proven to be more useful clinically than CA125.

As a screening test no marker is ideal. However, serial CA125 measurement in combination with ultrasonography is undergoing evaluation in randomized controlled trials of screening for ovarian cancer in the general population. Serum tumour markers are of diagnostic value in the differential diagnosis of ovarian masses. The role of markers in evaluating prognosis is emerging and they will eventually play a larger role in decisions regarding therapy in poor prognosis disease. The greatest value, still not fully exploited, is in the monitoring of response to therapy and recurrence in advanced disease.

Bibliography

Alagoz T, Buller RE, Berman M et al (1994) What is a normal CA125 level? *Gynecol Oncol* **53:**93–7.

Avall-Lundqvist EH, Sjovall K, Nilsson BR et al (1992) Prognostic significance of pretreatment serum levels of squamous cell carcinoma antigen and CA125 in cervical carcinoma, *Eur J Cancer* **28A:**1695–702.

Bast RC Jr, Feeney M, Lazarus H et al (1981) Reactivity of a monoclonal antibody with human ovarian carcinoma, *J Clin Invest* **68:**1331–7.

Bast RC Jr, Klug TL, St John E et al (1983) A radioimmunoassay using a monoclonal antibody to monitor the course of epithelial ovarian cancer, *N Engl J Med* **309:**883–7.

Blaakaer J, Micic S, Morris ID et al (1993) Institution immunoreactive inhibin production in post-menopausal women with malignant epithelial ovarian tumors, *Eur J Obstet Gynecol Reprod Biol* **52**(2)**:**105–10.

Boggess JF, Soules MR, Goff BA et al (1997) Serum inhibin and disease status in women with ovarian granulosa cell tumors, *Gynecol Oncol* **64:**64–9.

Bolger BS, Dabbas M, Lopes A et al (1997) Prognostic value of preoperative squamous cell carcinoma antigen level in patients surgically treated for cervical carcinoma, *Gynecol Oncol* **65:**309–13.

Bon GG, Kenemans P, Verstraeten R et al (1996) Serum tumour marker immunoassays in gynaecologic oncology: establishment of reference values , *Am J Obstet Gynecol* **174:**107–14.

Bonfrer JM, Gaarenstroom KN, Kenter GG et al (1994) Prognostic significance of serum fragments of cytokeratin 19 measured by Cyfra 21–1 in cervical cancer, *Gynecol Oncol* **55:**371–5.

Bonfrer JM, Gaarenstroom KN, Korse CM et al (1997) Cyfra 21–1 in monitoring cervical cancer: a comparison with tissue polypeptide antigen and squamous cell carcinoma antigen, *Anticancer Res* **17:**2329–34.

Borras G, Molina R, Xercavins J et al (1995) Tumour antigens CA19,9, CA125, and CEA in carcinoma of the uterine cervix, *Gynecol Oncol* **57:**205–11.

Buller RE, Berman ML, Bloss JD et al (1992) Serum CA125 regression in epithelial ovarian cancer: correlation with reassessment findings and survival, *Gynecol Oncol* **47:** 87–92.

Buller RE, Vasilev S, DiSaia PJ (1996) CA125 kinetics: a cost-effective clinical tool to evaluate clinical—trial outcomes in the 1990s, *Am J Obstet Gynecol* **174:**1241–53.

Burger HG, Robertson DM, Cahir N et al (1996) Characterization of inhibin immunoreactivity in post-menopausal women with ovarian tumours, *Clin Endocrinol (Oxf)* **44:**413–18.

Burger HG, Baillie A, Drummond AE et al (1998) Inhibin and ovarian cancer, *J Reprod Immunol* **39:**77–87.

Canney PA, Moore M, Wilkinson PM et al (1984) Ovarian cancer antigen CA125: a prospective clinical assessment of its role as a tumour marker, *Br J Cancer* **50:**765–9.

Carter PG, Iles RK, Neven P et al (1995) Measurement of urinary beta core fragment of human chorionic gonadotrophin in women with vulvovaginal malignancy and its prognostic significance, *Br J Cancer* **71:**350–3.

Chow SN, Yang JH, Lin YH et al (1996) Malignant ovarian germ cell tumors, *Int J Gynaecol Obstet* **53:**151–8.

Cole LA, Tanaka A, Kim GS et al (1996) Beta-core fragment (beta-core/UGF/UGP), a tumour marker: a 7-year report , *Gynecol Oncol* **60:**264–70.

Cooke I, O'Brien M, Charnock FM et al (1995) Inhibin as a marker for ovarian cancer, *Br J Cancer* **71:**1046–50.

Crombach G, Scharl A, Vierbuchen M et al (1989) Detection of squamous cell carcinoma antigen in normal squamous epithelia and in squamous cell carcinomas of the uterine cervix, *Cancer* **63:**1337–42.

Cruickshank DJ, Terry PB, Fullerton WT (1991) The potential value of CA125 as a tumour marker in small volume, non-evaluable epithelial ovarian cancer, *Int J Biol Markers* **6:**247–52.

Curtin JP (1994) Management of the adnexal mass, *Gynecol Oncol* **55:**S42–6.

Davidson NG, Khanna S, Kirwan PH (1991) Prechemotherapy serum CA125 level as a predictor of survival outcome in epithelial carcinoma of the ovary, *Clin Oncol (R Coll Radiol)* **3:**32–6.

De Bruijn HW, van der Zee AG, Aalders JG (1997) The value of cancer antigen 125 (CA125) during treatment and follow-up of patients with ovarian cancer , *Curr Opin Obstet Gynecol* **9:**8–13.

Duk JM, van Voorst Vader PC, ten Hoor KA et al (1989a) Elevated levels of squamous cell carcinoma antigen in patients with a benign disease of the skin, *Cancer* **64:** 1652–6.

Duk JM, Aalders JG, Fleuren GJ et al (1989b) Tumor markers CA125, squamous cell carcinoma antigen, and carcinoembryonic antigen in patients with adenocarcinoma of the uterine cervix, *Obstet Gynecol* **73:**661–8.

Duk JM, De Bruijn HW, Groenier KH (1990) Adenocarcinoma of the uterine cervix, Prognostic significance of pre-treatment serum CA125, squamous cell carcinoma antigen, and carcinoembryonic antigen levels in relation to clinical and histopathologic tumour characteristics, *Cancer* **65:**1830–7.

Duk JM, Groenier KH, de Bruijn HW et al (1996) Pre-treatment serum squamous cell carcinoma antigen: a newly identified prognostic factor in early-stage cervical carcinoma, *J Clin Oncol* **14:**111–18.

Einhorn N, Bast RC Jr, Knapp RC et al (1986) Preoperative evaluation of serum CA125 levels in patients with primary epithelial ovarian cancer, *Obstet Gynecol* **67:**414–16.

Ferdeghini M, Gadducci A, Annicchiarico C et al (1993) Serum CYFRA 21–1 assay in squamous cell carcinoma of the cervix, *Anticancer Res* **13:**1841–4.

Ferdeghini M, Gadducci A, Prontera C et al (1994) Determination of serum levels of different cytokeratins in patients with uterine malignancies, *Anticancer Res* **4:** 1393–7.

Fioretti P, Gadducci A, Ferdeghini M et al (1992) The concomitant determination of different serum tumor markers in epithelial ovarian cancer: relevance for monitoring the response to chemotherapy and follow-up of patients, *Gynecol Oncol* **44:**155–60.

Fisken J, Leonard RC, Badley A et al (1991) Serological monitoring of epithelial ovarian cancer, *Dis Markers* **9:** 175–90.

Gaarenstroom KN, Bonfrer JM, Kenter GG et al (1995) Clinical value of pretreatment serum Cyfra 21–1, tissue polypeptide antigen, and squamous cell carcinoma antigen levels in patients with cervical cancer, *Cancer* **76:** 807–13.

Gadducci A, Ferdeghini M, Prontera C et al (1990) A comparison of pretreatment serum levels of four tumor markers in patients with endometrial and cervical carcinoma, *Eur J Gynaecol Oncol* **11:**283–8.

Gadducci A, Zola P, Landoni F et al (1995a) Serum half-life of CA125 during early chemotherapy as an independent prognostic variable for patients with advanced epithelial ovarian cancer: results of a multicentric Italian study, *Gynecol Oncol* **58:**42.

Gallion HH, Hunter JE, van Nagell JR et al (1992) The prognostic implications of low serum CA125 levels prior to the second-look operation for stage III and IV epithelial ovarian cancer, *Gynecol Oncol* **46:**29–32.

Gocze PM, Vahrson HW, Freeman DA (1994) Serum levels of squamous cell carcinoma antigen and ovarian carcinoma antigen (CA125) in patients with benign and malignant diseases of the uterine cervix, *Oncology* **51:**430–4.

Gold P, Freedman SO (1965) Specific carcinoembryonic antigens of the human digestive system, *J Exp Med* **122:** 467–81.

Hakala A, Kacinski BM, Stanley ER et al (1995) Macrophage colony-stimulating factor 1, a clinically useful tumour marker in endometrial adenocarcinoma: comparison with CA125 and the aminoterminal propeptide of type III procollagen, *Am J Obstet Gynecol* **173:**112–19.

Hasholzner U, Baumgartner L, Stieber P et al (1994) Significance of the tumour markers CA125 II, CA 72–4, CASA and CYFRA 21–1 in ovarian carcinoma, *Anticancer Res* **14:**2743–6.

Hasholzner U, Baumgartner L, Stieber P et al (1996) Clinical significance of the tumour markers CA125 II and CA 72–4 in ovarian carcinoma, *Int J Cancer* **69:**329–34.

Hawkins RE, Roberts K, Wiltshaw E et al (1989a) The clinical correlates of serum CA125 in 169 patients with epithelial ovarian carcinoma, *Br J Cancer* **60:**634–7.

Hawkins RE, Roberts K, Wiltshaw E et al (1989b) The prognostic significance of the half-life of serum CA125 in patients responding to chemotherapy for epithelial ovarian carcinoma, *Br J Obstet Gynaecol* **96:**1395–9.

Healy DL, Burger HG, Mamers P et al (1993) Elevated serum inhibin concentrations in postmenopausal women with ovarian tumors, *N Engl J Med* **329:**1539–42.

Hempling RE, Piver MS, Natarajan N et al (1993) Predictive value of serum CA125 following optimal cytoreductive surgery during weekly cisplatin induction therapy for advanced ovarian cancer, *J Surg Oncol* **54:**38–44.

Inaba N, Negishi Y, Fukasawa I et al (1995) Cytokeratin fragment 21–1 in gynecologic malignancy: comparison with cancer antigen 125 and squamous cell carcinomarelated antigen, *Tumour Biol* **16:**345–52.

Jacobs I, Bast RC Jr (1989) The CA125 tumour-associated antigen: a review of the literature, *Hum Reprod* **4:**1–12.

Jacobs I, Oram D, Fairbanks J et al (1990) A risk of malignancy index incorporating CA125, ultrasound and menopausal status for the accurate preoperative diagnosis of ovarian cancer, *Br J Obstet Gynaecol* **97:**922–9.

Jacobs I, Davies AP, Bridges J et al (1993) Prevalence screening for ovarian cancer in postmenopausal women by CA125 measurement and ultrasonography *BMJ* **306:** 1030–4.

Jacobs IJ, Skates S, Davies AP et al (1996) Risk of diagnosis of ovarian cancer after raised serum CA125 concentration: a prospective cohort study, *BMJ* **313:**1355–8.

Jobling T, Mamers P, Healy DL et al (1994) A prospective study of inhibin in granulosa cell tumors of the ovary, *Gynecol Oncol* **55:**285–9.

Kabawat SE, Bast RC Jr, Bhan AK et al (1983) Tissue distribution of a coelomic-epithelium-related antigen recognized by the monoclonal antibody OC125, *Int J Gynecol Pathol* **2:**275–85.

Kainz C, Sliutz G, Mustafa G et al (1995) Cytokeratin subunit 19 measured by CYFRA 21–1 assay in follow-up of cervical cancer, *Gynecol Oncol* **56:**402–5.

Karlan BY, Raffel LJ, Crvenkovic G et al (1993) A multidisciplinary approach to the early detection of ovarian carcinoma: rationale, protocol design, and early results, *Am J Obstet Gynecol* **169:**494–501.

Kato H, Torigoe T (1977) Radioimmunoassay for tumour antigen of human squamous cell carcinoma, *Cancer* **40:** 1621–8.

Kenemans P, van Kamp GJ, Oehr P et al (1993) Heterologous double-determinant immunoradiometric assay CA125 II: reliable second-generation immunoassay for determining CA125 in serum , *Clin Chem* **39:**2509–13.

Kinugasa M, Nishimura R, Koizumi T et al (1995) Combination assay of urinary beta-core fragment of human chorionic gonadotropin with serum tumour markers in gynaecologic cancers, *Jpn J Cancer Res* **86:** 783–9.

Lam CP, Yuan CC, Jeng FS et al (1992) Evaluation of carcinoembryonic antigen, tissue polypeptide antigen, and squamous cell carcinoma antigen in the detection of cervical cancers, *Cbung Hua I Hsueb Tsa Cbib* (Taipei) **50:** 7–13.

Lambert-Messerlian GM, Steinhoff M, Zheng W et al (1997) Multiple immunoreactive inhibin proteins in serum from postmenopausal women with epithelial ovarian cancer, *Gynecol Oncol* **65**(3):512–16.

Lappohn RE, Burger HG, Bouma J et al (1989) Inhibin as a marker for granulosa cell tumors, *N Engl J Med* **321**(12): 790–3.

Leminen A, Alftan H, Stenman UH et al (1992) Chemotherapy as initial treatment for cervical carcinoma: clinical and tumor marker response, *Acta Obstet Gynecol Scand* **71**(4):293–7.

Lidor YJ, Xu FJ, Martinez-Maza O et al (1993) Constitutive production of macrophage colony-stimulating factor and interleukin-6 by human ovarian surface epithelial cells, *Exp Cell Res* **207:**332–9.

Lozza L, Merola M, Fontanelli R et al (1997) Cancer of the uterine cervix: clinical value of squamous cell carcinoma antigen (SCC) measurements, *Anticancer Res* **17:**525–9.

Maggino T, Gadducci A, D'Addario V et al (1994) Prospective multicenter study on CA125 in postmenopausal pelvic masses, *Gynecol Oncol* **54:**117–23.

Makar AP, Kristensen GB, Kaern J et al (1992) Prognostic value of pre- and postoperative serum CA125 levels in ovarian cancer: new aspects and multivariate analysis, *Obstet Gynecol* **79:**1002–10.

Makar AP, Kristensen GB, Bormer OP et al (1993a) Serum CA125 level allows early identification of nonresponders during induction chemotherapy, *Gynecol Oncol* **49:**73–9.

Makar AP, Kristensen GB, Bormer OP et al (1993b) Is serum CA125 at the time of relapse a prognostic indicator for further survival prognosis in patients with ovarian cancer? *Gynecol Oncol* **49:**3–7.

Mann K, Saller B, Hoermann R (1993) Clinical use of HCG and hCG beta determinations, *Scand J Clin Lab Invest* Suppl **216:**97–104.

Massuger LF, Koper NP, Thomas CM et al (1997) Improvement of clinical staging in cervical cancer with serum squamous cell carcinoma antigen and CA125 determinations, *Gynecol Oncol* **64:**473–6.

Mayordomo JI, Paz-Ares L, Rivera F et al (1994) Ovarian and extragonadal malignant germ-cell tumors in females: a single-institution experience with 43 patients, *Ann Oncol* **5:**225–31.

Michiel DF, Oppenheim JJ (1992) Cytokines as positive and negative regulators of tumor promotion and progression, *Semin Cancer Biol* **3:**3–15.

Morgan RJ Jr, Speyer J, Doroshow JH et al (1995) Modulation of 5-fluorouracil with high-dose leucovorin calcium: activity in ovarian cancer and correlation with CA-125 levels, *Gynecol Oncol* **58:**79–85.

Muto MG, Cramer DW, Brown DL et al (1993) Screening for ovarian cancer: the preliminary experience of a familial ovarian cancer center, *Gynecol Oncol* **51:**12–20.

Nagele F, Petru E, Medl M et al (1995) Preoperative CA125: an independent prognostic factor in patients with stage I epithelial ovarian cancer, *Obstet Gynecol* **86:** 259–64.

Nam JH, Chang KC, Chambers JT et al (1990) Urinary gonadotropin fragment, a new tumor marker, III, Use in cervical and vulvar cancers, *Gynecol Oncol* **38:**66–70.

Nasu K, Etoh Y, Yoshimatsu J et al (1996) Serum levels of cytokeratin 19 fragments in cervical cancer, *Gynecol Obstet Invest* **42:**267–70.

Ngan HY, Cheung AN, Lauder IJ et al (1996) Prognostic significance of serum tumour markers in carcinoma of the cervix, *Eur J Gynaecol Oncol* **17:**512–17.

Nustad K, Bast RC Jr, Brien TJ et al (1996) Specificity and affinity of 26 monoclonal antibodies against the CA125 antigen: first report from the ISOBM TD-1 workshop, International Society for Oncodevelopmental Biology and Medicine, *Tumour Biol* **17:**196–219.

Olt G, Berchuck A, Bast RC Jr (1990) The role of tumor markers in gynecologic oncology, *Obstet Gynecol Surv* **45:** 570–7.

Onsrud M (1991) Tumour markers in gynaecologic oncology, *Scand J Clin Lab Invest* Suppl **206:**60–70.

Parker WH, Levine RL, Howard FM et al (1994a) A multicenter study of laparoscopic management of selected cystic adnexal masses in postmenopausal women, *J Am Coll Surg* **179:**733–7.

Parker D, Bradley C, Bogle SM et al (1994b) Serum albumin and CA125 are powerful predictors of survival in epithelial ovarian cancer, *Br J Obstet Gynaecol* **101:** 888–93.

Patsner B, Orr JW Jr, Mann WJ Jr (1990) Use of serum CA125 measurement in posttreatment surveillance of early-stage endometrial carcinoma, *Am J Obstet Gynecol* **162:** 427–9.

Pectasides D, Economides N, Bourazanis J et al (1994) Squamous cell carcinoma antigen, tumor-associated trypsin inhibitor, and carcinoembryonic antigen for monitoring cervical cancer , *Am J Clin Oncol* **17:** 307–12.

Peters-Engl C, Medl M, Ogris E et al (1995) Cancer antigen 125 (CA125) in patients with epithelial ovarian cancer, *Anticancer Res* **15:**2727–30.

Petraglia F, Luisi S, Pautier P et al (1998) Inhibin B is the major form of inhibin/activin family secreted by granulosa cell tumors, *J Clin Endocrinol Metab* **83**(3):1029–32.

Phocas I, Sarandakou A, Sikiotis K et al (1996) A comparative study of serum alpha-beta A immunoreactive inhibin and tumor-associated antigens CA125 and CEA in ovarian cancer, *Anticancer Res* **16:**3827–31.

Price FV, Chambers SK, Chambers JT et al (1993) Colony-stimulating factor-1 in primary ascites of ovarian cancer is a significant predictor of survival, *Am J Obstet Gynecol* **168:**520–7.

Redman CW, Blackledge GR, Kelly K et al (1990) Early serum CA125 response and outcome in epithelial ovarian cancer, *Eur J Cancer* **26:**593–6.

Rey RA, Lhomme C, Marcillac I et al (1996) Antimullerian hormone as a serum marker of granulosa cell tumors of the ovary: comparative study with serum alpha-inhibin and estradiol, *Am J Obstet Gynecol* **174**(3):958–65.

Rose PG, Baker S, Fournier L et al (1993) Serum squamous cell carcinoma antigen levels in invasive cervical cancer: prediction of response and recurrence, *Am J Obstet Gynecol* **168:**942–6.

Rosen A, Sevelda P, Klein M et al (1990) A CA125 score as a prognostic index in patients with ovarian cancer, *Arch Gynecol Obstet* **247:**125–9.

Rosman M, Hayden CL, Thiel RP et al (1994) Prognostic indicators for poor risk epithelial ovarian carcinoma, *Cancer* **74:**1323–8.

Rustin GJ, Nelstrop AE, McClean P et al (1996a) Defining response of ovarian carcinoma to initial chemotherapy according to serum CA125, *J Clin Oncol* **14**(5):1545–51.

Rustin GJ, Nelstrop AE, Tuxen MK et al (1996b) Defining progression of ovarian carcinoma during follow-up according to CA125: a North Thames Ovary Group Study, *Ann Oncol* **7:**361–4.

Salman T, el-Ahmady O, Sawsan MR et al (1995) The clinical value of serum TPS in gynecological malignancies, *Int J Biol Markers* **10:**81–6.

Scambia G, Benedetti PP, Foti E et al (1994) Squamous cell carcinoma antigen: prognostic significance and role in the monitoring of neoadjuvant chemotherapy response in cervical cancer, *J Clin Oncol* **12:**2309–16.

Scholl SM, Bascou CH, Mosseri V et al (1994) Circulating levels of colony-stimulating factor 1 as a prognostic indicator in 82 patients with epithelial ovarian cancer, *Br J Cancer* **69:**342–6.

Schwartz PE, Chambers JT, Taylor KJ et al (1991) Early detection of ovarian cancer: preliminary results of the Yale Early Detection Program, Yale *J Biol Med* **64:** 573–82.

Seifer DB, Schneyer AL (1997) Multiple immunoreactive inhibin proteins in serum from postmenopausal women with epithelial ovarian cancer, *Gynecol Oncol* **65:** 512–16.

Shabana A, Onsrud M (1994) Tissue polypeptide-specific antigen and CA125 as serum tumor markers in ovarian carcinoma, *Tumour Biol* **15:**361–7.

Silverman LA, Gitelman SE (1996) Immunoreactive inhibin, mullerian inhibitory substance, and activin as biochemical markers for juvenile granulosa cell tumors, *J Pediatr* **129**(6):918–21.

Skates SJ, Xu FJ, Yu YH et al (1995) Toward an optimal algorithm for ovarian cancer screening with longitudinal tumor markers, *Cancer* **76** (suppl):2004–10.15.

Skates SJ, Chang Y, Xu FJ et al (1996) A new statistical approach to screening for ovarian cancer, *Tumor Biol* **17:** 45.

Sliutz G, Tempfer C, Kainz C et al (1995) Tissue polypeptide specific antigen and cancer associated serum antigen in the follow-up of ovarian cancer, *Anticancer Res* **5:**1127–9.

Sproston AR, Roberts SA, Davidson SE et al (1995) Serum tumour markers in carcinoma of the uterine cervix and outcome following radiotherapy, *Br J Cancer* **72:** 1536–40.

Suresh MR (1996) Classification of tumor markers, *Anticancer Res* **16:**2273–7.
Suzuki M, Ohwada M, Aida I et al (1993) Macrophage colony-stimulating factor as a tumor marker for epithelial ovarian cancer, *Obstet Gynecol* **82:**946–50.
Suzuki M, Ohwada M, Sato I et al (1995) Serum level of macrophage colony-stimulating factor as a marker for gynecologic malignancies, *Oncol* **52:**128–33.
Takeshima N, Shimizu Y, Umezawa S et al (1994) Combined assay of serum levels of CA125 and CA19–9 in endometrial carcinoma, *Gynecol Oncol* **54:**321–6.
Tamakoshi K, Kikkawa F, Shibata K et al (1996) Clinical value of CA125, CA19–9, CEA, CA72–4, and TPA in borderline ovarian tumor, *Gynecol Oncol* **62:**67–72.
Tingulstad S, Hagen B, Skjeldstad FE et al (1996) Evaluation of a risk of malignancy index based on serum CA125, ultrasound findings and menopausal status in the pre-operative diagnosis of pelvic masses, *Br J Obstet Gynaecol* **103**(8):826–31.
Tomas C, Penttinen J, Risteli J et al (1990) Serum concentrations of CA125 and aminoterminal propeptide of type III procollagen (PIIINP) in patients with endometrial carcinoma, *Cancer* **66:**2399–406.
Tomas C, Risteli J, Risteli L et al (1991) Use of various epithelial tumor markers and a stromal marker in the assessment of cervical carcinoma, *Obstet Gynecol* **77:** 566–72.
Tsai SC, Kao CH, Wang SJ (1996) Study of a new tumour marker, CYFRA 21–1, in squamous cell carcinoma of the cervix, and comparison with squamous cell carcinoma antigen, *Neoplasma* **43:**27–9.
Van der Burg ME, Lammes FB, van Putten WL et al (1988) Ovarian cancer: the prognostic value of the serum half-life of CA125 during induction chemotherapy, *Gynecol Oncol* **30:**307–12.
Venesmaa P, Lehtovirta P, Stenman UH et al (1994) Tumour-associated trypsin inhibitor (TATI): comparison with CA125 as a preoperative prognostic indicator in advanced ovarian cancer, *Br J Cancer* **70:**1188–90.
Vergote IB, Bormer OP, Abeler VM (1987) Evaluation of serum CA125 levels in the monitoring of ovarian cancer, *Am J Obstet Gynecol* **157:**88–92.
Welt CK, Lambert-Messerlian G, Zheng W et al (1997) Presence of activin, inhibin, and follistatin in epithelial ovarian carcinoma, *J Clin Endocrinol Metab* **82**(11): 3720–7.
Whicher JT, Banks RE (1995) Cytokines and tumour markers, *Scand J Clin Lan Invest* **55**(221):122–44.
Woolas RP, Xu FJ, Jacobs IJ et al (1993) Elevation of multiple serum markers in patients with stage I ovarian cancer, *J Nail Cancer Inst* **85:**1748–51.
Yamashita K, Yamoto M, Shikone T et al (1997) Production of inhibin A and inhibin B in human ovarian sex cord stromal tumors, *Am J Obstet Gynecol* **177**(6):1450–7.
Yedema CA, Kenemans P, Thomas CM et al (1993a) CA125 serum levels in the early post-operative period do not reflect tumour reduction obtained by cytoreductive surgery, *Eur J Cancer* **29A:**966–71.
Yedema CA, Kenemans P, Voorhorst F et al (1993b) CA125 half-life in ovarian cancer: a multivariate survival analysis, *Br J Cancer* **67**(6):1361–7.
Zalel Y, Piura B, Elchalal U et al (1996) Diagnosis and management of malignant germ cell ovarian tumors in young females, *Int J Gynaecol Obstet* **55:**1–10.

4
Cross-sectional imaging

Jeremiah Healy

Simon Padley

Modern pelvic imaging is largely achieved using the cross-sectional modalities of ultrasonography, computed tomography and magnetic resonance imaging. These techniques can all elegantly display pelvic anatomy but have different strengths and weaknesses for the evaluation of gynaecological malignancies. Imaging may be used at presentation for diagnosis, in the assessment of disease extent prior to operation, and postoperatively for residual or recurrent disease evaluation. Imaging is also central to the assessment of response to adjuvant chemotherapy.

Carcinoma of the endometrium

In approximately 90% of cases, endometrial cancer is well-differentiated adenocarcinoma which typically presents with postmenopausal bleeding. Histopathological diagnosis is usually confirmed by hysteroscopy and curettage, which despite a small false negative rate of 2–6% remains the ‘gold standard’ for differentiating benign from malignant endometrium. At presentation 75% of women have tumour confined to the endometrium (stage IA) for whom the 5-year survival rate is 80% following total hysterectomy (Creasman et al., 1987). The International Federation of Obstetrics and Gynaecology (FIGO) committee recommends staging by total hysterectomy, bilateral salpingo-oophorectomy and lymphadenectomy.

Role of imaging

Imaging aids detection of endometrial carcinoma and helps select those postmenopausal women with bleeding who need dilatation and curettage for histopathological diagnosis. It can provide preoperative information about depth of myometrial invasion, an important prognostic indicator. In endometrial carcinoma the incidence of nodal metastases increases from 3% for stage IB tumours (invasion of less than half of the myometrium) to 40% for stage IC tumours (invasion of more than one half of the myometrium).

Imaging also allows assessment of the local extent of the tumour, such as cervical involvement (stage II) and local spread (stage III). Imaging can demonstrate enlarged pelvic and para-aortic lymph nodes which may assist surgical planning or identify patients with advanced disease (stage IV) in whom nonsurgical treatment may be more appropriate. Imaging is particularly useful in patients unfit for surgery or in whom clinical examination is difficult.

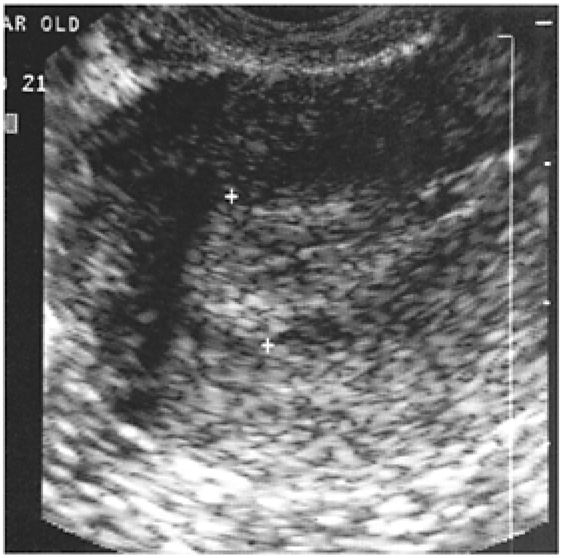


Figure 1

Transvaginal ultrasound. Normal hyperreflective endometrial appearances during the proliferate phase of the cycle. The endometrium is homogeneous in reflectivity and clearly delineated in outline

Ultrasonography

An office endometrial biopsy is the initial investigation of postmenopausal bleeding; pelvic ultrasonography may be used to select patients in whom hysteroscopy, dilatation and curettage are indicated. The normal endometrium is visualized as a highly reflective band in the centre of the uterus. Transvaginal sonography allows more precise measurement of endometrial thickness as the higher-frequency ultrasound probe gives images of improved spatial resolution.

Normal endometrial thickness and appearance vary with hormonal status (prepubertal, menstrual age or postmenopausal) and phase of the menstrual cycle. Early in the menstrual cycle the endometrium is visualized as a thin reflective line. In the proliferative phase the endometrium appears as a triple line (Figure 1), and in the secretory phase of the endometrium is at its greatest thickness, with homogeneously increased reflectivity and greater through transmission.

In women with postmenopausal bleeding a thin endometrium measuring 4 mm or less obviates the need for endometrial biopsy. Endometrial carcinoma is characterized by increased endometrial thickness, often with heterogeneous reflectivity and an irregular, ill-defined margin. However, there is overlap between the sonographic appearances of endometrial polyps, hyperplasia (associated with hormone replacement and tamoxifen therapy) and carcinoma in postmenopausal women with bleeding.

Transabdominal sonography is considered unreliable for staging endometrial carcinoma, but the reported accuracy of transvaginal ultrasound for assessing the depth of myometrial invasion ranges from 78% to 87%. However, overstaging is well recognized if the tumour is polypoid or when blood clot distends the endometrial cavity. The evidence for the benefit of Doppler ultrasonography in detecting and locally staging endometrial carcinoma is equivocal. Reports suggest no significant differences in Doppler flow measurements between benign and malignant uterine tumours.

Sonohysterography (transvaginal ultrasound scanning during the instillation of saline into the uterine cavity) can be helpful in further evaluating focal endometrial thickening and also appears to be very sensitive in identifying significant uterine pathology. Tumour spread beyond the uterus, especially nodal status, cannot be precisely evaluated using transvaginal ultrasound, which is a limitation in its overall usefulness in staging endometrial carcinoma.

From a recent meta-analysis transvaginal sonography appears to be very sensitive at detecting endometrial carcinoma (94.3%) but has a poor specificity (52.4%), giving it an overall accuracy of only 57%. However, it does have a very high negative predictive value (98.6%) (Timmermann et al., 1997).

Computed tomography

Dynamic contrast-enhanced computed tomography (CT) may show endometrial tumours as hypodense masses in the endometrial cavity or myometrium. In locally advanced disease it may show an eccentric mass extending into the parametrial tissues. Occasionally the uterus may be fluid-filled secondary to tumour obstruction of the endocervical canal or owing to tumour necrosis. However, CT is not as good as transvaginal sonography or magnetic resonance imaging (MRI) for staging early disease, with a staging accuracy of 76% for stage I and stage II disease.

The strength of CT lies in its ability to evaluate more advanced disease where there is parametrial or pelvic side-wall tumour spread. It is also useful in identifying both local and retroperitoneal lymph node enlargement, which if present should encourage lymphadenectomy at surgery. It may also identify distant metastases to the lungs, liver, bone and brain, which will aid in the planning of appropriate therapy.

Magnetic resonance imaging

On T_2-weighted imaging the uterus has a clearly delineated zonal anatomy which provides a useful guide in staging the depth of myometrial invasion in endometrial carcinoma (Figure 2). In the normal patient the endometrium has a high signal intensity and is separated from the peripheral myometrium by the inner myometrium or junctional zone which has a very low signal intensity because of its low water content and scanty extracellular matrix. The outermost layer identified on MRI, the peripheral myometrium, has a moderately high signal intensity which is slightly greater than that of striated muscle.

On T_2-weighted sequences endometrial carcinoma has a relatively high signal intensity, which widens the endometrial canal or causes its signal intensity to be more heterogeneous. These changes may be the only abnormality in stage IA carcinoma. On T_2-weighted sequences the signal intensity of the endometrial carcinoma is usually equal to (or less than) that of myometrium, and the tumour may be difficult to delineate (Figure 3). On T_2-weighted sequences the normal low signal of the junctional zone is replaced by hyperintense tumour in stage IB tumours (Figure 4). In stage IC tumours there is extension through the junctional zone into the outer half of the myometrium (Figure 5).

On T_2-weighted imaging the cervix also has a zonal anatomy, with high-signal central secretions, an inner low-signal band and an outer intermediate-signal band (see Figure 3). Disruption of the normal appearance allows identification of high-signal tumour extension into the cervical stroma, indicating stage II disease.

The accuracy for T_2-weighted sequences in assessing depth of myometrial invasion has been reported to be 68–85%. Overestimation of myometrial invasion is more common than its underestimation, especially in bulky tumours within a small uterus where the zonal anatomy is distorted, or if the junctional zone is atrophied, which commonly occurs in the menopause.

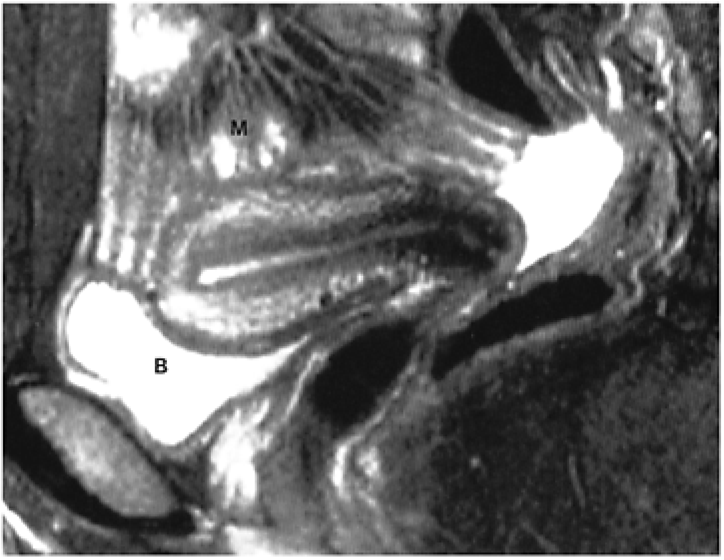


Figure 2

Sagittal T_2-weighted MR scan through a normal uterus. The normal signal characteristics of the uterus are demonstrated, with a relatively increased signal in the peripheral myometrium, a reduced signal from the junctional zone or inner myometrium and a high signal from the endometrium. The endometrial high signal continues into the cervical canal. The body of the cervix is generally of homogeneously low signal intensity owing to the lower water content. B, urinary bladder; M, small bowel mesentery

Contrast-enhanced T_1-weighted images of the uterus improve the accuracy of assessment of depth invasion because endometrial carcinoma enhances to a lesser degree than the surrounding myometrium. This also aids detection of extension into the cervix and spread into the parametrial tissues.

Dynamic contrast enhancement, with rapid acquisition of images after a bolus injection of gadolinium DTPA, assists myometrial staging by the identification of a subendometrial zone. The region enhances before the rest of the myometrium and corresponds histologically to the innermost part of the junctional zone (see Figure 4). Overall the sensitivity and accuracy of MRI for detecting deep myometrial invasion are significantly higher than transvaginal sonography or CT, ranging from 82% to 94%.

With the advent of rapid imaging sequences that allow acquisition of information during a single breath-hold, the ability of MRI to detect more advanced disease in the retroperitoneum and liver is improving. However, older studies report a poor sensitivity (17%) and positive predictive value (50%) for MRI detection of advanced disease.

Uterine sarcoma

Uterine sarcoma is a rare tumour, accounting for only 2–6% of gynaecological malignancies. Uterine sarcomas may be broadly divided into three subtypes. The first is the mixed müllerian sarcoma, which occurs most frequently in postmenopausal women. The other two types are endometrial stromal sarcomas and leiomyosarcomas, which usually present in younger women. Mixed müllerian sarcomas tend to be bulky, arising centrally within the uterus, and are frequently associated with necrosis (Figure 6). However, they have no imaging characteristics that aid their differentiation from endometrial carcinoma.

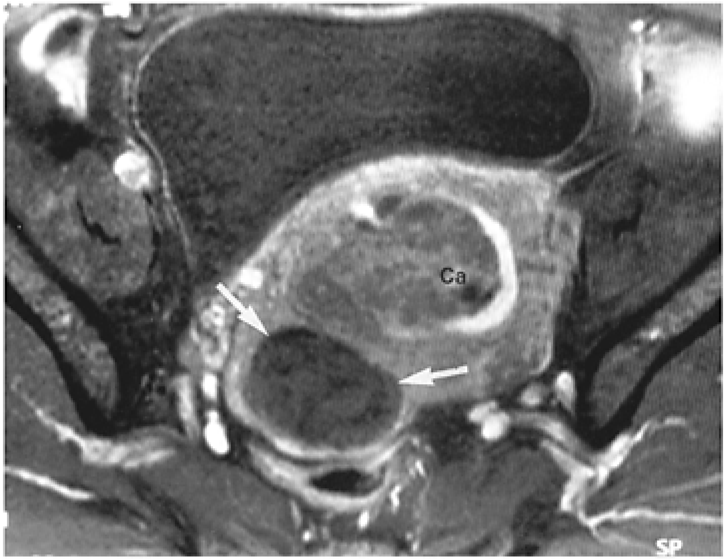


Figure 3

Axial T_1-weighted gradient echo MR scan through the body of the uterus. The signal from fat has been suppressed. There is an endometrial carcinoma bulging into the endometrial cavity (Ca). More posteriorly a low signal intensity uterine fibroid is present (arrows)

Leiomyosarcomas also tend to be bulky tumours indistinguishable from benign fibroids on imaging. Malignancy should be suspected if the tumour shows marked contour irregularity, significant necrosis or evidence of metastatic disease.

Carcinoma of the cervix

Invasive carcinoma of the cervix is most frequently squamous in histologic type (80–90% of cases), developing at the squamocolumnar junction. Adenocarcinoma and adenosquamous carcinomas tend to arise deeper in the endocervical canal and may remain occult until they are advanced. Histological examination establishes the diagnosis and determines whether disease is preinvasive (cervical intraepithelial neoplasia) or invasive.

Role of imaging

The FIGO committee recommends a clinical staging system with vaginal examination under anaesthesia, even though this strategy has obvious limitations in advanced disease. Although not officially part of the FIGO system of staging, cross-sectional imaging techniques are increasingly used to assess volume of the disease, parametrial spread (stage IIB, IIIB disease) and lymph node enlargement. More than 90% of patients with stage IB1 tumours (< 4 cm) and disease-free lymph nodes will be cured. In patients with stage IB2 disease (lesions more than or equal to 4 cm in diameter) the prognosis is halved if lymph node involvement is present.

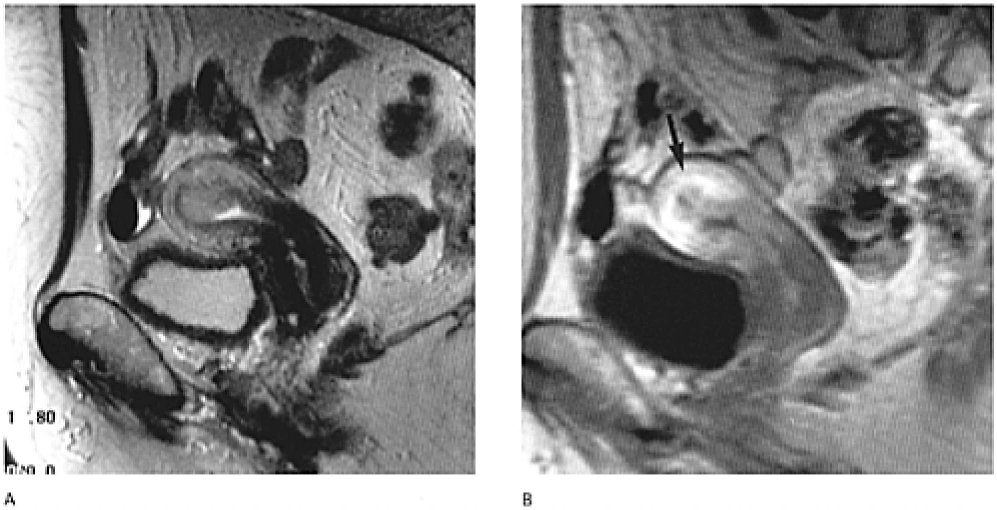


Figure 4

Stage IB endometrial carcinoma. (A) Sagittal T_2-weighted image demonstrates an endometrial carcinoma replacing the normal low-intensity junctional zone and bulging into the endometrial cavity. (B) The post-gadolinium contrast-enhanced T_1-weighted sagittal image demonstrates an intact and normally enhancing junctional zone (arrow), indicating that the tumour is confined to the inner myometrium without extension into the outer myometrium

Demonstration of lymphadenopathy may also modify treatment plans by directing the extent of lymphadenectomy Patients with parametrial spread (stage IIB, IIIB disease) may be treated with radiotherapy rather than surgery, or be treated with chemotherapy to achieve downstaging prior to surgery

Ultrasonography

Cervical tumours are usually hypoechoic on transvaginal and transrectal ultrasound scans, which are useful for assessing tumour size and determining infiltration into cervical tissues. Some reports suggest that local staging of early cervical cancer is equivalent to MRI and better than spiral CT (Yang et al., 1996).

Parametrial extension is suggested when there is soft tissue stranding laterally from the tumour, but because of their limited focal range neither transvaginal nor transrectal techniques can evaluate parametrial spread in bulky tumours or detect pelvic lymphadenopathy.

Computed tomography

Computed tomography has no role in the early stages of cervical cancer in terms of local spread. Local tumour may be identified on dynamic post-contrast images as an area of low attenuation in normally enhancing cervical stroma. A CT scan may identify parametrial spread as poor definition of the cervix with the surrounding fat or soft tissue stranding in the parametrial fat. False positive diagnoses are frequent, because hyperaemia and pericervical inflammatory changes (which are very common) can have similar appearances. Reliance on CT therefore often leads to overestimates of the extent of local disease, resulting in varying reports of accuracy in local staging of disease of 58% to 88%. More reliable signs of local spread include obliteration of the pericervical fat planes or an eccentric parametrial soft tissue mass (Vick et al., 1984).

Figure 5

Stage IC endometrial carcinoma. Tumour fills the endometrial cavity and extends into the outer myometrium, seen on a sagittal T_2-weighted image

More recent work suggests that helical CT may improve the differentiation between normal parametrial vessels and ligaments from adenopathy and tumour extention. Pelvic side-wall extension is characterized by tumour reaching the obturator internus or piriformis muscles. Bladder and rectal involvement is suggested if there is loss of the fat plane and asymmetric wall thickening of the adjacent viscera, nodular thickenings or contiguous masses extending into these organs, or by the demonstration of a fistula (Figure 7). Overall accuracy of diagnosing tumour extension to the pelvic side wall is over 90%.

Computed tomography will identify more distant spread by revealing retroperitoneal lymph node enlargement, hydronephrosis and liver metastases, which are infrequently present at the time of presentation.

Recurrent disease is also accurately assessed by CT, which has a high sensitivity and specificity for detecting recurrent pelvic tumour or pelvic and para-aortic lymph node enlargement. However, CT is not accurate in the differentiation of radiation fibrosis from postsurgical change or from recurrent disease. Vesicovaginal and rectovaginal fistulas can also be difficult to delinate on CT.

Magnetic resonance imaging

Magnetic resonance imaging, like CT, is not part of the formal FIGO staging system. However, it is frequently able to make a significant contribution to the staging of cervical cancer. This is especially so in bulky tumours, endocervical tumours, or tumours difficult to assess on examination under anaesthesia. In these cases MRI will aid evaluation of local tumour extent and can identify para-aortic and pelvic lymph node enlargement.

Invasive cervical carcinoma that is less than stage IB is not usually identified on MRI, but the site of the cervical biopsy is usually easily identified because of oedema and blood products. Tumours are usually of

Figure 6

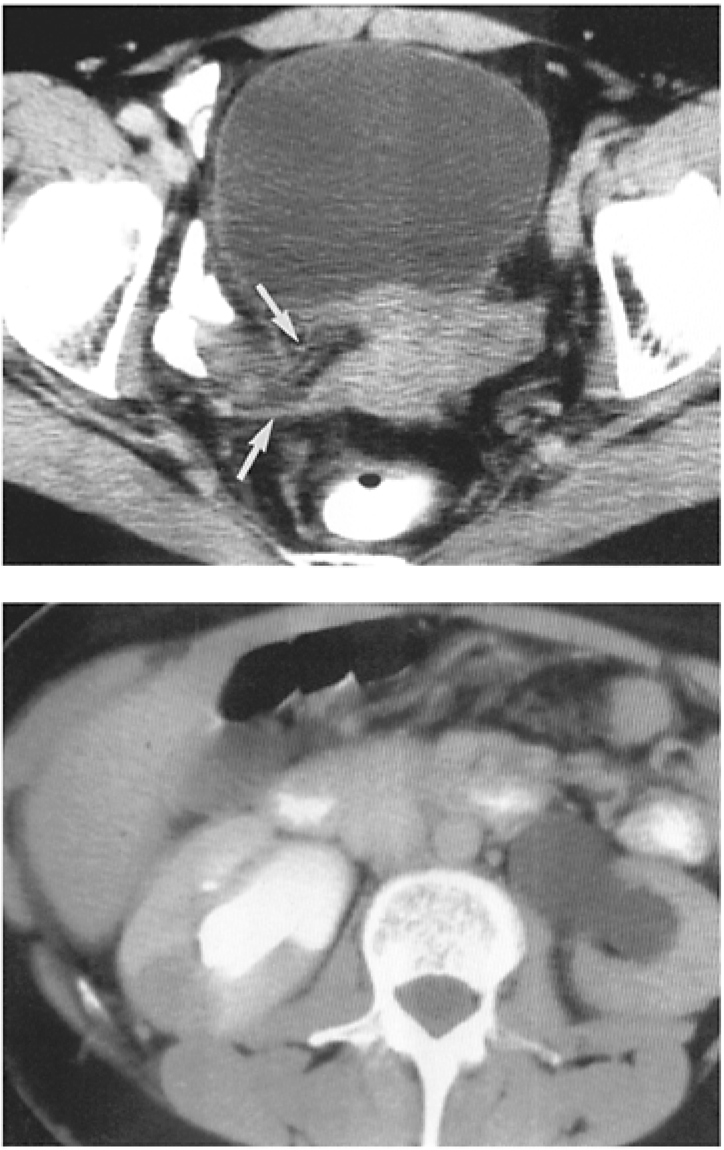
Sagittal T_2-weighted image through the pelvis. There is a Foley catheter (F) and a tampon (t) in situ. A large mixed signal intensity tumour replaces the normal uterus; at surgery this proved to be a partially necrotic uterine sarcoma

intermediate or high signal intensity on T_2-weighted images, surrounded by the very low signal intensity of the cervical stroma (Figure 8). Preservation of this low-intensity rim around the tumour on T_2-weighted imaging and a smooth interface with the surrounding parametrium (Figure 9) are reliable signs of tumour confined to the cervix (stage IB).

Extension into the vagina is readily identified on sagittal or coronal MRI; it may be into the upper third (stage IIA) or the lower third (stage IIIA). The accuracy of MRI for assessing vaginal extension is reported to be 72–93%.

Extension of tumour through the cervical stroma and into the surrounding parametrial fat is best seen on T_1-weighted images (stage IIB) (Figure 10). Magnetic resonance imaging will detect 95% of stage IB tumours and has an overall accuracy of detecting parametrial invasion of 70–90%. Similarly, stage IIIB tumour, which extends to the muscles of the pelvic side wall or obstructs the lower end of the uterus, is clearly seen on T_1- and T_2-weighted imaging. The use of MRI also allows detection of stage IVA disease by demonstration of extension into the bladder or rectum (Figure 11). Obliteration of the intervening fat planes can be identified on T_1-weighted images and disruption of the low signal intensity bladder or rectal wall can be identified on T_2-weighted images. Lymph node enlargement is best detected on T_1-weighted images, which can be achieved using breath-hold axial T_1-weighted images or coronal T_1-weighted images to survey the retroperitoneum. Magnetic resonance imaging performs similarly to CT in its ability to detect lymph node metastases, with accuracy ranging from 76% to 88%.

Like CT, MRI can be used to detect recurrent disease, but it is not always possible confidently to distinguish recurrent disease from postsurgical and radiotherapy changes which can appear as high-signal areas on T_2-weighted imaging for a prolonged time (Figure 12).



A

B

Figure 7

Computed tomography. (A) Contrast-enhanced scan through the cervix. There is bilateral parametrial invasion and thickening of the posterior bladder wall due to direct extension of carcinoma of the cervix into the adjacent tissue. Note the soft tissue density stranding in the paracervical fat, best seen on the right (arrows). (B) Scan through the level of the kidneys demonstrates partial obstruction of the right kidney and complete obstruction of the left kidney with bilateral hydronephrosis. No contrast has passed into the collecting system on the left because of the greater degree of obstruction (stage III)

Dynamic contrast-enhanced MRI with quantitative analysis of the time-enhancement curves may allow separation of recurrent disease from irradiated tissue. There are reports that initial staging of cervical cancer

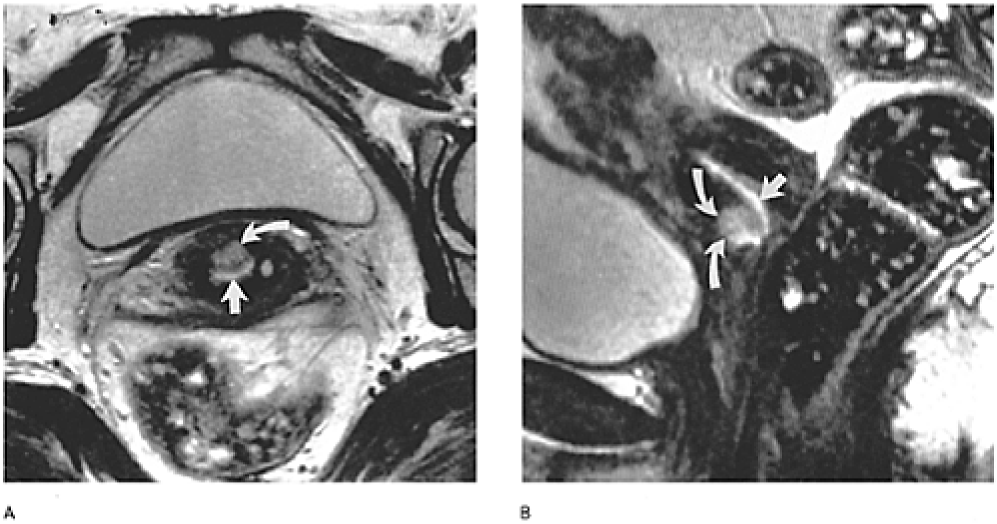


Figure 8

Stage I carcinoma of the cervix. (A) The axial T_2-weighted image through the cervix demonstrates the relatively high-signal carcinoma (curved arrow) surrounded by the low-signal normal cervical stroma. Normal high signal is demonstrated in the cervical canal (straight arrow). A nabothian follicle is also present as a round area of high intensity adjacent to the canal. (B) Sagittal image in the same patient. The normal cervical canal is demonstrated (short arrow) with a small carcinoma in the anterior lip of the cervix (curved arrows)

may be improved using this technique (Yamashita et al., 1996).

Magnetic resonance imaging is very good for the evaluation of vaginal fistulas (Figure 13), and furthermore can be used to distinguish fistulas associated with recurrent disease from those that are a complication of surgery or radiotherapy (Healy et al., 1996).

Gestational trophoblastic disease

Gestational trophoblastic disease is caused by abnormal proliferation of trophoblastic elements in the fertilized ovum, which has the potential for malignant transformation. Complete hydatidiform mole is the most common subtype of this disease, accounting for 80% of cases. The uterine cavity becomes distended by a grape-like proliferation of chorionic villi. Sonographically the uterus contains a complex multicystic/solid mass filling the uterine cavity, with anechoic spaces reflecting hydropic swelling of the villi. The process can be invasive with penetration of the uterine myometrium by trophoblastic elements. Malignant transformation into choriocarcinoma can also occur.

Ultrasonography cannot reliably distinguish between cpmplex hydatidiform mole confined to the uterus and invasive forms of the disease, such as choriocarcinoma, but can sometimes show myometrial invasion. Computed tomography and MRI are of limited value in routine management, but do have a role in demonstrating metastatic disease to the lungs or central nervous system (Newlands et al., 1995).

Surgical management is discussed in Chapter 13.

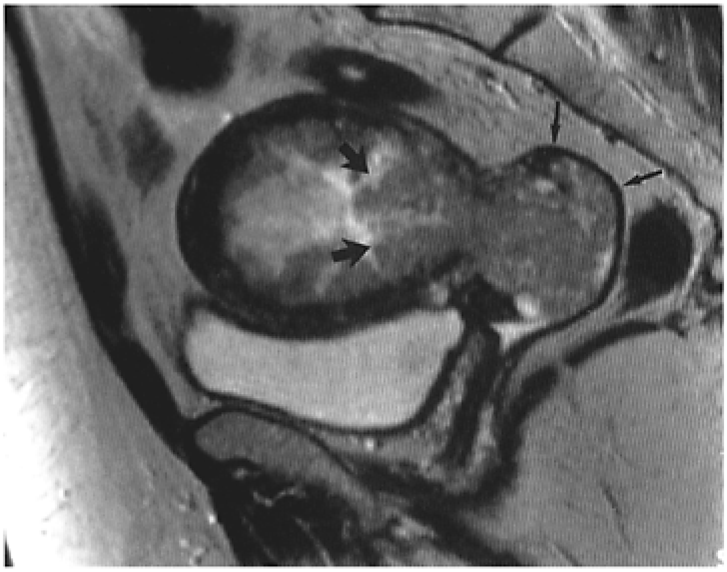


Figure 9

Carcinoma of the cervix (stage IBii). There is extension of a bulky cervical tumour into the uterus (arrows), and preservation of the normal low-signal vaginal wall in the posterior fornix (small arrows)

Carcinoma of the ovary

Ovarian cancer accounts for about 4% of all female cancers but is the most frequent cause of death from gynaecological malignancy. Primary ovarian tumours arise from one of three ovarian components, namely the surface epithelium, germ cells or stroma of the ovary. The age distribution varies according to tumour histology. Epithelial ovarian cancer is a disease of postmenopausal women, with approximate age at diagnosis of 60 years, whereas ovarian germ cell tumours and sex cord stromal tumours are most prevalent in the second and third decades. The majority of patients do not present until the tumour is large and there has been spread beyond the ovary, usually with intraperitoneal dissemination.

No satisfactory screening test exists for ovarian cancer, and thus early detection is very difficult. The value of cancer antigen 125 (CA125) in screening for ovarian cancer was assessed in 22 000 females by a study that highlights the difficulty in the early detection of these tumours. Amongst this large cohort 11 cancers were identified, of which 7 were advanced stage III and IV tumours. Seven patients with normal screening CA125 levels subsequently presented with ovarian cancer, two within a year of the normal result (Jacobs et al., 1993): see Chapter 3.

Once the diagnosis of ovarian cancer has been established FIGO recommends a staging system based on laparotomy with specified parameters for sampling high-risk areas such as the omentum and peritoneal reflections.

Role of imaging

At presentation imaging is important for identifying the organ of origin of a palpable pelvic mass, and aids characterization. Although imaging acts as a guideline for the differentiation of malignant from benign tumours, it is not sufficiently accurate to preclude the need for tissue diagnosis.

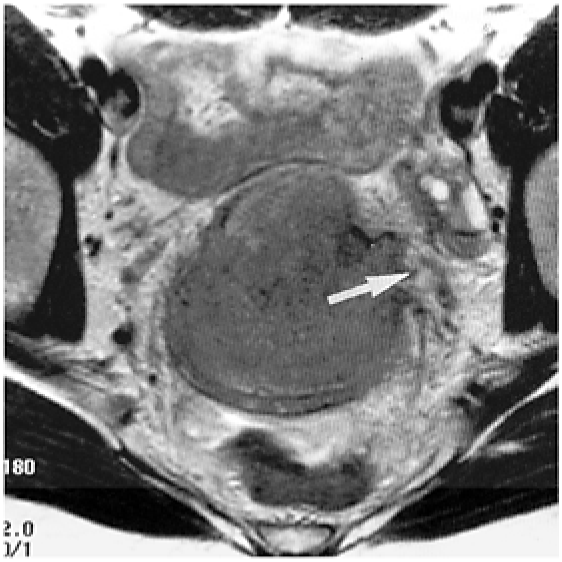


Figure 10

Axial T_2-weighted image through a cervical carcinoma. There is direct extension into the left parametrium with strands of tissue extending into the paracervical fat (arrow), indicating a stage IIB tumour

Characterization is usually achieved initially using ultrasound. Cross-sectional imaging may be performed before surgery if malignancy is clinically suspected in order to assess para-aortic and pelvic lymph nodes. There are a number of situations in which further preoperative imaging is required:

- when the diagnosis is uncertain
- when the gynaecologist requires overall assessment of the extent of disease
- for guidance of percutaneous aspiration/biopsy— care is required in cases of ‘seeding’ tumour
- to assess invasion of adjacent organs or structures in advanced local disease.

Ultrasonography

Ultrasonography is a valuable method of detecting and characterizing ovarian masses. This examination may be performed via a transabdominal or transvaginal approach and benefits from being quick, inexpensive and noninvasive. Transvaginal Ultrasonography is especially sensitive for detecting small tumours in postmenopausal females and is said to provide additional diagnostic information in 70% of cases, particularly in distinguishing malignant from benign pathology. Unilocular simple cysts with a thin wall, measuring less than 5 cm, are likely to be benign and can be followed up with imaging (Higgins et al., 1989; Fleischer, 1991).

Malignant ovarian masses range from entirely cystic to solid masses. Sonographic features that suggest malignancy include soft tissue vegetations on the cyst wall, irregular cyst wall thickening, a partially solid mass, a homogeneously solid mass, the presence of ascites, and peritoneal nodules. However, there is a significant overlap between the appearances of benign and of malignant masses, preventing accurate characterization by imaging criteria alone.

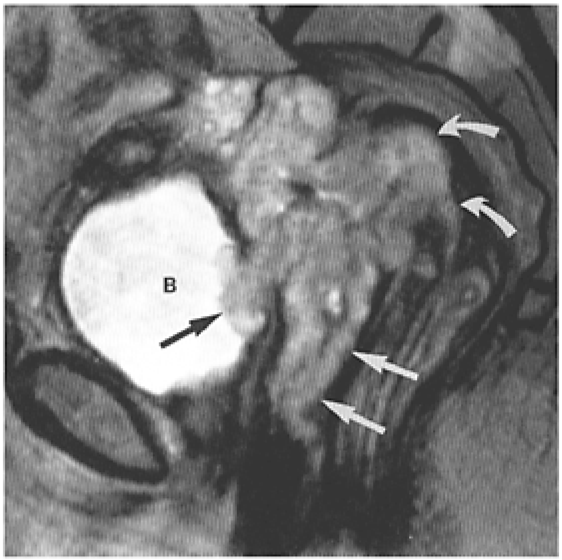


Figure 11

Carcinoma of the cervix, stage IVA. There is a large and exophytic adenocarcinoma of the cervix. On this T_2-weighted sagittal image there is direct extension through the posterior wall of the bladder, outlined by high-signal urine (arrow). There is also extension into the vagina (white arrows) and into the rectum (curved arrows). B, bladder

Colour flow Doppler studies may give some information regarding tumour vascularity, but again there is considerable overlap between the flow characteristics of benign and of malignant masses, and there is also regional variation in flow characteristics within malignant lesions (Figure 14).

Ultrasound is not widely used for staging ovarian malignancy because bowel gas can obscure deposits related to serosal surfaces and to peritoneal reflections. The overall staging accuracy is consequently poor (50–60%). Ultrasonography has an accuracy of 90% for detecting recurrent tumour within the pelvis but is not very sensitive for the identification of recurrent disease elsewhere within the peritoneum.

Computed tomography

Computed tomography is currently the most widely used imaging technique for staging ovarian cancer. On CT malignant ovarian masses frequently appear solid, partially solid/cystic, or cystic with papillary projections (Figure 15). Contrast enhancement is variable within septa, cyst walls and solid components. This imaging method has an accuracy in detecting ovarian masses of up to 95% but its ability to distinguish benignity from malignancy is reported to range from 64% to 94%. Signs of disseminated malignancy include invasion of adjacent organs or pelvic side-wall spread (stages II and III), and ascites, peritoneal and omental deposits (stage III).

On CT, peritoneal deposits may appear as rounded, cake-like, stellate or ill-defined masses (Figure 16). These tumour deposits may show contrast enhancement or uniform peritoneal thickening, especially in the right subphrenic space, greater omentum and pouch of Douglas.

Omental tumour is seen as an increased density within the omentum, which can be subtle or masslike. Computed tomography can identify psammomatous calcification in plaque-like peritoneal metastases, seen especially with serous cystadenocarcinoma. Distinctive mucinous peritoneal deposits are seen with

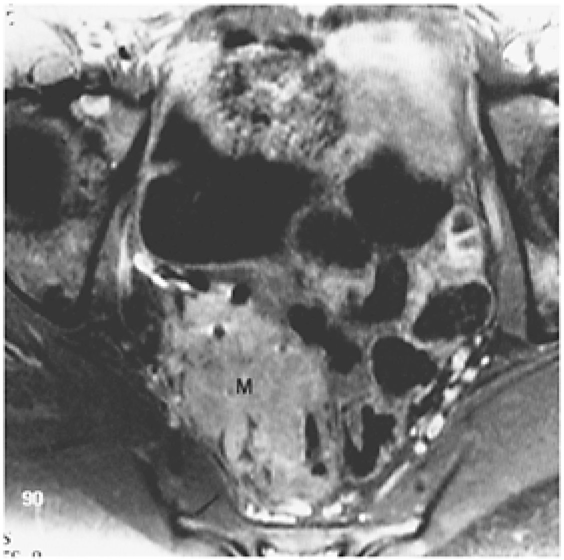


Figure 12

Post-contrast T_1-weighted fat-suppressed images through the pelvis of a patient following radical surgery for carcinoma of the cervix. There is a right posterolateral recurrent tumour mass (M) confirmed by needle biopsy

mucinous cystadenocarcinoma, which produces pseudomyxoma peritonei characterized by low-attenuation masses scalloping the liver margins and pushing the bowel posteriorly within the peritoneal cavity.

Computed tomography is frequently used to detect recurrent ovarian cancer and to document response to chemotherapy (Figure 17). However, because CT is predominantly an axial modality, deposits related to the vaginal vault and at the bladder base can be missed. The staging accuracy of CT ranges from 70% to 90%.

As stated above, CT cannot replace staging laparotomy but is useful for postoperative staging in patients with irresectable tumours or where surgery may have missed deposits—for example, posteriorly in the right lobe of the liver in a subcapsular location, or when there are enlarged retroperitoneal or retrocrural lymph nodes. Consequently CT is now the recommended imaging modality for staging, evaluating therapeutic response, and detecting recurrence.

Magnetic resonance imaging

Magnetic resonance imaging offers some potential benefits for evaluating ovarian neoplasms because of its multiplanar capabilities, its superior soft tissue contrast resolution, and the absence of ionizing radiation. However, despite more rapid sequences, physiologic motion in the form of bowel peristalisis and breathing can degrade abdominal imaging, with consequent reduced spatial resolution when compared with CT. In the pelvis these factors are less significant and in this location MRI is very good for evaluating ovarian pathology. At present, MRI has a role in the characterization of ovarian masses rather than staging ovarian malignancy.

Ovarian masses generally give a low to intermediate signal on T_1-weighted imaging and appear as complex masses with areas of low, intermediate and high signal on T_2-weighted images. The signal intensity of the cystic components of ovarian masses may vary depending on the protein content. Pure fluids will be

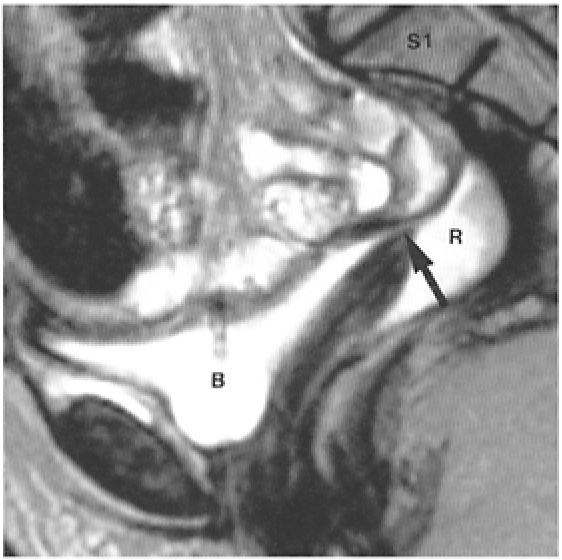


Figure 13

Rectovesical fistula following surgery and radiotherapy for carcinoma of the cervix. Sagittal T_2-weighted image demonstrating communication between the rectal and bladder contents via a fistulous tract (arrow). B, bladder; R, rectum; S1, first sacral segment

high-intensity on T_2-weighted images only, but mucinous or haemorrhagic cysts may be high-intensity on T_1 and intermediate on T_2-weighted images. The high degree of contrast on T_1-weighting between pelvic fat and ovary enhances the ability to detect extraovarian pelvic spread (stage II). Magnetic resonance imaging is also useful at identifying fat within ovarian teratomas, but calcification is not so clearly seen as on CT or ultrasound. Intravenous gadolinium improves lesion characterization by increasing the conspicuity of nodules and septa in complex cystic adnexal masses (Figure 18) (Forstner et al., 1995).

Magnetic resonance imaging has an accuracy of 60–93% in distinguishing benign from malignant lesions. Its multiplanar capability means that it is superior to both ultrasound and CT in differentiating adnexal from uterine masses and also in identifying spread to the bladder and rectum.

Although MRI has a limited role in staging intra-abdominal metastatic spread, peritoneal deposits greater than 1 cm can be identified with a similar sensitivity to CT. Using intravenous gadolinium with fat-suppressed T_1-weighted images may increase the conspicuity of peritoneal implants.

Despite some of the advantages of MRI, CT continues to be preferred for staging peritoneal disease, owing to the inferior spatial resolution of MRI and the degradation from bowel peristalsis and breathing artifact from the anterior abdominal wall.

References

Creasman WT, Morrow CP, Bundy BN et al (1987) Surgical pathologic spread patterns of endometrial cancer. A Gynecologic Oncology Group Study. *Cancer* **60**(8 suppl.): 2035–41.

Fleischer AC (1991) Transabdominal and transvaginal sonography of ovarian masses. *Clin Obstet Gynecol* **34:** 433–42.

Forstner R, Hricak H, Occhipinti KA et al (1995) Ovarian cancer: staging with CT and MR imaging. *Radiology* **197:** 619–26.

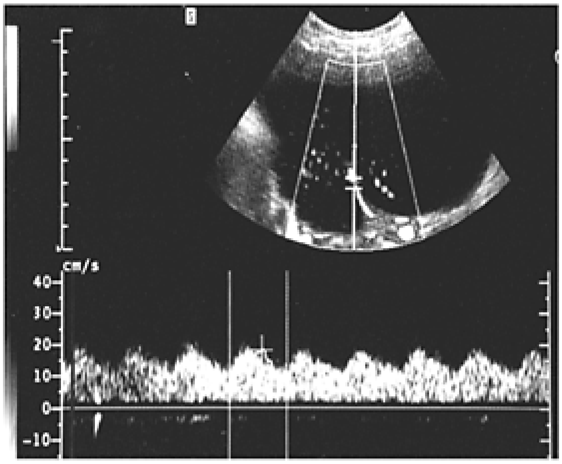
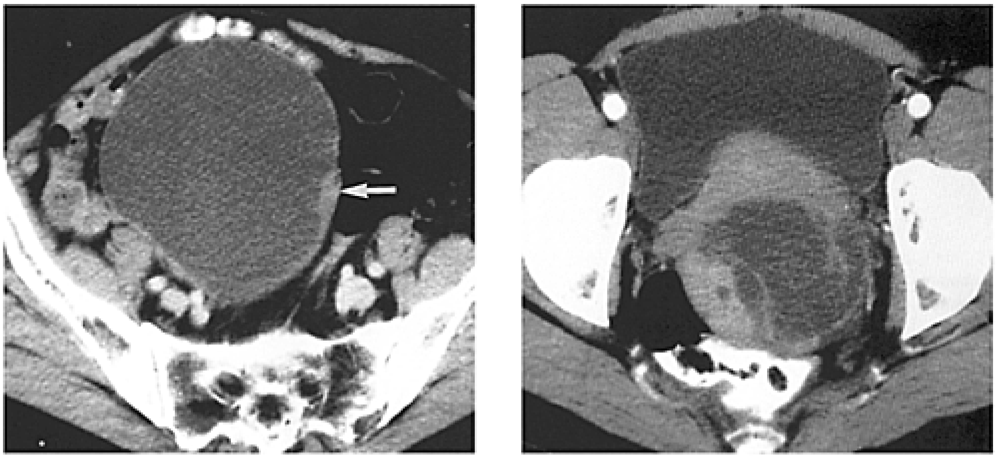


Figure 14

Ultrasound of septate, predominantly cystic pelvic mass. Doppler ultrasound scan of a septal vessel reveals a low-resistance waveform consistent with malignancy



A B

Figure 15

Ovarian carcinoma. (A) Contrast-enhanced CT scan through the pelvis demonstrating predominantly cystic carcinoma of the ovary with some mural thickening (arrow). (B) Mixed solid and cystic ovarian carinoma in a different patient

Healy JC, Phillips RR, Reznek RH et al (1996) The MR appearance of vaginal fistulas. *Am J Roentgenol* **167:** 1487–9.

Higgins RV, van Nagell JR, Donaldson ES et al (1989) Transvaginal sonography as a screening method for ovarian cancer. *Gynecol Oncol* **34:**402–6.

Jacobs I, Davies AP, Bridges J et al (1993) Prevalence screening for ovarian cancer in postmenopausal women by CA 125 measurement and ultrasonography [see comments]. *Br Med J* **306:**1030–4.

Newlands ES, Price P, Sikora K, editors (1995) *Treatment of cancer.* 3rd edn. London: Chapman & Hall, pp. 721–34.

Timmermann D, Vergote I, Brosens I, Wamsteker K, editors (1997) *Diagnostic imaging in obstetrics and gynaecology: a practical guide.* London: WB Saunders; p. 200.

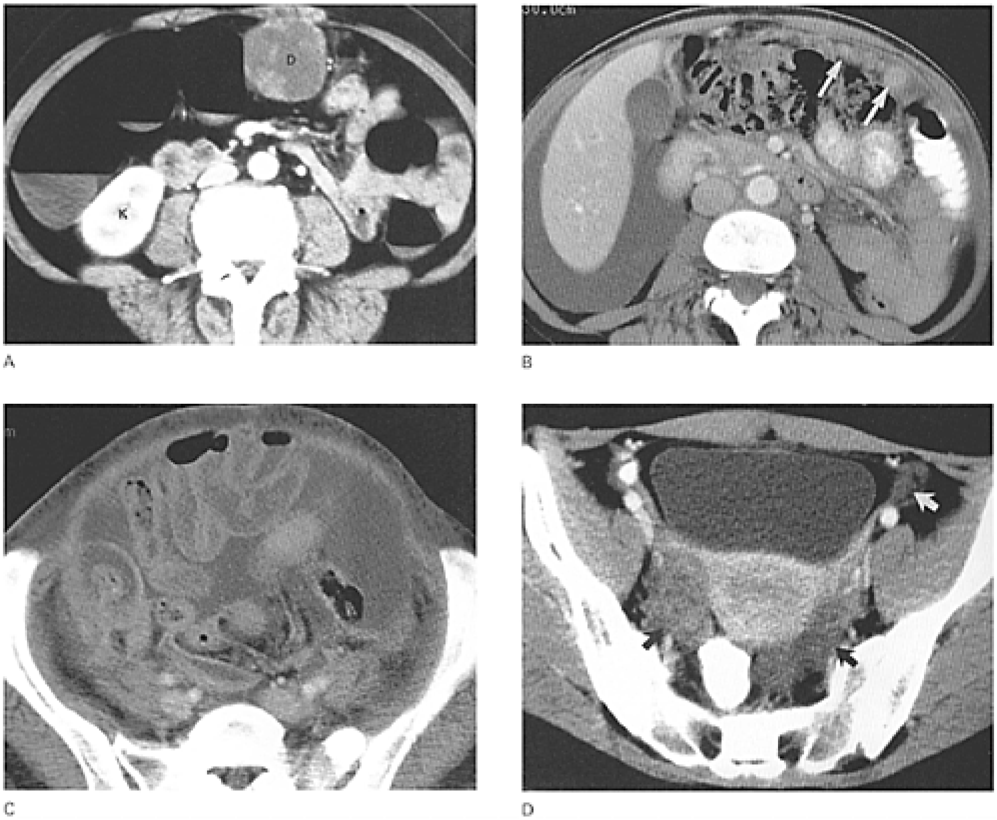


Figure 16

Manifestations of peritoneal spread from carcinoma of the ovary. (A) Partially necrotic, solid omental deposit (D) at the level of the lower pole of the right kidney. K, kidney. (B) Nodular omental deposits (arrows) and abdominal ascites. (C) Diffuse serosal thickening of the surface of the small bowel with extensive ascites due to low-volume peritoneal disease. (D) Bilateral ovarian carcinoma (black arrows) with a deposit in the left round ligament (white arrow)

Vick CW, Walsh JW, Wheelock JB, Brewer WH (1984) CT of the normal and abnormal parametria in cervical cancer. *Am J Roentgenol* **143:**597–603.

Yamashita Y, Harada M, Torashima M et al (1996) Dynamic MR imaging of recurrent postoperative cervical cancer. *J Magn Reson Imaging* **6:**167–71.

Yang WT, Walkden SB, Ho S et al (1996) Transrectal ultrasound in the evaluation of cervical carcinoma and comparison with spiral computed tomography and magnetic resonance imaging. *Br J Radiol* **69**(823): 610–16.

Figure 17

Recurrent carcinoma of the ovary producing surface deposits within the liver. (A) Surface deposit underneath the right hemidiaphragm scalloping the superior surface of the liver. (B) Further deposit posteriorly in the right lobe (arrow)

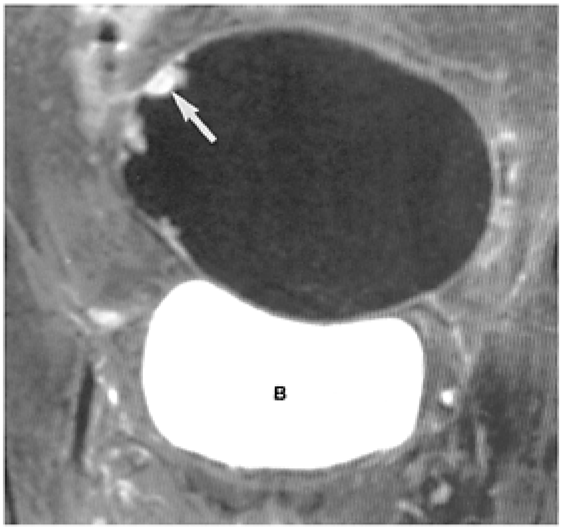


Figure 18

Coronal T_1-weighted image following gadolinium contrast through a predominantly cystic carcinoma of the ovary. Following gadolinium there is enhancement of tumour nodules within the cyst wall (arrow). B, bladder

5
Sigmoidoscopy, cystoscopy and stenting

Peter A Davis

David J Corless

Sigmoidoscopy

Indications

Sigmoidoscopy forms part of the routine examination of patients who complain of colorectal symptoms. Patients presenting with rectal bleeding or a change in bowel habit should undergo either a rigid Sigmoidoscopy followed by a barium enema, or a colonoscopy. In addition, patients presenting with vulval carcinoma extending to the perineum should have anal and rectal assessment. Flexible Sigmoidoscopy can be used to confirm lesions in the distal colon and rectum, to obtain material, and in the follow-up of patients who have undergone colonic resections.

Preoperative preparation

Rigid Sigmoidoscopy can be performed in the outpatient department without any special preparation. Bowel preparation in most instances is unnecessary but in some cases faeces in the rectum may limit views and the advancement of the sigmoidoscope. In these cases either a glycerine suppository or a phosphate enema can be used prior to the examination.

Flexible Sigmoidoscopy is usually carried out in the endoscopy suite with or without sedation. Adequate bowel preparation of the left colon and rectum is usually provided by a regimen of clear fluids for 24 hours and two sachets of sodium picosulphate taken the previous day.

Instrumentation

Rigid sigmoidoscope

The rigid sigmoidoscope (Figure 1) is approximately 25 cm long with a 19 mm internal diameter and an internal obturator to aid insertion. It has a detachable eye-piece, which allows instruments to be passed along the shaft, and a circumferential light source. Bellows attached to the distal end are used to insufflate the rectum with air. Newer instruments are disposable, being made of self-lubricating plastic. Useful appendages are a punch biopsy, grasping forceps and suction tubing.

Figure 1

Rigid sigmoidoscope and proctoscope

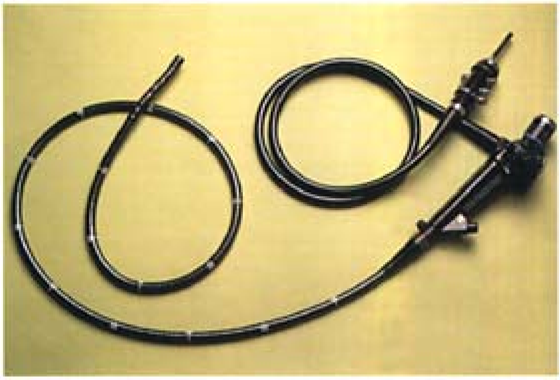


Figure 2

Flexible sigmoidoscope or colonoscope

Flexible sigmoidoscope

The flexible sigmoidoscope (Figure 2) is 70–110 cm long and consists of a control head with eye-piece and controls, a multichannel flexible shaft and a control-lable tip. The flexible shaft contains fibreoptic channels carrying the optics and light source to the visual field, as well as channels for suction, irrigation and insufflation of the colon, and the passage of instruments. Movement of the tip in two planes is produced by pulling wires operated at the control head. The eye-piece can be attached to a video camera and the image viewed on a monitor. Immediately after use, instruments should be washed in fresh disinfectant in accordance with the manufacturers' instructions.

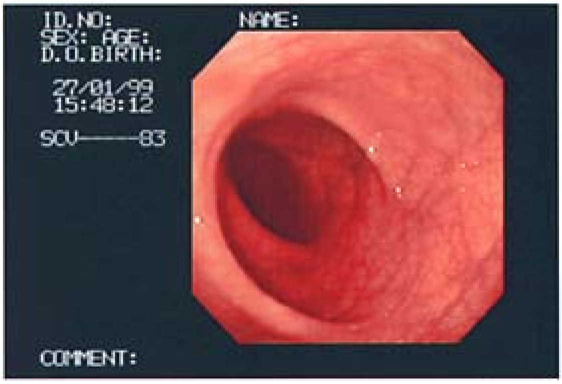


Figure 3

View of rectum at sigmoidoscopy

Operative procedure

Rigid sigmoidoscope

Patients are usually placed in the left lateral position on a couch or bed and a digital examination of the rectum is performed. The sigmoidoscope is held in the right hand with the left hand holding the buttocks for insertion. The instrument is lubricated and inserted into the anal canal, pointing towards the umbilicus with the obturator in place. When the instrument is felt to enter the rectum it is directed posteriorly and the obturator removed. Using the bellows the rectum is gently insufflated with air which allows the sigmoidoscope to be advanced while visualizing the whole circumference of the lumen. As the sigmoidoscope is passed through the rectum it follows an anterior curve formed by the hollow of the sacrum (Figure 3). Inspection of the whole mucosa can be achieved by rotating the instrument. Negotiation of the instrument at the rectosigmoid junction should be carried out with care; it can be achieved using gentle insufflation and manipulation in order to find the lumen of the sigmoid colon. The best views are often obtained while withdrawing the sigmoidoscope, and inspection of the mucosa—particularly around the horizontal rectal folds—should be carried out.

Rectal biopsy

The sigmoidoscope is manipulated so that the lesion is at the tip of the instrument. The glass eye-piece is removed; although this causes deflation of the rectum, the lesion should still be in view. Punch biopsy forceps are passed along the sigmoidoscope and the biopsy is taken under direct vision. The jaws of the biopsy forceps are closed around the lesion and removal is aided by rotation of the closed forceps. Excessive bleeding at the site of the biopsy can easily be controlled with pressure from a cotton-wool swab or occasionally injection of 1 in 1000 adrenaline.

Polypectomy

Polyps with a long stalk can be removed using a diathermy snare technique through the rigid sigmoidoscope. The polyp is grasped with polyp-holding forceps which have been passed through the loop of a diathermy snare. The snare is then passed over the polyp and closure of the snare during application of diathermy coagulates the stalk. The polyp is then removed by the forceps and the excision site inspected for bleeding. It is important to avoid excessive traction on the forceps since this may result in removal of excess normal mucosa and hence perforation.

Flexible sigmoidoscope

Patients are placed in the left lateral position on a couch or bed and a digital examination of the rectum is performed. Intravenous sedation and oxygen may be administered via a face mask or nasal prongs and a pulse oximeter attached to the patient. The tip of the sigmoidoscope is lubricated and inserted into the anal canal for a distance of 4–5 cm. Initially inspection usually reveals a red blur as the tip of the sigmoidoscope rests against the rectal mucosa. The rectum is gently inflated and the tip position adjusted and withdrawn until the lumen comes into view. It may be necessary to adjust the focus, wash the lens and suck out any residual fluid or faeces to optimize the image. With gentle insufflation and guidance of the tip, the sigmoidoscope is advanced through the lumen and the rectosigmoid junction negotiated under direct vision. If the lumen or movement across the mucosa is not seen, then the sigmoidoscope should be withdrawn until the lumen once again comes into view. Looping of the sigmoidoscope prevents advancement and in such cases the instrument should also be withdrawn. In most patients, a combination of manipulation of the tip and twisting of the shaft should make it possible to examine the whole left colon. The best views are once again seen on slow withdrawal of the sigmoidoscope, keeping the lumen in view all the way and aspirating as much air as possible. Biopsy can also be performed on withdrawal. The lesion is cleaned by injecting water down the irrigation channel and biopsy forceps are passed through the instrument port. The biopsy is taken under direct vision, the closure usually performed by an assistant who then removes the forceps while the operator directs the sigmoidoscope and the position of the biopsy. The incidence of perforation with flexible sigmoidoscopy is extremely low, but if the patient complains of excessive pain or discomfort then the examination should cease.

Postoperative care

No special postoperative care is necessary after routine sigmoidoscopy. After a polypectomy or biopsy the patient should be observed for signs of excessive bleeding or perforation. Barium enema should not be performed for 10 days after biopsy because of the risk of extravasation of contrast.

Cystoscopy and stenting

Indications

Cystoscopy is the single most common urological procedure and is used in the investigation of urinary symptoms. Patients who present with urological symptoms such as frequency, dysuria and haematuria undergo cystoscopy for the diagnosis of lesions of the urethra and bladder. In addition, cystoscopy may be performed as part of the FIGO preoperative staging for cervical carcinoma or where it is suspected that

Figure 4

Rigid cystoscope

tumours may involve the bladder and urethra. It can also be used to perform retrograde ureterography to provide x-ray visualization of the ureter and collecting system and the placement of retrograde ureteric stents. Stents provide ureteric drainage and can also be used to identify the position of the ureter. Where retrograde stenting proves impossible the interventional radiologist may well be able to pass antegrade stents or, failing this, to insert bilateral nephrostomy tubes.

Preoperative preparation

Rigid cystoscopy is carried out under general anaesthesia in the operating theatre with the patient in the lithotomy position. It is important to rule out severe osteoarthritis of the hips which may make examination impossible. Antibiotic prophylaxis is given if there is any evidence or suspicion of a urinary tract infection.

Flexible cystoscopy is usually carried out in the endoscopy suite under local anaesthesia. Lignocaine (lidocaine) gel inserted into the urethra acts as both lubricant and local anaesthetic agent. If possible the patient should void prior to examination to ensure the bladder is empty.

Instrumentation

Rigid cystoscope

The rigid cystoscope (Figure 4) is composed of a sheath, a bridge and a telescope: it is 30 cm long. The sheath has both an inlet and an outlet port for irrigation and is attached to the bridge with a watertight lock. The endoscope is introduced into the sheath through the bridge, and is also fitted with a watertight lock. The telescope comprises a hollow metal cylinder containing a series of solid rod lenses and a magnifying eye-piece. In front of the eye-piece is a pillar connected to a fibre-optic light source which transmits light to the visual field. The bridge has one or two other ports for the introduction of biopsy forceps and electrodes, and a director which allows the passage of a ureteric catheter and its advancement into the ureteric orifice. Endoscopes with viewing angles of 0°, 30°, 70° and 90° are available.

Flexible cystoscope

The flexible cystoscope (Figure 5) is 35–40 cm long and consists of a control head with eye-piece and controls, a multichannel flexible shaft and a controllable tip. The flexible shaft contains fibreoptic channels carrying the optics and light source to the visual field, an irrigation channel and a biopsy channel. Movement of the tip occurs in one plane and ranges from 145° to 180°, controlled by a deflecting level adjacent to the eye-piece.

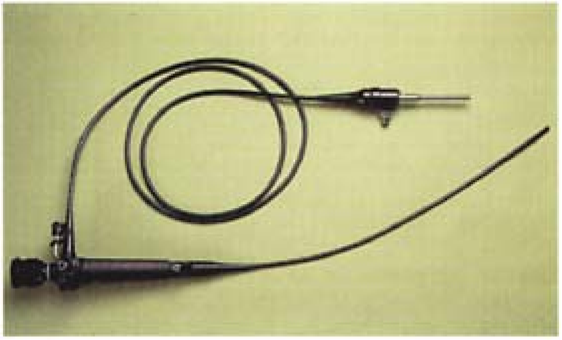


Figure 5

Flexible cystoscope

Figure 6

Ureteric orifices

Operative procedure

Rigid cystoscope

The patient is placed on the operating table in the lithotomy position. The cystoscope sheath is lubricated and introduced into the urethra. The female urethra is about 4 cm long and has a relatively uniform calibre from the meatus to the bladder outlet. Upon entering the bladder the telescope is removed to allow the residual urine and irrigant to drain from the bladder: this may be sent for cytological and bacteriological analysis. Approximately 50 ml of saline is inserted and the fundus of the bladder is identified by finding the air bubble. With incomplete distension the bladder mucosa appears rugated, but as the irrigant fluid distends the bladder the mucosa becomes smooth. The ureteric orifices are visualized on the interureteric ridge at the superolateral corners of the trigone (Figure 6). By regular sweeping of the cystoscope backwards and forwards and rotation of the endoscope the entire bladder mucosa can be visualized. Views of the

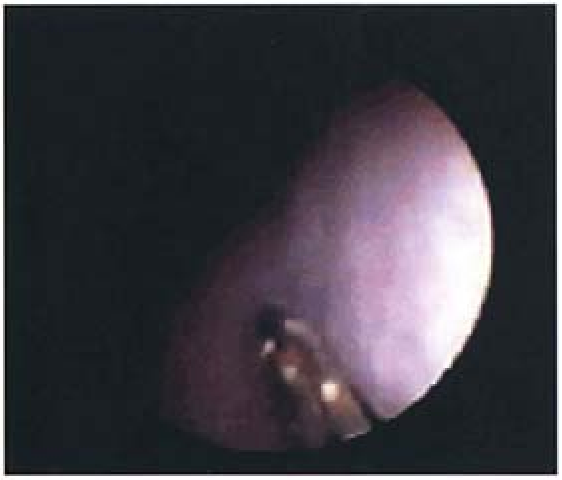


Figure 7

Bladder biopsy

anteroinferior bladder are obtained by suprapubic compression with the hand. At the completion of the examination, the irrigating fluid is evacuated from the bladder by removing the telescope and the instrument is slowly withdrawn. A bimanual examination of the pelvis is performed after the procedure.

Bladder biopsy

Bladder biopsy (Figures 7, 8) is the procedure most commonly performed during cystoscopy Biopsy forceps are introduced down the cystoscope sheath via a port in the bridge, sometimes together with a diathermy wire. This allows cup biopsies of the mucosa to be taken. If required, the biopsy sites are then cauterized with diathermy to prevent excessive bleeding.

Ureteric catheterization and stenting

The instrumentation and stenting of ureters should only be performed by clinicians such as gynaecologic oncologists trained in this procedure since it is easy to damage the ureteric orifices and ureters. Ureteric catheterization and the placement of double J stents is achieved with the 30° telescope. There is a special port for the introduction of the stents which can be directed towards the ureteric orifices. A floppy-tipped, Teflon-coated guide wire is first placed into the ureteric orifice and advanced under fluoroscopic control into the renal pelvis. The double J stent is slid over the guide wire through the channel of the cystoscope and into the ureter (Figure 9). The stent is radio-opaque and its position is monitored by fluoroscopic control. Excessive force used in insertion of the guide wire or stent should be avoided. The proximal and distal ends curl to form a J shape when they are correctly placed in the renal pelvis and bladder respectively.

Flexible cystoscope

The patient is placed on the operating table or bed in the ‘frog-leg’ position. The cystoscope is lubricated and introduced into the urethra. The end of the cystoscope is passed into the bladder and deflected upwards.

Figure 8

Bladder biopsy

Figure 9

Introduction of the double J stent

The midline of the anterior bladder is examined by withdrawing the instrument until the bladder outlet is encountered. The cystoscope is then pushed back into the bladder, rotated 30° and withdrawn again. This process is continued until the entire bladder has been inspected. Biopsy of the bladder mucosa can also be achieved by the passage of biopsy forceps down the instrumental channel of the cystoscope.

Postoperative care

No special postoperative measures are needed.

Bibliography

Calne RY, Pollard SG (1992) *Operative surgery*. London: Gower.
Carter DC, Russell RCG, Pitt HA (1996) *Atlas of general surgery*, 3rd edn. London: Chapman & Hall.
Cotton PB, Williams CB (1990) *Practical gastrointestinal endoscopy*, 3rd edn. Oxford: Blackwell.
Jackson E, Fowler JR (1992) *Urological surgery*. Mastery of Surgery series. New York: Little, Brown.
Reuter HJ (1987) *Atlas of urological endoscopy: diagnosis and treatment*. New York: Thieme.

6
Cone biopsy

Giuseppe Del Priore

Introduction

The cone biopsy, the removal of a cone-shaped portion of the cervix, has been performed by gynecologists for decades. Recently, the electrosurgical technique referred to as the loop electrosurgical excision procedure' (LEEP) or 'loop excision of the transformation zone' (LETZ) has gained popularity. It has several advantages over other methods such as laser, cryotherapy and scalpel excision: these include less bleeding and discomfort, and the avoidance of general anesthesia, while still providing a reasonable specimen for pathologic interpretation. The scalpel and LEEP techniques are generally equivalent in their clinically significant outcomes, e.g. cure rates. However, the scalpel cone tends to be larger. This is not a particular advantage except perhaps when used in patients with adenocarcinoma of the endocervix: because this lesion may be more multifocal than squamous lesions, a larger specimen may be more likely to remove all of the lesion. As it may occasionally be necessary to perform a scalpel cone biopsy, all gynecologists should be familiar with both techniques. The histological specimen obtained by scalpel or LEEP allows assessment of excision margins. If cervical intraepithelial neoplasia (CIN) extends to the excision margins, the LEEP specimen is not reliably predictive of recurrence. Thus a scalpel cone biopsy is useful in cases of suspected microinvasion as well as in those cases of suspected adenocarcinoma.

Indications

Cone biopsy is indicated for the diagnosis or exclusion of microinvasive cervical cancer suspected from a presurgical Papanicolaou (Pap) smear or colposcopic punch biopsy. It should also be used to exclude and possibly treat endocervical adenocarcinoma. As mentioned above, a large scalpel cone biopsy may be a better option for these women. A LEEP cone biopsy is also indicated for patients with high-grade squamous epithelial lesions on Pap smear but no colposcopically identifiable lesion.

Anatomic considerations

Vascular supply

A small descending branch of the uterine artery supplies the cervix. This vessel can usually be found laterally in the vaginal portion of the cervix at the 3 o'clock and 9 o'clock positions.

Innervation

The nerves of the cervix arise from the hypogastric plexus. Specific branches from this plexus to the cervix, sometimes known as the uterovaginal plexus, are found in the broad ligament. More distally, the uterine cervical ganglion may be identified in the paracervical tissue closest to the cervix. The autonomic sympathetic nerves arise from the sympathetic trunk originating in the nerve roots from T10 to L1. The parasympathetic nerves arise from the roots of S2 to S4.

Muscles involved

The cervix sits above the urogenital diaphragm and thus has no direct muscle connection.

Bony landmarks

The cervix lies roughly in the plane of the ischial spine, being slightly anterior and inferior to it. It is important to consider the bony pelvic outlet when contemplating operating transvaginally on the cervix. For cone biopsies, only the most contracted pelvis would present a significant limitation.

Operative procedure

LEEP/LETZ

The procedure begins with the positioning of the patient’s legs. The standard examination table with stirrups is usually suitable. A speculum large enough to hold the vaginal wall away from the cervix should be inserted. An insulated speculum is not necessary; in fact, if an insulated speculum has an undetected break in its insulation, it may allow a high-energy discharge and injure the patient. Regardless of the speculum used, a suction apparatus for evacuating the copious amount of smoke produced is essential. It may either be built into the speculum or clipped on to a standard one. Hand-held wall suction is generally not appropriate as the apparatus is usually too large to fit into the vagina.

Immediately before the actual procedure, colposcopy is used to identify the lesion. Local anesthetic solution should be administered circumferentially using a narrow gauge (27 G) reinforced needle such as a Potocky needle. Larger needles will lead to significantly more bleeding. Any local anesthetic solution with epinephrine (adrenaline) 1 in 100 000 may be used. Since water dissipates the electrosurgical current, excess stromal injections may make the procedure difficult, and shallow injection is advised. Discomfort from the local injection can be minimized by having the patient cough while the needle is placed on the surface of the cervix. The inferior movement of the cervix during this Valsalva maneuver is usually all that is needed to enable the needle to enter the cervix painlessly. The anesthetic solution should be administered early to allow enough time for it to take effect (Figure 1).

Different electrosurgical units have different settings and power sources. The only important parameter is current density. This is the actual energy that the cervix receives and is dependent on the diameter of the wire loop, the diameter of the wire itself, and the current setting. The highest current density possible should be used to minimize drag through the tissue and consequently cautery artifact. However, too high a current density will result in the loop wire breaking. If this should happen, completing the procedure will be more difficult because the operator will have to begin with a new wire loop in the middle of the specimen. Trial and error may be needed depending on the combination of generator and loop wires used.

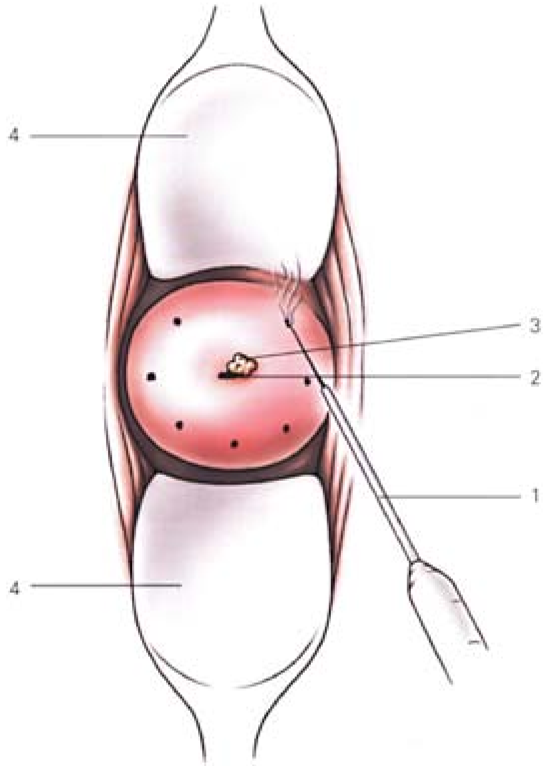


Figure 1

1 Reinforced shaft with thin needle

2 Squamocolumnar junction

3 Acetowhite epithelium

4 Speculum blades

After infiltration of the cervix, the operator should choose a loop size and shape that can remove the colposcopically identified acetowhite lesion with clear margins (Figure 2). It is customary to remove the entire transformation zone. The operator should practice the motion to be used before actually turning on the current. Once a comfortable motion has been established, the colposcope is used to identify the lesion and the transformation zone should be removed. A very low magnification setting is selected to facilitate ease of operability. Once everything has been checked, the operator applies the pure cutting current and smoothly passes the loop wire through the cervix, being careful not to touch the vaginal wall. The specimen may be grasped with forceps and removed for despatch to the pathology department. A sample of the endocervical canal may be obtained at this point using an endocervical curette or brush. It is also possible to use a smaller loop to obtain a 'top hat' of tissue if colposcopy suggests that the lesion is in the endocervical canal out of view.

Although there is usually no immediate bleeding, late rebleeding can be reduced by prophylactic cauterization of the cone base. This should be done using a ball or spatula tip cautery attachment. The current should be set on 'coagulation' at a sufficiently high current setting to exceed the capacitance of air.

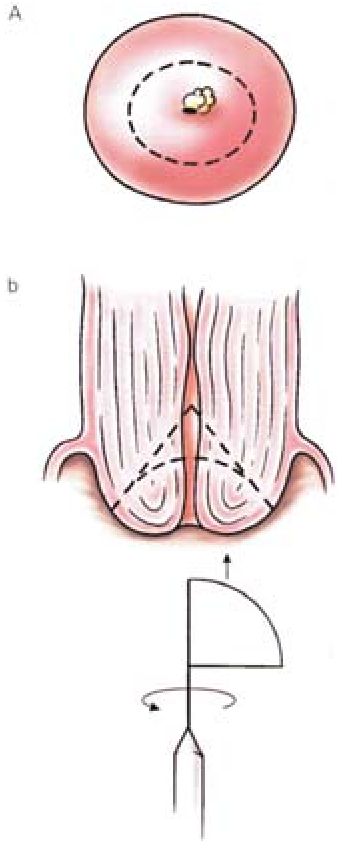


Figure 2

A Clear lateral margins

B Profile of cone biopsy margins

The ball or other tip should then be held a few millimeters from the surface of the cone base to allow the current to arc across to the tissue requiring hemostasis. This cauterization produces thermal damage to a depth of 2–3 mm, further reducing the chances of recurrence but making the excision margins of the sample unreliable for determining prospects of recurrence. After the entire base has been cauterized in this manner, ferric subsulfate (Monsel's) solution should be applied. The patient should be instructed not place anything in the vagina for at least 2 weeks. A routine postoperative visit is not necessary.

Scalpel or 'cold knife' cone biopsy

Colposcopy should again be used to identify the lesion. The scalpel cone biopsy procedure does not require a special speculum with smoke evacuator. However, wall suction must be available since considerably more bleeding will be encountered. Since the procedure lasts longer than the LEEP and patient cooperation is necessary to deal with the intraoperative bleeding, either general or regional anesthesia is usually required.

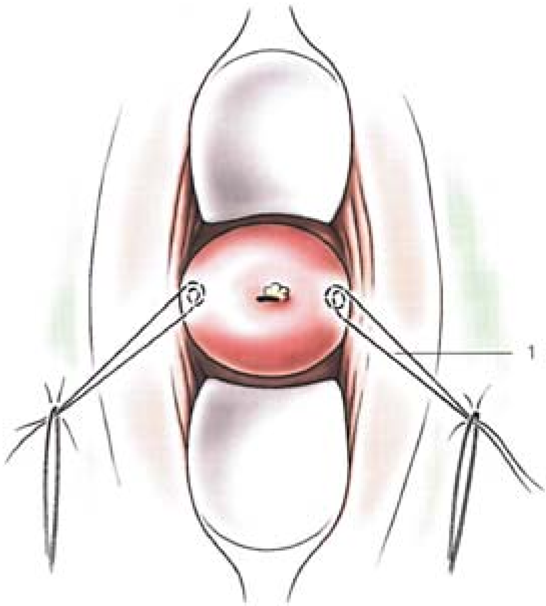


Figure 3

1 Hemostat on drape

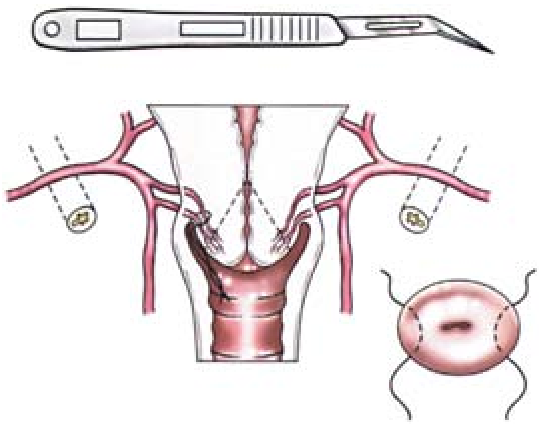


Figure 4

Cone to be excised

After positioning of the speculum, two lateral stay sutures are placed at approximately 3 o'clock and 9 o'clock. The sutures are placed in a figure-of-eight manner to help hold the cervix and reduce the blood supply by ligation of the cervical branch of the uterine artery. An absorbable suture of 0 or 00 is sufficient just at the level of the vagina fornices. The sutures are held with hemostats attached to the drapes to help draw the cervix down into the lower vagina (Figure 3). Starting posteriorly, using a large, curved knife handle, the colposcopically identified acetowhite lesion is excised (Figure 4). Again, for diagnostic cones, the entire

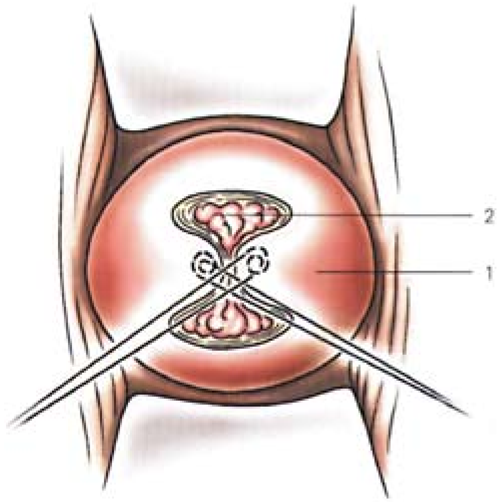


Figure 5

1 Ectocervix

2 Hemostatic absorbable packing filling cone base

transformation zone should be removed. The base of the cone may be difficult to separate completely with the scalpel; instead, curved scissors may be used. A sample of the endocervical canal may be obtained at this point using an endocervical curette or brush. Active bleeding may be controlled with cautery or fine 000 absorbable sutures. Care must be taken not to occlude the os. A cotton-tipped swab, inserted in the os before any sutures are placed, will help in avoiding this complication. The remainder of the cone base should be cauterized and treated with Monsel's solution for prophylaxis. If bleeding is still a problem, a commercial hemostatic agent (such as sheets of oxidized cellulose) may be used to tamponade the bleeding base and held in place by the lateral stay sutures. These sutures can be brought together over the midline and tied together (Figure 5).

Complications

There is a small risk of primary hemorrhage and an approximately 5% risk of secondary hemorrhage and, although rare, infection. Cold knife cone biopsy and LETZ with 'top hat' techniques may increase the risks of future cervical stenosis and incompetence. The use of LETZ to a depth of no more than 1 cm may not affect cervical competence or cause stenosis.

7
Radical abdominal hysterectomy

J Richard Smith

Deborah CM Boyle

Giuseppe Del Priore

Radical abdominal hysterectomy is designed to remove the uterus, cervix, upper third of the vagina, either part or the whole of the parametrium, and the uterosacral and vesicouterine ligaments. In addition, the common iliac, internal iliac, external iliac, obturator, hypogastric and presacral lymph nodes are also removed, as may be the paraaortic nodes.

This operation is used for management of Stage IA2 and IB1 and 2 tumors of the uterine cervix. It may be used by some surgeons for management of Stage IIA cervical tumours and occasionally in management of vaginal cancer. It has been classified by Rutledge as radical abdominal hysterectomy types II and III (Piver et al, 1974). Staging of cervical cancer, carried out preoperatively, is not further discussed in this chapter. The choice of whether to perform this procedure or one of those described in Chapters 8, 9 and 10 depends upon the surgeon's preference, with each operation tailored to the needs of the specific patient. The radicality of the procedure planned depends upon the characteristics of the tumor.

Prior to surgery, the patient's bowel should be prepared using the standard protocol. Consent for the specific procedure, including oopherectomy if planned, should have been obtained.

Operative procedure

A general anesthetic is administered with or without an epidural anesthetic. The addition of a regional anesthetic allow better pain control post-operatively and facilitates surgery by reducing intraoperative blood loss.

The patient is then placed supine on the operating table. The bladder is catheterized with an indwelling Foley catheter and the vagina packed with a roll of gauze. Some surgeons insert the Foley catheter postoperatively, whilst others prefer to insert a suprapubic catheter at the end of the procedure. The authors' practice depends on the radicality of the procedure. In cases of Stage IIA cervical cancer the vagina may be marked with cutting diathermy 2–3 cm away from the vaginal lesion to assist in later ensuring good resection margins.

The abdomen is opened using either a subumbilical, vertical midline incision or a large lower transverse, rectus muscle-cutting incision, dependent on the patient's desire for cosmesis (Figure 1). It may be helpful to insert stay sutures to hold the peritoneum to the edges of the transverse skin incision.

After adequate exposure of the pelvis, the lymph nodes of the pelvis, the common iliac nodes and those above the bifurcation of the aorta are palpated, as is the liver.

The round ligament is then grasped, divided and ligated close to the pelvic side-wall and the broad ligament opened to expose the retroperitoneal structures including the ureter attached to the medial aspect (Figure 2).

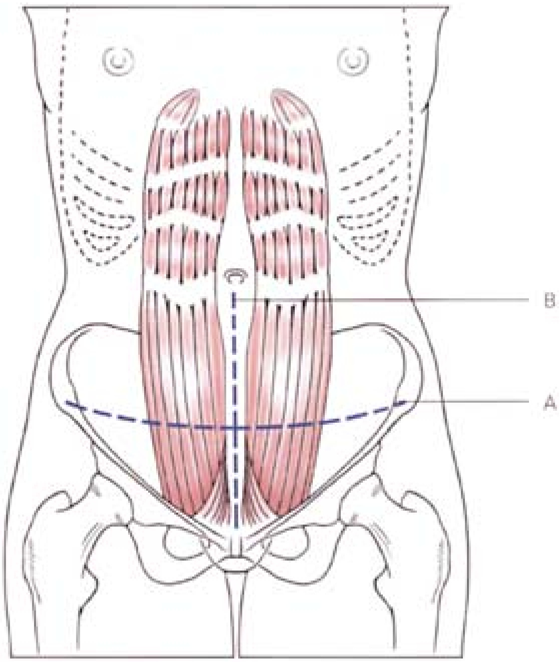


Figure 1

Opening the abdomen. (A) Low transverse rectus muscle-cutting incision. (B) Vertical subumbilical incision

The paravesical space is the first of the potential spaces to be developed during the operation (Figure 3). This is achieved with the use of blunt dissection with a combination of dissecting scissors and fingers or mounted pledgets. The dissection is commenced medial and slightly inferior to the external iliac vein. The paravesical space is bounded medially by the bladder and obliterated hypogastric artery and caudally by the ventral aspect of the cardinal ligament. The obturator muscle and fossa form the lateral border; this is dissected out later.

The pararectal space is then opened using a similar technique (Figure 4). This space is bounded by the rectum medially, the sacrum ventrally, the pelvic sidewall and internal iliac vessels laterally and the cardinal ligament anteriorly. This allows the cardinal ligament and parametrium to be directly assessed by placing one's fingers in the newly opened paravesical and rectal spaces (Figure 5).

The lymphadenectomy is commenced at the bifurcation of the common iliac vessels, excising the loose lymphatic tissue overlying the internal and external iliac arteries and veins (Figures 6, 7). This is performed in a caudal direction, having first identified psoas muscle and the genitofemoral and lateral cutaneous nerve of the thigh. The dissection of the external iliac vessels continues caudally until the circumflex iliac vessels are encountered. Dissection in a cephalad direction allows clearance of common iliac and paraaortic nodes. Presacral nodes are also removed (Figure 8).

Once the external iliac artery and vein are exposed they can be separated from the underlying tissue laterally. With gentle lateral (Figure 9) and/or medial (Figure 10) traction on the external iliac vessels the obturator fossa is now exposed. It is often helpful to sweep the external iliac vessels off the pelvic side-wall and approach the obturator fossa from the lateral side (Figure 11). Great care must be taken to preserve the obturator nerve, and the dissection always becomes much easier once this structure has been identified

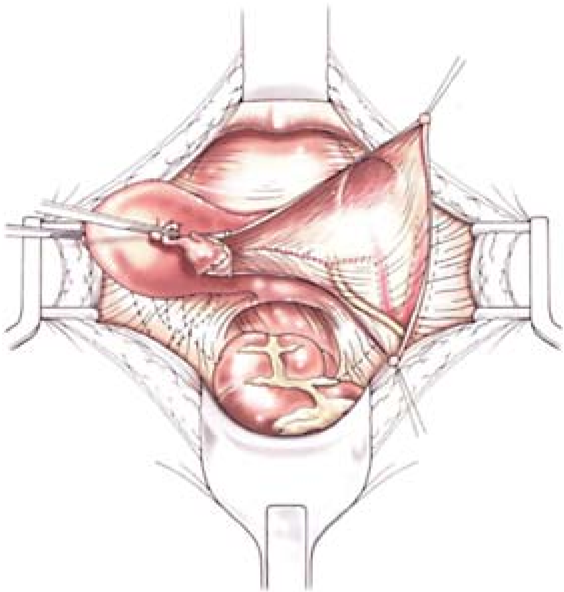


Figure 2

The round ligament is divided and the broad ligament opened

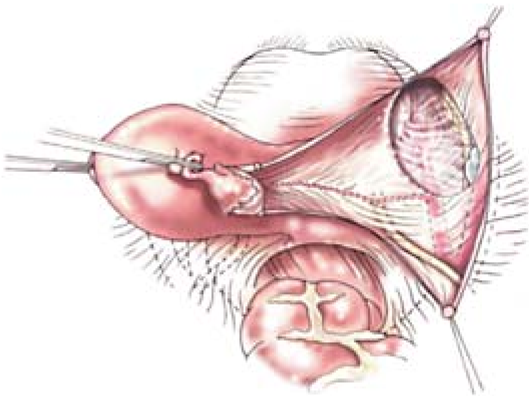


Figure 3

Developing the paravesical space

(Figures 12 and 13). Occasionally, the obturator artery and vein may require to be sacrificed to allow adequate dissection of the tissues posterior and lateral to the nerve.

The ureter is further dissected from the peritoneum. Sharp dissection is employed to create the vesicouterine and vesicocervical space (Figure 14). It is important to find the correct tissue plane since this facilitates easier and bloodless dissection. The uterine arteries are clamped, divided and ligated close to their origins at the internal iliac arteries using either ligatures or haemoclips (Figure 15).

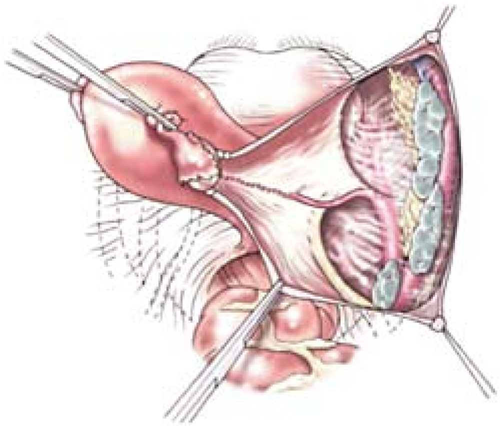


Figure 4

Developing the paravesical space

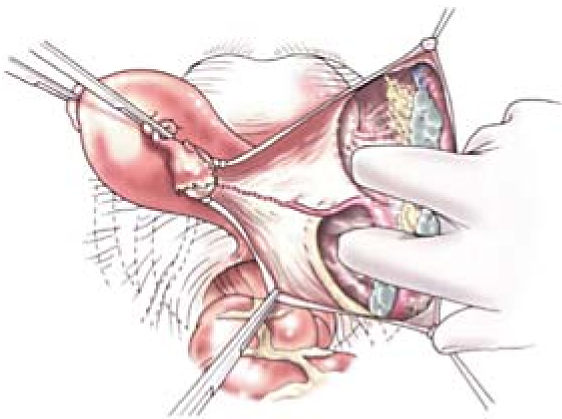


Figure 5

Boundaries of the paravesical space

The ureteric tunnels are then deroofed, allowing exposure of the ureters and their separation from parametrial tissue (Figure 16). This can be performed cephalad to caudal or vice versa. Roberts clamps or large haemoclips are helpful in minimizing haemorrhage. Whatever technique is used, bleeding tends to be brisk at this stage.

The pararectal space is further developed from above from between the ureter medially and the internal iliac vessels laterally (Figure 17). The boundaries have been described above but the dissection now takes place to the level of the pelvic floor. The rectum is dissected away from the uterus, thus freeing it of its posterior visceral attachments (Figure 18). This is best achieved by grasping the rectum between the fingers and lifting it in a cephalad direction and then entering the rectovaginal space by sharp dissection. The rectum is often much higher on the uterus than is often at first suspected and this technique minimizes the prospects for inadvertent rectal injury.

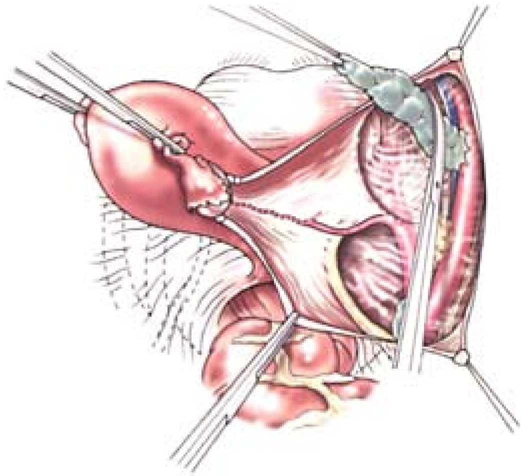


Figure 6

Pelvic lymphadenectomy

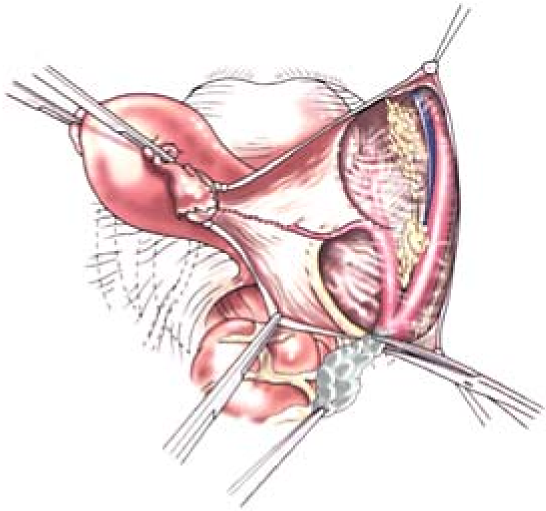


Figure 7

Pelvic lymphadenectomy: side-wall dissection

Clamping, division and ligation of the uterosacral ligament then takes place (Figures 19, 20). This can either be performed midway along the ligaments or at the sacrum, depending upon the size and nature of the tumor. The cardinal ligaments are then clamped, divided and ligated again either halfway between the cervix and the pelvic side-wall or at the pelvic sidewall, using the same criteria as with the uterosacral ligaments (Figure 21). These differing levels of radicality have been classified by Rutledge and the procedures just described are Rutledge II and III procedures (Piver et al 1974) (Figure 22).

The division of these ligaments causes the paravesical and pararectal spaces to be united (Figures 23 and 24).

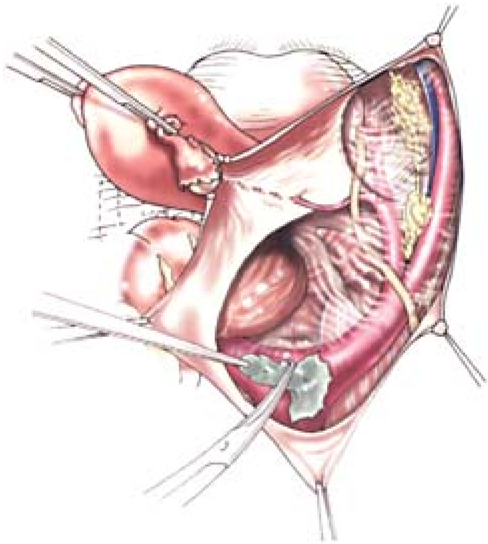


Figure 8

Presacral node removal

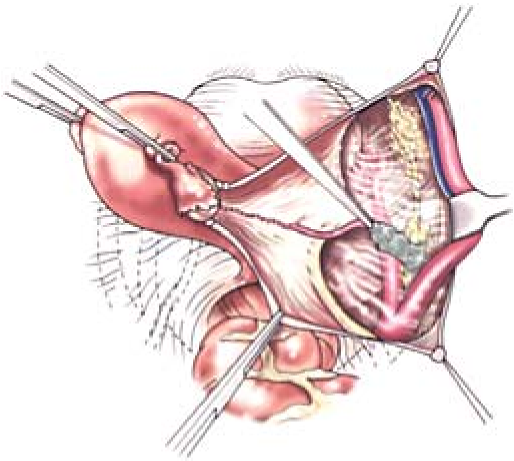


Figure 9

Exposure of the obturator fossa

Right-angle clamps are applied to the vagina far enough caudally to allow removal of the upper third of the vagina (Figure 25). As described above in cases of Stage 2a tumor, the vagina may have been marked with diathermy at the start of the procedure to ensure adequate resection margins are obtained. The vagina is then incised and the uterus with parametrium and upper vagina is then removed. The upper edges of the vagina may be oversewn circumferentially with a locked-on suture to achieve hemostasis, while leaving the vagina open to act as a natural drain. It is also thought that this suturing allows the edges of the vagina to come together by direct apposition, thus minimizing the chances of vaginal mucosa being obscured from

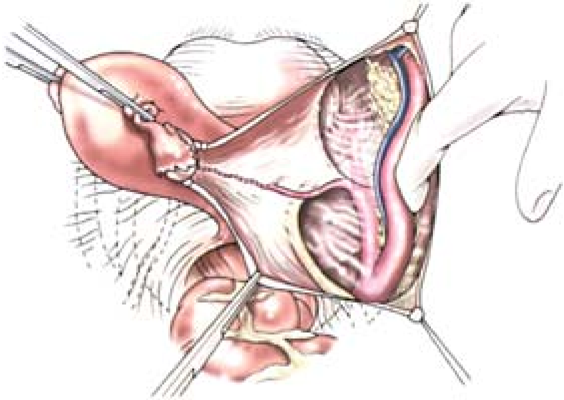


Figure 10

Exposure of the obturator fossa: lateral approach

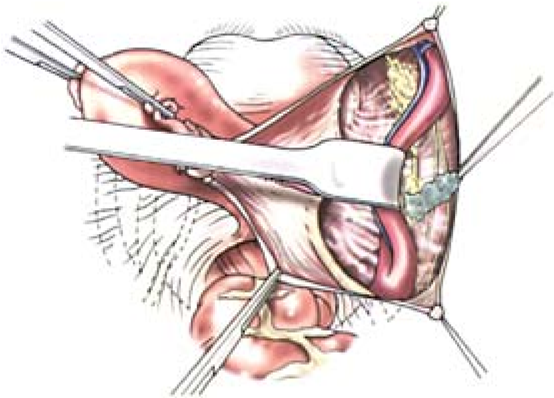


Figure 11

Exposure of the obturator fossa

view during longterm follow up. Direct closure of the vagina will inevitably leave some vagina above the suture line and thus out of sight when inspected at follow up.

At the end of the procedure, the skeletonized vessels, nerves and ureters may be clearly seen. The paravesical and pararectal spaces are joined and the rectum is exposed to the level of the pelvic floor. It is often sensible to leave a silastic drain with gravity drainage in situ at the end of the procedure. This will probably not be required for more than 24 hours (Figure 26). A suprapubic catheter may be inserted at this point. It is the authors' practice to use one when a Rutledge III procedure has been performed, since these patients are more likely to encounter urinary difficulties in the postoperative period.

The abdomen is then closed with mass closure for vertical incision using a looped PDS suture; a fat suture is not used and the authors use clips to skin. Transverse incisions are closed in layers, usually without attempting to repair the transected rectus muscles; again, clips to skin are used.

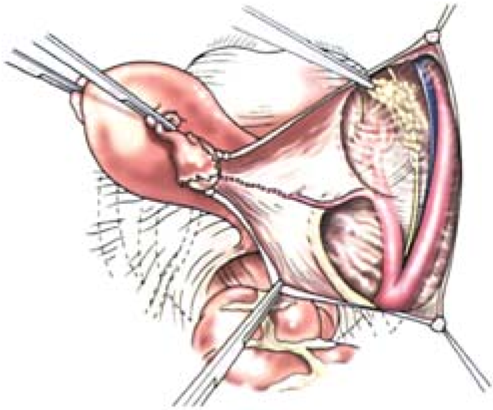


Figure 12

Exposure of the obturator fossa

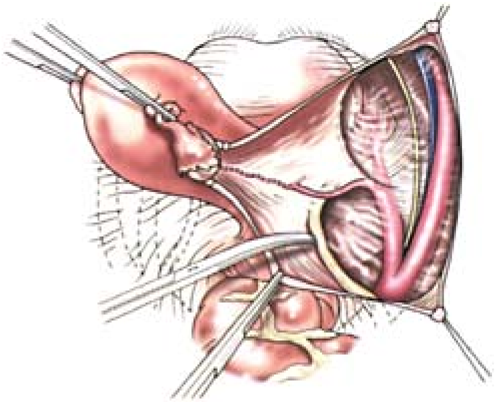


Figure 13

Exposure of the obturator fossa

Bibliography

Piver MS, Rutledge FN, Smith JP (1974) Five classes of extended hysterectomy for women with cervical cancer. *Obstet Gynecol* **44:**265–72.

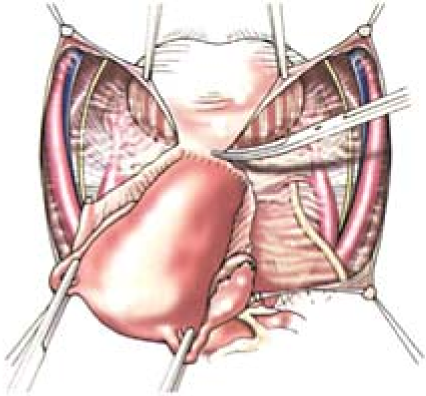


Figure 14

Developing the vesicouterine and vesico-cervical spaces

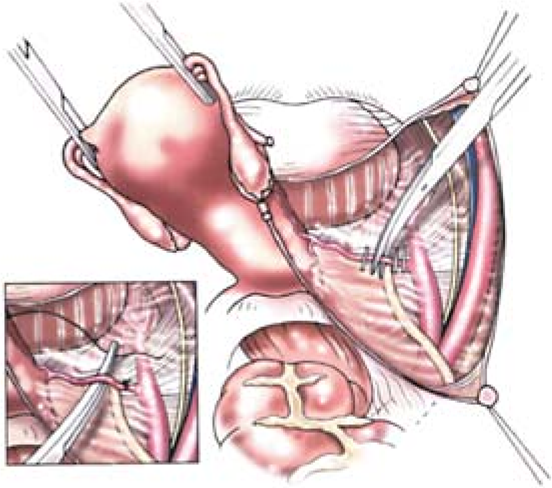


Figure 15

The uterine arteries are clamped and divided close to their origins

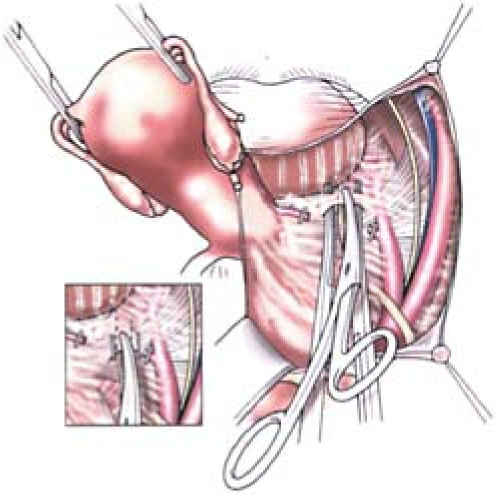


Figure 16

Deroofing of the ureteric tunnels

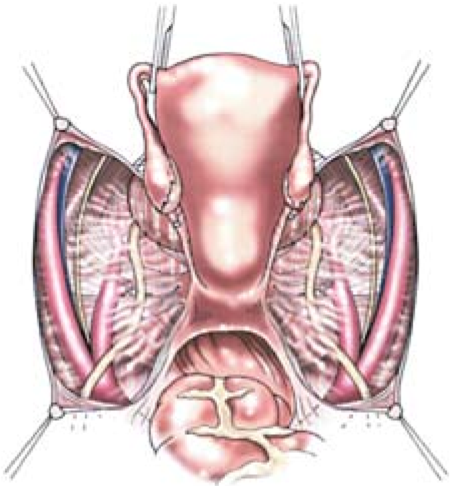


Figure 17

Further dissection of the pararectal space

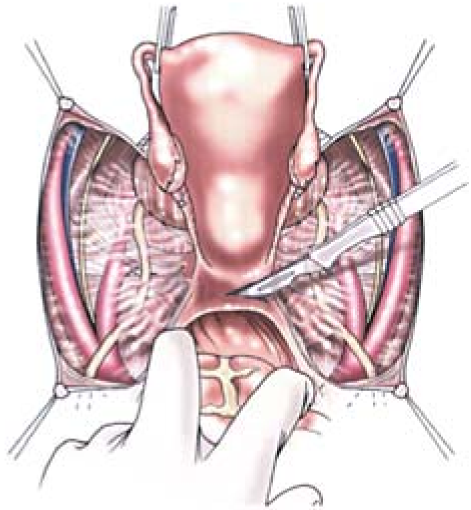


Figure 18

Dissection of the rectum from the uterus, opening the rectovaginal space

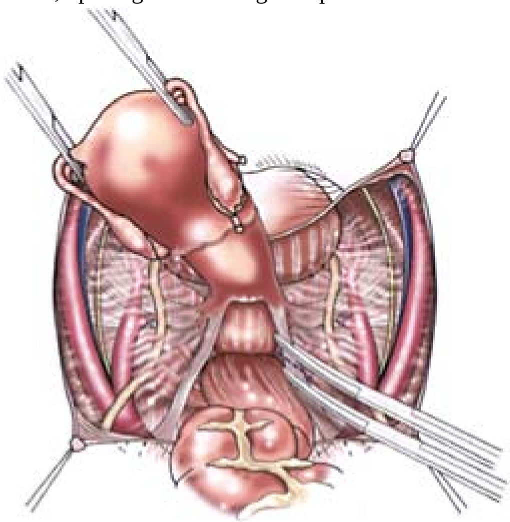


Figure 19

Division of the uterosacral ligaments

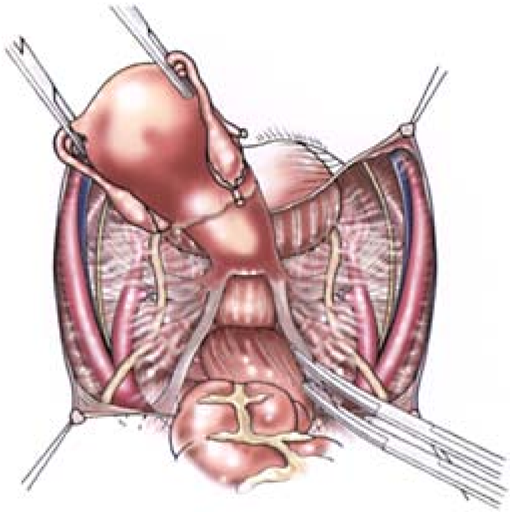


Figure 20

Division of the uterosacral ligaments

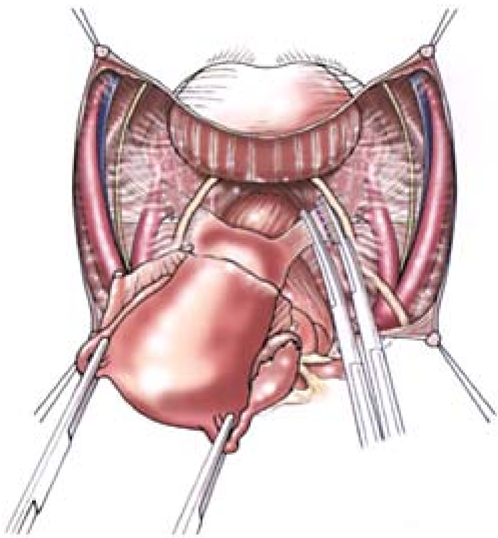


Figure 21

Division of the cardinal ligaments

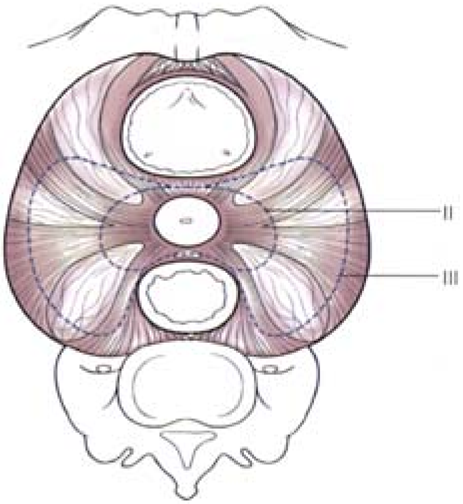


Figure 22

Rutledge II and III procedures

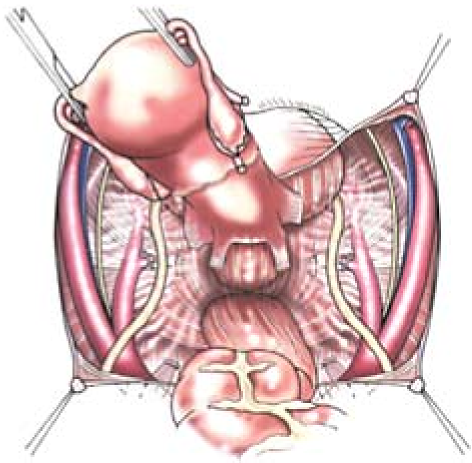


Figure 23

Pararectal spaces united

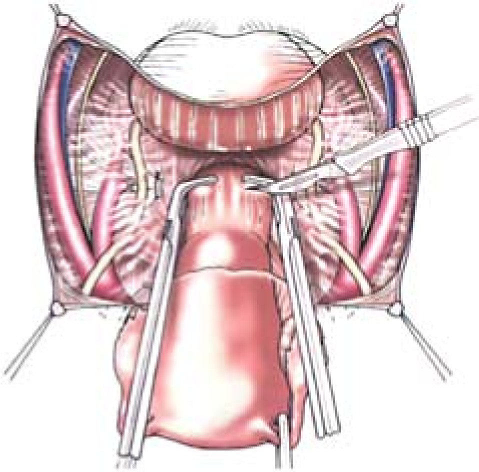


Figure 24

Paravesical spaces united

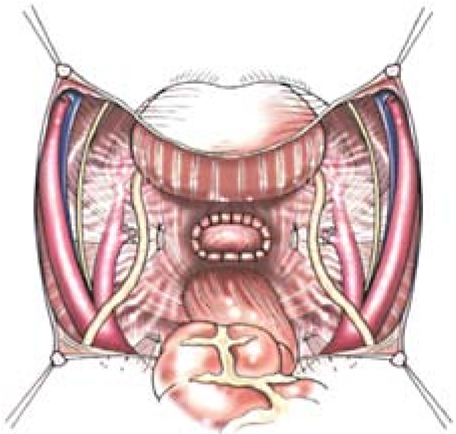


Figure 25

Division of the vagina

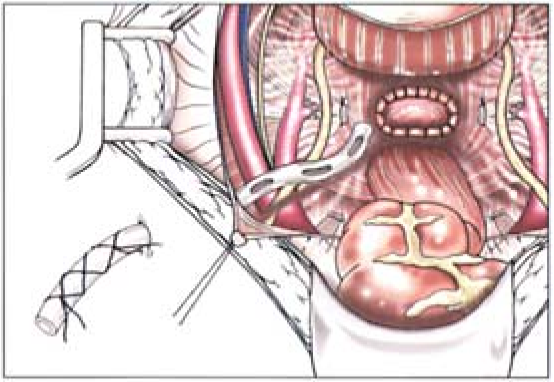


Figure 26

The completed procedure. A drain is left in situ

8
Radical vaginal hysterectomy
Daniel Dargent

Introduction

The vaginal approach was first used when surgeons considered treating cancers of the cervix in ways other than by cauterization or similar palliative tools (Recamier 1829). However, at the turn of the nineteenth century the abdominal approach became prevalent, as a consequence of two simultaneous changes. First, even if it was more risky than vaginal surgery, abdominal surgery was no longer a death sentence. Second, the concept of radical surgery, introduced by Halsted in the field of breast cancer, was also spreading to the management of all other malignancies. The first ‘radical hysterectomy’ performed by Clark in 1895 included, as a true Halstedian operation, an extirpation of the parauterine tissues and pelvic lymph nodes. Just before Clark devised the radical abdominal hysterectomy, Pavlik in Czechoslovakia (1889) and Schuchart in Germany (1893) had described a method enabling the removal of the parauterine tissues at the same time as the uterus, while maintaining a vaginal approach. The removal of the pelvic lymph nodes was obviously not included in this operation.

The abdominal and vaginal techniques were used concurrently in middle Europe at the end of the nineteenth century. Wertheim became the champion of the first technique and Schauta the defender of the second. The long and hard fight between the two surgeons stopped at the time of publication of Wertheim’s book (1911). Despite higher rates of per-and postoperative complications, the survival rates obtained by Wertheim were far higher than those noted by Schauta in his book of 1908. With Marie Curie’s subsequent discovery of radium, surgery disappeared as an option.

Surgery found a new place in the management of cervical cancer as a tool to solve the problem of positive lymph nodes that were not managed by radiotherapy. Leveuf in France (1931) andTaussig in the USA (1935) proposed a combination of radiation therapy and pelvic lymphadenectomy in order to improve outcomes. This idea was the first step towards the reintroduction of radical surgery, whose official beginning was 1945, the year in which JV Meigs delivered his first paper about the new Wertheim operation. Since the highlight of the new radical surgery was systematic pelvic lymphadenectomy, the vaginal approach clearly could not benefit from the revival of surgery. However, the Indian surgeon Suboth Mitra (1959), following an idea first expressed by Navratil, found a way to reintroduce radical vaginal surgery and proposed to combine it with a systematic pelvic lymphadenectomy performed through an abdominal extraperitoneal approach.

The Suboth Mitra operation suited the local circumstances because, even if combined with an extraperitoneal abdominal incision, the vaginal approach remained three times less dangerous than the abdominal approach, just as it had been at the beginning of the twentieth century. In countries where the post-operative mortality rate after abdominal radical surgery is almost negligible, the Suboth Mitra operation cannot be considered as the operation of choice. We used it, as does Massi today, as a solution for high-risk surgical patients, but imposing an operation which leaves three scars instead of one is not acceptable for low-risk patients. The technique of laparoscopy has changed everything.

The role of laparoscopy

In 1986 we devised the laparoscopic lymphadenectomy in an attempt to avoid the ‘three scars operation’. Subsequently the combination of laparoscopic lymphadenectomy with radical vaginal hysterectomy (RVH, or the ‘coelio-Schauta’ operation) became our elective method to treat early cervical cancer.

The first role of laparoscopy in this new surgical strategy is the assessment of the pelvic lymph nodes. If these nodes are not involved there is no reason not to adopt RVH as the procedure of choice. Conversely, if the nodes are involved, the combination of laparoscopic lymphadenectomy and RVH generates a lot of criticism. If the metastatic glands are enlarged and adherent, performing a debulking lymphadenectomy with the laparoscope is not sensible because of the risk of tumoral cell seeding from manipulations of laparoscopic instruments in the atmosphere of carbon dioxide insufflation. On the other hand, whilst aortic lymphadenectomy is mandatory in cases of pelvic lymph node involvement, it is not necessary if the pelvic nodes are not involved. Performing the aortic lymphadenectomy with the laparoscope is technically feasible, but such an extension of the dissection increases the operation time for a patient whose treatment is basically chemotherapy rather than surgery.

The second role of laparoscopy is, in the cases where RVH is chosen as definitive treatment, to assist the vaginal operation. In fact, during the first years of our experience the ‘coelio-Schauta’ procedure was simply the addition of laparoscopic pelvic lymphadenectomy to a genuine Schauta operation. At the time the endostapler became available it became clear that laparoscopy could be used as to make RVH both more radical and simpler to perform. Hence was born the concept of Laparoscopically Assisted Radical Vaginal Hysterectomy (LARVH). The first LARVHs performed were more radical than the Schauta Amreich procedures, (i.e. the most radical variant of the classical Schauta operation). Due to its radical nature the ‘LARVH prototype’ was more dangerous than the initial coelio-Schauta, particularly in the field of urinary bladder dysfunction. This negative outcome led Denis Querleu and the author to set up a third variant which appears as radical as the Schauta Amreich procedure but avoids the complications of it. This is the operation described in the following pages.

Indications

LARVH should be reserved for early cervical cancers, as was the classical abdominal approach. One has to remember that a radical operation must include the removal of 2 cm of uninvolved tissues around the tumor. The width of the pelvis is no more than 10.5 cm between the two sciatic spines where the paracervical ligaments are attached laterally. This anatomic constraint makes radical surgery controversial in cancers more than 4 cm in diameter. This is the case in radical abdominal surgery, but even more so in radical vaginal surgery, where placing clamps on the ligaments alongside the pelvic wall is more difficult from below than from above because of the slope of the pelvic wall. Careful assessment of the tumoral dimensions is the first step in the decision-making; we systemically use MRI. We do not perform LARVH in cases where the tumor is more than 4 cm in diameter.

The second condition for accepting RVH is certainty that the lymph nodes are not involved. As already discussed, the preliminary laparoscopic dissection aims to make the selection; here again preoperative imaging has an important role to play. If the nodes appear enlarged, stereotactic puncture is performed. In the cases where the metastatic involvement is confirmed, chemoradiotherapy has to be selected. Prior surgical node debulking can be considered but this debulking has to be performed through an open abdomen; the same applies if massive lymph node involvement is unexpectedly discovered at the beginning of the laparoscopy.

The laparoscopically retrieved nodes can be assessed by frozen section. Such an extemporaneous assessment enables the two parts of LARVH to be performed at the same sitting, but the rate of a false-negative frozen section is between 10 and 30%. In spite of this, the negative predictive value remains high because the incidence of lymph node involvement is low (around 15%) in the accepted indications of LARVH. However, the consequences of undertreatment due to ignorance of lymph node involvement can be considered more detrimental in a patient affected by early cancer. For this reason I prefer to perform the two parts of LARVH in two sittings. The assessment of the lymph nodes can be made after paraffin embedding. This means not only that false negatives can be avoided, but also that the final decision is taken with full information and the consent of the patient. This in itself is a psychological advantage that compensates for the discomfort induced by the necessity of two anesthetics and two hospital stays (the first one very short).

Operative procedure

The aim of the radical hysterectomy operation, whichever approach is chosen, is to retrieve part of the vagina and the parauterine tissues, together with the uterus itself. The ventral and dorsal surfaces of the vagina and of the tissues adjoining the uterus are in close proximity to the bladder floor and, to a lesser degree, to the rectum. In the vaginal operation one detaches the bladder floor (and the ureters) from the ventral surface of the specimen when opening the vesico-vaginal space on the midline and the paravesical spaces on either side in order to locate the bladder pillars and divide them after identification of the ureters. The dorsal aspect of the specimen is freed when the rectal pillars are divided (a much simpler step of the operation).

The laparoscopic operation

The laparoscopic part of the LARVH can be done using either the classical transumbilical transperitoneal route, or a direct extraperitoneal approach: the latter is more appropriate because if the peritoneal cavity is not entered, there is less chance of inducing peritoneal adhesions, but it takes more time. The rate of adhesions after laparoscopic surgery, whatever the route, is low; the only situation where it is important to have no adhesions is the conservative variant of the LARVH where one intends to preserve fertility (see below).

The cutaneous incision is made along the inferior brim of the umbilicus. The abdominal fascia is opened under direct endoscopic guidance using a trocar with a transparent cutting tip (Visiport: Merlin Medical, Rhymney, UK; Optiview: Ethicon Endosurgery, Edinburgh, UK). Once the preperitoneal space is entered the trocar is removed, the carbon dioxide insufflation is linked to the sheath and the laparoscope is introduced, pushing it vertically until contact is made with the symphysis pubis. This creates a vertical tunnel, at the lower extremity of which an ancillary trocar is introduced. This preparation is pushed laterally to the McBumey area, at which level two more ancillary trocars are introduced, one on each side. Then, using three instruments (two forceps and one pair of scissors), the peritoneal sac is mobilized dorsally after the round ligaments have been cut at their most ventral, extraperitoneal, parts.

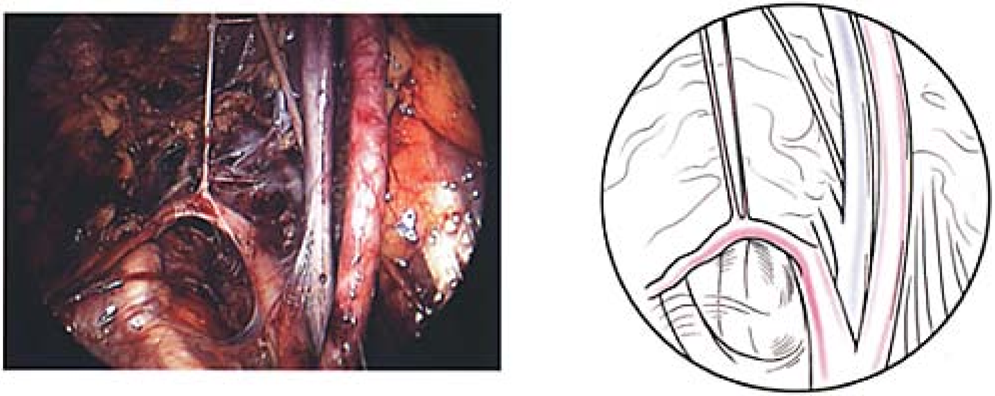


Figure 1

Laparoscopic view of the medial aspect of the common iliac bifurcation: laparoscopy has been performed using the preperitoneal approach. The superior vesical artery runs in a dorsal direction; the obturator artery runs in a ventral direction

The lymphadenectomy is performed in the same way as it is in the transumbilical transperitoneal laparoscopy. The panoramic view is the same. The only differences are better 'baro' haemostasis and absence of trouble with the intestines.

The medial aspect of the iliac vessels is easily cleaned. The lateral aspect is a little more difficult; however, it can be treated laparoscopically as carefully as it is treated using laparotomy, if not better. The iliac vessels are detached from the psoas muscle and pushed medially (Figure 1). The opened space is cleaned out until the obturator nerve is identified (Figure 2).

The last step of the laparoscopic procedure is dividing the uterine arteries and preparing the cardinal ligament (Figure 3). Rather than cutting the ligament laparoscopically, its lateral part is emptied of the lymph node-bearing tissues which are imprisoned in the vascular network of the ligament. This emptying is done by gentle teasing of the adipose tissue between the vessels. Among the vessels handled are the uterine arteries which are accompanied by lymphatic channels. A superficial uterine vein can accompany the artery as well.

The Vaginal Operation

The Schauta operation starts with determination of the vaginal margin (Figure 4). The separation is made roughly at the junction between the middle third and the upper third of the vagina. Traction is exerted on the forceps, creating a form of internal prolapse of the vagina. The inferior brim of the head of the prolapse is infiltrated using diluted synthetic vasopressin, primarily for prophylactic haemostasis but also to separate the two parts of the fold.

Dividing the vagina is done in four stages. The anterior aspect is treated first (Figure 5). It is the most difficult step, because the bladder floor is drawn inside the vaginal fold one pulls on. All the layers of the vaginal wall must be cut, without injury to the bladder wall. Treating the posterior aspect is easier because of the tissue present between the rectum and vagina. On the lateral aspects only the mucosa is cut (Figure 6) in order to keep the relationship between the vaginal cuff and the underlying structures, i.e. the paracervical ligaments. Compare this with the anterior and posterior surfaces, where the goal was separating the cuff from the underlying organs, i.e. the bladder and rectum.

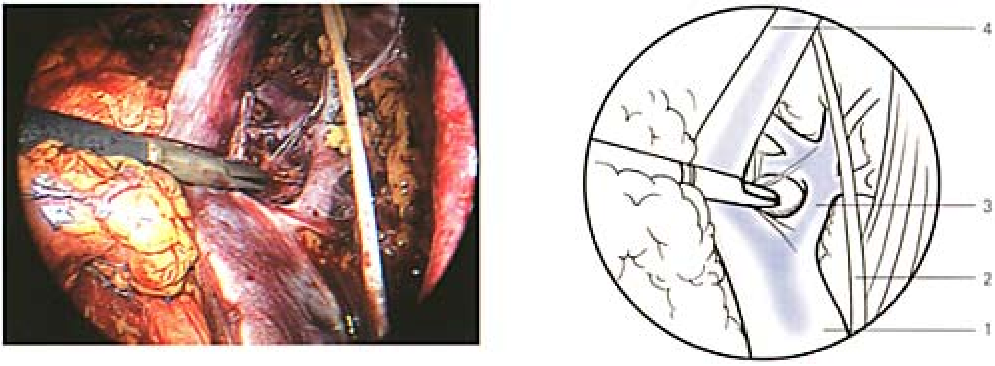


Figure 2

Laparoscopic view of the lateral aspect of the common iliac venous convergence: the obturator nerve crosses the gluteal vessels

1 Common iliac vein

2 Obturator nerve

3 Internal iliac vein

4 External iliac vein

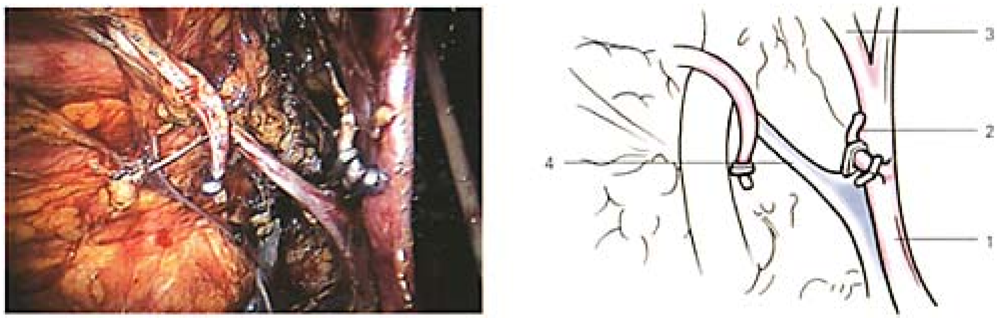


Figure 3

Laparoscopic view after transection of uterine artery: a superficial uterine vein will be cut next

1 Inferior iliac artery

2 Uterine artery

3 Superior vesical artery

4 Uterine vein

Once the vaginal cuff is separated it is grasped using Chrobak forceps (Figure 7) and pulled downwards. Traction reveals the supravaginal septum, a pseudomembrane made by condensation of the connective fibres joining the bladder floor to the vagina. This pseudoaponeurosis has to be opened on the midline close to the base of the trigone (Figure 8). Once the aponeurosis has been opened (use the scissors perpendicularly to the vagina), the areolar tissue of the vesicovaginal space is visible and a tunnel can be dug and enlarged up to the level of the vesico-vaginal peritoneal fold (using the scissors parallel to the vagina becomes possible).

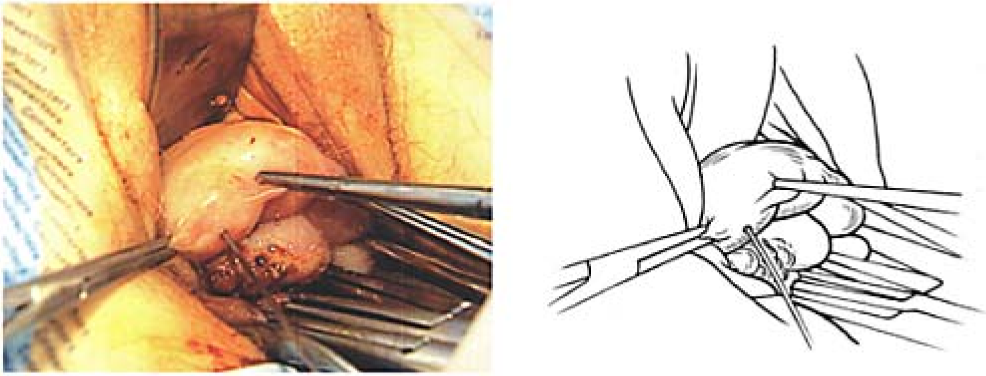


Figure 4

Infiltration of the vaginal margin

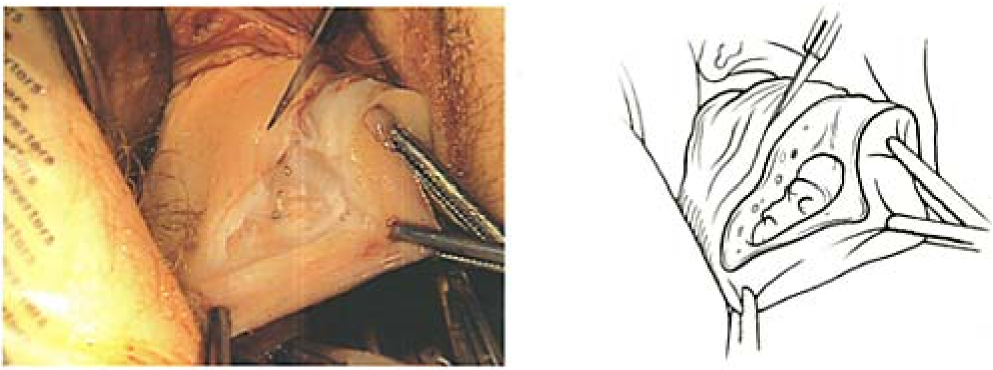


Figure 5

The Schauta operation: separatipn of the vaginal cuff on the ventral (anterior) aspect; the incision is full thickness

Next the vesicovaginal space is opened, with the paravesical space.

To open the paravesical spaces, two forceps are applied to the brim of the vagina (at positions 1 o’clock and 3 o’clock for the left side, 11 o’clock and 9 o’clock for the right side). Pulling on the forceps reveals a depression located close to the most lateral instrument (Figure 9). Deepening this depression by blunt use of Metzenbaum’s scissors oriented laterally and ventrally (Figure 10) opens the paravesical space, into which is introduced a micro-Breiski retractor. The structure interposed between this retractor and the previously opened vesicovaginal space is the bladder pillar, inside which the contour of the ureter can be identified while palpating, the pillar against the retractor. The characteristic ‘snap’ of the ureter is evinced (Figure 11).

While appropriate exposure is maintained with the retractors, the inferior brim of the pillar, which appears vertical, is opened with the tip of the scissors and its lateral fibres are separated using the same scissors (Figure 12). After a new palpatory assessment (make sure the ureter is located, laterally to the isolated part of the pillar) the fibres of the pillar are cut (Figure 13). The paravesical space becomes wider, and a broader retractor is introduced. The lateral aspect of the ‘knee’ of the ureter becomes visible (Figure 14). The medial fibres of the pillar can then be cut to release the ventral aspect of the paracervical ligament (Figure 15): this enables location of the arch of the uterine artery in the para-isthmic window (a

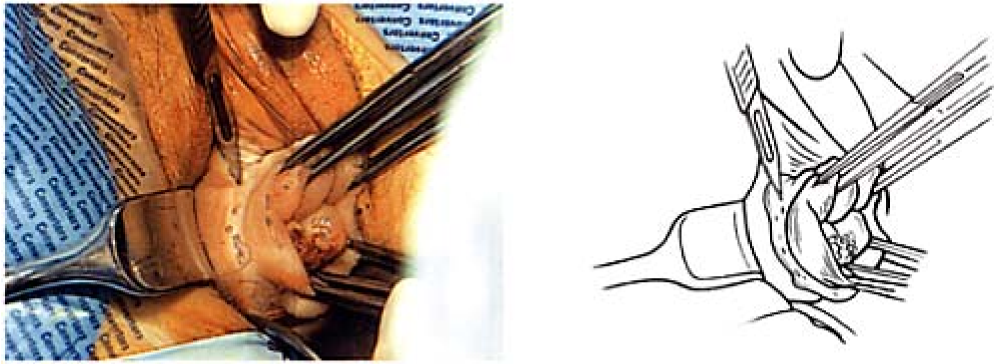


Figure 6

Separation of the vaginal cuff on the lateral aspect; the incision is only through the skin

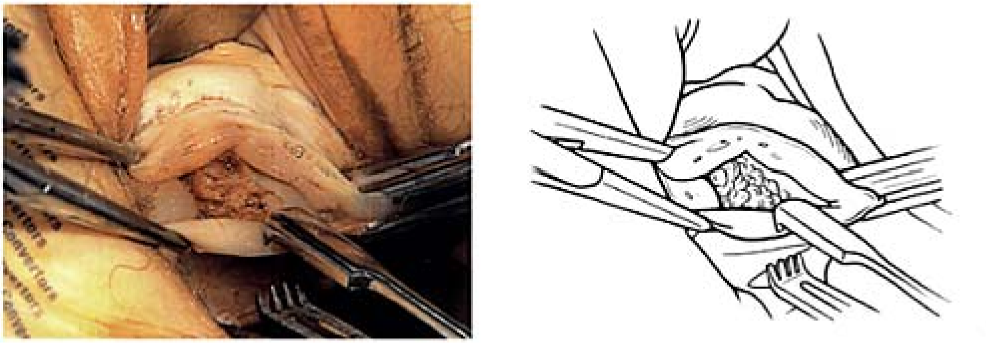


Figure 7

Grasping the vaginal cuff with the forceps

space whose inferior brim is the superior edge of the paracervical ligament). The descending branch of the arch is tugged and the already divided artery arrives in the operative field with a staple at the cut end (Figure 16).

After freeing the ventral aspect of the specimen, the surgeon moves to the dorsal aspect. The first step is opening the pouch of Douglas (Figure 17). The rectouterine ligaments are then divided, at a point equidistant between the uterus and the intestine. Cutting at this level is easy (no preventive clamping is needed) and leads directly to the dorsal aspect of the paraisthmic window, the ventral aspect of which has been identified previously. The tip of a right angle forceps is pushed into the window from back to front.

Two clamps can be put onto the cardinal ligament. The first one is placed medially, and traction is exerted. The second clamp (which has a slightly greater curvature) is placed laterally; the convexity of its curvature lies in contact with the ‘knee’ of the ureter (Figure 18).

Following transection of the ligaments the uterine body can be turned in a dorsal direction, and the adnexa can be left in place or removed, depending on the age of the patient (Figure 19). The subsequent steps are straightforward. The author’s preference is for peritonization with two lateral angled stitches and a middle continuous suture, placing the stumps in an extraperitoneal position and joining the rectal peritoneum

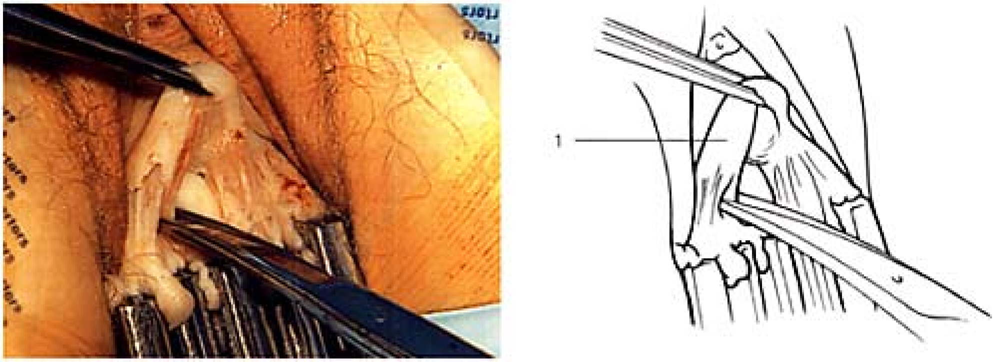


Figure 8

Opening the vesicovaginal space on the midline

1 Bladder

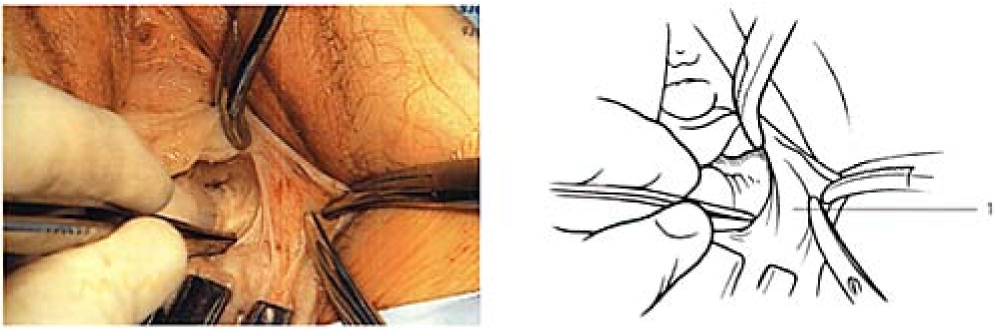


Figure 9

Opening the paravesical space

1 Bladder pillar

and the vesical peritoneum. Haemostasis is performed as necessary. The vagina is closed without a drain or gauze. A Foley catheter is left in place for 4 days.

Conclusion

RVH is an acceptable alternative to radical abdominal hysterectomy as long as it is combined with control of the regional lymph nodes. Before the era of laparoscopy such control could not be obtained other than by performing two lateral extraperitoneal abdominal incisions, leaving RVH suitable in only exceptional circumstances. With the advent of laparoscopy the assessment of the regional nodes is possible and the combination of 'regional nodes control-RVH' has become realistic. There is no increase in the rates of per- and post-operative complications, disease-free long-term survival rates are no less, and the patient does not bear visible scars: this latter advantage is not open to dispute. The other advantages of faster recovery—better self-image, minimized sequelae and so on—are not, at the moment, proven, just as the cost-benefit balance remains to be assessed. Whatever the results of the studies currently in progress, one certain

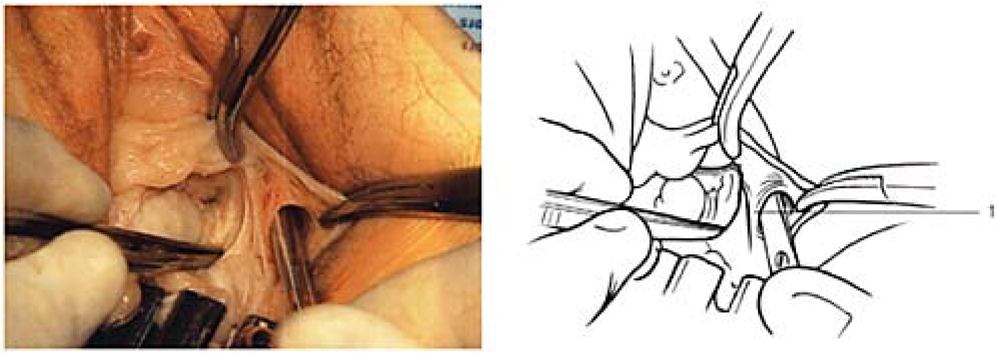


Figure 10

Evincing the entry into the paravesical space on the left side

1 Bladder pillar

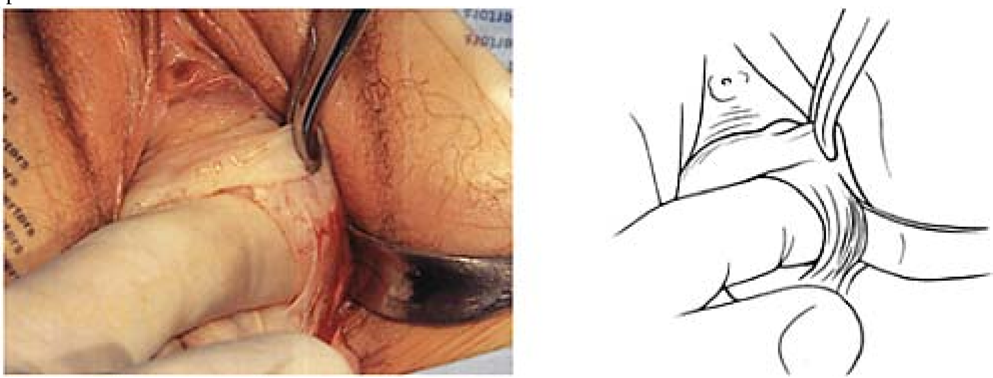


Figure 11

Palpation of the bladder pillar on the left side to elicit the 'snap' of the ureter

advantage favors the laparoscopically assisted vaginal technique. There is now the possibility of obtaining pregnancies and births for patients undergoing the conservative variant of the operation—a result that could never have been obtained by the surgeons performing the radical operation through laparotomy.

Bibliography

Amreich AI (1924) Zur Anatomic und Technik der erweiterten vaginalem Carzinom Operation. *Arch Gynäkol* **122:**497.

Clark JG (1895) A more radical method for performing hysterectomy for cancer of the uterus. *Bull Johns Hopkins Hosp* **6:**120.

Leveuf J (1931) L'envahissement des ganglions lymphatiques dans le cancer du col de l'utérus. *Bull & Mem Soc Nat De Chir* **57:**662.

Meigs JV (1945) Wertheim operation for carcinoma of the cervix. *Am J Obstet Gynecol* **49:**542.

Mitra S (1959) Extraperitoneal lymphadenectomy and radical vaginal hysterectomy for cancer of the cervix (Mitra technique). *Am J Obstet Gynecol* **78:**191–6.

Pavlik K (1889) O extirpaci cele dèlohy a casti vaziva panvicniho. *Casopis Lekaru Ceskych* **XVIII:**28.

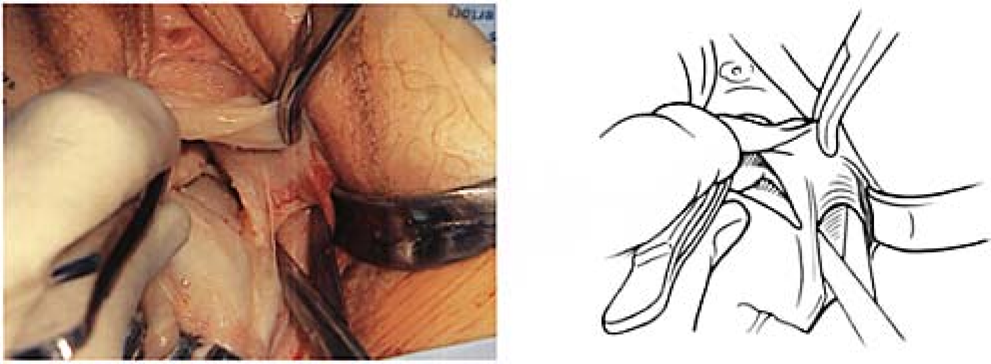


Figure 12

Separation of the lateral part of the bladder pillar on the left side

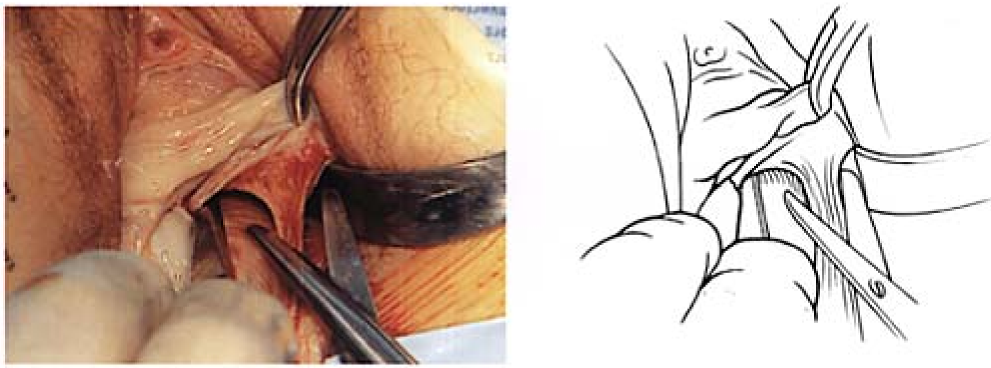


Figure 13

Cutting the lateral part of the bladder pillar

Recamier JCA (1829) Ablation de l’utérus cancéreux. In: *Recherche sur le traitement du cancer*. Paris: Gabon, 519–29.
Schauta F (1908) *Die erweiterte vaginale Totalextirpation des Uterus beim Kollumkarzinome*. Vienna: J. Safar.
Schuchart K (1893) Eineneue Methode der Gebärmutterexstirpation. *Zbl Chir* 1131.
Stoeckel W (1928) Die vaginale Radikaloperation des Collumkarzinomes. *Zbl Gynäkol* **52:**39.
Taussig FJ (1935) The removal of lymph nodes in cancer of the cervix. *Am J Roentgenol* **34:**354.
Wertheim (1911) *Die erweiterte abdominale Operation bei Carcinoma Colli Uteri.* Berlin: Urban & Schwarzenberg.

Figure 14

Further division of the lateral fibers of bladder pillar on left side: the knee of the ureter is visible

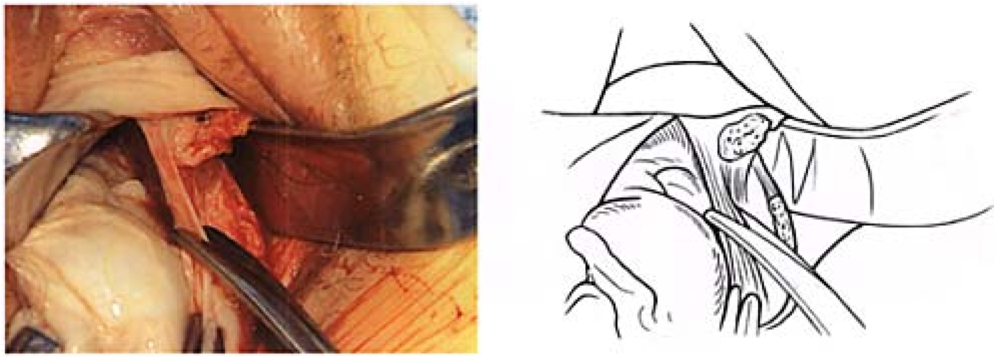


Figure 15

Division of medial part of bladder pillar on left side

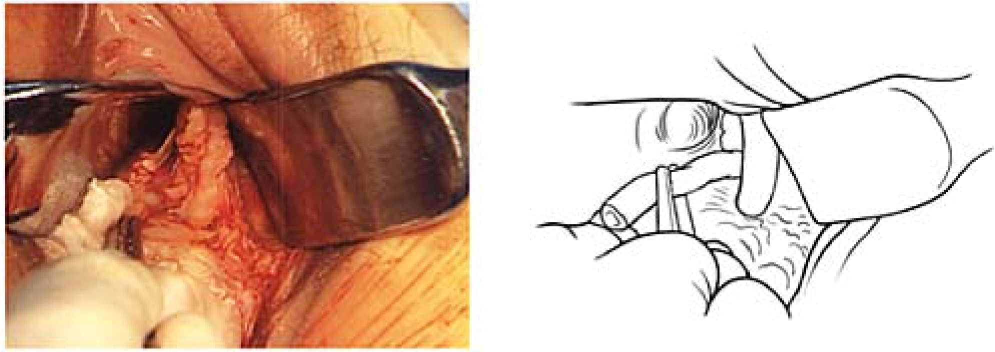


Figure 16

Pulling on the descending branch of arch of uterine artery on left side

Figure 17

Opening the pouch of Douglas and the rectal pillar

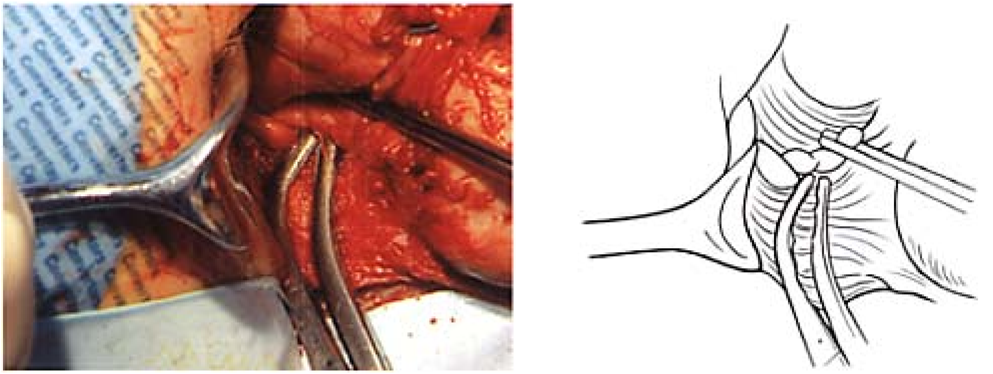


Figure 18

Paracervical ligament, is clamped, the lateral clamp being put underneath the tip of the 'knee' of the ureter

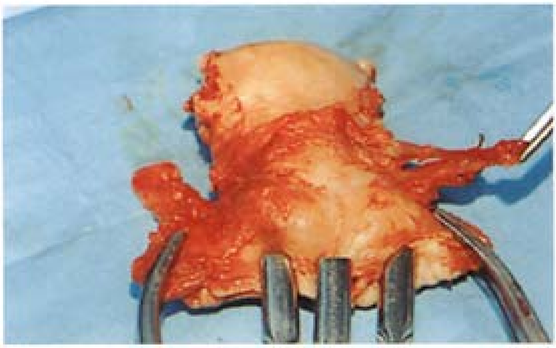


Figure 19

Lateral portions of paracervical ligaments are lacking here, having been cleared out during the laparoscopic procedure

9
Radical vaginal trachelectomy

Marie Plante

Michel Roy

Introduction

Radical vaginal trachelectomy (RVT) is a new conservative surgical procedure for the treatment of selected cases of early-stage cervical cancer. It has the advantage of preserving the uterine body, which in turns allows the preservation of childbearing potential. This procedure has been described by Professor Daniel Dargent from Lyon, France. Among the group of more than a hundred women who have undergone this operation, more than 20 healthy babies have been born so far, the majority by elective cesarean section at term.

Indications

The indications for RVT are not definitely established at this point. The eligibility criteria currently used by the authors are as follows:

1. Desire to preserve fertility
2. No clinical evidence of impaired fertility
3. Lesion size less than 2.0 cm
4. FIGO stage IA2-IB1
5. Squamous cell carcinoma or adenocarcinoma
6. No involvement of the upper endocervical canal as determined by colposcopy
7. No metastasis to regional lymph nodes.

As data accumulate, these criteria may change in the future.

Anatomical considerations

Vascular supply

The blood supply to the cervix is assured by the cervical (or descending) branch, of the uterine artery, and by the vaginal artery which originates from the hypogastric, the uterine or the superior vesical artery. At the level of the upper endocervix, these two arteries form a network of anastomoses and a rich vascular plexus. At the isthmus, the uterine artery also forms a loop, often referred to as the cross of the uterine artery. This

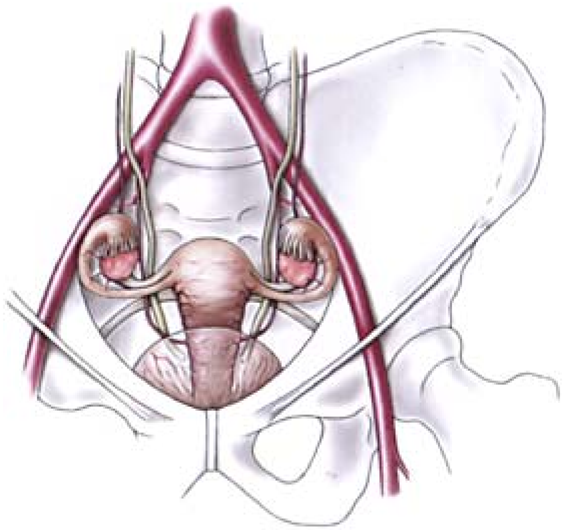


Figure 1

Cervical vascular supply

is an important landmark because all efforts should be made to preserve the uterine artery in order to assure a good vascular supply to the uterine body, particularly in the event of a pregnancy. The venous supply follows the arterial one (Figure 1).

Uterovaginal endopelvic fascia

The endopelvic fascia consists of the reflections of the superior fascia of the pelvic diaphragm upon the pelvic viscera. This thin layer thus encases the urethra and bladder (urethrovesical fascia), the vagina and lower uterus (uterovaginal fascia) and the rectum (rectal fascia). The uterovaginal endopelvic fascia is of particular importance as it lies in close proximity to the pelvic peritoneum. The fascial plane is an avascular space that should be defined when mobilizing the bladder base at the time of RVT, but the anterior pelvic peritoneum itself should not be entered (Figure 2).

Cardinal (Mackenrodt) ligament

The cardinal ligament is composed of condensed fibrous tissue and some smooth muscle fibers. It extends from the lateral aspect of the uterine isthmus toward the pelvic wall. This fibrous sheath contains the ureter, the uterine vessels and associated nerves, the lymphatic channels and lymph nodes draining the cervix and some fatty tissue. It is commonly referred to as the parametrium. The cardinal ligament is in continuity anteriorly with the uterovaginal endopelvic fascia, and posteriorly its fibers are integrated with the uterosacral ligament. Since RVT is performed in patients with small lesions, only the medial part (i.e. approximately 2 cm) of the cardinal ligaments is usually taken (Figure 3).

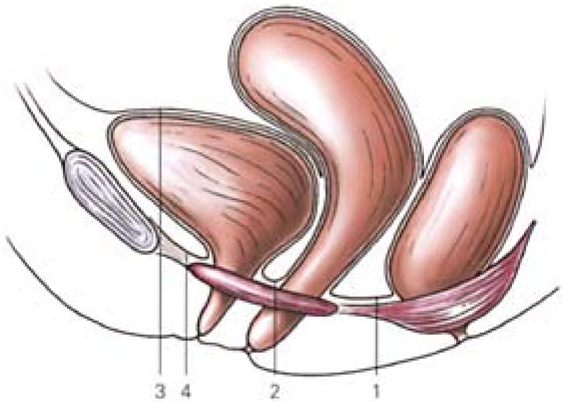


Figure 2

1 Rectal fascia

2 Uterovaginal fascia

3 Pelvic peritoneum

4 Urethrovesical fascia

Uterosacral ligaments

The uterosacral ligaments are true ligaments of musculofascial consistency which run from the upper part of cervix to the sides of the sacrum. They contribute to the uterine support together with the cardinal ligaments. Only the proximal parts of the uterosacral ligaments are taken at the time of RVT to leave adequate uterine support.

Operative procedure

Anatomical relationship

It is of paramount importance to understand the relationship between the ureter, the uterine artery and the cardinal ligament (parametrium), and to picture the relationship between the bladder base and the lower uterine segment when performing radical vaginal surgery. When a radical hysterectomy is done abdominally, the uterus is pulled upwards bringing with it the parametrium and the uterine vessels, while the bladder base is mobilized downwards. Therefore, the uterine vessels lie above the concavity of the ureters as the ureters run into the parametrial tunnel to enter the bladder base; after mobilization, the ureters end up lateral to and below the parametrium (Figure 4A). When the radical hysterectomy is done vaginally, the relationship between the structures is completely the opposite. The uterus is pulled downwards and the bladder base along with the ureter is mobilized upwards. As a result, the uterine vessels end up below the concavity or the 'knee' of the ureter, and after mobilization the ureter courses above the parametrium (Figure 4B) (see also Chapter 8).

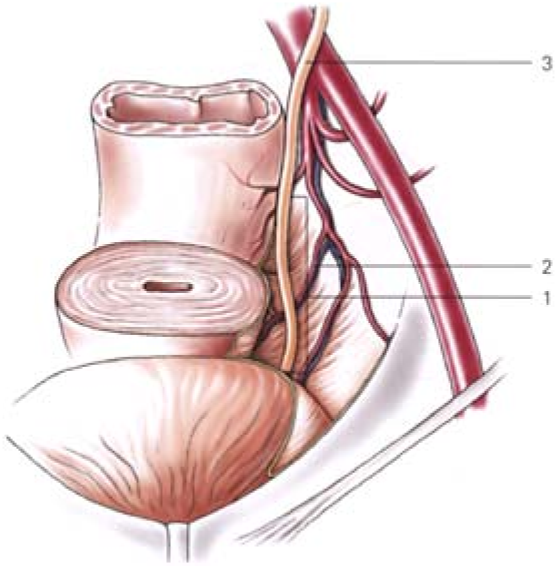


Figure 3

1 Cardinal ligament

2 Uterine artery

3 Ureter

Vaginal cuff preparation

A rim of vaginal mucosa is delineated circumferentially clockwise using 8-10 straight Kocher clamps (Lawton, Montreal, Canada) placed at regular intervals. For small lesions, 1–2 cm of vaginal mucosa is sufficient. To reduce bleeding from the edges of the vaginal mucosa, 20–30 ml of lidocaine 1% solution mixed with adrenaline (epinephrine) 1:100000 is used to inject the vaginal mucosa between each Kocher clamp. A circumferential incision is then made with a scalpel just above the Kocher clamps (Figure 5). Finally, the edges of the vaginal mucosa are grasped with 5 or 6 Chrobak clamps (Groupe Lépine, Lyon, France) in order to cover the exocervix completely and allow a good traction on the specimen (Figure 6).

Identification of the vesicouterine space

The vesicouterine space is opened by directing Metzenbaum scissors (Lawton, Montreal, Canada) perpendicular to the cervix. Care is taken not to enter the peritoneum as in a simple vaginal hysterectomy. The space should be avascular, allowing the surgeon easily to palpate the anterior surface of- the endocervix and isthmus and see the whitish body of the uterus. When the space is stretched with a narrow retractor, the anterior bladder pillars lie on each side of the space as vertical strands of tissue (Figure 7).

Opening the paravesical space

The opening of the paravesical space is described here for the patient’s left side. The Chrobak clamps are pulled towards the patient’s right side. Straight Kocher clamps are placed onto the vaginal mucosa at the 1

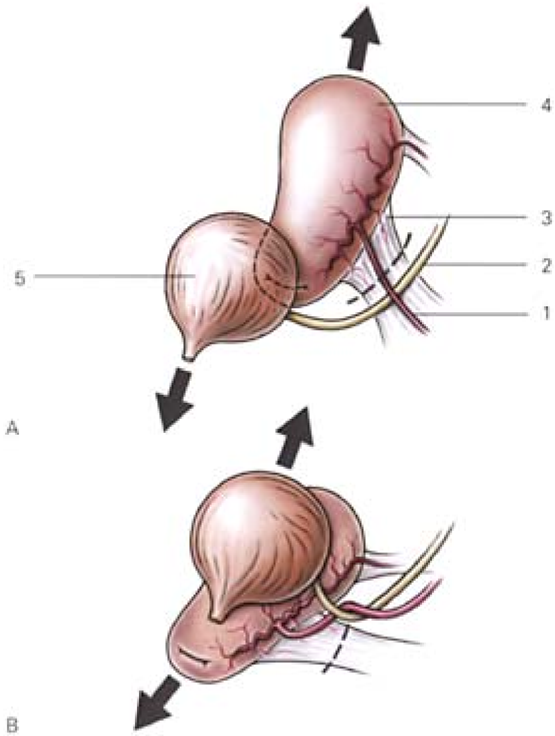


Figure 4

Comparison of (A) abdominal and (B) vaginal approaches to radical hysterectomy (after Dr Hélène Roy). The arrows indicate the direction of traction; the dotted line indicates the level of excision of the parametrium

1 Uterine artery

2 Ureter

3 Parametrium

4 Uterus

5 Bladder

o'clock and 3 o'clock positions and stretched out. An areolar plane is seen just medial and slightly anterior to the 3 o'clock clamp. The paravesical space is blindly entered using Metzenbaum scissors, with the tips pointing upwards and outwards. The space is widened by rotating the scissors under the pubic bone in a semicircular rotating motion to the patient's right side (Figure 8).

Identification and mobilization of the ureter

A small retractor is placed in the left paravesical space and rotated under the symphysis pubis, pulling the bladder pillars and the bladder medially. The 'knee' of the ureter is seen on the lateral aspect of the bladder pillars, which act as pseudoligaments (Figure 9). With the Chrobak clamps held between the palms of both hands, the surgeon's right index finger is placed in the left paravesical space and the left index finger in the

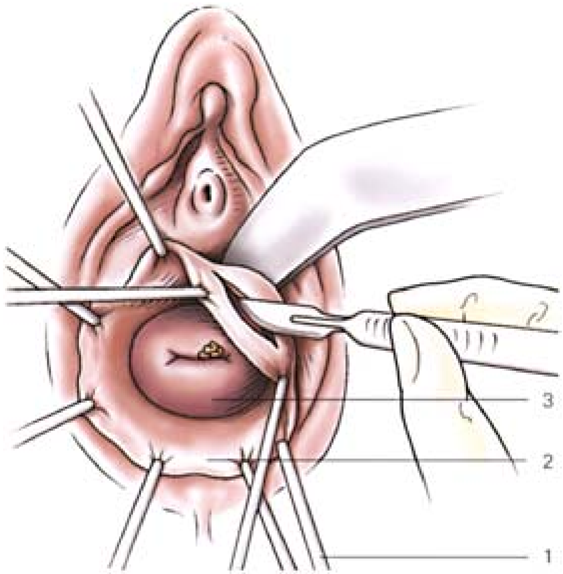


Figure 5

Vaginal cuff preparation: incision (after Dr Hélène Roy)

1 Straight Kocher clamps

2 Vaginal mucosa

3 Cervix

vesicouterine space. The surgeon's fingers are then pulled down gently until the 'click' is heard and the ureter is felt rolling under the fingers. To avoid damage, the ureter must be seen and palpated unequivocally (Figure 10). With Metzenbaum scissors, the ureter is freed laterally from its posterior attachment to allow its mobilization upwards. Medial dissection of the ureter should be avoided because of the risk of injury to the bladder base.

Section of the bladder pillars

Once the ureter has been safely mobilized upwards, the bladder pillars can be excised midway between the bladder base and the anterior aspect of the specimen. This maneuver allows the bladder base to be mobilized upwards as well (Figure 11).

Section of the cardinal ligament (proximal parametrium)

After opening the posterior cul-de-sac, the proximal aspect of the uterosacral ligament is excised. After careful identification of the ureter and the cross of the uterine artery, two curved Heaney clamps (Lawton, Montreal, Canada) are used to secure the cardinal ligament or proximal parametrium. The first Heaney clamp is placed medially and with gentle traction the second is placed more distally to obtain wider parametrium, with the ureter safely mobilized upwards (Figure 12). The cervicovaginal branch of the uterine artery is then

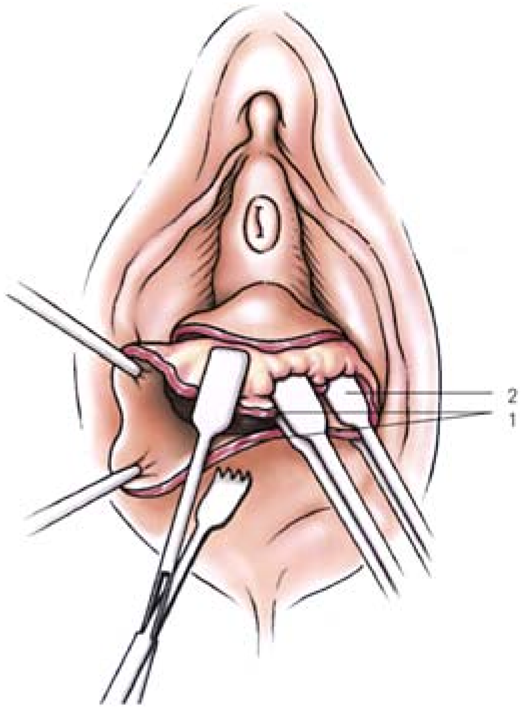


Figure 6

Vaginal cuff preparation: placing the clamps (after Dr Hélène Roy)

1 Anterior and posterior vaginal mucosa covering cervix

2 Chrobak clamps

identified at the level of the isthmus, clamped, incised and ligated. Care should be taken to identify and preserve the cross of the uterine artery (Figure 13).

Excision of the specimen

The preceding steps are then repeated on the patient's right side. The cervix is amputated, using a scalpel held perpendicularly to the specimen at about 1 cm from the isthmus (Figure 14). This is followed by endocervical curettage of the residual endocervical canal. The trachelectomy specimen is sent for immediate frozen section examination to assess the level of the tumor in relation to the endocervical resection margin. At least 8–10 mm of free endocervical canal should be obtained, otherwise additional endocervical tissue should be removed, or the trachelectomy should be aborted and a radical vaginal hysterectomy (Schauta procedure) completed instead (see Chapter 8).

Prophylactic cervical cerclage and closure of the vaginal mucosa

The posterior cul-de-sac is first closed with a pursestring suture of chromic 2–0 suture. A permanent cerclage is then placed using a nonresorbable polypropylene 0 suture, starting at the 6 o'clock position to

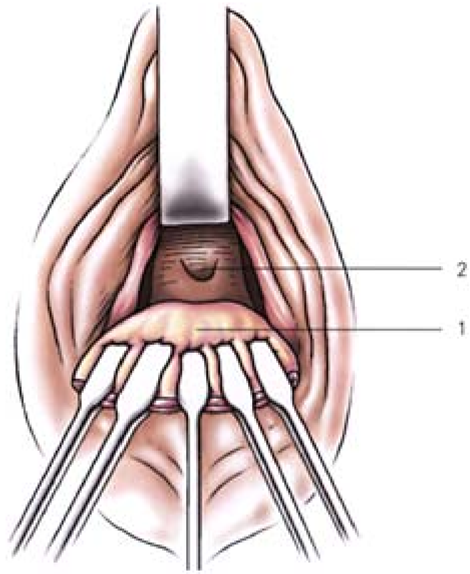


Figure 7

Opening the vesicouterine space (after Dr Hélène Roy)

1 Exocervix

2 Uterine isthmus

have the knot lying posteriorly. Sutures are placed at the level of the internal os and not too deeply within the cervical stroma. When the knot is being tied a uterine probe can be left in the cervical os to avoid overtightening of the knot, which could cause cervical stenosis (Figure 15). The edges of the vaginal mucosa are sutured to the residual ectocervical stroma (and not to the endocervical tissue) with interrupted figure-of-eight stitches. Sometimes, excess vaginal mucosa has to be excised to facilitate the closure. Sutures should not be placed too close to the new cervical os to avoid burying the cervix, making follow-up examinations more difficult (Figure 16).

Trachelectomy specimen

Ideally, the cervical specimen should be at least 1 cm long, with 1 cm of vaginal mucosa and 1–2 cm of parametrium. Figure 17A shows a cervix with a small exophytic lesion; Figure 17B shows a lateral view of the trachelectomy specimen demonstrating the endocervical cut margin, proximal parametria (stretched by the Debaky instruments) and vaginal cuff (suture) covering the cervical lesion; Figure 17C shows the appearance of the cervix after suturing of the vaginal mucosa to the residual exocervix.

Cervical appearance after trachelectomy

With time, the new cervix gradually resumes an almost normal appearance except for its shorter length. It therefore remains accessible for monitoring with colposcopic examination, cytology and curettage.

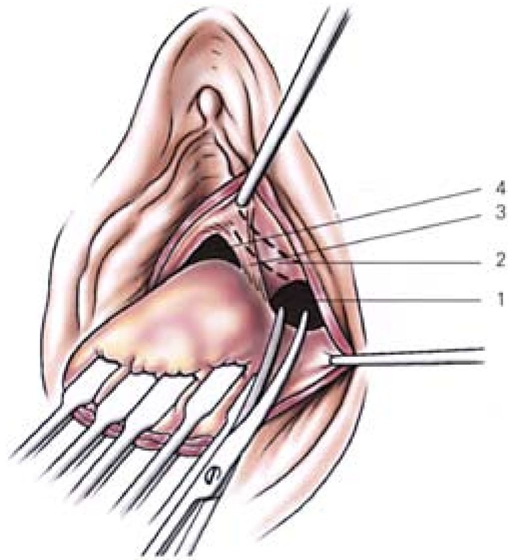


Figure 8

Opening the paravesical space (after Dr Hélène Roy)

1 Paravesical space

2 Ureter

3 Bladder pillars

4 Vesicouterine space

Figure 18A shows the appearance of the cervix 6 months after trachelectomy; Figure 18B shows it in the first trimester in a patient who became pregnant after the procedure.

Saling procedure

Second trimester abortion and prematurity can be a major problem after RVT (Roy and Plante 1999). The inevitable shortening of the cervix after this procedure seems to prevent the formation of an efficacious mucus plug: the mucus plug is thought to be a physiological barrier between the vaginal flora and the membranes to prevent ascending infections. In order to avoid chorioamnionitis, which is most likely responsible for premature rupture of membranes and premature labor following RVT, Dargent (1999) has proposed a complete cervical closure of the cervix during pregnancy, a technique described by Saling in 1981 for patients with habitual abortions.

The Saling technique of cervical closure is simple. The procedure is ideally performed at around 14 weeks of pregnancy under general anesthesia. The vaginal tissue just around the external os is superficially injected with a saline solution in order to separate the mucosa from the underlying mucosal layers. A 1.5 cm-wide area of cervicovaginal mucosa is then removed 360° around the external os. The defect is closed with a monofilament resorbable suture in two layers: the deep layer includes the cervical stroma, taking care not to go too deep in order to avoid rupturing the membranes; and the second layer includes the vaginal

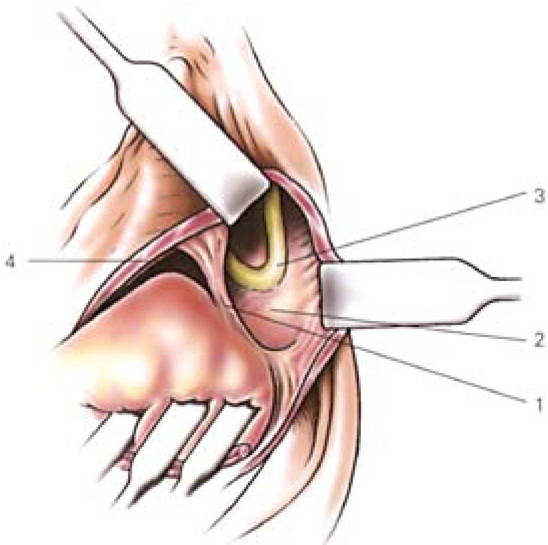


Figure 9

The ‘knee’ of the ureter is exposed on the lateral aspect of the bladder pillars (after Dr Hélène Roy)

1 Bladder pillars

2 Paravesical space

3 Knee of ureter

4 Vesicouterine space

mucosa. Restoration of the permeability of the cervix is accomplished at the time of the planned caesarean section (at approximately 38 weeks) by digital perforation of this reversible vaginal closure. Only one of the six patients operated on by Dargent with this technique had premature labor, compared to 6 of 21 before the routine use of the Saling procedure (personal communication). Thus this technique warrants further evaluation, since it appears promising to prevent premature labor and delivery in patients with shortened cervices following RVT.

Results

The authors retrospectively reviewed their first 30 patients treated by laparoscopic pelvic lymphadenectomy followed by RVT. The median age of the patients was 32 years (range 22–42 years); 15 were nulligravid and 19 nulliparous. Twenty cancers were at stage IB, 1 was at stage IA1, 7 were at stage IA2, and 2 were at stage IIA. The majority of cases (18) were squamous: 2 lesions were >2 cm in size and only 4 had vascular space invasion. The median operative time was 285 minutes (range 155–455 minutes), median blood loss 200 mL (range 50–1200 mL), and median hospital stay 4 days (range 2–9 days). There were 4 intraoperative complications—2 attributed to the RVT and 2 resulting from the lymphadenectomy.

The median follow-up time at review was 25 months (range 1–79 months). One patient had a recurrence in the left parametrium 18 months after RVT and died of metastatic disease. The only six patients attempting pregnancy have succeeded.

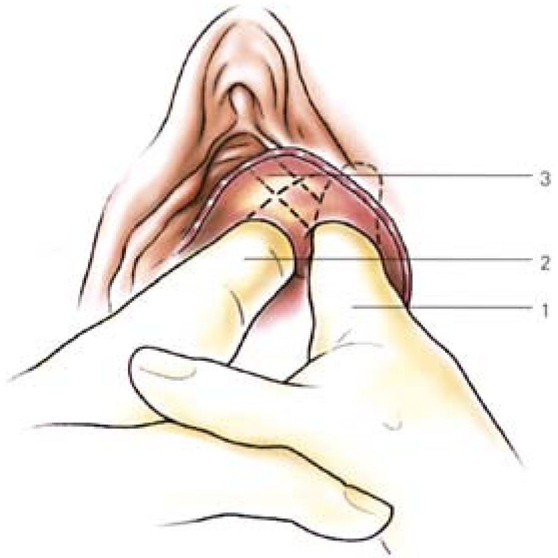


Figure 10

To avoid damage to the ureter, it must be clearly seen and palpated (after Dr Hélène Roy)

1 Right index in paravesical space

2 Ureter

3 Left index in vesicouterine space

In conclusion, RVT appears to be a valuable procedure in well-selected patients with early-stage cervical cancer. Successful pregnancies are definitely possible after this procedure. This new surgical technique warrants further careful evaluation to determine precise indications.

Bibliography

Dargent D (1999) The story of Mme M (videocassette). In: *Proceedings of the 30th Annual Meeting of the Society of Gynecologic Oncologists*. San Francisco.

Dargent D, Brun J-L, Roy M, Mathevet P, Remy I (1994) La trachélectomie élargie (TE). Une alternative à 1'hystérectomie radicale dans le traitement des cancers infiltrants développés sur la face externe du col utérin. *J Obstet Gynecol* **2:**285–92.

Plante M, Roy M (1997) Radical trachelectomy surgical technique. In: Gershenson D, editor. *Operative techniques in gynecologic surgery*. Philadelphia: WB Saunders; vol. 2, pp. 187–99.

Roy M, Plante M (1999) (Reply to a letter to the Editor). *Am J Obstet Gynecol* **181:**230.

Roy M, Plante M (1998) Pregnancies after radical vaginal trachelectomy for the treatment of early-stage cervical cancer. *Am J Obstet Gynecol* **179:**1491–6.

Saling E (1981) Der frühe totale Muttermundverschlufl zur Vermeidung habitueller Aborte und Frühgeburten. *Z Geburtshilfe Perinatol.* **185:**259–61.

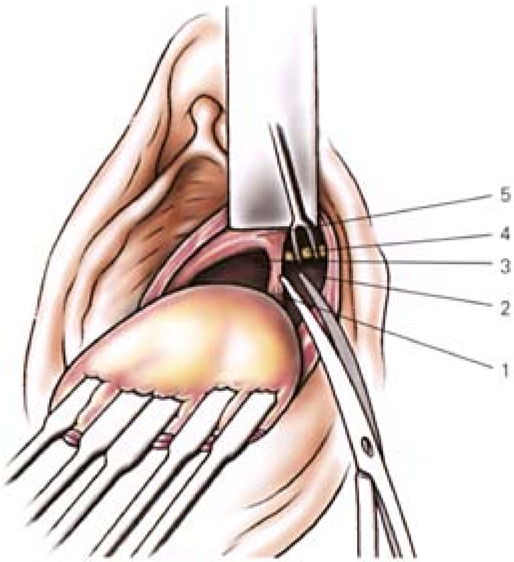


Figure 11

Excision of the bladder pillars (after Dr Hélène Roy)

1 Bladder pillars

2 Paravesical space

3 Vesicouterine space

4 Ureter

5 Bladder base

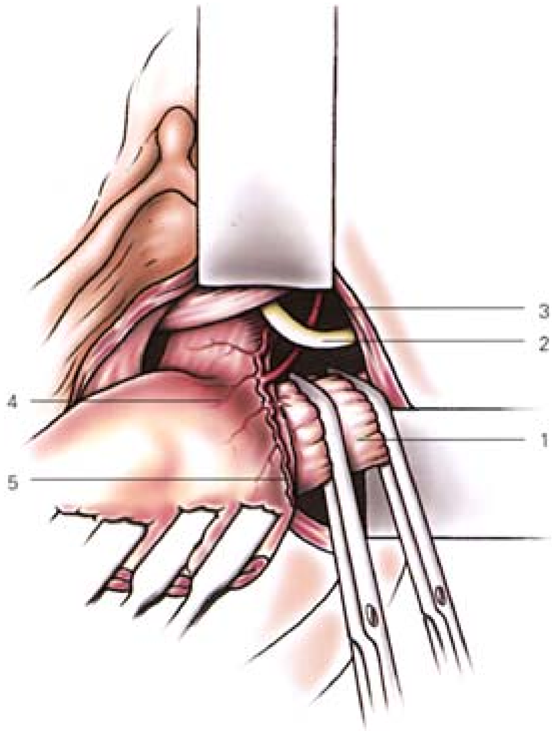


Figure 12

Excision of the parametrium (after Dr Hélène Roy)

1 Parametrium

2 Ureter

3 Uterine artery

4 Isthmus with cross of uterine artery

5 Descending branch of uterine artery

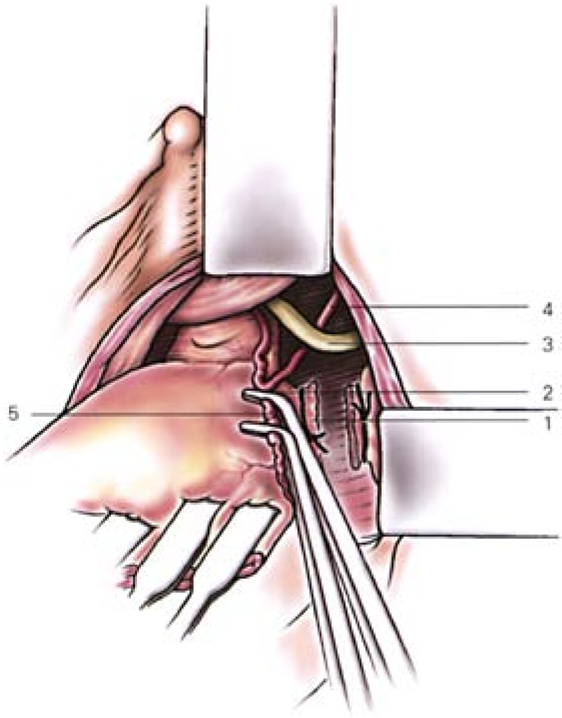


Figure 13

Care is needed to preserve the cross of the uterine artery (after Dr Hélène Roy)

1 Excised parametrium

2 Cross of the uterine artery

3 Ureter

4 Uterine artery

5 Descending branch of uterine artery

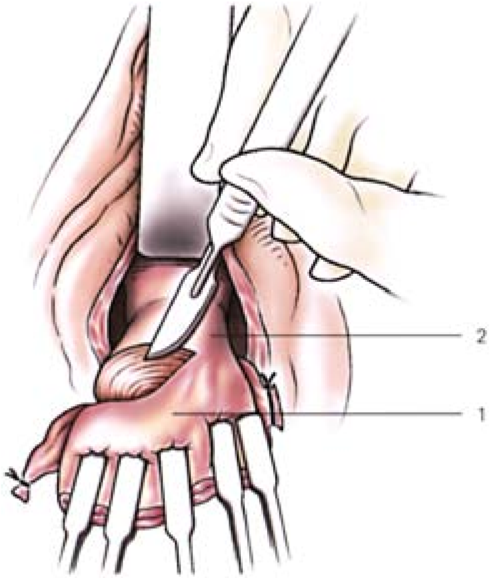


Figure 14

Excision of the cervix (after Dr Hélène Roy)

1 Trachelectomy specimen

2 Residual endocervix

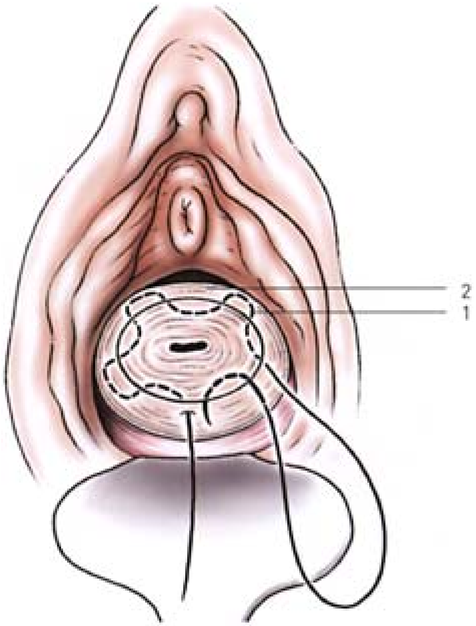


Figure 15

Placing the cervical cerclage (after Dr Hélène Roy)

1 Suture

2 New exocervix

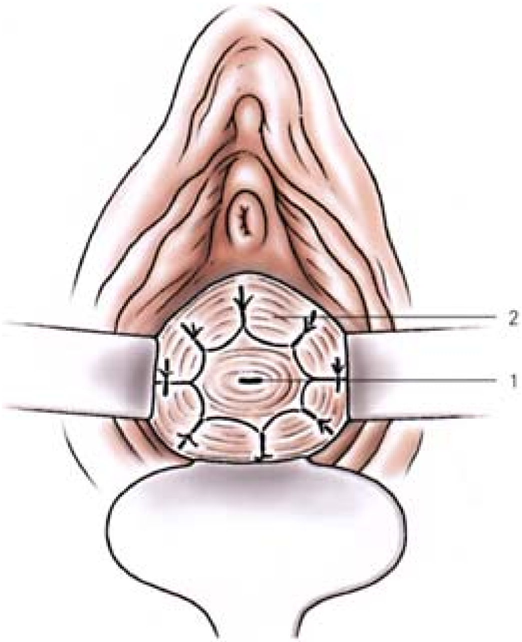


Figure 16

Closure of vaginal mucosa (after Dr Hélène Roy)

1 New external os

2 New exocervix

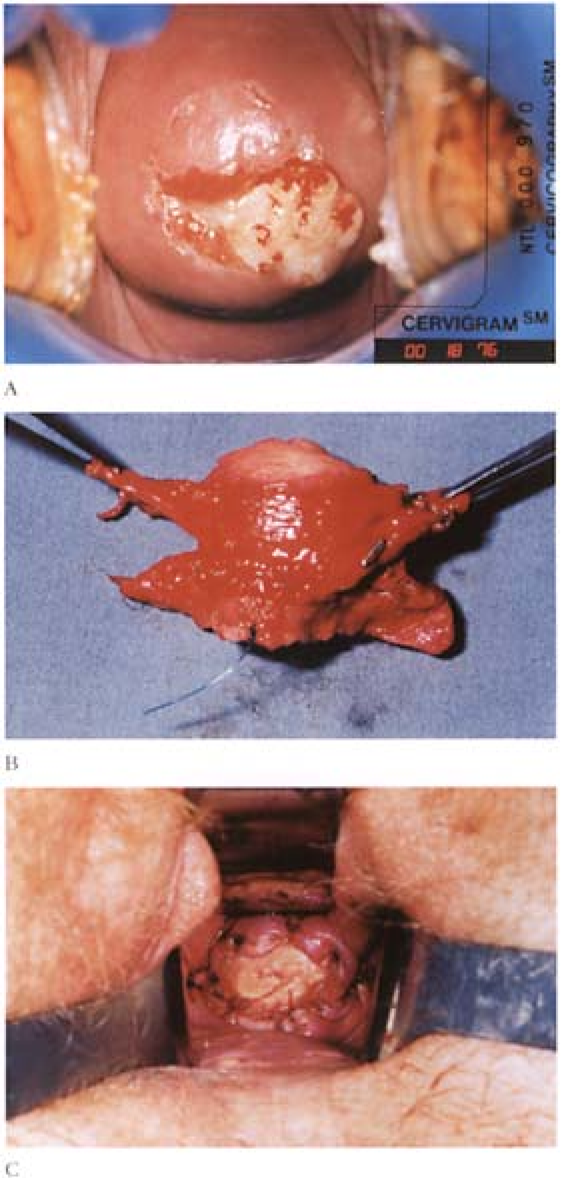


Figure 17

Example of trachelectomy specimen. (A) Exophytic cervical lesion. (B) Lateral view. (C) After closure

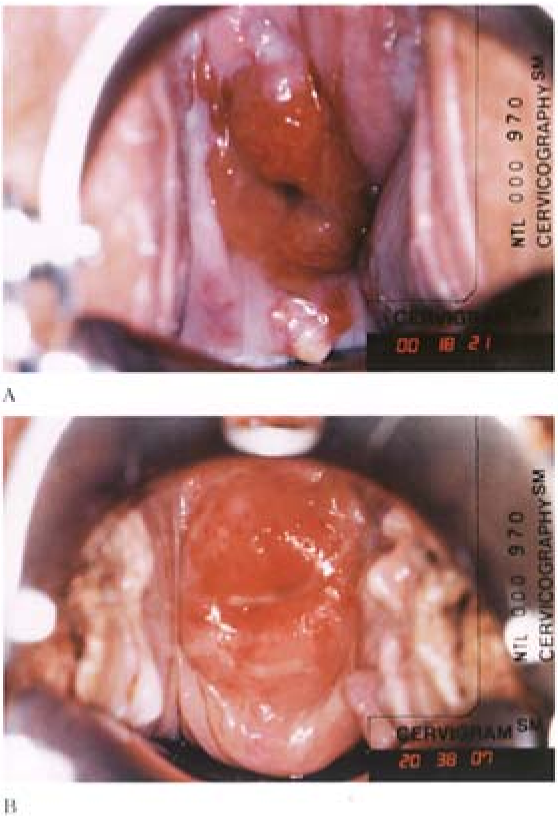


Figure 18

Postoperative appearance. (A) Six months after RVT. (B) First trimester of a subsequent pregnancy

10
Radical abdominal trachelectomy

Deborah CM Boyle

Laszlo Ungars

Giuseppe Del Priore

J Richard Smith

FIGO staging

The traditional management of invasive cervical carcinoma has naturally depended on the stage of

Table 1 The Fédération Internationale de Gynécologie et d'Obstétrique (FIGO) staging of cervical cancer

Stage	*Extent*
0	Intraepithelial neoplasia
I	The carcinoma is strictly confined to the cervix; extension to the uterine corpus should be disregarded
IA	Preclinical carcinomas of the cervix (i.e. those diagnosed by microscopy only). All gross lesions even with superficial invasion are stage IB. Invasion is limited to measured stromal invasion with a maximum depth of 5 mm and no wider than 7 mm. Measurement of the depth of invasion should be from the base of the epithelium, either surface or glandular, from which it orinates. Vascular space involvement, either venous or lymphatic, should not alter the staging
IA1	Minimal microscopically evident stromal invasion. The stromal invasion is no more than 3 mm deep and no more than 7 mm in diameter
IA2	Lesions detected microscopically that can be measured. The measured invasion of the stroma is deeper than 3 mm but no greater than 5 mm, and the diameter is no wider than 7 mm
IB	Clinical lesions confined to the cervix, or preclinical lesions greater than stage IA.
IB1	Clinical lesions not greater than 4 cm in size
IB2	Clinical lesions greater than 4 cm in size
II	Involvement of the vagina except the lower third, or infiltration of the parametrium. No involvement of the pelvic side-wall
IIA	Involvement of the upper two-thirds of the vagina, but not out to the side-wall
IIB	Infiltration of the parametrium, but not out to the side-wall
III	Involvement of the lower third of the vagina. Extension to the pelvic side-wall. On rectal examination there is no cancer-free space between the tumour and the pelvic side-wall. All cases with a hydronephrosis or nonfunctioning kidney should be included, unless this is known to be attributable to another cause
IIIA	Involvement of the lower third of the vagina, but not out to the pelvic side-wall if the parametrium is involved.
IIIB	Extension onto the pelvic side-wall and/or hydronephrosis or nonfunctional kidney ,
IV	Extension of the carcinoma beyond the reproductive tract
IVA	Involvement of the mucosa of the bladder or rectum

Stage	*Extent*
IVB	Distant metastasis or disease outside the true pelvis

the tumour (Table 1). As outlined above, conization is suitable management for cervical intraepithelial neoplasia (CIN) and stage IA1 tumours. It is also probably adequate management for the majority of stage IA2 tumours. Table 2 shows the papers

Table 2 Results of pelvic lymphadenectomy in microinvasive carcinomas (adapted from Burghardt 1993) (≤5 mm invasion, early stormal invasion excluded)

Author	*Year*	*No.*	*Maximal depth (size)*	*CLS involvement (%)*	*Confluent pattern (%)*	*Lymph -node involvement*	*Died of disease*
Roche and Norris	1975	30	5 mm	57	37	0	–
Sedlis et al	1979	74	5×>8mm	NS	22.5 (of 133 cases)	0	–
Lohe et al	1978	37	5×10mm	NS	NS	0	–
Taki et al	1979	55	3 mm	0	0	0	–
Hasumi et al	1980	29	3.1–5 mm	11.1	100	4	–
van Nagell et al	1983	52	3.1–5 mm			3	–
Creasman et al	1985	32	5 mm	15.6 (of 95 cases)	20 (of 96 cases)	0	–
Simon et al	1986	69	5×12mm	6.6 (of 105 cases)	NS	1	–
Maiman et al	1988	30	3.1–5 mm				
Kolstad	1989	63	5 mm	16.1 (of 411 cases)	NS	1	–
Burghardt et al	1991	39	5×10mm	NS	NS	0	–
Creasman et al	1998	51	5 mm	25	NS	0	–

NS=Not stated
CLS=Capillary-like space

published relating to extracervical spread of microinvasive tumours, suggesting that the majority will be adequately managed by conization. Most gynaecologic oncologists would qualify this, depending on whether lymphovascular permeation was present. If it was, they might proceed to a radical hysterectomy and pelvic lymphadenectomy. As can be seen from the table, this practice is not based strictly on evidence. It should be noted that, according to current FIGO definitions, some of the tumours referred to in the table would now be staged beyond IA2 by virtue of their lateral dimensions; however, this serves further to confirm that radical hysterectomy is overtreatment in many cases. Practice will also vary depending on the woman’s desire to retain fertility. Traditionally, stage IB1, IB2 and IIA tumours have been managed by radical hysterectomy and pelvic lymphadenectomy. Stage IIB, III and IV tumours are managed by radiotherapy, chemotherapy and surgery, either singly or in combination, and dependent upon the individual centre and the individual patient. Units vary on their policy for commencing radiotherapy depending on the number of lymph nodes involved.

An increasing number of young women are being diagnosed with invasive cervical cancer. This is probably a result of the cervical smear programme, which enables women to be detected both at an earlier stage in their malignancy and at an earlier age. The increasing number of young patients has made many wonder whether a less radical treatment than a radical hysterectomy and pelvic lymphadenectomy could be offered, while still maintaining a high cure rate and allowing preservation of fertility.

Daniel Dargent describes in Chapter 8 the radical vaginal hysterectomy. Expertise in this procedure is the prerequisite to having the skill required for a new technique he has described for removal of exophytic tumours—stages IA2 to IIA—which were unsuitable for treatment by conization; he called this procedure 'radical vaginal trachelectomy'. It involves removal of the cervix, parametrium and upper vagina via the vaginal route. Patients also undergo a pelvic lymphadenectomy performed laparoscopically prior to the trachelectomy (this operation is fully described by Plante and Roy in Chapter 9). This procedure requires considerable skill in both vaginal and laparoscopic techniques. Many gynaecological oncologists have recently acquired laparoscopic skills to complement their open surgical skills, but few have been trained to perform Schauta's radical vaginal hysterectomy. For these reasons, we have been involved in developing an abdominal approach to radical trachelectomy which is technically similar to a traditional radical hysterectomy, but still offers prospects for future fertility.

When considering more conservative surgery than has previously been the norm for a given condition, one has to consider both the pathology of the disease and its mode of metastasis. The spread of squamous cervical carcinoma is predominantly lateral; it may be continuous, where the tumour spreads in a confluent manner towards the pelvic side-wall, or discontinuous, with vessel or parametrial node involvement.

Vertical spread of cervical cancer is much less common than lateral spread. In Burghardt's series of 395 women (1991) there were no cases of vertical spread in any stage IB or IIA tumours. In the case of stage IIB tumours, there were 11 out of 220 cases (20%) of spread to the uterine corpus, while other workers quote figures of 26% (Mitani 1964) and 24% (Ferrari 1988). Age may be an important factor in spread to the uterine body. Balzer (1978) found that in women under the age of 50 the vertical spread of stage IIB tumours was 9.5%, whereas in women over 50 years old the figure rose to 32%.

Anatomical considerations

Fertility

To retain fertility without the need for assisted conception techniques, a woman must retain her ovaries, fallopian tubes, uterus, a residuum of cervix with a patent cervical os and a functioning vagina. With the use of assisted conception and ovum donation techniques, a woman requires as an absolute minimum to have retained her uterus and enough cervix to retain a cervical cerclage suture.

Vascular considerations

The uterus is supplied by three pairs of arteries: the uterine, ovarian and vaginal arteries, the latter two via collaterals. Viability of the uterus can certainly be maintained in the absence of uterine arteries, but probably only if there is no interruption of the ovarian or vaginal arterial supply. At the Society of Gynaecologic Oncologists Meeting in New Orleans in February 1996, the membership in an interactive session were asked to vote on how many vessels they felt were required for uterine preservation: the majority felt that the uterus required three of its six supplying vessels to remain viable. Interestingly, we now know that uterine viability may be maintained by the ovarian arteries alone, as demonstrated in 7 cases of radical abdominal trachelectomy already undertaken.

Oncological considerations

Any form of radical surgery for treatment of cervical carcinoma requires the removal of at least the cervix, some of or all the parametrium and upper vagina coupled with pelvic lymphadenectomy. The extent of parametrial resection required is still a subject of controversy (Hagen et al 2000). Pelvic lymphadenectomy should involve removal of the paracervical obturator, internal, external and common iliac nodes and possibly also the para-aortic nodes. A full description of Dargent's vaginal technique is given in Chapter 9. Laparoscopic lymphadenectomy techniques are described in Chapter 16.

Operative procedure

Figure 1 demonstrates the tumour requiring to be removed and the vascular supply to the uterus. In our technique for performing a radical abdominal trachelectomy, the abdomen is opened in standard fashion, through either a midline incision or a modified Cherney's incision, and the operation proceeds initially like a standard radical abdominal hysterectomy. The dissection commences by dividing the round ligaments, opening the broad ligament, paravesical and pararectal spaces (Figure 2). The external iliac, common iliac, internal iliac and obturator nodes are removed (Figure 3). The ureter is dissected from its entry into the pelvis until it runs under the uterine artery. The dissection of the anterior division of the internal iliac artery into the superior vesical and uterine vessels is continued with skeletonization of these vessels (Figure 4). The uterine artery is further dissected out alongside the uterine body to produce a completely skeletonized vessel. Bulldog clamps are applied and the vessel is divided approximately 4 cm from its origin at the internal iliac artery. A solution of heparin is instilled into the vessel (Figure 5). The ureteric tunnels are then opened and dissected and the bladder deflected anteriorly. The rectovaginal septum is opened to the level of the pelvic floor. The uterosacral ligaments are divided close to the sacrum and the vagina and parametrium are then incised. The uterus, cervix, upper third of vagina and parametrium are then swung superiorly, still attached to the ovarian pedicle (Figure 6). This allows excision of the cervix, parametrium and upper vagina. A small residuum of cervix is left as the site for inserting a cervical cerclage suture. Frozen section histological examination is performed on tissue from the upper surface of the cervix, to ensure adequate resection margins, and also from the lymph nodes. If the cervix demonstrates inadequate resection margins or the pelvic lymph nodes contain tumour, the procedure is abandoned and a full radical hysterectomy performed

Current research is investigating whether the uterus supplied only by the ovarian arteries can be assessed for viability intraoperatively by pulse oximetry. If the uterus proves to be viable supplied by the ovarian arteries alone then no further action will be required. If, however, uterine perfusion appears compromised, the divided uterine arteries will be anastomosed (Figure 7). A cervical cerclage suture is inserted in the residuum of the cervix to ensure competence in any future pregnancy and the body of the uterus is sutured to the upper edge of the vagina. The abdomen is then closed in the standard fashion.

Future developments

It would appear that the uterus is probably viable in most cases supplied only by the ovarian arteries and drained by the ovarian veins (as per the findings of Dr L Ungars).

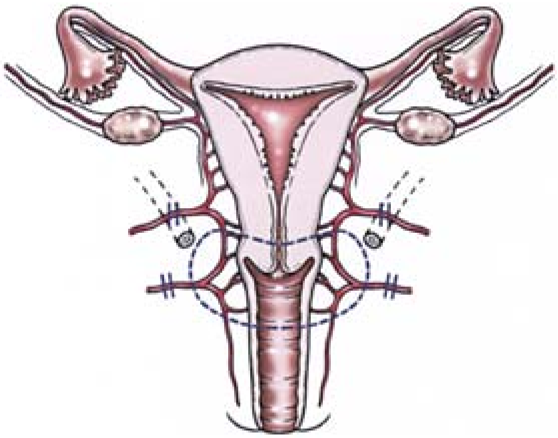


Figure 1

The area to be removed during the procedure

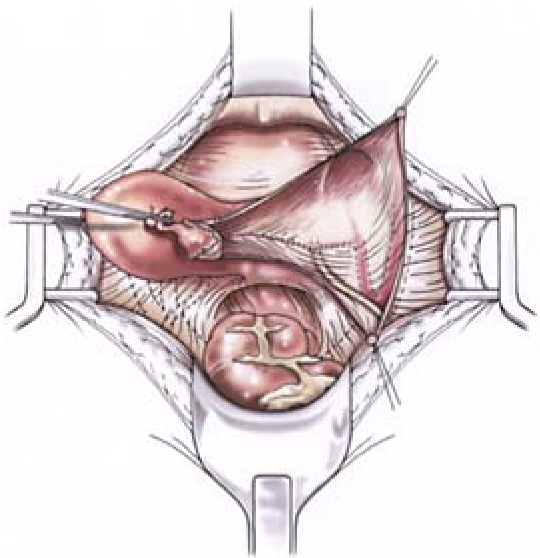


Figure 2

The round ligaments are divided and the broad ligament opened onto the pelvic sidewall

In those cases where uterine arterial anastomosis may be required, we have tested a number of methods. The 3-M Precise Microvascular Anastomotic Device (3M, Leicestershire, UK) is easy to use but does not allow for vessel expansion during pregnancy and is therefore not suitable. We have used 6–0 Prolene and 7–0 PDS sutures (both Ethicon Endosurgery, Edinburgh, UK) in a porcine model and shown both to be effective in suturing the vessels. Flow characteristics as determined by Doppler flow studies were normal throughout pregnancy and the sows delivered normal litters in terms of both size and numbers of piglets. The vessels had normal calibre and appearance at post-mortem. 7–0 PDS was technically the easier material to use. Operating magnifying loops are required. Bulldog clamps (Vascu-Statt: Scanlon International, USA) are

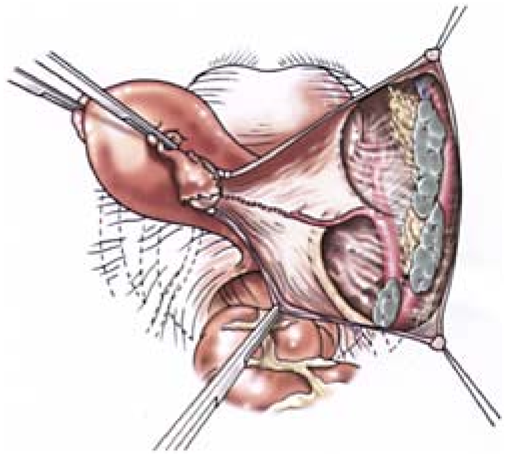


Figure 3

The internal iliac and uterine arteries are skeletonized

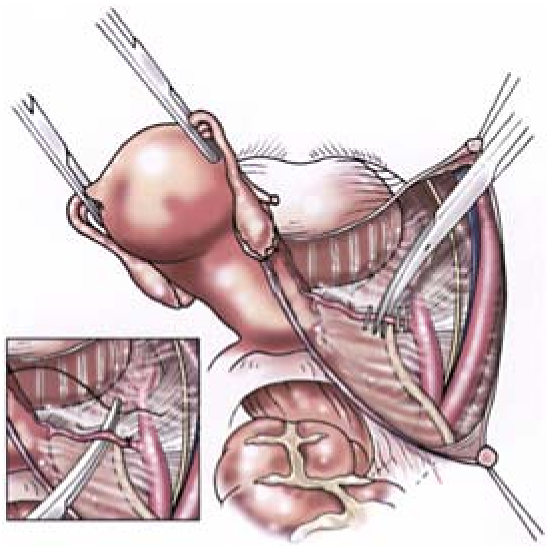


Figure 4

The uterine artery is divided close to its origin following application of haemoclips or ligation (see inset)

applied to the uterine arteries which are irrigated with heparin. Three sutures are inserted outside to inside and then inside to outside with care to include the full thickness of the vessel wall. The Bulldog clamps are then removed and, using a Yankauer (Sherwood Medical, Tullamore, Eire) suction cannula, any bleeding points are identified. The clamps are then reapplied and further sutures placed at any bleeding points. A total of 5 or 6 sutures per vessel is usually required to achieve a dry result.

Criticism of our procedure is not oncological, since our operation, in terms of clearance, is virtually the same as a radical hysterectomy and, we believe, has equal capacity to deliver clearance of tumour. Either a

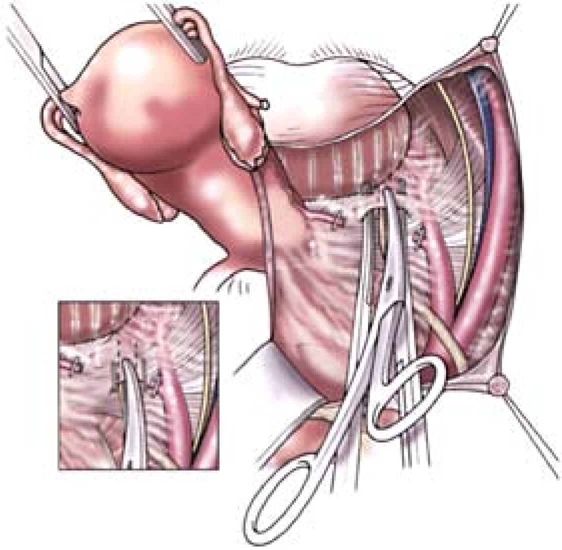


Figure 5

The ureteric tunnel is opened. Bleeding can be profuse at this point and the application of haemoclips may be helpful

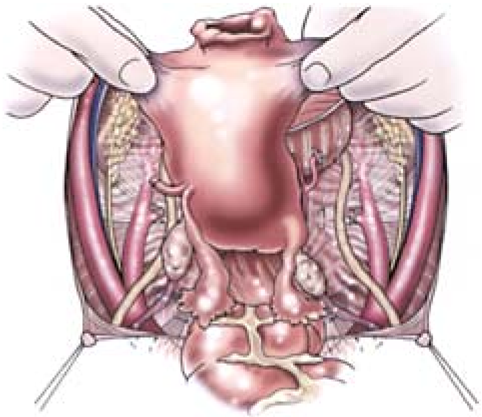


Figure 6

The vagina has been incised and the uterus is shown here, swung superiorly with the ovaries and uterine tubes attached. Arterial supply at this point is via the ovarian vessels alone

proportion of or all the parametrium can be removed, depending upon the tumour being excised. Rather, criticism must be related to possible increased intraoperative and postoperative morbidity associated with a procedure which takes longer than a standard radical hysterectomy, and involves reanastomosis of vessels. If the anastomosis fails or becomes blocked, and the uterus does not appear to be well perfused, then a hysterectomy would be required. Microvascular surgeons, however, quote success rates in excess of 99% for suturing vessels 2.5–3 mm in diameter, i.e. vessels of similar size to the uterine artery. If failure does occur, it is expected to do so at the time of surgery, not in the immediate postoperative phase. As noted

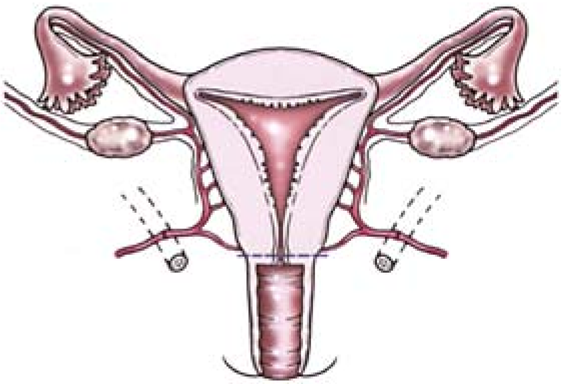


Figure 7

Diagrammatic representation of the end result. The uterine arteries have been anastomosed and the residuum of the cervix sutured to the vagina

above, it is likely that uterine arterial anastomosis is not required in the majority of cases with the uterus supplied and drained via the ovarian vessels alone. The authors are currently researching a novel method for determining uterine viability and its relationship to the number of reanastomosed vessels.

One of the authors (LU) has performed the operation in 7 cases: one patient subsequently underwent a hysterectomy owing to an abnormal Papanicolaou smear result (the histology in this case was negative); the remaining six are well, all having regular periods, with no documented pregnancies. One patient was probably pregnant but had a miscarriage prior to ultrasound confirmation; the remaining patients have not as yet tried for pregnancy.

In summary, radical abdominal hysterectomy offers an oncologically sound procedure with a good chance of cure, but fertility is not preserved. It is this operation which is most commonly performed and has the best follow-up data. Radical vaginal trachelectomy requires advanced vaginal and laparoscopic surgical skills. It has, however, been proved that fertility follows such surgery, and so far the long-term survival data look impressive. Radical abdominal trachelectomy appears to be oncologically sound, and is perhaps more accessible in technical terms than radical vaginal trachelectomy. Fertility and long-term survival rates, despite limited follow-up data, we believe should be similar to those in radical abdominal hysterectomy.

Bibliography

Baltzer J (1978) *Die operative Behandlung des Zeruixcarcinoms. Klinische, histologische und tumormetrische Untersuchungsergebnisse einer kooperativen Studie an vier Universitätsfrauenkliniken bei 1092 Patientinnen mit Zervixcarcinom* (dissertation). Munich: University of Munich.

Burghardt E (1993) Cervical cancer. In: Burghardt E, Webb MJ, Monaghan JM and Kindermann G, editors. *Surgical gynecologic oncology*. New York: Thieme, 306.

Burghardt E, Girardi F, Lahousen M et al (1991) Microinvasive carcinoma of the uterine cervix. *Cancer* **67:**1037–45.

Creasman WT, Fetter BF, Clarke-Paterson DL et al (1985) Management of Stage 1A carcinoma of the cervix. *Am J Obstet Gynecol* **153:**164–72.

Creasman WT, Zaino RJ, Major FJ et al (1998) Early invasive carcinoma of the cervix (3–5mm invasion): Risk factors and prognosis . *Am J Obstet Gynecol* **178:**62–5.

Ferraris G, Lanza A, Re A et al (1988) The significance of lymph node status at pelvic, common iliac and paraortic levels. *Bailliere's Clin Obstet Gynaecol* **2:**913–20.

Hagen B, Shepherd JH, Jacobs IJ (2000) Parametrial resection for invasive cancer. *Int J Gynecol Cancer* **10:** 1–6.

Hasumi K, Sakamoto A, Sugano H (1980) Microinvasive carcinoma of the uterine cervix. *Cancer* **45:**928–31.

Kolstad P (1989) Follow-up study of 232 patients with stage Ia1 and 411 patients with Ia2 squamous cell carcinoma of the cervix (microinvasive carcinoma). *Gynecol Oncol* **33:**265–72.

Lohe KJ, Burghardt E, Hillemans HG et al (1978) Early squamous cell carcinoma of the uterine cervix: clinical results of a cooperative study in the management of 419 patients with early stromal invasion and microcarcinoma. *Gynecol Oncol* **6:**31–5.

Maiman MA, Fruchter RG, DiMaio TM et al (1988) Superficially invasive squamous cell carcinoma of the cervix. *Obstet Gynecol* **72:**399–403.

Mitani Y, Jimi S, Iwasaki H (1964) Carcinomatous infiltration into the uterine body in carcinoma of the uterine cervix. *Am J Obstet Gynecol* **89:**984.

Roche WD, Norris HJ (1975) Microinvasive carcinmoma of the cervix: the significance of lymphatic invasion and confluent patterns of stromal growth. *Cancer* **36:**180–6.

Schauta R (1908) *Die erweiterte vaginale Totalextirpation des Uterus beim Kollumkarzinom,* Vienna: Safar.

Sedlis A, Sall S, Tsukada Y et al (1979) Microinvasive carcinoma of the uterine cervix: a clinical-pathologic study. *Am J Obstet Gynecol* **133:**64–74.

Simon NL, Gore H, Shingleton HM et al (1986) Study of superficially invasive carcinoma of the cervix. *Obstet Gynecol* **68:**19–24.

Smith JR, Boyle D, Corless D et al (1997) Abdominal radical trachelectomy: a new approach to the management of early cervical cancer . *Br J Obstet Gyn* **104:**1196–1200.

Taki I, Sugimori M, Matsuyami T et al (1979) Treatment of microinvasive carcinoma. *Obstet Gynecol Surv* **34:** 839–43.

Van Nagell JR Jr, Greenwell N, Powell DF et al (1983) Microinvasive carcinoma of the cervix. *Am J Obstet Gynecol* **145:**981–91.

11
Central recurrent cervical cancer: the role of exenterative surgery

John Monaghan

Introduction

The procedure of pelvic exenteration was first described in its present form by Brunschwig in 1948. Over the years it has been used mainly in the treatment of advanced and recurrent carcinoma of the cervix. Its primary role at the present time is the management of the numerous patients who develop recurrent cancer of the cervix following primary radiotherapeutic treatment. It has been estimated that between one third and one half of patients with invasive carcinoma of the cervix will have residual or recurrent disease after treatment. Approximately one quarter of these cases will develop a central recurrence which may be amenable to exenterative surgery. However, pelvic exenteration as a therapy for recurrent cancer of the cervix has not been widely accepted and many patients will succumb to their disease having been through the process of radiotherapy followed by chemotherapy and other experimental treatments without being given the formal opportunity of a curative procedure. The published results of exenterative procedures show an acceptable primary mortality of approximately 3–4% and an overall survival/cure rate of 30–60%. The procedure is also applicable to a wide range of other pelvic cancers including cancer of the vagina, vulva and rectum, both for primary and secondary disease. It is less often applicable to ovarian epithelial cancers and melanomas and sarcomas because of their tendency for widespread metastases.

The surgery involved is extensive and postoperative care is complex; as a consequence, the operation has become part of the repertoire of the advanced gynaecological oncologist working in a centre with a wide experience of radical surgery. The procedure does demand of the surgeon considerable expertise and flexibility: virtually no two exenterations are identical, and considerable judgment and ingenuity are required during the procedure in order to achieve a comprehensive removal of all tumour. With small recurrences, more limited procedures may be carried out with a degree of conservation of structures in and around the pelvis. With extensive procedures and particularly following extensive radiotherapy, complete clearance of all organs from the pelvis (total exenteration) together with widespread lymphadenectomy may be essential in order to achieve a cure. There is now considerable evidence that even in patients with node metastases at the time of exenteration a significant survival rate can be achieved.

Selection of the patient for exenterative surgery

Exenterative surgery should be considered for both advanced primary pelvic carcinoma and recurrent disease. Many patients will be eliminated from the possibility of surgery at an early stage because of complete fixity of the tumour mass to the bony structures of the pelvis. The only exception to this rule is the

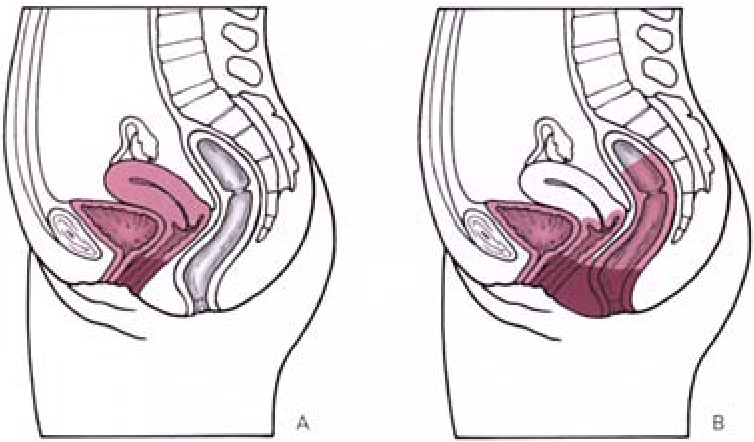


Figure 1

The limits of resection for (A) anterior and (B) total exenteration

rare circumstance in which a vulval or vaginal cancer is attached to one of the pubic rami: the ramus can be resected and a clear margin around the cancer obtained. In general terms exenterative surgery should not be used as a palliative, except perhaps in the presence of malignant fistulas in the pelvis when it may significantly improve the quality of the patient's life without any significant extension to her life. It is important that the surgical team including nurses and ancillary workers are confident in their ability to manage not only the extensive surgery involved but also the difficult, testing and sometimes bizarre complications that can sometimes occur after exenteration. The average age of patients who are subject to exenteration is 50–60 years, but the age range is wide—from early childhood through to the eighth or ninth decade.

Patient assessment

It is frequently difficult following radiotherapeutic treatment to be certain that the mass palpable in the pelvis is due to recurrent disease and not to radiation reaction or persistent scarring associated with infection or the effects of adhesion of bowel to the irradiated areas.

In recent years both computed tomography (CT) and more recently magnetic resonance imaging (MRI) have been used extensively in the preoperative assessment of patients for many oncological procedures. The considerable difficulties of assessing CT scans in patients who have had preceding surgery or radiotherapy are a particular problem in patients being assessed for exenteration. Some clinicians feel that CT scanning is useful, whereas the author has not found the level of reliability to be acceptable. There will be many individual variations from centre to centre depending upon the skills available to the clinician. A tissue diagnosis is essential prior to embarking on exenterative surgery, and needle biopsy, aspiration cytology or even open biopsy at laparotomy will be required. As distant metastases tend to occur with recurrent and residual disease, it is sometimes helpful to perform scalene node biopsies and radiological assessments of the pelvic and para-aortic lymph nodes together with fine-needle aspiration, in order to assist with the assessment. The mental state of the patient is also important, but should not in itself be a bar to the performance of such surgery.

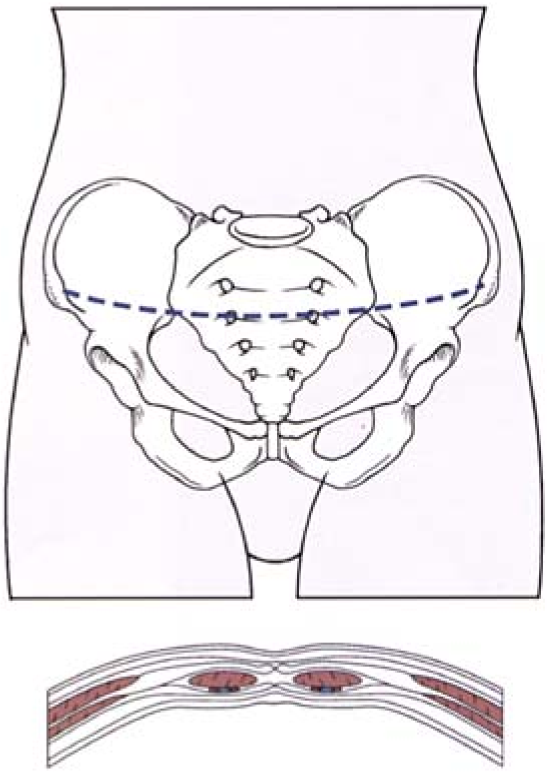


Figure 2

A Maylard or high transverse incision

Absolute contraindications

If there are metastases in extrapelvic lymph nodes, abdominal viscera, lungs or bones there appears to be little value in performing such major surgery. However, there is evidence that patients with pelvic lymph node metastases may well survive, and a good quality of life is reported in a small but significant percentage of such patients.

Relative contraindications

- Pelvic side-wall spread: if the tumour has extended to the pelvic side-wall either in the form of direct extension or nodal metastases the prospects of a cure are extremely small and the surgeon must decide whether the procedure will materially improve the patient's quality of life. The triad of unilateral uropathy, renal nonfunction or ureteric obstruction together with unilateral leg oedema and sciatic leg pain is an ominous sign. The prospects of a cure are poor; readers are, however, referred to Chapter 12 for possible combination therapies. Perineural lymphatic spread is not visible on CT and can be a major source of pain and eventual death.

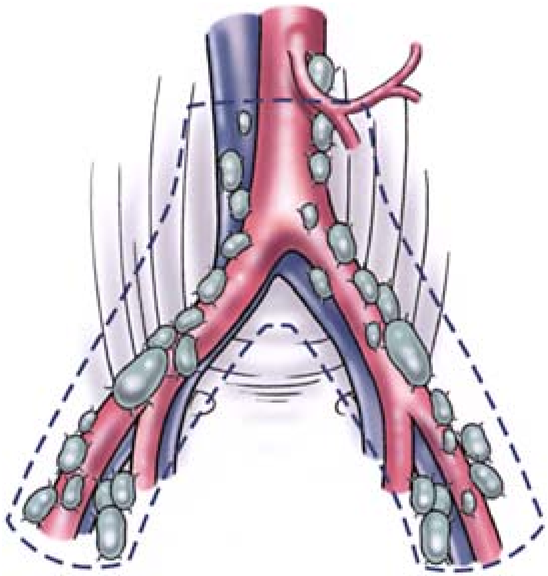


Figure 3

Pelvic and para-aortic node assessment

- Obesity is a problem with all surgical procedures, producing many technical difficulties as well as postoperative respiratory and mobilization problems. The more massive the surgery the greater are these problems.

Types of exenteration

In North America the majority of exenterations performed are total; in the author's series approximately half of his exenterations have been of the anterior type, removing the bladder, uterus, cervix and vagina, but preserving the rectum (Figure 1). For very small, high lesions around the cervix and lower uterus and bladder it may be possible to carry out a more limited procedure (a supralevator exenteration) retaining considerable parts of the pelvic floor. Posterior exenteration (abdominal perineal procedure) is rarely performed by gynaecological oncologists as this procedure tends to be the province of the general surgeon.

Preoperative preparation

Probably the most important part of the preoperative preparation is the extensive counselling needed to make certain that the patient and her relatives, particularly her partner, understand fully the extent of the surgery and the marked effect it will have upon normal lifestyle, in particular the loss of normal sexual function when the vagina has been taken out. The transference of urinary and bowel function to the chosen type of diversionary procedure should be discussed, as should the possibility of reconstructive surgery of the vagina and bladder, and the significant risks of such extensive surgery must be honestly explained. During the course of this counselling the patient should be seen by a stoma therapist. The author finds it

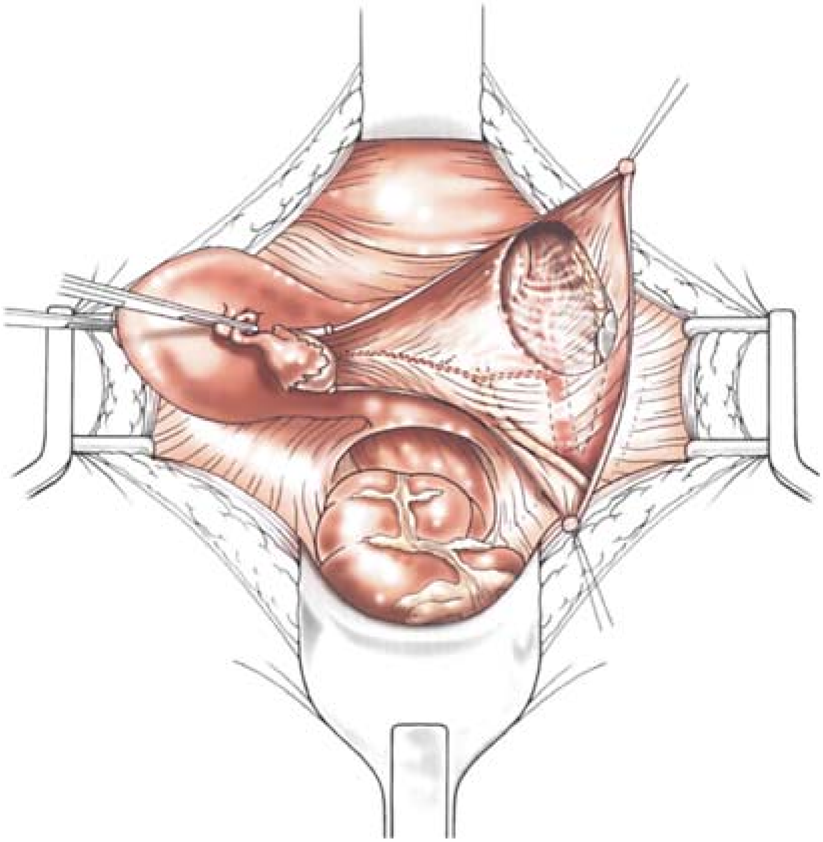


Figure 4

Division of the round and infundibulopelvic ligaments and the beginning of the lateral pelvic dissection

ideal for the patient to meet others who have had the procedure, to discuss on a woman-to-woman basis the real problems and feelings about exenteration.

The patient is usually admitted to hospital 2–3 days prior to the planned procedure to undergo high-quality bowel preparation. With the modern alternative liquid diets and antibiotic therapy, complete cleaning of the small and large bowel can be achieved very rapidly. The anaesthesiologist responsible for the patient's care will see the patient and explain the process of anaesthesia. The author prefers to carry out all radical surgery under a combination of epidural or spinal analgesia together with general anaesthesia. Cardiac and blood gas monitoring is essential. Although the majority of patients do not require intensive care therapy, its availability must be ensured prior to the surgical procedure. Prophylaxis against deep venous thrombosis is usually organized by the ward team utilizing a combination of modern elastic stockings and low-dose heparin which is initiated immediately following surgery.

The final intraoperative assessment

The final decision to proceed with exenteration will not be made until the abdomen has been opened and assessment of the pelvic side-wall and posterior abdominal wall has been made, utilizing frozen sections where necessary. In the author's practice the procedure is performed by a single team. If plastic surgical procedures such as the formation of a neovagina are planned then a second plastic surgical team will carry out the necessary operation at the same time as the diversionary procedures are being performed by the primary team.

Operative procedure

Once the patient has been anaesthetized and placed in the supine position in the operating theatre the abdomen is opened using either a longitudinal midline incision extending above the umbilicus, of a high transverse (Maylard) incision (Figure 2) cutting through muscles at the interspinous level. Exploration of the abdomen will confirm the mobility of the central tumour mass; thereafter the para-aortic lymph nodes and pelvic side-wall nodes are dissected (Figure 3) and sent for frozen section examination. Once the frozen sections show no extension of tumour the procedure of total exenteration can begin. At the same time as this initial intraoperative assessment the experienced exenterative surgeon will have opened tissue planes, including the paravesical, pararectal and presacral spaces to a deep level (Figures 4, 5) in the pelvis in order to become familiar with the full extent of the tumour. The dissection is achieved by opening the broad ligament: this can be done directly or the round ligament can be ligated and divided first. These dissections can be carried out without any significant blood loss and will yield considerable information. If it is not possible to proceed with the operation the abdomen may be closed at this stage as no significant trauma has been inflicted by the surgeon. Considerable experience and judgment is required in order to make this decision. Often the most difficult decision is to stop operating. Very occasionally, for example with some vulval cancers, resection of pubic bones may be attempted, but in general terms if there is bony involvement of tumour the procedure should be abandoned.

Total and anterior exenteration

After the comprehensive manual and visual assessment of the pelvis and the abdominal cavity, the surgeon proceeds by dividing the round ligament (if it is not already divided), drawing back the infundibulopelvic ligament and opening up the pelvic side-wall (Figure 6). The line of incision for removal of the entire pelvic organs begins at the pelvic side-wall, over the internal iliac artery, and will pass forward through the peritoneum of the upper part of the bladder, meeting with the similar lateral pelvic sidewall incision at the opposite side. The sigmoid colon will be elevated and at a suitable point will be transected, the peritoneal incision will be continued around the brim of the pelvis—with identification of the ureter as it passes over the common iliac artery— and will meet up with the similar incision on the opposite side. After the round ligaments have been divided and tied and the pelvic side-wall space opened, the infundibulopelvic ligament can also be identified, divided and tied. The incision is continued posteriorly and the ureters are separated and identified. If an anterior exenteration is to be performed the peritoneal dissection will be brought down into the pelvis to run across the anterior part of the rectum, just above the pouch of Douglas; this will allow a dissection from the anterior part of the rectum passing posteriorly around the uterosacral ligaments to the sacrum, releasing the entire anterior contents of the pelvis. For a total exenteration the dissection is even simpler: the mesentery of the sigmoid colon is opened and individual vessels clamped, divided and tied. The colon is divided, usually with a stapling device which allows the sealed ends of the colon to lie, without

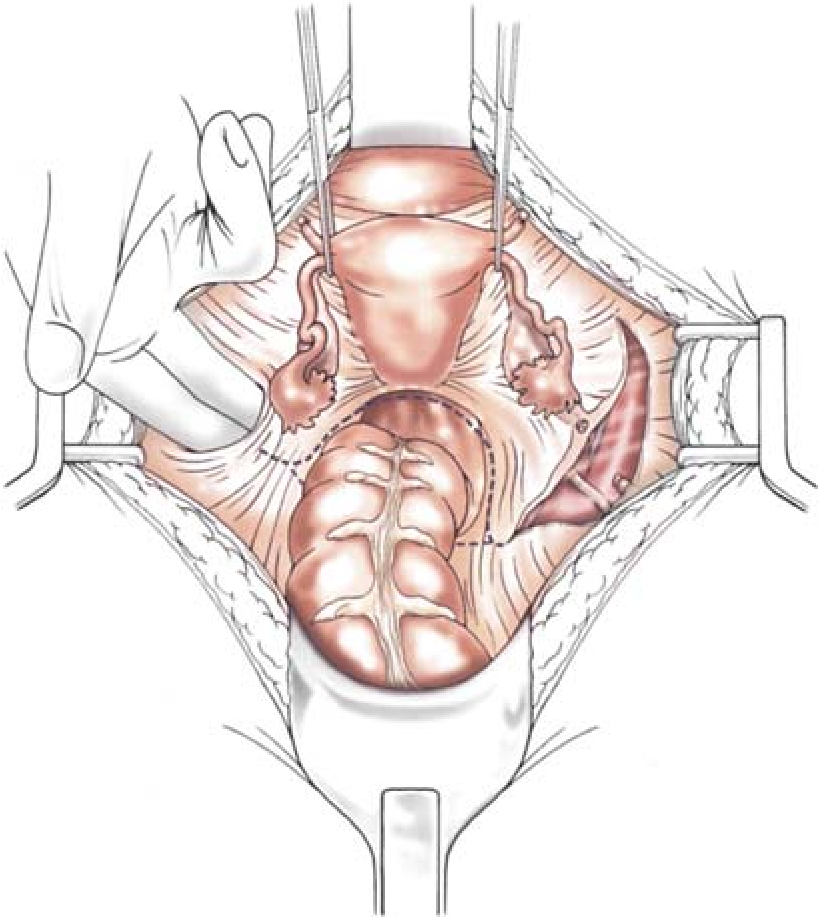


Figure 5

Deepening the lateral pelvic dissection to reveal the pelvic spaces

interfering with the operation in the upper abdomen (Figure 7). A dissection posterior to the rectum is then carried out from the sacral promontory, deep behind the pelvis; this dissection is rapid and simple and permits complete separation of the rectum from the sacrum. This allows complete and usually bloodless removal of the rectal mesentery including lymph nodes. Anteriorly, the bladder is dissected with blunt dissection from the cave of Retzius resulting in the entire bladder with its peritoneal covering falling posteriorly. This dissection is carried down to the pelvic floor, isolating the urethra as it passes through the pelvic floor (perineal diaphragm). As dissection is carried posteriorly into the paravesical spaces, the uterine artery and the terminal part of the internal iliac artery will become clearly visible. By steadily deepening this dissection the anterior division of the internal iliac will be isolated and the tissues of the lower obturator fossa identified; at this point, large exenteration clamps may be placed over the anterior division of the internal iliac artery and its veins (Figure 8). The ureter by this time will have been divided a short distance beyond the pelvic brim. The pelvic phase of the procedure is at this point completed and the perineal phase is now to be carried out.

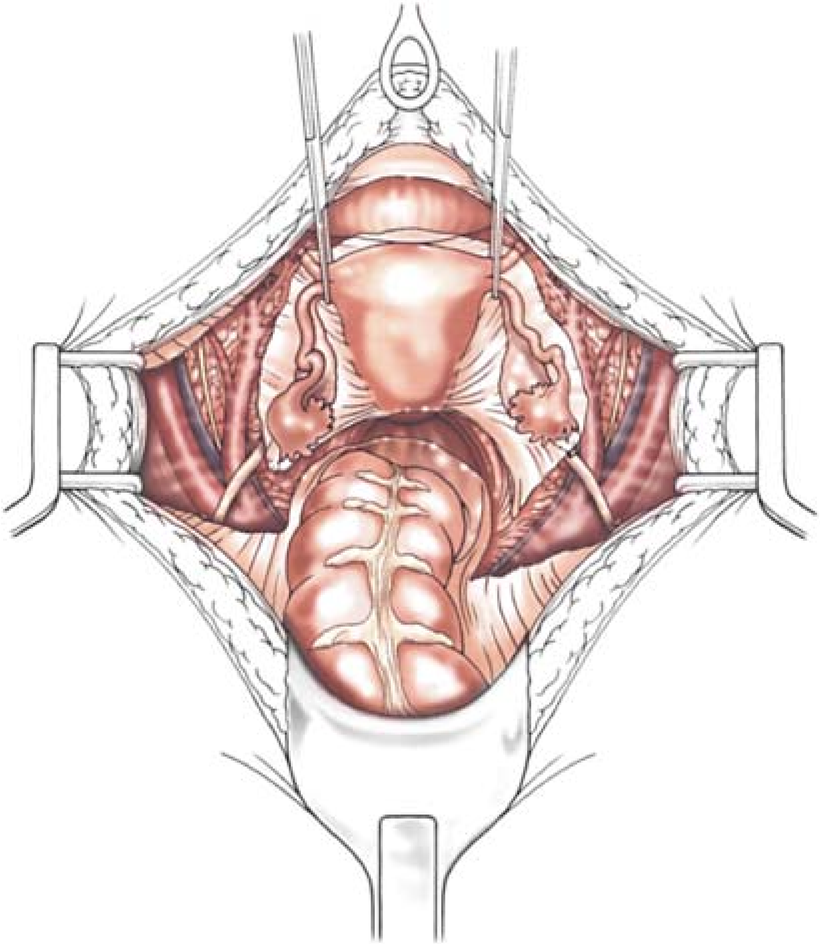


Figure 6

The pelvic incision for an anterior exenteration

The patient is placed in the extended lithotomy position and an incision made to remove the lower vagina (for an anterior exenteration) or the lower vagina and rectum (for a total exenteration) (Figure 9). Anteriorly the incision is carried through above the urethra just below the pubic arch to enter the space of the cave of Retzius which has been dissected in the pelvic procedure. The dissection is carried laterally and posteriorly, dividing the pelvic floor musculature, and the entire block of tissue is then removed through the inferior pelvic opening. Small amounts of bleeding will occur at this point, usually arising from the edge of the pelvic floor musculature. These can be picked up by either isolated or running sutures which will act as a haemostat.

Once the perineal dissection has been completed and haemostasis achieved, the surgeon's choice will depend on the preoperative arrangements made with the patient. If in the preoperative assessment period it was decided by the clinician and the patient that a neovagina should be formed, than at this point either the primary surgeon or the plastic surgeon will initiate the development of a neovagina. This may be in the form

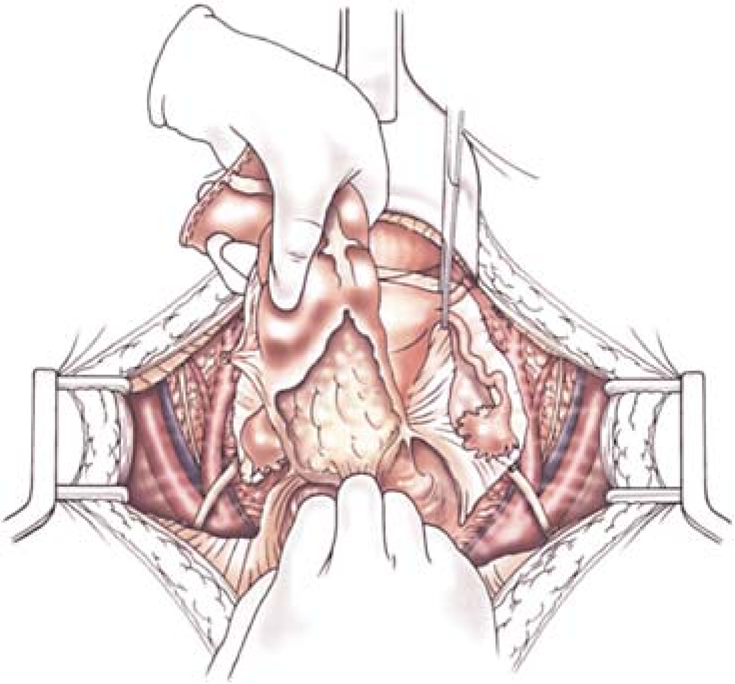


Figure 7

The pelvic incision for a total exenteration

of a myocutaneous graft using the gracilis muscle, or a Singapore graft may be used from alongside the vulva; other possible techniques involve the development of a skin graft placed within an omental pad, or transposition of a segment of sigmoid colon in order to form a sigmoid neovagina (see Chapter 21). For many patients, however, the desire to have a new vagina is a very low priority and it is surprising how frequently patients will put off these decisions until well after the time of exenteration. Surviving the cancer appears to be their uppermost desire. To this end the careful closure of the posterior parts of the pelvic musculature, a drawing together of the fat (Figure 10) anterior to that and a careful closure of the skin is all that is required. It is usually possible to preserve the clitoris, the clitoral fold and significant proportions of the anterior parts of the labia minora and labia majora so that when recovery is finally made the anterior part of the genitalia has a completely normal appearance. On some occasions patients will be able to have a neovagina formed some significant period of time following the exenteration. This is becoming the predominant pattern in the author's experience of some 89 cases.

Once the perineal phase is finished the legs can be lowered so that patient is once more lying supine and attention can be addressed to dealing with the pedicles deep in the pelvis. All that remains following a total exenteration will be the two exenteration clamps on either side of the pelvis and a completely clean and clear pelvis. The pelvic side-wall dissection of lymph nodes can be completed before dealing with the clamps and any tiny blood vessels that require haemostasis are ligated. As the exenteration clamps are attached to the distal part of the internal iliac arteries it is important that comprehensive suture fixation is carried out (Figure 11). This is usually readily and easily done, although occasionally the large veins of the pelvic wall can provide difficulties and the use of mattress sutures may be necessary in order to deal with

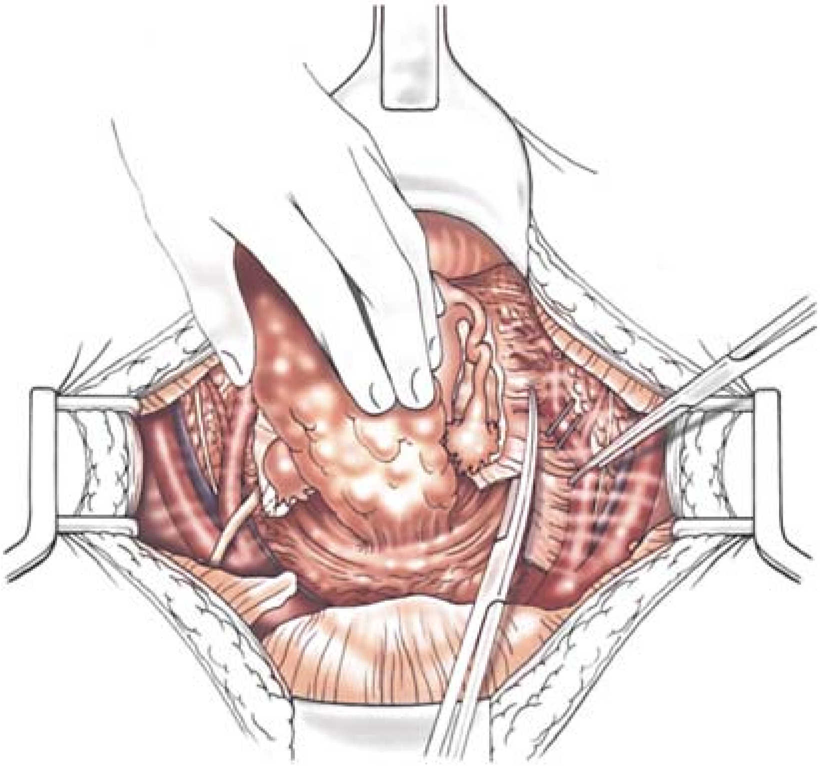


Figure 8

Exenteration clamps applied to the anterior division of the internal iliac arteries

these complex vascular patterns. Having completed the dissection of the pelvis the clinician now moves to produce either a continent urinary conduit or a Wallace or Bricker ileal conduit, and if the procedure has been a total exenteration a left iliac fossa stoma will be formed (see Chapters 2 and 9).

Dealing with the empty pelvis

A problem which must be avoided is that of small bowel adhesion to the tissues of a denuded pelvis. This is particularly important when patients have previously had radiotherapy, as the risk of fistula formation in these circumstances is extremely high. A variety of techniques have been utilized to deal with this potentially life-threatening complication, including the placing in the pelvis of artificial materials such as Merselene (Ethicon, Edinburgh, UK), Dacron (DuPont) and Gortex sacs (WL Gore & Associates, Flagstaff, Arizona, USA), or even using bull’s pericardium. Stanley Way in the 1970s described a sac technique in which he manufactured a bag of peritoneum which allowed the entire abdominal contents to be kept above the pelvis. This resulted in an empty pelvis, which from time to time became infected and generated a new problem, that of the empty pelvis syndrome. Intermittently over the years patching with the peritoneum has been used, but the most successful method appears to be the mobilization of the omentum from its attachment to the transverse colon leaving a significant blood supply from the left side of the transverse colon and allowing the formation of a complete covering of the pelvis by a soft ‘trampoline’ of omentum which will then

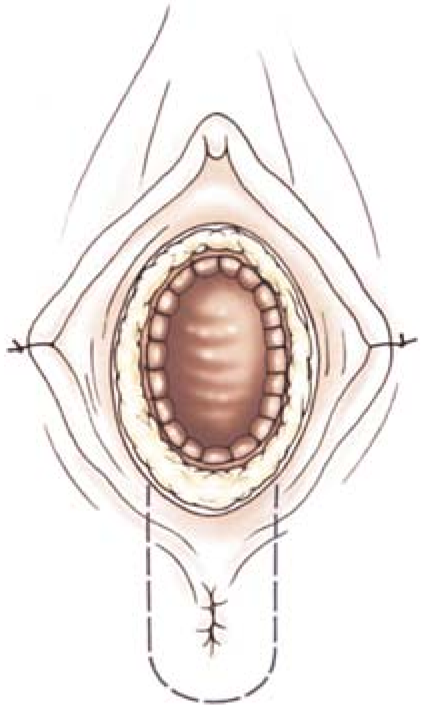


Figure 9

The perineal incisions for anterior and total exenterations

stretch, completely covering and bringing a new blood supply into the pelvis. From time to time procedures such as bringing gracilis muscle flaps into the empty pelvis have been carried out to deal with the difficulty of a devitalized epithelium due to previous radiation.

It is the author's current preference to use an omental graft mobilizing the omentum from the transverse colon using a powered autosuture; this allows a broad pedicle to remain at the left-hand end of the transverse colon, maintaining an excellent blood supply to the omentum. This is brought down to the right side of the large bowel, dropping into the pelvis immediately to the left side of the ileal conduit which is anchored just above the sacral promontory. By careful individual suturing around the edge of the pelvis and sometimes by refolding the peritoneum upon itself, a complete covering of the true pelvis with a soft central 'trampoline' area can be generated (Figure 12). A suction drain is inserted below the omentum, which when activated will draw the omentum down into soft contact with the pelvic floor. The small bowel can thus come into contact with an area with a good blood supply, obviating the risk of adherence and subsequent fistula formation. At the end of the procedure the bowel is carefully oriented to make sure that no hernia can develop and the abdomen is closed with a mass closure. The stomas are dressed in theatre and their appliances put in place. The patient leaves the operating theatre and is then transferred back to the ward at the appropriate time.

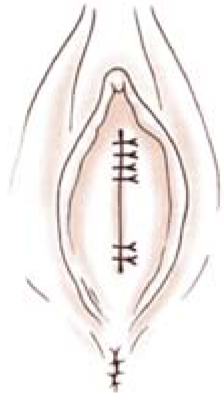


Figure 10

Closure of the pelvic floor musculature

Postoperative care

The postoperative care of exenterations is straightforward, essentially being a matter of maintaining good fluid balance, good haemoglobin levels and ideally a significant flow of urine of 2.5–3.5 litres per day. Bowel function often returns at the usual time of 2–4 days following the procedure, and a nasogastric tube (the author's preference) can be removed after 3–4 days; the return to oral intake, beginning with simple fluid, is initiated on the third day. During and following the procedure prophylactic antibiotic cover is maintained, as is subcutaneous heparin cover as prophylaxis against deep venous thrombosis. Mobilization should be rapid. Patients are usually discharged 10–15 days postoperatively, once they are used to dealing with the stomas and the ileal conduit tubes have been removed.

Results of exenteration

Most series show that the 5-year survival rate following exenteration is of the order of 40–60%; these figures depend very largely upon the selection of patients. A figure that is rather more difficult to obtain is the exact number who are assessed for exenteration but fail at one of the many hurdles that the patient must face before finally undergoing the procedure. It is therefore likely that the final, truly salvageable figure is an extremely low percentage. The value of exenteration procedures in patients who have lymph node involvement has been shown to be low but significant, and it is now many clinicians' practice to carry on with an exenterative procedure even in circumstances where one or two pelvic lymph nodes are involved by tumour.

Bibliography

Barber HRK (1969) Relative prognostic significance of preoperative and operative findings in pelvic exenteration, *Surg Clin North Am* **49**(2):431–7.

Brunschwig A (1948) Complete excision of the pelvic viscera for advanced carcinoma, *Cancer* **1:**177.

Crawford RAF, Richards PJ, Reznek RH et al (1996) The role of CT in predicting the surgical feasibility of exenteration in carcinoma of the cervix . *Int J Gynecol Cancer* **6:**231–4.

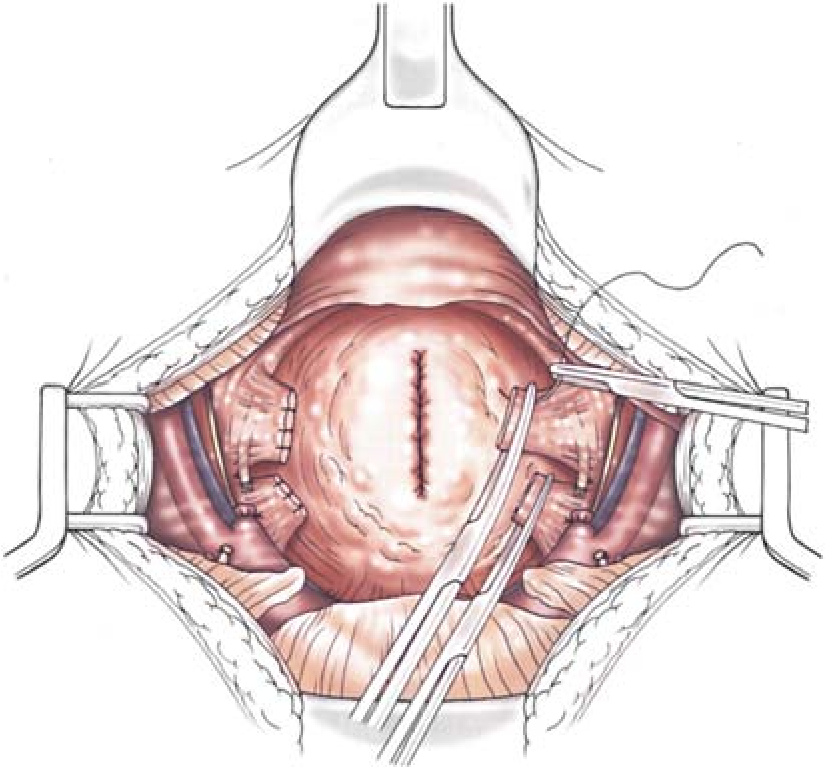


Figure 11

Suture of the internal iliac arteries and lateral pelvic pedicle

Disaia PJ, Creasman WT (1981) *Clinical gynaecologic oncology; cancer of the cervix, pelvic exenteration*, Chapters 2–8, New York: Mosby; pp. 82–8.

Robertson G, Lopes A, Beynon G, Monaghan JM (1994) Pelvic exenteration: a review of the Gateshead experience 1974–1992, *Br J Obstet Gynaecol* **96:**1395–9.

Shingleton HM, Orr JW (1983) In: Singer A, Jordan J, editors. *Cancer of the cervix, diagnosis and treatment.* Edinburgh: Churchill Livingstone, p. 170.

Stanhope CR, Symmonds RE (1985) Palliative exenteration —what, when and why? *Am J Obstet Gynecol* **152:**12–16.

Symmonds RE, Webb MJ (1981) Pelvic exenteration. In: Coppleson M, editor. *Gynaecologic Oncology*. Edinburgh: Churchill Livingstone, pp. 896–922.

Symmonds RE, Webb MJ (1992) Pelvic exenteration. In: Coppleson M, editor. *Gynaecologic Oncology* (2nd edn). Edinburgh: Churchill Livingstone, pp. 1283–312.

Way S (1974) The use of the sac technique in pelvic exenteration. *Gynecol Oncol* **2:**476–81.

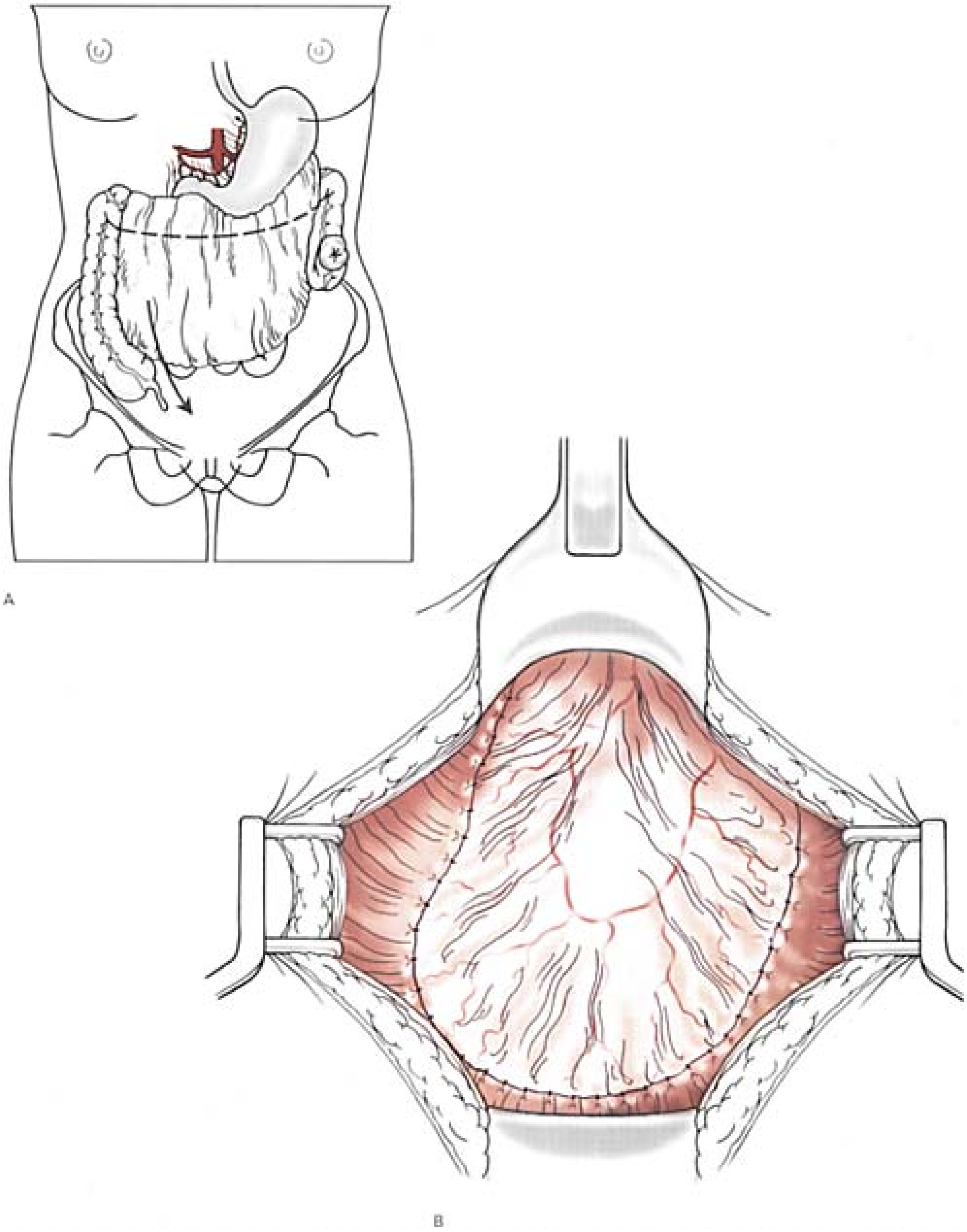


Figure 12

Development of the ‘omental pelvic floor’: (A) omental incision; (B) soft ‘trampoline’ area

12
Pelvic side-wall recurrence of cervical cancer: the LEER/CORT procedure

Michael Höckel

Introduction

Pelvic side-wall recurrences of cervical cancer are generally considered to be inoperable. If patients suffering from this type of relapse have not been irradiated in the pelvis before, radiotherapy or chemoradiotherapy can lead to remission. However, in about 95% of patients with side-wall recurrences the disease is diagnosed after primary or adjuvant pelvic irradiation, or has not been controlled by radiotherapy. Thus for the majority of patients with side-wall recurrences of cervical cancer no chance of long-term survival existed.

The diagnosis of pelvic side-wall recurrence is suspected if a previously undetected mass fixed to the pelvic wall is palpated or if a tumour extending to the pelvic wall structures is identified with radiologic imaging after completion of the primary therapy. Frequently, one or more symptoms out of the triad of troubles are present: hydronephrosis, leg swelling, and pain in the lower back, pelvis or leg (Figure 1). The diagnosis is confirmed by histopathologic demonstration of neoplastic tissue compatible with the primary disease.

The location of the recurrent tumour at the anatomically complex pelvic side-wall is determined by oncological and treatment-related factors. For a more accurate description of the multiple sites, a two-dimensional, topographic anatomical classification is proposed, based on the projection (not infiltration) of the tumour on the pelvic girdle and on its relation to the iliac vessels. Locations of pelvic side-wall recurrences can be peri-iliac or infrailiac in one dimension and ischiopubic, acetabular or iliosacrococcygeal in the other dimension (Figure 2). An operative technique for the resection of different types of pelvic side-wall recurrences has now been developed, known as Laterally Extended Endopelvic Resection (LEER). Peri-iliac recurrences are resected en bloc as clusters with parts of the related vessels, nerves and pelvic wall muscles. However, the neurovascular structures vital for leg function (common and external iliac arteries, lumbosacral plexus) are spared. Peri-iliac recurrences are usually removed with potential microscopic residue. Infrailiac recurrences are resected by laterally extended pelvic evisceration. Exenteration en bloc with the parietal endopelvic fascia and the adjacent pelvic wall muscles leads to clear margins in the majority of cases.

In cases of resections with microscopic residual disease, guide tubes for postoperative brachytherapy are implanted on the tumour bed at the pelvic wall. By transposition of nonirradiated autologous tissue from the abdominal wall or from the thigh a compartmentalization of the tumour bed is achieved. This pelvic wall plasty also provides therapeutic angiogenesis (Höckel et al 1993) and creates a protective distance of several centimetres to the remaining hollow organs in the pelvis. These three features allow the application

Figure 1

The most frequent symptoms of pelvic wall recurrences of gynaecological malignancies are unilateral hydronephrosis (A), leg swelling and leg or pelvic pain (B). These symptoms are often misinterpreted or regarded as evidence for inoperability in irradiated patients. Since the LEER/CORT procedures lead to local control and open a possibility of long-term survival to patients with pelvic side-wall disease even in the irradiated pelvis if the diagnosis is made early, regular clinical follow-up examinations at short intervals are important. If a suspicious mass is palpated or symptoms of the triad of troubles are apparent, high-resolution pelvic MRI with and without contrast medium is now the optimal diagnostic imaging procedure. Pelvic-wall recurrences can thus be detected much earlier than in the case shown above (C) in whom the LEER/CORT procedures are no longer applicable.

of a high localized irradiation dose to the tumour bed despite the prior irradiation. The complete therapy is known as Combined Operative and Radiotherapeutic Treatment (CORT).

The rate of severe complications of these extensive operations is 25%. No lethal complications have occurred. Treatment sequelae are acceptable for tumour-free patients most of whom rated their quality of life as good (Höckel et al 1996). Local control rates between 80% and 90% and 5-year survival rates between 30% and 40% can be achieved in patients with pelvic side-wall recurrences of cervical cancer in an irradiated pelvis selected according to the criteria outlined below (Höckel et al 1989, 1991, 1994, 1996; Höckel 1999a, b).

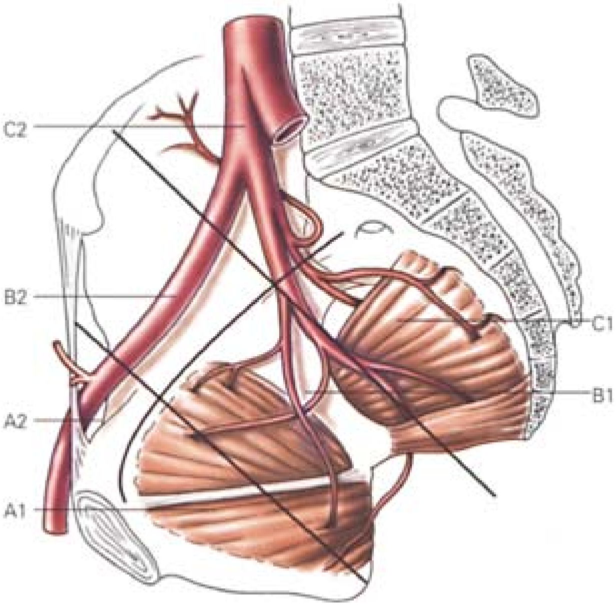


Figure 2

Topographical anatomical representation of different types of pelvic side-wall recurrences according to the suggested classification (Höckel et al 1996). (After W.Hanns.)

A1 Infrailiac ischiopubic

A2 Peri-iliac ischiopubic

B1 Infrailiac acetabular

B2 Peri-iliac acetabular

C1 Infrailiac sacrococcygeal

C2 Peri-iliac iliosacral

Indications

The LEER/CORT procedure is indicated for histologically confirmed, unifocal pelvic side-wall recurrences. Suitable candidates should be free from tumour dissemination (multifocal pelvic disease, intraperitoneal disease, distant metastases) with tumours limited to a maximum diameter of less than 5 cm. Advanced age is not in itself a contraindication, but should be considered as a factor in performance status. Medical conditions not compatible with major surgery or an unwillingness to accept urinary or faecal diversion would also disqualify a patient.

Anatomic considerations

Vascular supply

The blood supply to the pelvis is derived mainly from the internal iliac vessels. Collateral circulation is provided to the true pelvis by the inferior mesenteric artery through anastomotic channels with the superior rectal artery and the middle sacral artery, and to a limited extent by the external iliac vessel's minor anastomoses (e.g. external pudendal and deep circumflex iliac arteries).

Nerve supply

Nerve roots from as high as T10 all the way down to the sacral roots pass through or into the pelvis. The pelvic side-wall contains many nerves, including (from medial to lateral) the obturator, femoral, genitofemoral, lateral femoral cutaneous, ilioinguinal and iliohypogastric nerves. There is a rich supply of autonomic nerves as well. Injury to these nerves is sometimes unavoidable in pursuit of complete surgical resection.

Muscles

The muscles of the endopelvis include the psoas, iliac, internal obturator and piriform muscles and the levator ani muscles. Depending on the requirements of the procedure, the rectus abdominis and transversus muscles may be used as a flap to resupply the area with healthy tissue. Transposition of these muscles does not lead to significant functional impairment.

Bony landmarks and general considerations

When evaluating a patient for any pelvic operation, the relationship of the anterior superior iliac spine should be noted. Regardless of the general body habitus, the operator will be limited laterally by the bony pelvis as indicated by the spine. Patients with generous amounts of soft tissue lateral to the spine can be difficult operative candidates.

Operative procedure

The patient is informed about the minimal and maximal version of the operation with respect to resection and reconstruction. The final extent of the operation will be determined by the intraoperative findings. Forty-eight hours before surgery mechanical bowel cleaning is begun. Using central venous access, total parenteral nutrition is established and a broad-spectrum antibiotic combination (e.g. ampicillin with clavulanic acid and metronidazole) is infused. Two stoma sites in the epigastric and hypogastric regions are marked. If a gluteal thigh flap is considered for reconstruction and pelvic wall plasty, the course of the inferior gluteal artery branch at the posterior thigh is drawn on the skin.

Standard surgical instruments for radical hysterectomy are required. In addition, Cobb periosteal dissectors (Normed Ltd, Tuttlingen, Germany) and a CORTset (Normed Ltd, Tuttlingen, Germany) will be needed. The CORTset contains marker clips, fixation bridges, guide tubes and special surgical instruments for their handling.

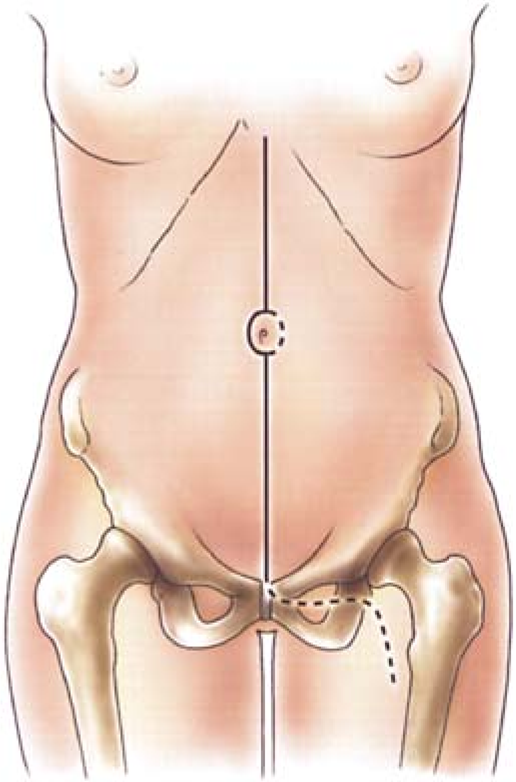


Figure 3

In most cases the LEER/CORT operation is performed through a hypo- and epigastric midline laparotomy. In very obese patients and those with peri-iliac lesions a modified abdominoinguinal incision is advantageous (After W.Hanns.)

Surgical access is through a hypogastric and epigastric midline laparotomy circumventing the umbilicus. In obese patients an abdominoinguinal incision is preferred; this is made by advancing the laparotomy to the middle of the inguinal region at the side of the recurrence and separating the origin of the rectus abdominis muscle without severing the inferior epigastric vessels (Figure 3). For low recurrences, additional perineal incisions at the vaginal introitus (possibly including the anus), are necessary.

The surgical techniques of the most extensive version of LEER, the laterally extended total exenteration for infrailiac pelvic wall recurrences, and the general techniques for the CORT procedure are illustrated in Figures 4–20. Pelvic wall resection and implantation of guide tubes are performed using the left pelvic wall in this example (see further Clamping, p. 119).

All peritoneal adhesions are lysed and the abdominal and pelvic intraperitoneal compartments are systematically explored by inspection and palpation. Biopsies are taken from all suspicious intraperitoneal sites.

If intraperitoneal tumour dissemination can be excluded, the retroperitoneal pelvic and midabdominal compartments are opened. On both sides the paracolic and pelvic parietal peritoneum is incised along the psoas muscles and the round ligaments are separated. The peritoneum at the base of the mesentery is dissected and the duodenum is mobilized against the vena cava and aorta. The small bowel and the right and transverse colon are packed into a bowel bag. The anterior visceral peritoneum of the bladder is incised and

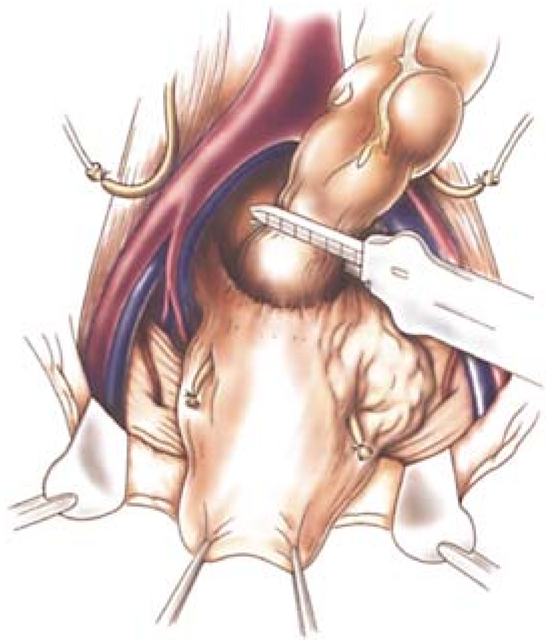


Figure 4

After the retroperitoneum is entered the pararectal and paravesical spaces are completely opened at the tumour-free pelvic side-wall (right). These spaces can only be developed in part on the side of the recurrent disease (left). Following selective periaortic and pelvic lymph node dissection both ureters are transected as deep in the pelvis as possible and stented. The bowel continuity is interrupted at the rectosigmoid transition. (After W.Hanns.)

the space of Retzius is opened. Both paravesical and pararectal spaces and the presacral space are developed. Depending on the location of the recurrent tumour these spaces may only be partially opened. Gross intralesional dissection should be strictly avoided. Both ureters are liberated. Selective periaortic and pelvic lymph node dissection is performed as dictated by the extent of earlier operations and the intraoperative findings.

If lymphatic tumour dissemination cannot be demonstrated in frozen sections, LEER is started. The infundibulopelvic ligaments are divided and the ureters are cut as low as possible in the pelvis. Biopsies of the distal ureters are examined as frozen sections. Stents are inserted into the ureters. The mesosigmoid is skeletized and the blood vessels are ligated at the rectosigmoidal transition. The bowel continuity is interrupted at this site using a gastrointestinal stapler (Figure 4). The sigmoid colon is included in the bowel bag.

At the right pelvic wall the urogenital mesentery structure containing the visceral branches of internal iliac vessels, the pelvic autonomic nerve plexus, the pubocervical ligaments and the paracolpium is completely divided by use of Wertheim clamps as in conventional exenteration procedures.

The left internal iliac artery is ligated and divided where it branches off from the common iliac artery (Figure 5). Thereafter all parietal branches of the iliac vessel system are transected between haemoclips: the ascending lumbar vein, superior gluteal artery and vein, inferior gluteal artery and vein, internal pudendal artery and vein (Figure 6). The internal iliac vein can now be divided at the bifurcation as well. The lumbosacral plexus and the piriform muscle are exposed by this manoeuvre.

Ventral incision of the internal obturator muscle is performed using the electric knife at the site of the obturator nerve, which is either elevated or divided if it is incorporated in the tumour (Figure 7). The muscle

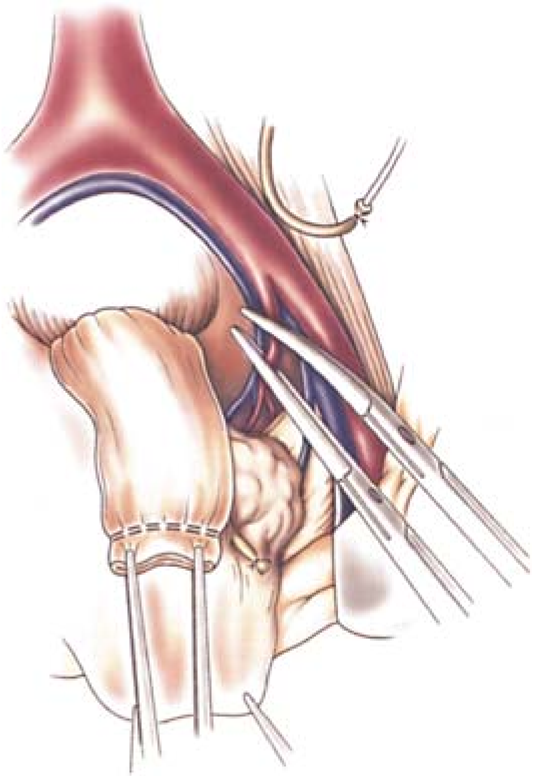


Figure 5

Ligation of the internal iliac artery. (After W.Hanns.)

is separated from the acetabulum and the obturator membrane by use of a Cobb periosteal dissector (Figure 8). Below the ischial spine the obturator muscle which leaves the endopelvis at this point is divided again, with ligation of the muscle stump (Figure 9). The separated endopelvic part of the obturator muscle in continuity with the attached iliococcygeus and pubococcygeus muscles is retracted medially exposing the ischiorectal fossa.

A superficial incision is made below the lumbosacral plexus between the ischial spine and the fourth sacral body and the coccygeus muscle is elevated from the sacrospinous ligament with a Cobb periosteal dissector (Figure 10).

At the level of the ischiorectal fossa the lateral vaginal wall is identified and incised (Figure 11). The anterior vaginal wall and urethra are transected along Wertheim clamps. The anal canal is mobilized from the posterior vaginal wall which is divided after clamping as well. The anorectal transition is separated with an articulated stapling instrument. Now the complete specimen of the laterally extended total evisceration consisting of the urethra, bladder, vagina, uterus and adnexa, rectum at the left side en bloc with the complete endopelvic urogenital mesentery, the coccygeus, iliococcygeus, pubococcygeus and the internal obturator muscle can be removed and examined with multiple frozen sections for tumour margins.

If necessary the caudal dissection can be shifted further downward to include the vaginal introitus, urethral meatus and anus, necessitating secondary access from the perineum.

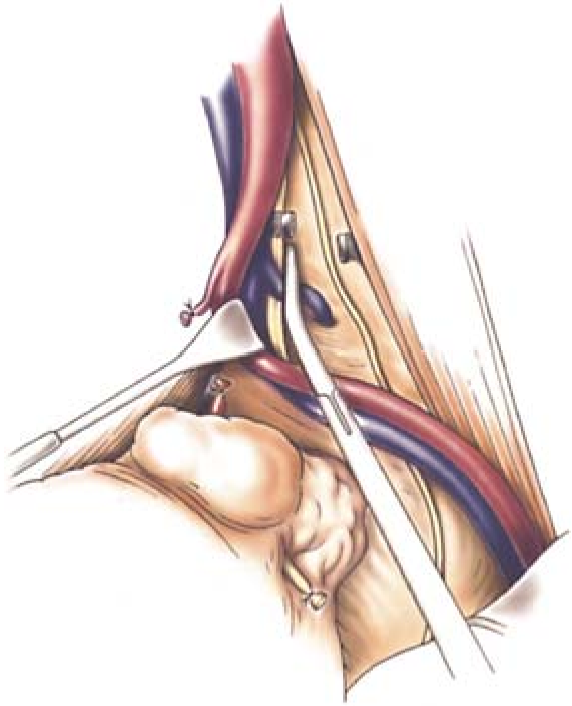


Figure 6

Transection of the parietal branches of the internal iliac artery and vein between haemoclips after retracting the common/external iliac vessels medially as a prerequisite for the ligation of the internal iliac vein. (After W.Hanns.)

If the pelvic side-wall recurrence has been resected with clean margins (RO) by LEER as demonstrated with multiple frozen sections, the CORT procedure is not applied. To improve wound healing in the irradiated pelvis, an omentum flap nourished by the ipsilateral gastroepiploic artery is elevated (Liebermann-Meffert and White, 1983), transposed to the pelvis along the paracolic gutter and fixed to the pelvic surface (Figures 12 and 13). The inclusion of the anus and anal canal into the laterally extended pelvic evisceration necessitates the reconstruction of the pelvic floor to avoid a perineal hernia in addition to the therapeutic angiogenesis. This can be accomplished by the use of a Transversus and Rectus Abdominis MusculoPeritoneal (TRAMP) flap (Höckel 1996, Konerding et al 1997) instead of the omentum flap.

If microscopic tumour extends to the lateral resection margins the tumour bed at the pelvic wall previously outlined with methylene blue is subsequently marked with specially designed titanium clips from the CORTset (Figure 14).

A titanium bridge implant for the fixation of the guide tubes is adjusted to fit to the midline of the tumour bed parallel to the linea terminalis and fixed with 3–0 polyglycolic sutures (Figure 15). The original bridge implant from the CORTset, containing six fixation rings at 2 cm distances, has to be tailored with a special pair of scissors to exceed the size of the tumour bed by at least 1 cm. The bridge implant must also be adapted to the irregular surface of the pelvic wall to maintain immediate contact of the guide tubes with the tumour bed. This can easily be accomplished manually.

The retractors at the abdominal wall are temporarily removed. The rectus abdominis muscle on that side is refixed to its origin by mattress sutures, and the fascia and skin layer of the inguinal extension of the

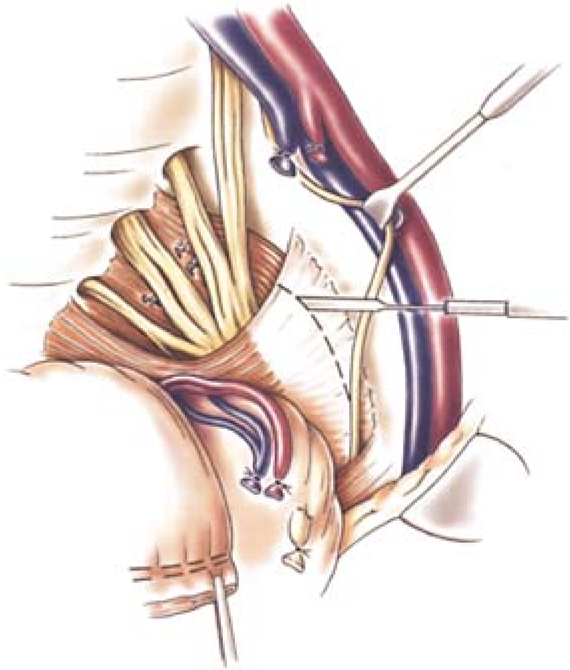


Figure 7

Ventral incision of the obturator internus muscle at the site of the obturator nerve which is retracted. (After W.Hanns.)

laparotomy is closed. Bringing the abdominal wall flap to the midline, 8 mm skin incisions projecting just beyond the fixation rings of the titanium bridge are performed through which the flexible guide tubes are transabdominally implanted using the trocar from the CORTset (Figure 16).

The guide tubes are inserted into the fixation rings of the titanium bridge and fixed to the anatomical structures at the pelvic wall by an additional two or three 3–0 polyglycolic sutures. For optimal dosimetry of the brachytherapy to the tumour bed the guide tubes must be strictly parallel and in direct contact with the pelvic wall surface (Figure 17). The endopelvic (closed) ends of the guide tubes should exceed the lower border of the tumour bed by at least 2 cm. The external (open) tube ends are temporarily cut about 3 cm from the skin surface.

For the pelvic wall plasty either the TRAMP flap from the inner abdominal wall (Höckel et al 1996), or the de-epithelialized extended Vertical Rectus Abdominis Musculocutaneous (VRAM) flap from the external abdominal wall (Taylor et al 1984) (Figure 18), or the (partially) de-epithelialized gluteal thigh flap (Hurwitz et al 1981) is used. These composite flaps are combined with an omentum flap to achieve the necessary area and thickness. The flap combination is always fixed with its muscular site to the pelvic wall. It should be at least 3 cm thick and completely overlie the array of guide tubes on the tumour bed. A suction drain is placed between the tumour bed and the pelvic wall plasty to occlude any dead space (Figure 19).

For supravesical urinary diversion either a conduit or a continent pouch is constructed from nonirradiated colon segments (ascending, transverse or descending colon) with the Mainz techniques (Fisch and Hohenfellner 1991, Fisch et al 1996): see Chapter 18.

Faecal diversion is accomplished by an end sigmoidostomy (see Chapter 5).

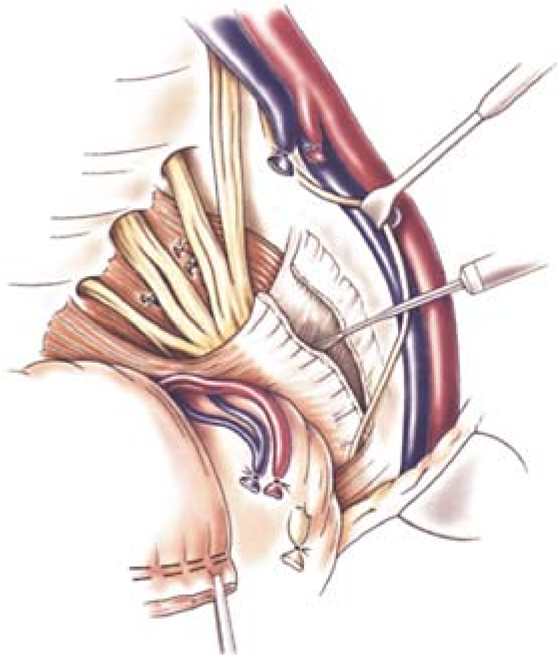


Figure 8

Separation of the obturator internus muscle from the acetabulum and obturator membrane with a Cobb periosteal dissector. (After W.Hanns.)

The perineum and parts of the vagina can be reconstructed with a skin island from the gluteal thigh flap. Total vaginal reconstruction is not possible in patients treated with CORT

The laparotomy is closed with a running Smead-Jones suture and skin staples. Fixation plates are slipped over the external ends of the guide tubes and glued to them at the level of the skin surface with pharmaceutical dermal glue. Each fixation plate is anchored to the skin with four monofilament 3–0 polyamide sutures. The overriding open ends of the guide tubes are cut and closed with plugs (Figure 20).

Depending on the location of the recurrent tumour at the pelvic side-wall, the extent of visceral and parietal resection can be reduced compared with the maximum version described above. Infrailiac sacrococcygeal recurrences may allow sparing of the bladder and the internal obturator muscle. With infrailiac ischiopubic relapses the rectum and coccygeus muscle may remain in situ. Pelvic exenteration is usually not necessary for peri-iliac recurrences; partial resection of the bladder or resection of bowel segments is sufficient. If ureteral compression has led to hydronephrosis and loss of kidney function, nephroureterectomy is performed.

The selection of the flap combination for the pelvic wall plasty depends on the area of the tumour bed, the extent of parietal resection, the reconstructive surgical procedures to be performed, the amount of subcutaneous and omental fat, and the location of scars from previous operations. To ensure uncompromised blood supply the composite flaps should be raised from the side contralateral to the tumour bed. The omentum flap is elevated ipsilaterally. A flap containing the rectus muscle should not be harvested from the colostomy site.

Following bowel anastomosis the patient receives total parenteral nutrition for at least 5 days. The postoperative care of the conduit or pouch for supravesical urinary diversion is carried out as described by

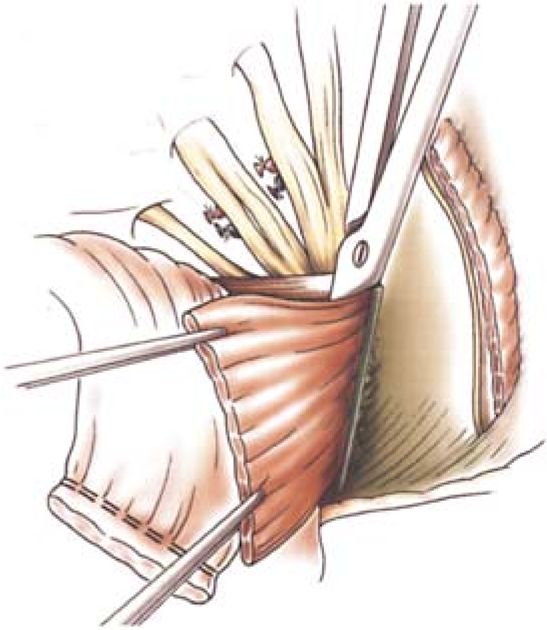


Figure 9

The obturator internus muscle is cut after its remaining part has been clamped at the lesser sciatic foramen. (After W. Hanns.)

Mainz urologists (Fisch and Hohenfellner 1991, Fisch et al 1996) (see also Chapter 15). One week after the operation a series of magnetic resonance imaging scans is performed to evaluate the viability and the location of the pelvic wall plasty. If no dead space between the pelvic wall plasty and the tumour bed can be detected, the suction drain is removed. The skin fixation of the guide tubes should be checked regularly for completeness; resuturing is sometimes necessary. Covering the site of the tube exits with an adhesive film dressing is recommended.

Following the perioperative intravenous antibiotics, the patient receives an oral sulphonamide as long as the guide tubes are in place. Prophylactic low-dose heparin is given during the entire hospital stay.

Radiation therapy

In principle, various modes of tube-guided brachytherapy (low dose rate, high dose rate, pulsed dose rate) are possible with the CORT concept. Irrespective of the dose rate, treatment planning and dosimetry must be optimal and the total dose applied to the pelvic wall must be high enough to eradicate all residual microscopic tumour at the target site.

Radiation treatment is started as soon as possible postoperatively, but not before the anticipated neovascularization of the pelvic wall plasty and the adjacent pelvic wall is established. From animal studies it is known that sufficient vascular connections from the musculocutaneous flaps to the recipient beds are formed after 7 days, after which ligation of the nourishing vessels does not result in flap necrosis. Based on the assumption that the timing of angiogenesis is similar in pelvic wall plasty, and also taking into consideration that the primary recovery time of patients from the extended radical surgery is usually a

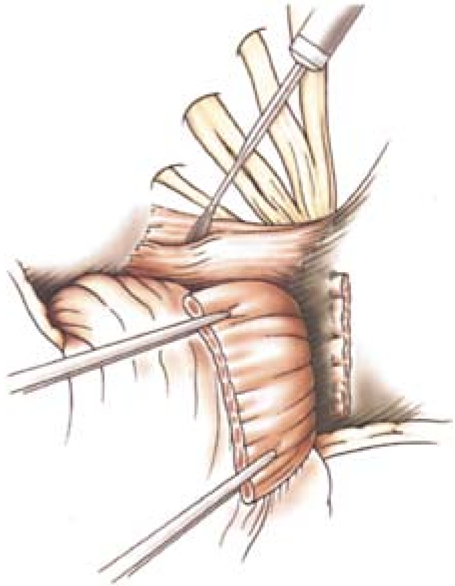


Figure 10

Elevation of the coccygeus muscle from the sacrospinous ligament with a Cobb periosteal dissector. (After W.Hanns.)

week, treatment is planned at the beginning of the second postoperative week and brachytherapy is started on day 10–14 in an uneventful postoperative course.

With calibrating dummies inserted into the guide tubes, several x-ray films of the pelvis in defined planes are taken with a therapy simulator. The area of the tumour bed outlined intraoperatively with marker clips and the corresponding target area for irradiation are drawn on the simulator x-ray films. The locations of (1) the guide tubes, (2) the target area and (3) anatomic points of interest (e.g. adjacent hollow-organ segments) are digitized into the computer for optimal dosimetry. A 100% isodose image is generated, which includes the surface area of the tumour bed with an approximately 2cm circumferential overlap and a 1.0–1.5 cm depth of penetration of the pelvic wall tissues.

The Mainz radiotherapists use a Microselectron Ir-192 high dose rate brachytherapy unit with PLATO planning system (Nucletron, Veenendaal, The Netherlands). Fractions of 6 Gy are given twice weekly. The total dose is limited to 30 Gy in cases of a short interval between the previous whole-pelvis irradiation and the CORT operation. The total dose is increased to 48–54 Gy if more than 6 months have passed since the previous radiotherapy. During radiation treatments the patient's haemoglobin count is kept above 7.5 mmol/1 (120 mg/1), which may necessitate erythrocyte transfusions or the administration of erythropoietin.

Immediately after the last brachytherapy fraction, the fixation sutures are cut and the guide tubes are removed with gentle traction. The titanium bridge implant stays in situ. The small stab wounds close spontaneously within 24 hours.

Clamping

Previous pelvic treatment by either surgery or radiation may render the dissection of the parietal branches of the internal iliac vein extremely difficult, owing to the fibrous abrogation of the pelvic wall anatomy. We

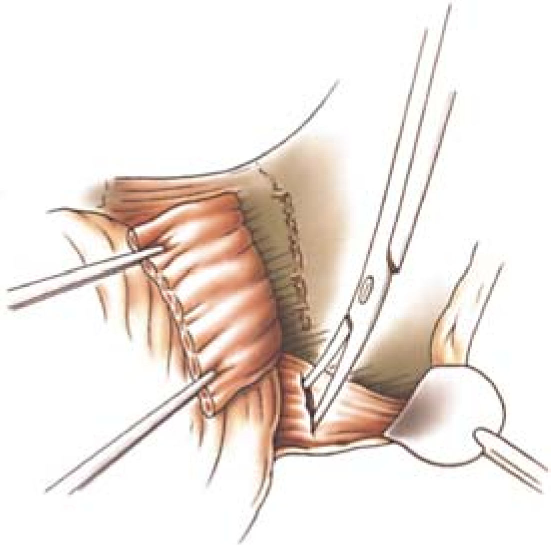


Figure 11

At the endopelvic surface of the ischiorectal fossa the lateral vaginal wall is identified and incised. (After W.Hanns.)

have recently begun to carry out this part of the operation in ischaemia through temporary clamping of both the abdominal aorta and the inferior vena cava below the level of the inferior mesenteric artery to avoid life-threatening haemorrhagia.

Acknowledgement

This work has been supported by a grant from Else-Kröner-Fresenius Stiftung, Bad Homburg, Germany.

Bibliography

Fisch M, Hohenfellner R (1991) Transversum Conduit, *Akt Urol* **22:**1–14.

Fisch M, Wammack R, Hohenfellner R (1996) Kolon-transversum-ascendens/descendens-Pouch, *Akt Urol* **27:** 1–8.

Höckel M (1996) The transversus and rectus abdominis musculoperitoneal (TRAMP) composite flap for vulvovaginal reconstruction, *Plast Reconstr Surg* **97:**455–9.

Höckel M (1999a) Laterally extended endopelvic resection: surgical treatment of infrailiac pelvic wall recurrences of gynecologic malignancies. *Am J Obstet Gynecol* **180:** 306–12.

Höckel M (1999b) Pelvic recurrences of cervical cancer: relapse pattern, prognostic factors and the role of extended radical treatment. *J Pelvic Surg* **5:**255–66.

Höckel M, Kutzner J, Bauer H, Friedberg V (1989) Eine neue experimentelle Methode zur Behandlung von Beckenwandrezidiven gynäkologischer Malignome, *Geburtsh Frauenbeilk* **49:**981–6.

Höckel M, Knapstein PG, Kutzner J (1991) A novel combined operative and radiotherapeutic treatment approach for recurrent gynecologic malignant lesions infiltrating the pelvic wall, *Surg Gynecol Obstet* **173:**297–302.

Höckel M, Schlenger K, Doctrow S, Kissel T, Vaupel P (1993) Therapeutic angiogenesis, *Arch Surg* **128:**423–9.

Höckel M, Baussmann E, Mitze M, Knapstein PG (1994) Are pelvic side wall recurrences of cervical cancer biologically different from central relapses? *Cancer* **74:** 648–55.

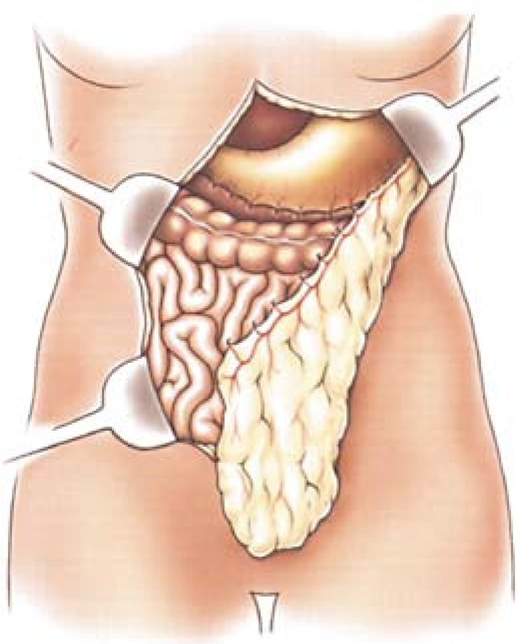


Figure 12

Omentum flap nourished by the left gastroepiploic vessels. (After W.Hanns.)

Höckel M, Schlenger K, Hamm H, Knapstein PG, Hohenfellner R, Rösler HP (1996) Five-year experience with combined operative and radiotherapeutic treatment of recurrent gynecologic tumors infiltrating the pelvic wall, *Cancer* **77**:1918–33.

Hurwitz DJ, Swartz WW, Mathes SJ (1981) The gluteal thigh flap: a reliable sensate flap for the closure of buttock and perineal wounds, *Plast Reconstr Surg* **68:**521–32.

Konerding MA, Gaumann A, Shumsky A, Schlenger K, Höckel M (1997) The vascular anatomy of the inner anterior abdominal wall with special reference to the transversus and rectus abdominis musculoperitoneal (TRAMP) composite flap for vaginal reconstruction, *Plast Reconstr Surg* **99:**705–10.

Liebermann-Meffert D, White H (1983) Protective and reconstructive surgery with the omentum in man. In: Liebermann-Meffert D and White H (eds) *The Greater Omentum*, pp. 211–329. Berlin: Springer.

Taylor GI, Corlett RJ, Boyd JB (1984) The versatile deep inferior epigastric (inferior rectus abdominis) flap, *Br J Plast Surg* **37:**330–50.

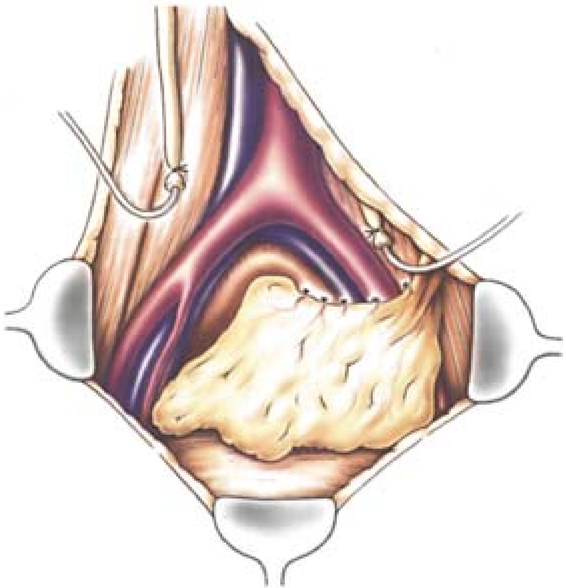


Figure 13

Omentum flap transposed to the pelvis for therapeutic angiogenesis. (After W.Hanns.)

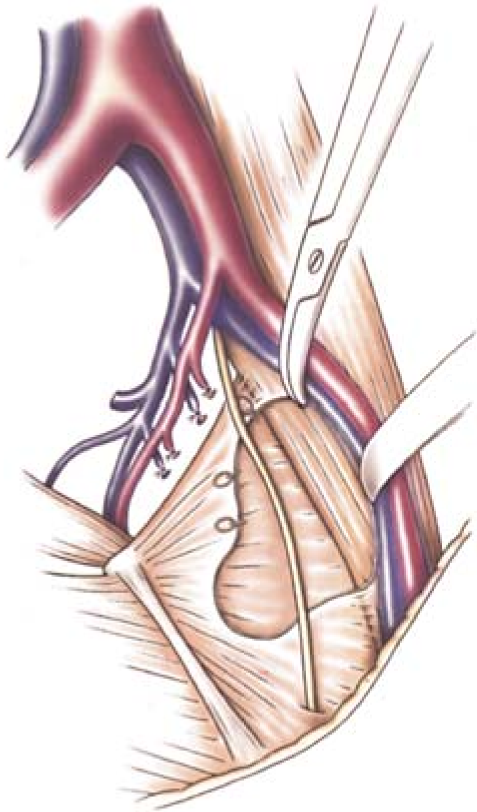


Figure 14

After microscopically incomplete resection of a left peri-iliac acetabular side-wall recurrence, the tumour bed is marked with methylene blue and specially designed titanium clips. (After W.Hanns.)

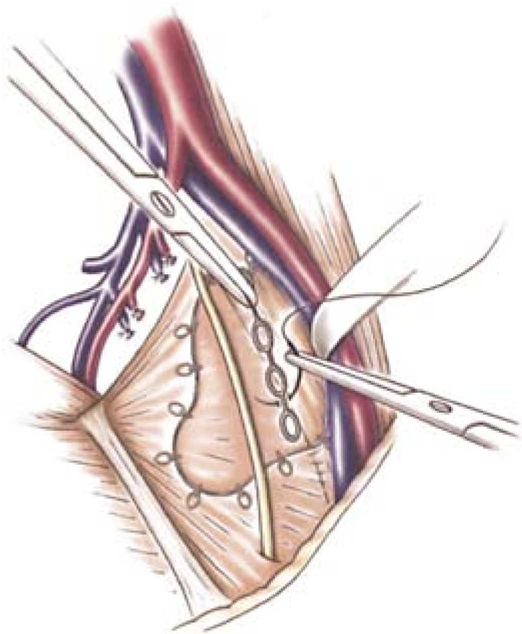


Figure 15

An adjusted titanium bridge implant is fixed to the pelvic wall in the middle of the tumour bed parallel to the linea terminalis. (After W.Hanns.)

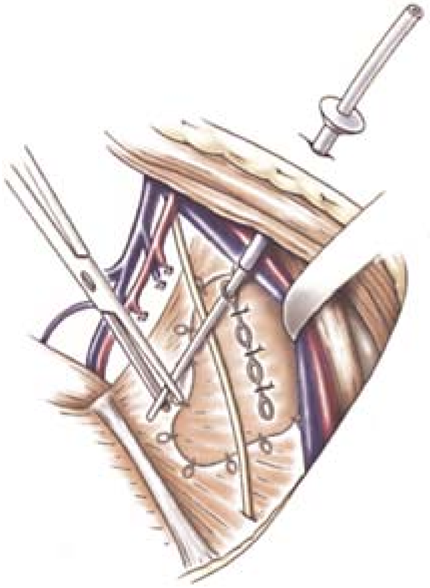


Figure 16

A flexible brachytherapy guide tube is placed transabdominally implanted by use of a trocar. (After W. Hanns.)

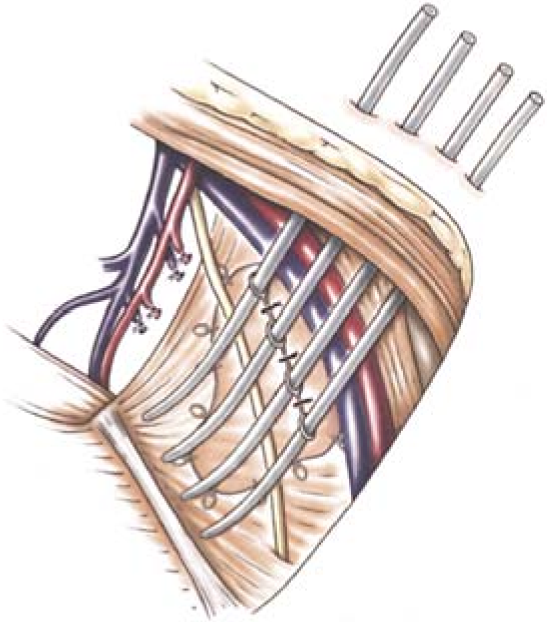


Figure 17

Complete array of transabdominal guide tubes for postoperative brachytherapy fixed to the tumour bed by the bridge implant and additional sutures. (After W.Hanns.)

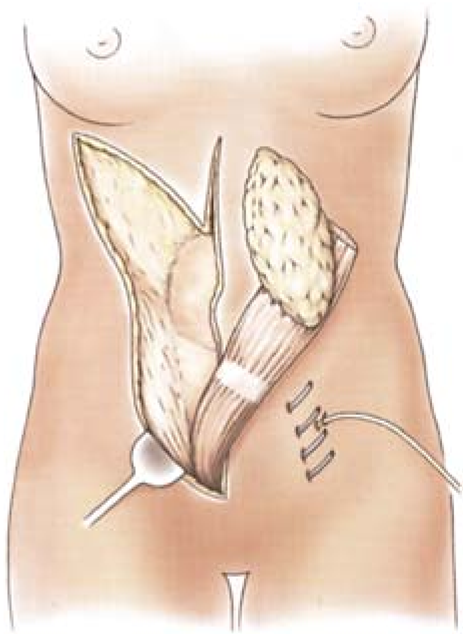


Figure 18

Elevation of a de-epithelialized extended VRAM flap based on the right deep inferior epigastric vessels. (After W.Hanns.)

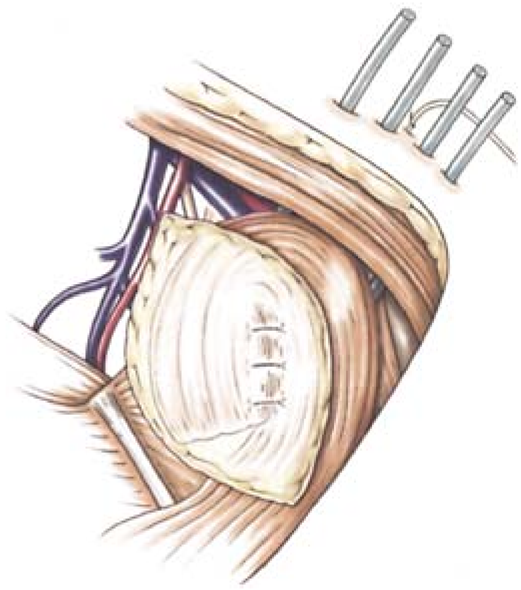


Figure 19

De-epithelialized extended VRAM flap used as pelvic wall plasty for CORT. (After W.Hanns.)

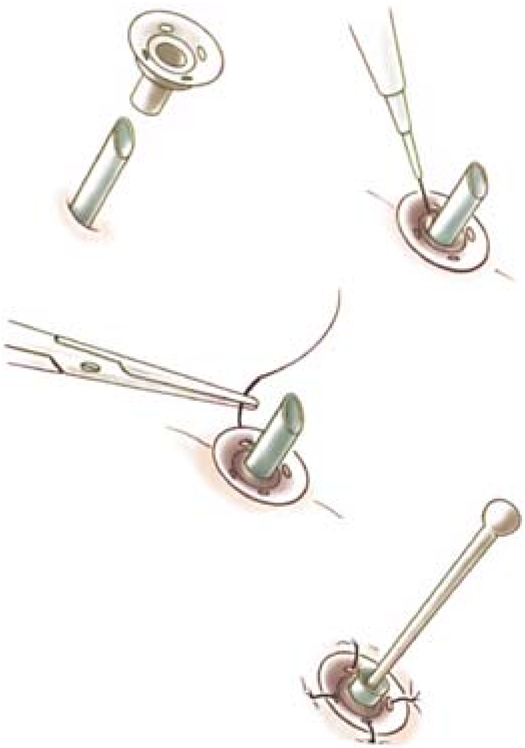


Figure 20

Adjustment and fixation of the guide tubes to the skin after laparotomy closure. (After W.Hanns.)

13
Surgical management of trophoblastic disease

J Richard Smith

Michael Seckl

Deborah CM Boyle

Management of trophoblastic disease in the first instance involves evacuation of the uterus. This should always be done using a suction curette. In the presence of persistently elevated human chorionic gonadotrophin (hCG) levels or continuing problems with haemorrhage, further evacuation may be necessary. This should normally be discussed with a gestational trophoblastic disease centre because of the risk of perforation, haemorrhage or infection. Thereafter, if the hCG levels remain elevated, chemotherapy should be instituted. The vast majority of patients will respond to these measures. For the small minority whose hCG levels remain elevated following chemotherapy, more definitive surgical management may be required, in the form of total abdominal hysterectomy. Elevated hCG levels predispose to ovarian cyst formation but this should not encourage bilateral oophorectomy at the time of hysterectomy unless there is another pre-existing reason. Total abdominal hysterectomy in the presence of choroiocarcinoma can prove very taxing. Uterine vascularity may be massively increased, presumably owing to the action of vasoactive peptides, etc., and the uterine arteries may be up to 1 cm in diameter. More troublesome still is the massive enlargement of the uterine venous plexus. This can lead to haemorrhage during ureteric dissection, particularly in cases where the tumour has spread beyond the uterus into the parametrium.

Preoperative assessment should include Doppler flow ultrasonography of the pelvis, CT and/or MRI scans of the chest, abdomen and pelvis and MRI of the head, together with hCG, full blood count and blood biochemistry measurements. Four to six units of blood should be cross-matched. The authors have found it useful in the presence of extrauterine spread to perform ureteric stenting (see Chapter 5). Laparotomy is performed, generally via a Pfannenstiel incision, but may require muscle cutting or a midline incision depending on the surgeon's preference and the size of the uterus. In the presence of huge vessels, the authors have found it helpful to commence the procedure by opening the broad ligament, identifying the ureter and dissecting it in a cephalad direction as far as the bifurcation of the common iliac artery. Vascular elastic slings can be placed around the internal iliac vessels (Figure 1). These vessels can be temporarily ligated prophylactically using surgical clips or the slings left loose until the need arises. These slings have proved useful to the authors in the face of the torrential haemorrhage which can arise. Dissection of the internal iliac arteries then takes place until the origins of the uterine arteries are identified, skeletonized and ligated using either polyglactin ties or surgical clips. The ureter is identified running under the uterine artery. The multiple uterine veins are ligated by applying three surgical clips to each vessel and transecting the vessel between them, leaving two proximally (see inset in Figure 1). In general the ureteric canal does not need to be opened; if it does, this should be done as described in Chapter 7. If a placental site trophoblastic tumour is suspected, removal of pelvic lymph nodes and para-aortic lymph nodes is advisable for gross lymph node disease.

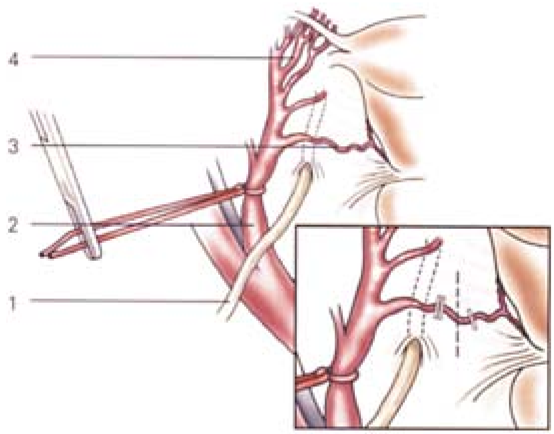


Figure 1

Vascular elastic slings are placed around the internal iliac vessels in case of haemorrhage. *(Inset)* Ligation of the uterine artery (incision marked by dotted line)

1 Ureter

2 Internal iliac vessels

3 Uterine artery

4 Superior vesical arteries

In conclusion, total abdominal hysterectomy for trophoblastic disease is rarely required. When it is, problems with haemorrhage should be anticipated and the suggested prophylactic measures should make uncontrollable haemorrhage less likely. Management of metastatic choriocarcinoma outside the area of gynaecological competence—e.g. in the thorax or brain—is beyond the scope of this book, but such tumours may well be amenable to management by the appropriate surgeon.

Bibliography

Hancock BW, Newlands ES, Berkowitz RS (1997), editors. *Gestational trophoblastic disease.* London: Chapman & Hall.

Smith JR, Bridges JE, Boyle DCM et al (2000) Regarding ligation of the hypogastric artery and blood loss. *Int J Gyn Cancer* **10:**173.

14
Epithelial ovarian cancer

Jane Bridges

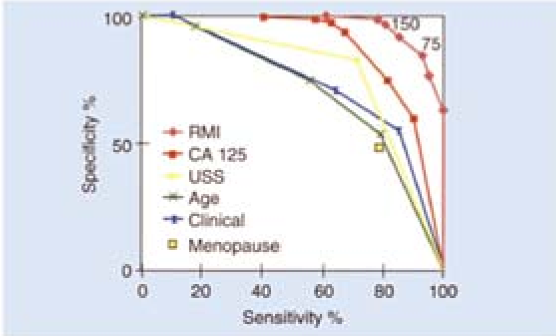
David Oram

Preoperative assessment

Ovarian cancer continues to frustrate. Clinicians are disadvantaged by the characteristics of unreliable, inconsistent symptomatology, which accounts for late presentation and poor associated survival figures. Even when the patient does present early, the preoperative diagnosis of ovarian cancer is frequently a difficult one to make. This is borne out by the fact that 50% of patients with this disease are initially referred to general physicians or general surgeons for investigation of symptomatology or ascites. The development by Jacobs et al (1990) of a scoring system, the risk of malignancy index (RMI), which incorporates the use of the serum CA125 level, pelvic ultrasound features and the menopausal status of the patient, has greatly eased this preoperative difficulty. The details of the calculation are shown in Figure 1 and the RMI has now been validated in clinical practice. Using this calculation to assess the nature of an abdominopelvic mass helps to confirm the diagnosis of malignancy with greater than 95% accuracy. This in turn allows for an appropriate referral to a cancer centre to be made, or at least prevents the initial surgery being inappropriately performed by an inexperienced surgeon. The importance of this has been demonstrated in data from the west of Scotland which confirm improved survival of patients with ovarian cancer if they are managed in a cancer centre using a multidisciplinary team approach. Furthermore, accurate preoperative diagnosis enables appropriate counselling to be given to the patient and her family. Appropriate investigation and management planning can be embarked upon in a proactive manner, and by no means the least important consideration is that the patient's initial surgery and exploration can be performed through the correct surgical incision.

Preoperative investigations

Investigations should include an assessment of the patient herself, including her performance status and her nutritional status; if necessary, parenteral feeding through central lines can be instituted preoperatively. This should not, however, delay the initial surgery. A thorough haematological and biochemical assessment should be undertaken. A chest x-ray is required: if a pleural effusion is present, this should be aspirated and the fluid examined cytologically for malignant cells. Pelvic ultrasonography is usually performed as part of the initial assessment and is complemented by specialist imaging such as computed tomography (CT) and magnetic resonance imaging (MRI) in assessing the extent of the disease spread, including intra- and extra-abdominal metastatic deposits (Figure 2). Preoperatively the patient requires a bowel preparatory agent, and in selected cases stoma counselling may be instituted.



RMI = U × M × serum CA125

where U and M are the ultrasound and menopausal scores.

Ultrasound was assessed for the following features suggestive of malignancy:

- multiloculated cysts
- evidence of solid areas
- evidence of metastases
- presence of ascites
- bilateral lesions.

A score of 0 was given where none of these was present; 1 if one was present; and a score of 3 for two or more.

A score of 1 or 3 was given to pre- or postmenopausal patients respectively.

An RMI of 200 had a sensitivity of 85% and a specificity of 97% for diagnosing ovarian cancer.

Figure 1

Risk of malignancy index (RMI)

Primary laparotomy

The correct staging of ovarian cancer is of paramount importance because it has implications for adjuvant therapy and also for appropriate counselling concerning prognosis. It is unfortunate that under-staging is commonplace in this disease, in spite of attention being drawn to this problem by various authors since the 1970s (Piver et al. 1976; Young et al. 1983; McGowan et al. 1985). The surgical procedure should be performed through a midline incision extending from the symphysis pubis to above the umbilicus if necessary. Any ascites present on opening the peritoneal cavity should be aspirated and sent for cytological assessment; otherwise the pelvis and paracolic gutters should be thoroughly irrigated with saline and the washings aspirated and sent for cytological assessment. Diaphragmatic swabs for cytology may also be taken. Thereafter thorough exploration and assessment of the extent of disease spread are crucial. Particular note should be taken of the tumour deposits in the upper abdomen: the hemidiaphragm should palpated and inspected; the surface and parenchyma of the liver, the omentum, appendix and small and large bowel

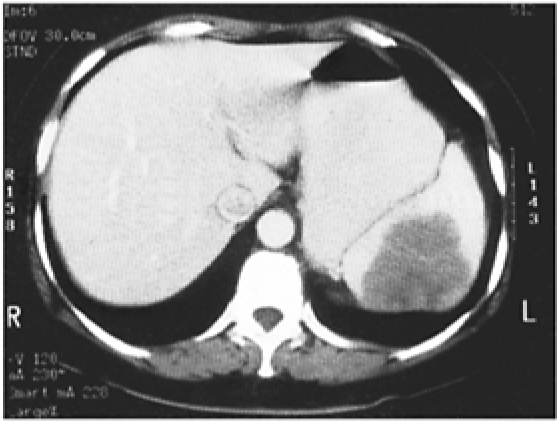


Figure 2

MRI demonstrating solitary splenic metastasis

should be assessed, and thereafter all peritoneal surfaces including the paracolic gutters and the pelvic peritoneum. Attention is then turned to the extent of disease in the pelvis: the pelvic and para-aortic lymph nodes should, in the first instance, be palpated. In selected cases adherent tissue and adhesions should be sampled for biopsy and if it is felt to be helpful-by the operating surgeon, frozen section of suspicious areas can be utilized. Where no obvious peritoneal disease is present, random biopsies should be taken from areas at high risk. Biopsy of the subdiaphragmatic peritoneum may be facilitated by the use of long-handled punch biopsy forceps.

Depending on the stage of the disease the surgical problems differ. In advanced disease, the stage is usually obvious and the surgical challenge centres on cytoreductive surgery. In apparent early-stage disease, however, tumour resection is usually easy, but accurate surgical staging is a major consideration. In such cases pelvic and para-aortic lymph node assessment is indicated.

Surgical techniques for advanced disease

Following completion of the staging procedure, optimal cytoreduction becomes the goal. The surgical approach in ovarian cancer differs from that for other solid tumours where the aim is to remove the tumour with a wide area of normal tissue clearance. In epithelial ovarian cancer the priority is to remove as much of the bulk disease as possible, but if complete tumour clearance is not achievable then reduction of the tumour burden to minimal residual disease becomes the goal. Tumour debulking was advocated initially in the early part of the twentieth century by Meigs (1934) and Bonney (1912) and further developed by Brunschwig (1961). Munnell in the 1950s coined the phrase ‘maximum surgical effort’ and Griffiths quantified this in the 1970s in his seminal paper, which has dictated subsequent surgical practice (Munnell 1952; Griffiths 1975). Griffiths demonstrated an improved survival in patients who had their disease reduced to residual nodules of less than 1.5 cm. However, no prospective trials addressing the issue of benefit of aggressive cytoreduction have been undertaken, and so its exact value remains debatable. The surgery for advanced-stage disease is often difficult and, unlike other forms of cancer surgery, there are no set moves. It often requires persistence and a flexible approach by the operating surgeon, depending on available tissue planes. At the very least the procedure should incorporate total or subtotal hysterectomy,

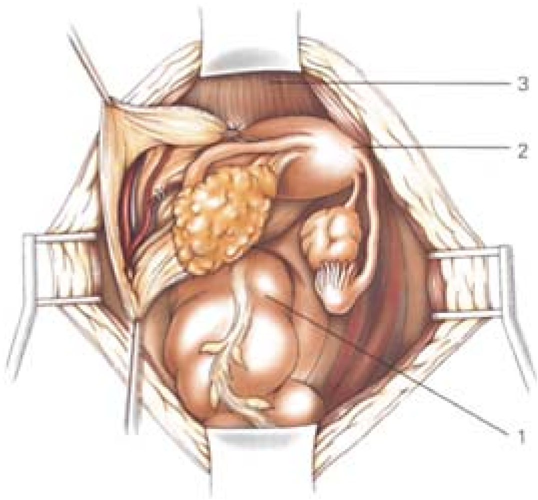


Figure 3

Extraperitoneal dissection

1 Rectum

2 Uterus

3 Bladder

bilateral salpingo-oophorectomy, omentectomy and removal of all bulk tumour deposits where possible. In most circumstances the retroperitoneal *en bloc* approach as described below should be used to clear all pelvic disease. Other surgical procedures that occasionally require to be undertaken include biopsy of parenchymal liver deposits. If the spleen is involved in the omental cake of tumour a splenectomy can be undertaken. Bowel resection (Chapter 17) is really only indicated in two clinical situations: the first is if there is bowel tumour causing impending obstruction, and the second is if resecting a segment of bowel will help to achieve complete tumour clearance. Prior to concluding the initial surgical procedure it is worth considering whether the patient might be suitable for intraperitoneal adjuvant chemotherapy: if so, an intraperitoneal catheter can then be inserted.

En bloc resection of advanced pelvic disease

The technique of *en bloc* resection was first described by Hudson (1968) in the management of patients with advanced pelvic disease where spread to the pelvic peritoneum, rectosigmoid and/or bladder had occurred. It facilitates resection of locally advanced tumours in one contiguous sample.

First the round and infundibulopelvic ligaments are divided and ligated. The pelvic peritoneum is then opened circumferentially from the symphysis pubis anteriorly to the rectosigmoid posteriorly. The peritoneum is dissected free in a lateral to medial direction, including that covering the dome of the bladder and the pelvis side walls. The uterine arteries are then divided and ligated in a lateral position close to their origin at the internal iliac artery, allowing the ureters to be mobilized laterally (Figure 3). The anterior vaginal fornix is exposed by further dissection of the bladder anteriorly and opened transversely. The hysterectomy can then be performed in a retrograde fashion, dividing and ligating the uterosacral and

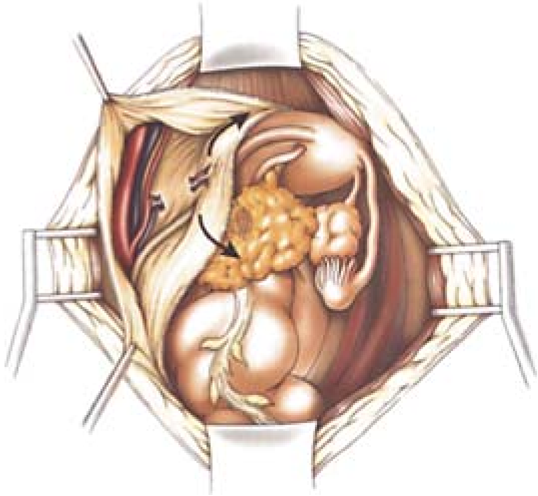


Figure 4

Development of the retrorectal space

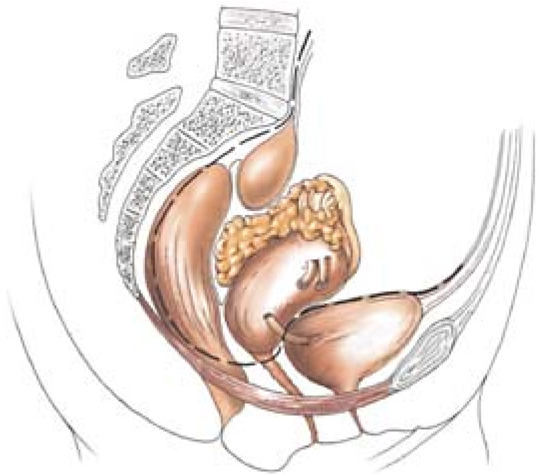


Figure 5

Resection outline

cardinal ligaments. Development of the retro-rectal space at this stage will allow elevation of the rectum, uterus and tumour from the sacral hollow, and an assessment of the need for rectosigmoid resection—depending on the tumour mobility and invasion—can be made (Figure 4). Where superficial invasion of the sigmoid serosa only has occurred, the tumour may be dissected free by stripping the outer muscular layer from the underlying circular muscular layer and the mucosa. In patients with a small area of deep invasion, local resection of the anterior wall of the sigmoid may be performed and the bowel defect closed in the anterior plane. Resection will include the lateral pelvic and sigmoid peritoneum within the specimen (Figures 5 and 6). Where there is more extensive rectosigmoid involvement, resection of this segment of the

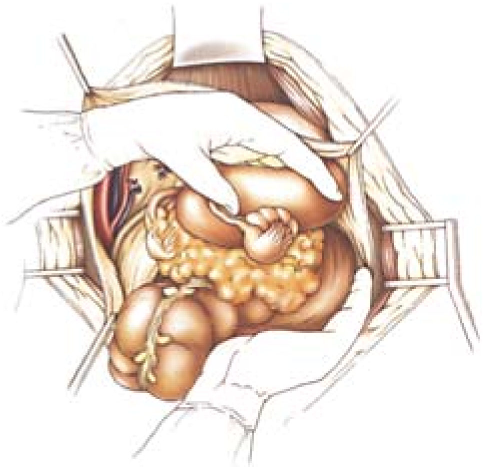


Figure 6

Resection

colon can be performed with a primary anastomosis. Initially the superior haemorrhoidal vessels are identified and ligated at the level of the sacral promontory. The sigmoid mesentery is then divided allowing margins for adequate tumour clearance, facilitated by division of the peritoneum and mobilization of the descending colon if necessary. The sigmoid is then divided, generally with a stapling device, and the proximal end of the sigmoid is placed in the left paracolic gutter while the final dissection of the tumour specimen is performed. Blunt dissection and traction on the distal rectosigmoid portion are used to mobilize the bowel, allowing the specimen to be drawn out of the pelvis and the resection margin of the rectum to be identified. At this stage the posterior anastomosis of the sigmoid to the rectal stump may be performed prior to the final division of the tumour *en bloc* specimen just above the anastomosis. The anastomosis can then be completed by hand or by a stapling device inserted through the anus. The anastomosis may be covered by a loop colostomy, but as the majority of women will not have received preoperative radiotherapy and will have had adequate bowel preparation, this may not always be necessary. Adequate drainage at the site of the anastomosis should be allowed at the end of the laparotomy, however, in the form of a large-bore tube drain.

The laparotomy should be completed with an omentectomy, with or without appendectomy and assessment of the para-aortic nodes.

Appendectomy

The appendix is a common site for metastatic disease but should only be removed when clearly involved by tumour (Fawzi et al. 1997). The appendix can be easily delivered through the midline incision. The mesoappendix is divided either following a single transfix suture if it is minimal, or by serial clipping section by section (Figure 7). A clip is then used to crush the base of the appendix, first close to the caecal wall and then immediately above it (Figure 8). A polyglactin tie is used to ligate the crushed area, and the suture ends are cut short. A purse-string suture is next inserted approximately 1 cm from the appendix, picking up only the seromuscular coat. The appendix is divided close to the clamp (Figure 9), the stump is invaginated and the purse-string suture-tied (Figure 10).

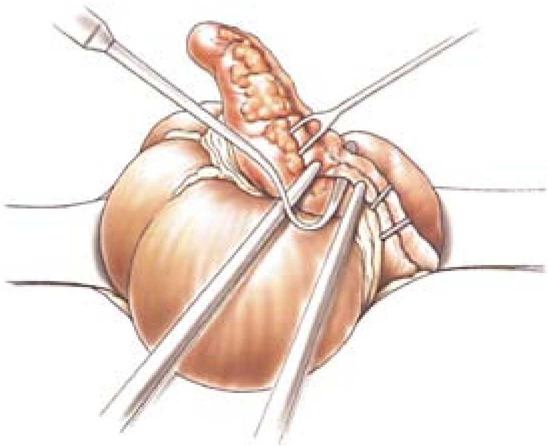


Figure 7

The mesoappendix is clipped

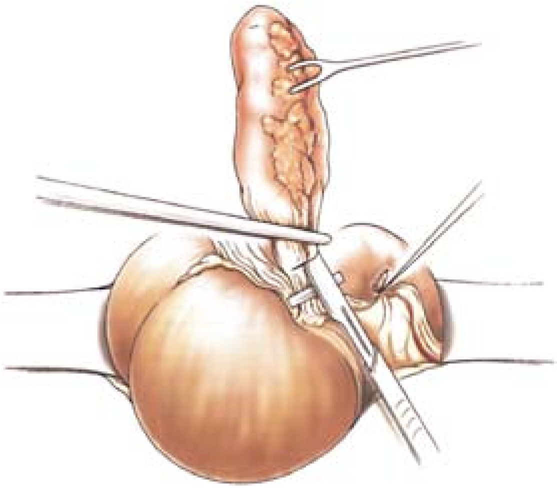


Figure 8

The base of the appendix is crushed

Splenectomy

Splenectomy is extremely rarely necessary or indicated, However, at the time of surgical staging, disease spread to the spleen may be apparent as an extension of the omental plaque or as implants of more focal disease on the capsule and/or hilum. Occasionally it may appear as an isolated site of recurrence.

First the spleen should be mobilized to allow exposure and division of its ligamentous attachments. Traction in an inferior and medial direction will expose the filamentous attachments to the diaphragm (splenophrenic) and colon (splenocolic), and these may then be divided and ligated. Entry into the lesser sac then allows exposure of the pancreas and the gastrosplenic ligament, which contains the short gastric arteries (Figure 11). Division of the short gastric vessels leaves only the splenorenal ligament intact, containing the splenic vessels and the tail of the pancreas. Holding the splenic hilum between the fingers, the operator

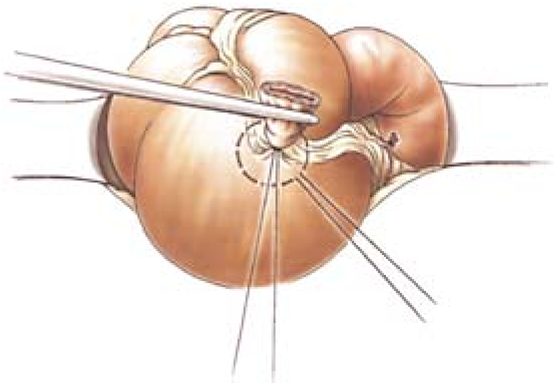


Figure 9

The appendix is divided

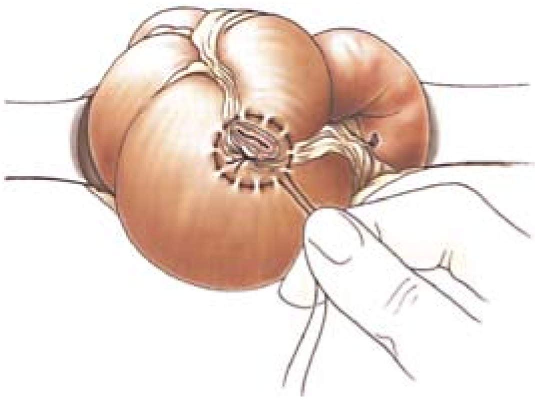


Figure 10

Purse-string suture

identifies and protects the tail of the pancreas while the peritoneum over the ligament is taken and the splenic artery identified and divided (Figure 12). Finally the large splenic vein is identified, ligated and divided, and the spleen is delivered.

Omentectomy

The omentum is frequently the site of massive metastatic deposits of disease and may cause the presenting symptoms at the time of diagnosis. An omental 'cake', as it is commonly referred to, may be found at the junction of the greater omentum and the transverse colon. Although initial assessment may give the appearance of gross involvement of the transverse colon, this is usually not the case and the tumour mass can be carefully mobilized and resected without the need for a transverse colectomy. Care should be taken to assess whether the omentum is adherent to the anterior abdominal wall peritoneum, as this peritoneal layer can be stripped in continuity with the omentum if necessary.

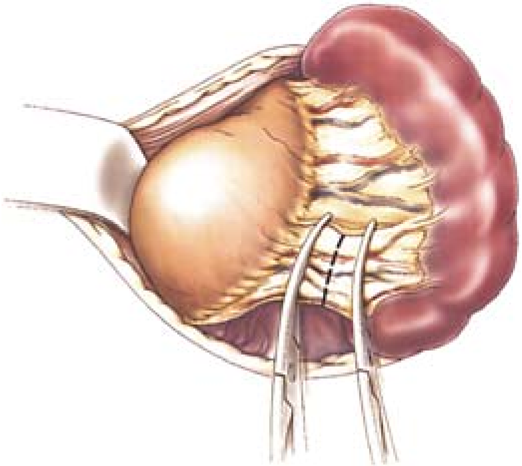


Figure 11

Exposure of the pancreas and gastrosplenic ligament

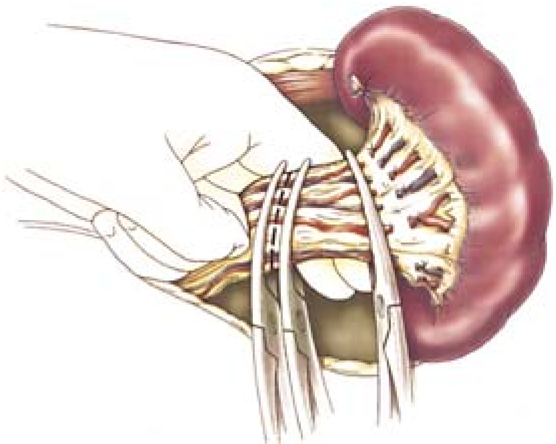


Figure 12

Division of the splenic artery

Initially the omentum should be elevated to expose the transverse colon. The posterior leaf of the omentum is then divided, beginning to the left of the hepatic flexure. Gradual mobilization of this layer allows the transverse colon to be rolled in a caudal direction to expose the gastrocolic ligament. Care must be taken to avoid damage to the spleen when dissecting free the left lateral section of the omentum at the level of the splenic flexure. The vessels in the gastrocolic ligament can then be ligated with a series of clips (Figure 13).

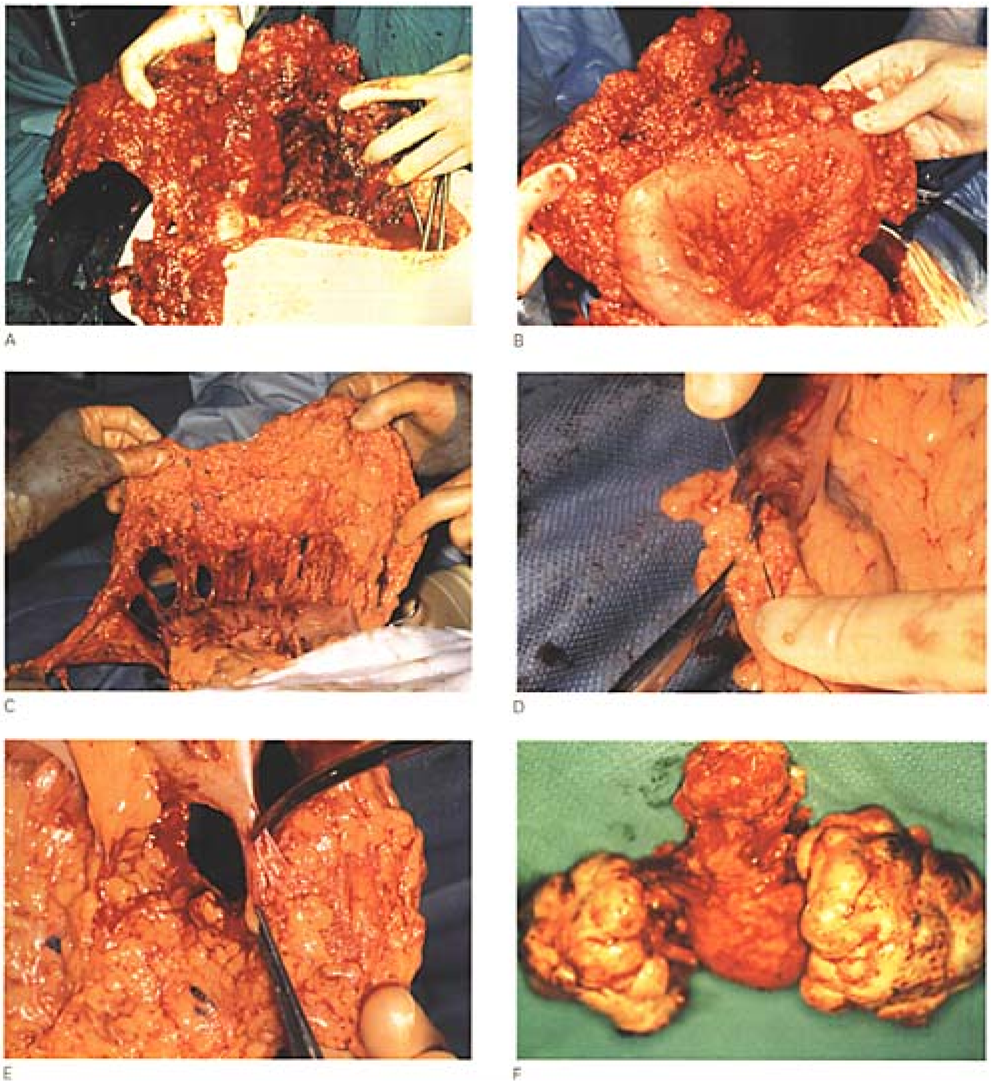


Figure 13

Omentectomy: (A) delivery of omentum with gross disease; (B) division of posterior leaf; (c) dissection of omentum; (D) ligature of vessels; (E) removal of omentum from bowel; (F) bilateral primary tumour.

Excision of liver nodules

Attempts at resection of large-volume disease are inappropriate as part of the tumour reductive surgical process. However, in rare instances where the only remaining focus of macroscopic disease is the presence of small subcapsular liver deposits, resection may be performed. The deposits may be shelled out digitally after incising the liver capsuk. Alternatively, they may be aspirated using a Cavitron ultrasonic aspirator (Cavitron Corporation, USA). Following resection haemostasis may be achieved using diathermy with a roller-ball handpiece (Figure 14).

Figure 14

Excision of liver nodules

Surgery for apparent early-stage disease

At the time of initial laparotomy a proportion of women will have apparent early-stage disease. It is imperative that a meticulous surgical staging procedure is performed to allow counselling regarding prognosis, the place of adjuvant therapy and, where appropriate, fertility options. In women who have completed their family, a total or subtotal abdominal hysterectomy, bilateral salpingo-oophorectomy, together with omentectomy, para-aortic node sampling and peritoneal biopsies should be performed. More conservative surgery should only be considered in women desiring to maintain fertility options with stage IA disease and well-differentiated or borderline tumours; in these cases the uterus may be conserved and a simple oophorectomy with inspection and biopsy of the contralateral ovary performed (Figure 15). The remainder of the staging laparotomy should then be undertaken. Full counselling about risks, completion surgery after childbirth and the concept of cryopreservation of ova, embryos or ovarian tissue should be undertaken.

Interval debulking surgery

The concept of interval debulking has been assessed in two centres. Initially a Birmingham (UK) study failed to demonstrate a survival benefit (Lawton et al. 1990), but a later EORTC study, despite its critics, has suggested that interval debulking of tumour following three courses of initial chemotherapy did confer survival benefits of the order of 6 months if the patient underwent resection of visible disease (van der Burg et al. 1995). Further validation of this work is in progress, but it remains perhaps the first convincing evidence that interval surgery does have a significant role in management.

Second-look surgery

Second-look procedures, either laparoscopy or laparotomy following completion of chemotherapy, in order to test tumour response and establish the need for secondary debulking procedures, have not proved to be helpful in treatment decisions, nor in terms of patient benefit and improved survival. It is now broadly agreed that these should be only undertaken as part of defined research protocols.

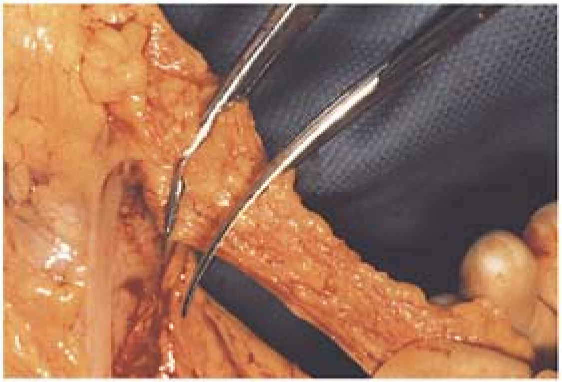


Figure 15

Oophorectomy

Palliative and salvage surgery

Palliative procedures often have an important part to play in the management of the preterminal stages of this disease and are usually concerned with relieving the effects of intestinal obstruction. The most common of these procedures is the bypass of obstructive loops of small bowel, in which circumstance an ileocolic bypass anastomosis is to be favoured over heroic attempts at mass resection (see Chapter 17). The use of such palliative and salvage surgery can provide a great degree of symptomatic relief for patients with bowel obstruction, but it is to be stressed that fine judgment needs to be exercised to ensure that the patient will benefit in her final weeks from such a surgical approach rather than merely have her discomfort increased by the pain of a laparotomy.

Germ cell and stromal tumours of the ovary

Germ cell and stromal tumours occur predominantly in younger women and adolescents. Preoperative diagnosis of these tumours may be facilitated by the use of tumour markers, and conservative surgery should be considered in all cases where fertility preservation is desired. Unilateral adnexectomy with biopsy of the contralateral ovary is sufficient as the pelvic surgical component in the majority of young women since the advent of successful adjuvant chemotherapy (Gershenson, 1988).

References

Bonney V (1912) The female genital tract. In: Choice CC, editor. *A system of surgery*, vol. 2. New York: Funk & Wagnalls.

Brunschwig A (1961) Attempted palliation by radical surgery for pelvic and abdominal carcinomatosis primary in the ovaries. *Cancer* **14:**384–8.

van der Burg ME, van Lent M, Buyse M et al. (1995) The effect of debulking surgery after induction chemotherapy on the prognosis in advanced epithelial ovarian cancer. *N Engl J Med* **332:**629–34.

Fawzi HW, Robertshaw JK, Bolger BS, et al. (1997) Role of appendicectomy in the surgical management of ovarian cancer. *Eur J Gynaec Oncol* **18:**34–5.

Gershenson DM (1988) Menstrual and reproductive function after treatment with combination chemotherapy for malignant ovarian germ cell tumours. *J Clin Oncol* **6:**270–5.

Griffiths CT (1975) Surgical resection of tumour bulk in the primary treatment of ovarian carcinoma. Symposium on ovarian cancer. *Nat Cancer Inst Monog* **42:**101–4.

Hudson CN (1968) A radical operation for fixed ovarian tumours. *J Obst Gynaec Br Cwlth* **75:**1155–60.

Jacobs I, Oram D, Fairbanks J et al. (1990) A risk of malignancy index incorporating CA125, ultrasound and menopausal status for the accurate preoperative diagnosis of ovarian cancer, *Br J Obstet Gynecol* **97:**922–9.

Lawton F, Luesley D, Redman C et al. (1990) Feasibility and outcome of complete tumor resection in patients with advanced ovarian cancer. *J Surg Oncol* **45:**14–19.

McGowan L, Lesher LP, Norris HJ, Barnett M (1985) Misstaging of ovarian cancer. *Obstet Gynec* **65:**568–72.

Meigs JV (1934) *Tumours of the female pelvic organs.* New York: Macmillan.

Munnell EW (1952) Ovarian carcinoma. Predisposing factors, diagnosis and management. *Cancer* **5:**1128–33.

Piver MS, Barlow JJ (1976) Preoperative and intraoperative Piver MS, Barlow JJ (1976) Preoperative and intraoperative evaluation in ovarian malignancy. *Obstet Gynec* **48:** 312–15.

Young RC, Decker DG, Wharton JT et al. (1983) Staging laparotomy in early ovarian cancer. *JAMA* **250:**3072–6.

15
Radical vulvar surgery

Roland Matthews

Introduction

Radical vulvectomy and groin node dissection have been the standard treatment for cancer of the vulva since 1912 when this procedure was first described by Basset. Because carcinoma of the vulva is rare, accounting for only 0.4% of all cancers in women, scientific comparisons of variations on this operation have often been limited by studies with small or heterogeneous samples. Traditionally, an en bloc radical resection of the entire vulva and bilateral inguinal nodes through the trapezoid or 'butterfly' incision was the treatment of choice for all vulvar carcinomas. Currently, unilateral radical vulvectomy and ipsilateral inguinal node dissection are considered to be adequate treatment of a lateral lesion which does not approach the clitoris or perineal body. Bilateral inguinal node dissection is indicated in cases of midline lesions or if positive lymph nodes are encountered during the ipsilateral groin node dissection associated with a lateral lesion. The current trend is toward individualization of treatment, more conservative surgery, and preservation of sexual function.

Indications

Vulvectomy can be performed for all stages of cancer of the vulva, in any woman with a resectable lesion. In borderline cases, radiation and chemotherapy can be used to increase resectability of larger lesions.

Anatomic considerations

Vascular supply

The rich blood supply to the vulva is derived from the internal pudendal artery, a terminal branch of the anterior division of the hypogastric artery, and the superficial and deep external pudendal arteries, which originate from the femoral artery. The internal pudendal artery and vein continue into the posterior labial vessels, which supply the posterior portion of the labia majora, labia minora and vestibule. The anterior labial branches of the external pudendals and the small artery of the ligamentum teres, a branch of the inferior epigastric, also contribute to the vascular supply. During the groin node dissection care must be taken to avoid injury to the femoral vessels and the saphenous vein.

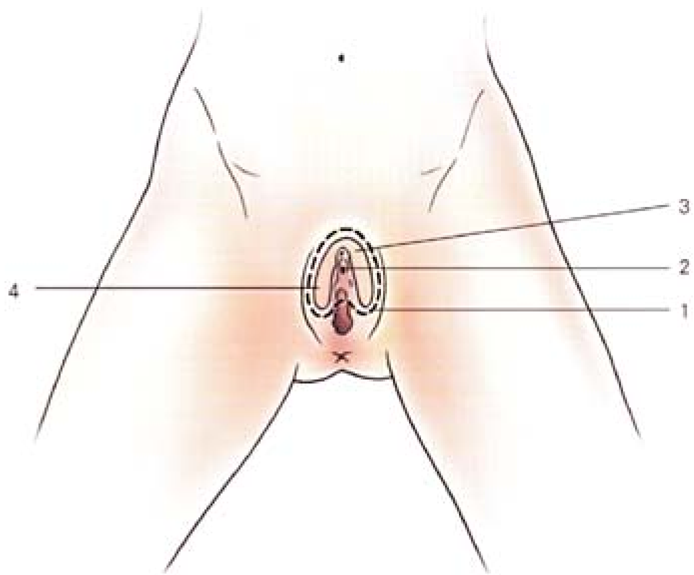


Figure 1

Lithotomy position, allowing two-team approach

1 2 cm margins (outlines marked with marking pen), extending into vagina

2 Urethra

3 Labia minora

4 Lesion

Nerve supply

The nerve supply of the vulva is derived from a variety of sources. The mons pubis and upper labia majora are innervated by the ilioinguinal nerve and the genital branch of the genitofemoral nerve. The superficial perineal branches of the pudendal nerve supply the labia majora and the structures of the external genitalia. The deep branches supply the clitoris, vestibular bulb and muscles of the region. The femoral nerve lies outside the femoral sheath and therefore does not require dissection.

Muscles involved

The major portion of the bulbocavernosus, ischiocavernosus and superficial transverse perineal muscles are included in the radical vulvectomy dissection. The sartorius and adductor longus muscles represent the lateral and medial borders of the groin node dissection. The posterior border is made mostly of the pectineus, with some psoas and iliacus muscles.

Operative procedure

The patient is placed in the dorsal lithotomy or Lloyd Davis position to allow a two-team approach to the procedure. The surgical site and the planned incision are delineated using a marking pencil. The most

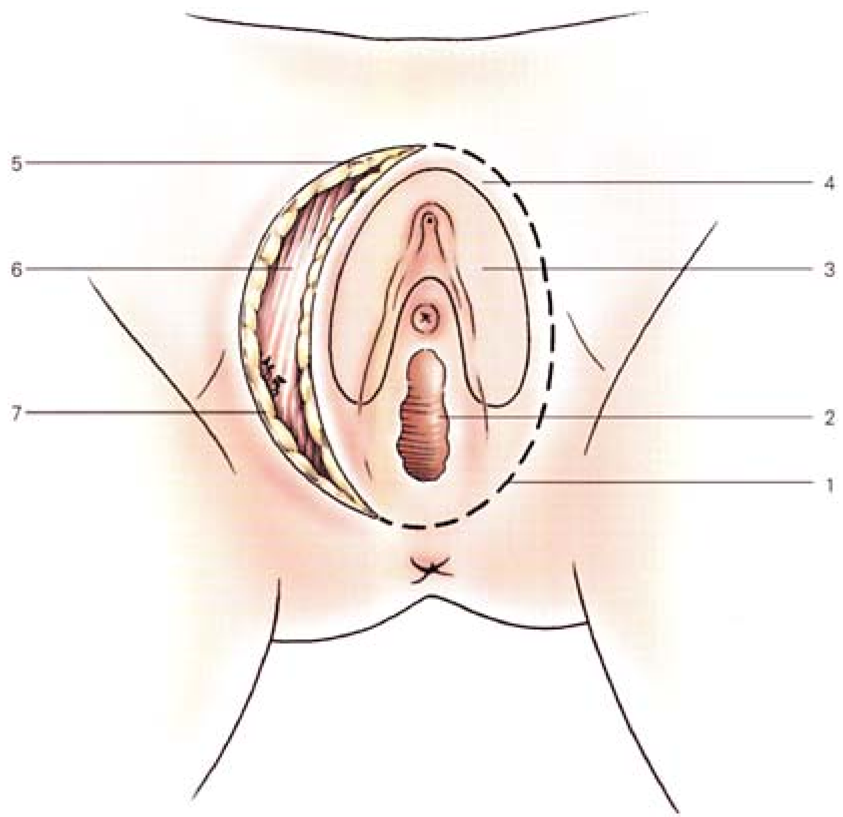


Figure 2

1 Outlines of area to be excised

2 Hymenal ring

3 Lesion

4 Normal skin

5 Subcutaneous fat

6 Ligated pudendal vessels

7 Fascia of the urogenital diaphragm

important aspects are to obtain a 1–2 cm tumor-free margin and to provide the best cosmetic closure. To that end, the surgery is strictly tailored to the lesion.

To perform a total radical vulvectomy, lateral skin incisions are made along the labiocrural crease. The incision should extend anteriorly over the pubis and posteriorly across the perineum, anterior to the rectum. A second incision is then made circumferentially around the vaginal introitus. This incision is usually made along the hymenal ring; however, it may be made higher to incorporate the distal urethra or vagina to achieve an adequate surgical margin (Figure 1).

An en bloc dissection is performed which extends down to the fascia lata and the inferior fascia of the urogenital diaphragm. Care must be taken to ligate the pudendal vessels which enter the vulva at the four

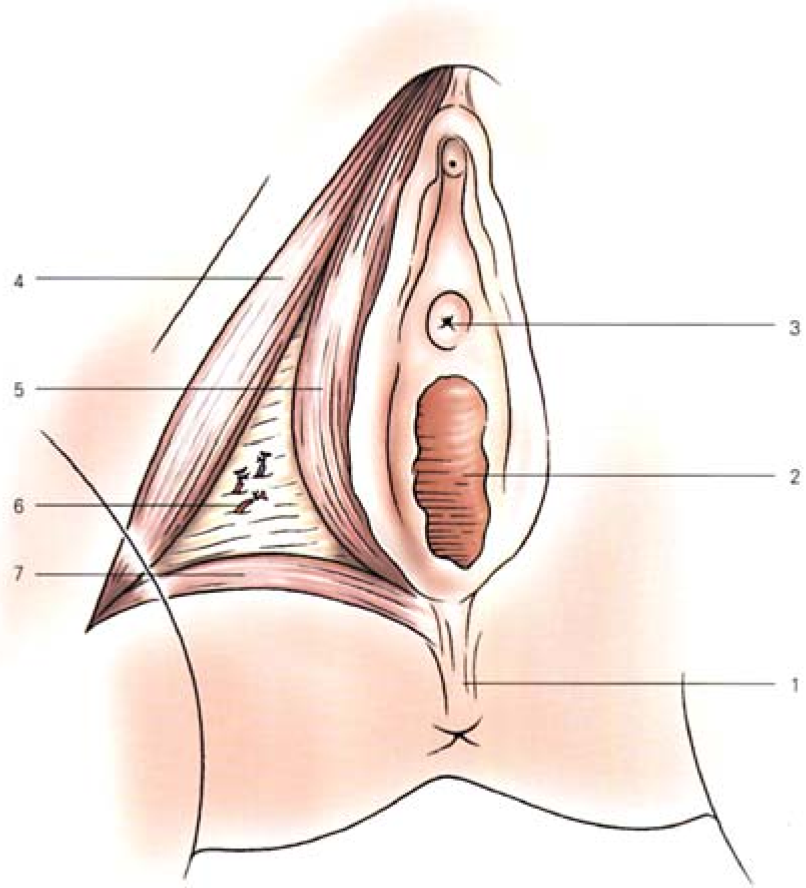


Figure 3

1 Perineal membrane

2 Vaginal orifice

3 Urethral orifice

4 Ischiocavernosus muscle

5 Bulbospongiosus muscle

6 Internal pudendal vessels, ligated

7 Superficial transverse perineal muscle

o'clock and eight o'clock positions. The posterior extent of the dissection involves the tissue in the ischiorectal fossa (Figure 2). The total radical vulvectomy results in the removal of the bulbocavernosus, ischiocavernosus and superficial transverse perineal muscles (Figure 3). Lesions involving the clitoris may require a more extensive excision of the mons. Those involving the perineum may require dissection into the thigh or partial resection of the anus.

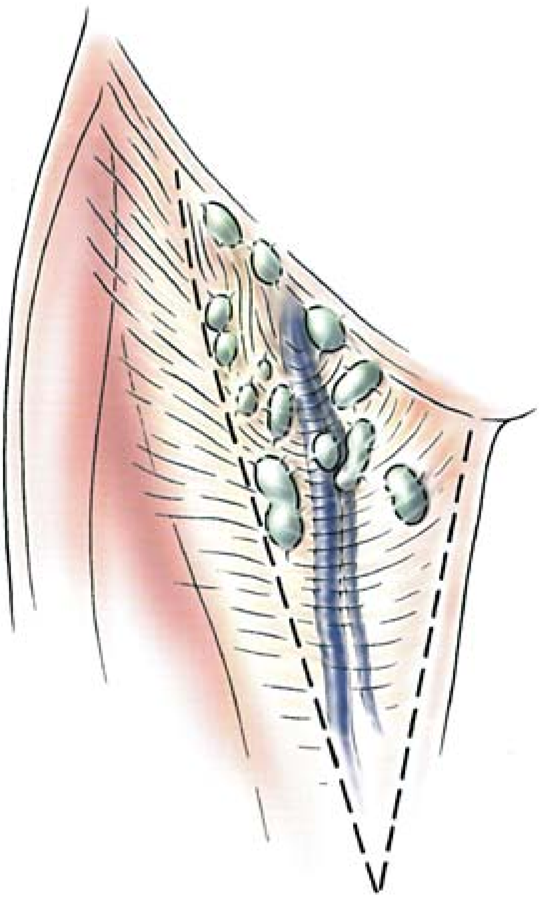


Figure 4

Node dissection area

Most vulvar incisions can be approximated primarily. Skin grafts or rotational flaps may be indicated if there is inadequate mobilization to allow for a tension-free closure (see Chapter 21). Obliteration of resultant dead space is important, as well as the use of suction drainage.

Superficial and deep inguinal lymph node dissection

For the superficial node dissection, groin incisions are first introduced 1–2 cm below Poupart's ligament. The superficial inguinal fat pad is then removed, facilitating exposure of the node.

The node-bearing fatty areolar tissue is then dissected deep to Camper's fascia and superficial to Colles' fascia, the cribriform fascia and fascia lata. Camper's fascia may not be clearly developed in all patients. Under these circumstances it is important to maintain the same plane throughout the dissection. Without the guidance of a clearly visible superficial fascia it is possible to move too superficially, leading to skin breakdown, or too deeply, leaving some potentially cancerous lymph nodes behind. Great care is taken to preserve the cribriform fascia over the fossa ovalis in order to minimize contact with the underlying femoral canal until ready. The node dissection area is confined medially by the medial surface of the adductor longus muscle, laterally by the medial border of the sartorius muscle, and 6 cm distal to Poupart's ligament into the adductor canal inferiorly (Figure 4). The operative field is drained with suction drains and the subcutaneous tissue and skin are closed accordingly upon completion of dissection.

Medial to the femoral vein and deep to the cribriform fascia, within the fossa ovalis, are a few deep nodes which should be dissected. This lymphatic tissue in the femoral sheath is removed by first identifying the femoral artery. In its dissection care must be taken to preserve the femoral nerve that runs adjacent to the adjoining structures (Figure 5). Next, the femoral and saphenous veins are identified and subsequently dissected until the saphenous vein is mobilized. The saphenous vein is then doubly ligated at the saphenofemoral junction; it may be preserved if technically possible. The segment of the saphenous vein containing the node-bearing tissue is removed. If the artery should have been injured or extensively uprooted, transposition of the sartorius to cover the vessel may protect it during the postoperative course. The sartorius muscle is then identified and mobilized. The sartorius is first transected at its insertion point, translocated over the femoral vessels and then finally sutured to the inguinal ligament with permanent sutures. As above, suction drains are placed bilaterally and the skin and subcutaneous tissue are closed.

Bibliography

DiSaia P, Creasman WT (1997), editors, *Clinical gynecologic oncology,* 5th edn. St Louis: CV Mosby Co.

Morrow CP, Curtin (1998) *Synopsis of gynecologic oncology,* 5th edn. New York: Churchill Livingstone.

Netter FH (1989) *Atlas of human anatomy.* West Caldwell: CIBA-Medical.

Nichols DH (1993), editor. *Gynecologic and obstetric surgery.* St Louis: Mosby-YearBook Inc.

Rohen JW, Yokochi C (1993) *Color atlas of anatomy*: *a photographic study of the human body,* 2nd edn. New York: Igaku-Shoin Medical Publishers, Inc.

Wheeless CR (1988) *Atlas of pelvic surgery,* 2nd edn. Malvern: Lea & Febiger.

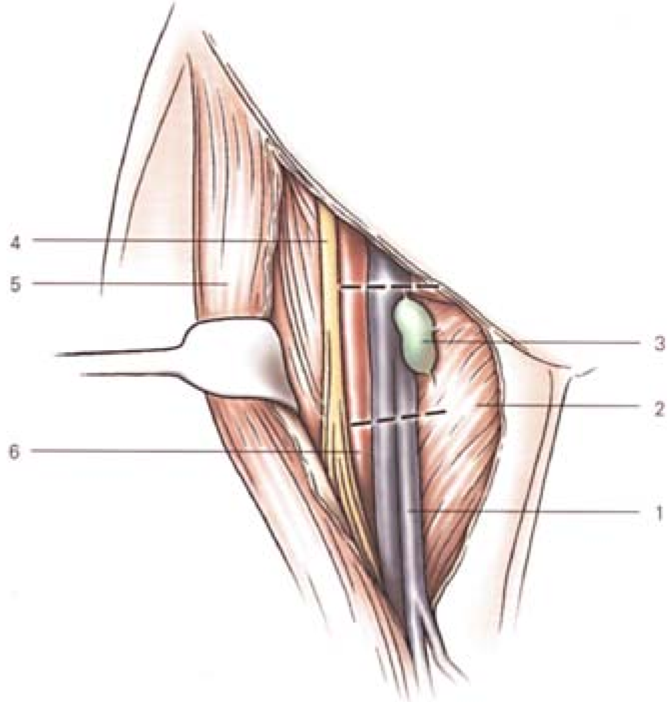


Figure 5

1 Femoral vein

2 Medial border of adductor longus muscle

3 Node bearing area

4 Femoral nerve

5 Sartorius muscle

6 Femoral artery

16
Laparoscopy

Farr Nezhat

Carmel Cohen

This chapter describes the procedures of appendectomy, hysterectomy (both standard and radical), omentectomy, palliative end colostomy and lymphadenectomy (encompassing both para-aortic and pelvic lymph nodes). Whole textbooks have been devoted to laparoscopic surgery but in line with the 'cookbook' approach of this volume, we believe these procedures are more than adequately described in the following text.

Appendectomy

Introduction

Since the first use of laparoscopy for appendectomy by Kurt Semms in Germany and Nezhat and others in the USA in the 1980s and early 1990s, this procedure has become widely accepted.

Two different techniques have been utilized for laparoscopic appendectomy: one uses sutures or bipolar electrodesiccation for severing the appendiceal blood vessels; the other uses a linear stapling device across the mesoappendix and appendix simultaneously.

Indications

Appendectomy is frequently performed incidentally in association with other pelvic surgical procedures, or whenever pathological changes are identified as in patients with infection, endometriosis or benign or malignant tumor. In certain ovarian cancers, such as mucinous cystadenocarcinoma, the appendix may be removed as part of the staging procedure.

Anatomic considerations

The appendix is an elongated vestigial diverticulum of the cecum which is richly endowed with lymphoid tissue. It is normally 7–10 cm in length but lengths up to 30 cm have been recorded. It receives blood supply from the appendicular artery, which is a branch of the lower division of the ileocecal artery. An accessory appendicular artery may be present in almost 50% of patients. The major vessels enter the mesoappendix a short distance from the base of the appendix. The location of the appendix is variable; up to 70% will be retrocecal and the remainder present primarily in front of the large bowel. Although it is usually found in the right iliac fossa, in maldescent of the cecum or advanced pregnancy the appendix may be seated in the right hypochondrium. In rare conditions such as situs inversus, the appendix is in the left iliac fossa.

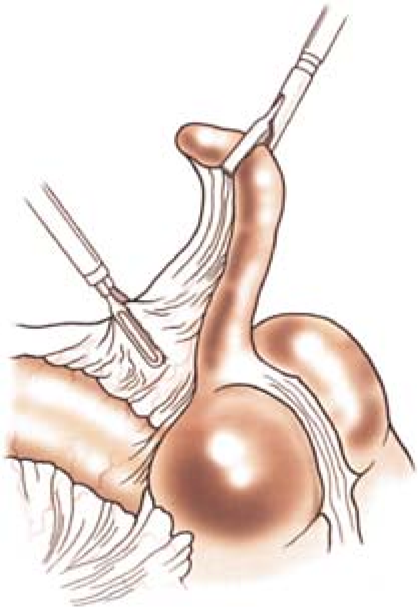


Figure 1

Bipolar electrodesiccation is applied to the base of the mesoappendix

Operative procedure

1. Trocar and cannula placement: the primary trocar is placed infraumbilically for introduction of the video laparoscope. Two 5mm secondary punctures are made lateral to the inferior epigastric vessels, one on the right and one on the left at the level of the iliac crest, and a 10 mm (or 12 mm if a linear stapling device is being used) puncture is made suprapubically 5 cm above the symphysis pubis.
2. After thorough evaluation of the abdominopelvic cavity any periappendiceal adhesions or attachments are lysed and the appendix is mobilized.
3. While the appendix is being elevated and put on traction, bipolar electrodesiccation is applied to the base of the mesoappendix for hemostasis of the appendiceal vessels (Figure 1). After adequate desiccation, the mesoappendix is cut using sharp or electrosurgical scissors until the base of the appendix is reached. Caution should be exercised to avoid thermal injury to the cecum or the ileum.
4. Next, the base of the appendix is ligated by applying two polydioxal or chromic Endoloop sutures (Ethicon Endosurgery, Somerville, NJ, USA). The third Endoloop suture is applied 5 mm distal to the first two sutures. The appendix is cut between the two sets of sutures (Figure 2).

   Alternatively, suturing is used for ligation of the appendiceal artery. An opening is made in the mesentery near the base of the appendix and a ligature of polyglactin is introduced into the opening. One ligature is tied around the base of the mesosalpinx and another is tied on the base of the appendix. Similar sutures are placed on the specimen side, and the appendix and mesoappendix are subsequently cut using sharp scissors (Figures 3 and 4).

   A linear stapling device can be directly applied across the mesoappendix and the appendix, speeding up the procedure (Figure 5).

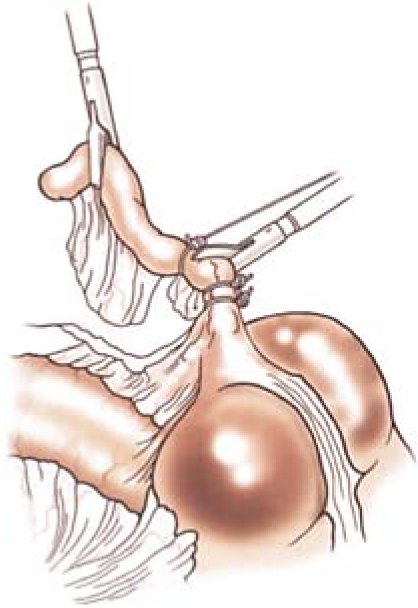


Figure 2

The appendix is cut between the sutures

5. After removal of the appendix, the abdominoperitoneal cavity is thoroughly irrigated. The appendix is removed through the 10 mm or 12 mm suprapubic trocar sleeve using Babcock forceps or by putting the appendix in a laparoscopic bag.

Hysterectomy

Introduction

Hysterectomy is one of the most frequently performed major surgical procedures in women. Approximately two-thirds of hysterectomies are performed abdominally and one-third vaginally. The purpose of laparoscopic surgery for hysterectomy is to avoid the adverse effects of laparotomy, maintain the principles of oncologic surgery and offer the advantages of a vaginal approach. Since its introduction in the late 1980s, numerous variants have been developed, described by terms such as ‘laparoscopically assisted vaginal hysterectomy’, ‘laparoscopic hysterectomy’ or ‘total laparoscopic hysterectomy’. While there may be technical differences and different skill requirements between the various laparoscopic procedures, there is no significant difference in postoperative pain, recovery, complications or cost. In this chapter total simple laparoscopic hysterectomy and radical hysterectomy are described.

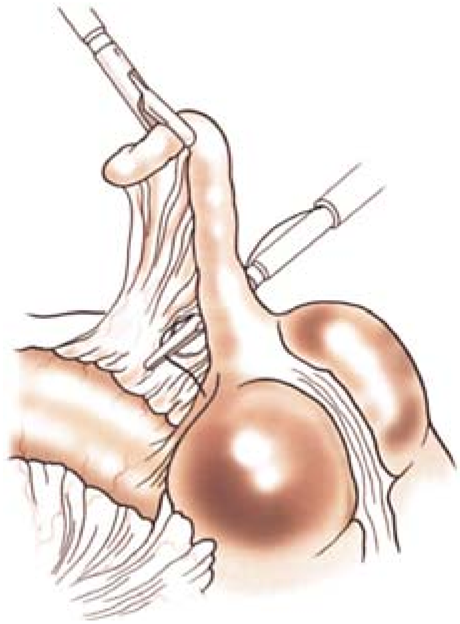


Figure 3

Ligatures are tied around the base of the appendix

Indications

In gynecologic oncology, hysterectomy has been performed either as part of the treatment and staging of endometrial, ovarian or fallopian tube carcinoma, in the form of intra- or extrafascial hysterectomy, or as radical hysterectomy for treatment of cervical and occasionally vaginal cancer.

Anatomic considerations

The blood supply of the uterus is from the uterine artery, which anastomoses with the ovarian and vaginal arteries. The nerve supply is from the urogenital plexus.

Operative procedure

1. Trocar placement: besides the primary intraumbilical trocar sleeve which is used for introduction of the video laparoscope, three other low abdominal trocar sleeves are introduced for the passage of the ancillary instruments. For hemostasis, bipolar electrodesiccation or linear stapling devices are currently favored; suturing or the ultrasonic harmonic scalpel may also be used. For cutting, sharp or electrosurgical scissors or lasers are commonly used.
2. After the anatomy of the pelvis is evaluated and any associated procedures (such as treatment of pelvic adhesions or endometriosis, or peritoneal biopsy) are performed, hysterectomy and salpingo-oophorectomy proceed as follows. If oophorectomy is planned, first the infundibulopelvic ligament blood supply is severed using bipolar electrodesiccation or a stapling device. The direction of the ureter

Figure 4

The appendix and mesoappendix are cut

crossing the pelvic brim over the bifurcation of the common iliac artery should be identified. In these patients the ureter can often be visualized, observed for peristalsis and avoided without mobilization. In obese patients, specific dissection may be required to identify and thus avoid injury to the ureter. Retroperitoneal or intraperitoneal ureteral dissection should be performed when there are severe adhesions or tumor involvement between the ovary and the pelvic side wall. The adnexa should be grasped with the forceps and retracted medially and caudally to stretch and outline the infundibulo-pelvic ligaments before application of the bipolar forceps or linear stapling device (Figure 6).

3. The round ligament is transected (Figure 7) or electrodesiccated approximately 4–5 cm lateral to the uterus, and the anterior leaf of the broad ligament is dissected using blunt, sharp or hydrodissection. The bladder is separated from the lower uterine segment and cervix (Figures 8 and 9). These steps are accomplished bilaterally.
4. While the assistant retracts the uterus to one side using an intrauterine manipulator, the uterine blood supply is skeletonized and severed, using bipolar electrodesiccation or a linear stapling device (Figure 10).
5. The direction of the ureters should be further identified and dissected laterally, especially for an extrafascial hysterectomy. The bladder is dissected away completely from the cervix and slightly from the upper vagina. The cardinal and uterosacral ligaments are electrodesiccated and cut or stapled (Figure 11). For anterior and posterior culdotomy, a folded 10 cm×10 cm gauze in a sponge forceps, or the tip of a right-angled retractor placed in the vagina, can be used to mark the anterior or posterior vagina cuff (Figure 12). The vaginal wall is thus clearly demonstrated, allowing horizontal transection with the cutting instrument. The uterus should be positioned anteriorly for a posterior culdotomy and posteriorly for anterior culdotomy (Figures 13 and 14). The remaining attachment of the uterus laterally is circumferentially dissected and after the uterus is completely freed it is removed vaginally by

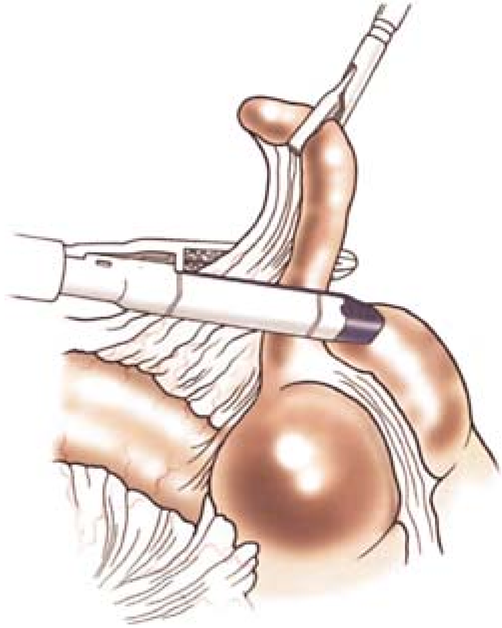


Figure 5

Linear stapling device

introducing a tenaculum through the vaginal vault to grasp the cervix, or to pull the uterus out with the previously attached elevator (Figure 15).

6. Vaginal vault closure and support: the vaginal vault can be closed either laparoscopically or transvaginally. In a larparoscopic approach to prevent loss of pneumoperitoneum either the uterus or a partially inflated surgical glove containing a folded gauze is left in the vagina. The uterosacral ligament is elevated with a grasping forceps and sutured to the vaginal angle on each side; the knot tying may be extra- or intracorporeal. The vaginal cuff is closed in the middle using several interrupted sutures, or a single or continuous suture (Figures 16 and 17).

Radical hysterectomy

The most common indications for the radical procedure are stage IA2, IB and IIA carcinoma of the cervix. Less common indications include small centrally recurrent postradiation cervical cancers, adenocarcinoma of the endometrium with clinical involvement of the cervix, and stage I to II carcinoma of the vagina.

1. Development of the rectovaginal space: an assistant elevates the uterus with a uterine manipulator, and with the other hand performs a rectovaginal examination, delineating the rectum and the vagina. The cul-de-sac peritoneum between the attachment to the rectum and to the vagina is incised laparoscopically and the rectum is separated from the posterior vaginal wall using sharp and blunt dissection to a level of 3–4 cm below the cervix (Figure 18). The pneumoperitoneum will help identify the correct plane.
2. Development of the vesicovaginal space: round ligaments are electrodesiccated and cut close to the pelvic side wall. The peritoneum is incised lateral and parallel to the ovarian vessels. Anterior leaves of

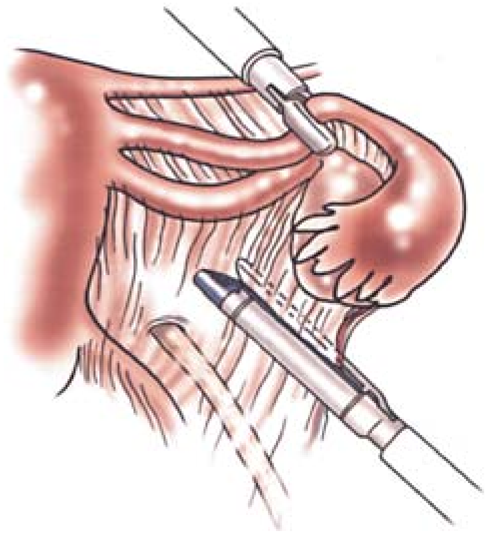


Figure 6

Bipolar forceps are applied to the infundibulopelvic ligaments

broad ligament are incised towards the vesicouterine peritoneal reflexion. Using hydrodissection, or sharp and blunt dissection, the vesicouterine ligament is divided and the bladder is pushed off the cervix and the upper third of the vagina (Figure 19).

3. Development of the paravesical spaces: the obliterated hypogastric artery is identified and is retracted medially with a suction irrigator probe or a grasping forceps. The paravesical space is developed between the obliterated hypogastric artery and the external iliac vein (Figure 20).
4. Development of the pararectal space: while the infundibulopelvic ligament and adnexa are retracted medially, the obliterated hypogastric artery is traced down until the ureter is identified retroperitoneally and traced from the pelvic brim towards the bladder. While the ureter is retracted medially, the pararectal space is entered using blunt dissection between the hypogastric artery laterally and the ureter medially and posterior to the uterine artery. Ureteral dissection is performed and the uterine artery is identified at its origin from the hypogastric artery (Figure 21).
5. Ligation of the uterine artery and unroofing the ureter: the uterine artery is electrodesiccated or clipped just medial to its origin, transected and rotated anterior to the ureter (Figure 22). An angled tip clamp or the tip of the suction irrigator probe is used to widen the ureteral canal; an incision is made anteriorly, it is opened completely and the ureter mobilized. The ureter is unroofed from the ureteral canal and the parametrium is freed. Bipolar electrodesiccation, staples or surgical clips can be used for achieving hemostasis of the hypogastric venous plexus (Figure 23). The uterosacral ligaments and the parametria are stapled or electrodesiccated with bipolar forceps and sequentially transected approximately 1.5–3 cm lateral to the cervix, based on the type of radical hysterectomy being performed. The dissection is taken to 2–3 cm below the cervix (Figure 24). Anterior and posterior coldotomy are performed as described above. After removal of the uterus the vaginal cuff is closed either laparoscopically or vaginally.

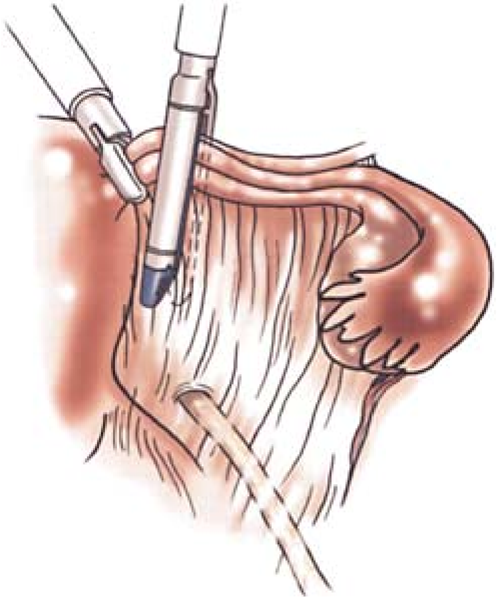


Figure 7

A stapler is used to transect the round ligament, ovarian ligament and fallopian tube

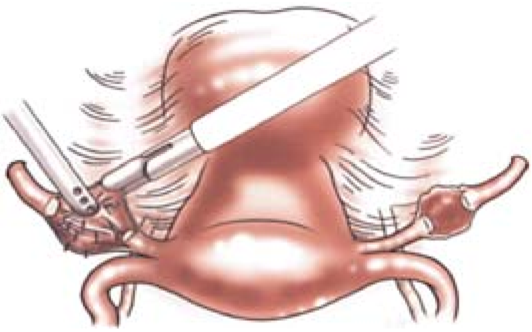


Figure 8

The anterior leaf of the broad ligament is dissected

Omentectomy

Introduction

Omentum frequently is involved with metastatic lesions whenever there is intra-abdominal spread of cancer. Omentectomy is part of the staging of ovarian cancer and is often performed in treating or staging other gynecologic cancers such as uterine papillary serous adenocarcinoma.

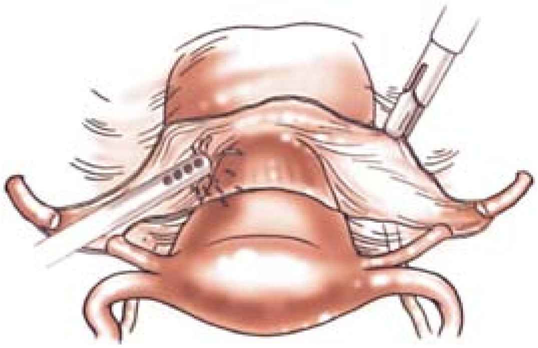


Figure 9

Hydrodessication of the bladder

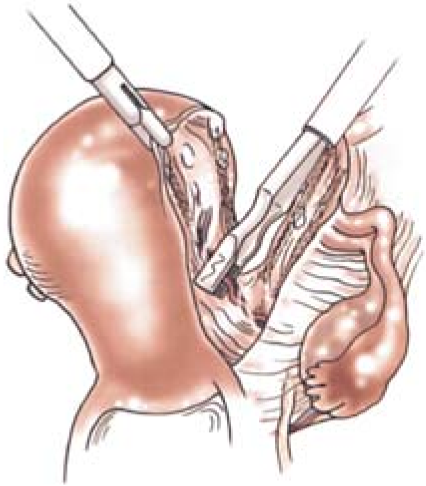


Figure 10

Uterine vessel dessication

Anatomic considerations

The grater omentum is a fatty apron attached to the transverse colon and draped over coils of the small intestine. It is attached along the first part of the duodenum; its left border is continuous with the gastrolienal ligament. If it is lifted and turned back over the stomach and liver, it can be seen to adhere to the transverse colon along the latter's whole length across the abdomen.

The omentum receives its blood supply from the gastro-omental arcade which is formed by the anastomosis of the left (a branch of the splenic artery) and right (a branch of the gastroduodenal artery) gastro-omental arteries.

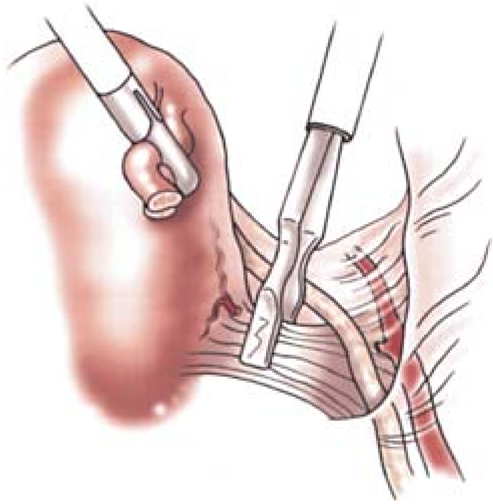


Figure 11

The cardinal and uterosacral ligaments are electrodessicated

Operative procedure

1. Patient position and trocar placement: the patient should be lying flat or in a slightly reversed Trendelenburg position for better access to the omentum. Primary and secondary trocar placement is similar to that described for appendectomy. Although stapling or bipolar electrodesiccation can be used for hemostasis of the omental vasculature, the harmonic scalpel is preferable because of its unique advantages of reducing both tissue damage and smoke plume production.
2. The omentum is elevated using two atraumatic grasping forceps introduced through the 5 mm trocar sleeves. After exposure of the omentum and assessment of its relation to the transverse colon, a harmonic scalpel is introduced through the midline trocar and the omentectomy is started from the middle or the hepatic flexure, proceeding towards the splenic flexure at the line of reflection onto the transverse colon. Attention should be paid to avoiding injury to the colon and its mesentery and the short gastric vascular cascades (Figures 25 and 26), especially if the anatomy has been distorted by the tumor deposit or adhesions.
3. After the omentum has been detached it can be extracted from the abdominal cavity in different ways. Following laparoscopic or laparoscopically assisted vaginal hysterectomy, it can be extracted through the vagina either directly or after placing it in a bag. Alternatively, the omentum can be removed through a 12 mm trocar sleeve or an enlarged anterior abdominal trocar site after enclosure in an endoscopic bag.

Before termination of the procedure, hemostasis should be assured by decreasing the pneumoperitoneum pressure and evaluating the site of the resection (Figure 27). Individual bleeding sites can be treated with bipolar electrocoagulation, application of clips or suture techniques.

Figure 12

Performing posterior culdotomy

Palliative end colostomy

Introduction

In palliative end colostomy the fecal stream is diverted above the rectum. End sigmoid colostomy with a Hartmann pouch or distal exteriorization of the distal portion of the rectosigmoid colon as a fistula in lieu of the Hartmann pouch may be utilized. Palliative end sigmoid colostomy with the Hartmann pouch is most frequently employed in gynecologic oncology when permanent diversion is required.

Indications

Palliative end colostomy in gynecologic oncology is required when the distal bowel has been removed or is permanently unusable, as in the case of non-resectable pelvic tumor causing rectosigmoid obstruction or irreparable fistula caused by tumor or radiation necrosis.

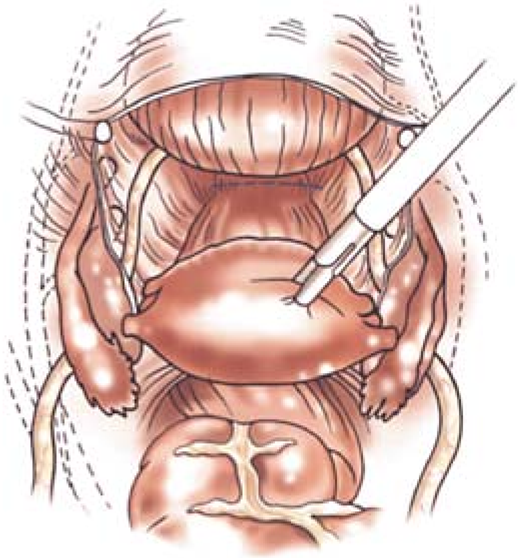


Figure 13

Anterior culdotomy

Anatomic considerations

The blood supply of the entire large intestine comes from the superior and inferior mesenteric arteries, with the former mainly supplying the midgut-derived right and transverse colon whereas the latter supplies the hindgut-derived left colon. The marginal artery of Drummond serves to connect the vascular territories of the two arteries.

The inferior mesenteric artery (IMA) arises from the dorsal side of the aorta often to the left at the level of L3, about 3–4 cm proximal to the bifurcation of aorta. After veering to the left it gives off the left colic artery which divides into ascending and descending branches. The sigmoid colon is supplied by two to four arteries. The first one, which is the largest, comes from the left colic artery (30% of cases) or the IMA. From this first sigmoid vessel, second or third vessels may originate, or may arise directly from the IMA. As the IMA enters the pelvis, it becomes the superior rectal (hemorrhoidal) artery.

Venous and lymphatic drainage of the large intestine follows the general pattern of the arterial supply.

Operative procedure

1. Patient position and trocar placement: the patient is placed in a supine position or slightly turned toward the right side. A principal intraumbilical trocar for video laparoscopy is inserted, with three or four other trocars for introduction of the ancillary instruments (Figure 28). Two trocars are placed on the left side: one 12 mm trocar between the umbilicus and iliac crest for introduction of a Babcock clamp or linear stapling device, and one 5 mm trocar at the level of the iliac crest for introduction of a grasping forceps. One 12 mm midline trocar is placed 5 cm above the symphysis pubis for introduction of the stapler, clip applier, scissors or harmonic scalpel, and one 5 mm trocar on the right side at the level of the iliac crest for introduction of a grasping forceps (Figure 28).

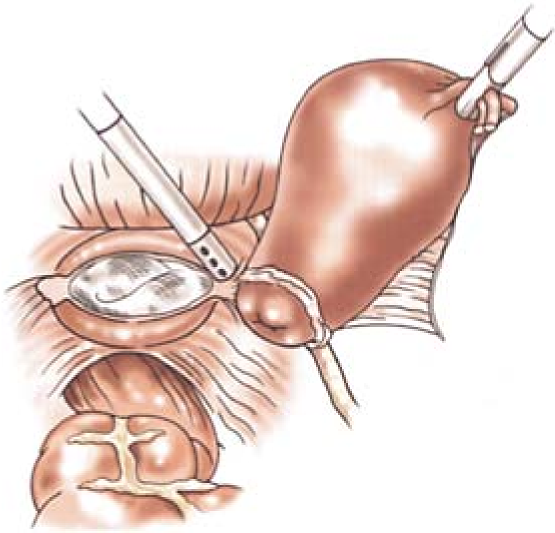


Figure 14

Detachment of uterus

2. After thorough evaluation of the abdominal and pelvic cavity the sigmoid colon is identified and mobilized from its attachment to the pelvic side wall. By means of a Babcock grasping forceps introduced through the left trocar incision, the sigmoid colon is elevated. Electrosurgery, a harmonic scalpel or a stapling device is used to divide the mesentery of the sigmoid colon and a window is made. Vascularity of the proximal end of the bowel should not be compromised. While the bowel is elevated with the Babcock clamp, a laparoscopic linear stapling cutter introduced through the left lower quadrant trocar is passed across the bowel, which is then divided (Figures 29 and 30).
3. After removal of the left lower quadrant trocar cannula, a disk of the subcutaneous fat at this site is incised and removed in preparation for location of the stoma. The fascia is incised and is enlarged using two fingers. Under direct laparoscopic visualization, a Babcock clamp is introduced through the left quadrant incision and the proximal portion of the sigmoid colon is grabbed and brought out through the incision (Figure 31).
4. The stapled end of the proximal colon is removed and a 'rosebud' stitch is used to evert the colon onto the skin, creating the stoma (Figure 32). Laparoscopically the serosa of the sigmoid colon is sutured to the peritoneum for prevention of internal hernia, using 2–0 polyglactin.

Lymphadenectomy

Introduction

Since the initial descriptions of laparoscopic pelvic and para-aortic lymphadenectomy in the late 1980s and early 1990s, numerous reports have verified the feasibility and safety of this technique. Its advocates point to the better magnification, fewer complications and superior visualization of the anatomy of blood vessels and lymph nodes provided by the video laparoscope in comparison with conventional techniques. In the

Figure 15

The uterus is removed transvaginally

hands of the experienced laparoscopist the efficacy of laparoscopic lymphadenectomy is equal to—if not better than—that achieved during laparotomy, with fewer complications.

Indications

Laparoscopic lymph node resection is performed as part of the treatment of cervical cancer, and node sampling is performed as part of the staging for endometrial or ovarian cancer.

Anatomic considerations

Para-aortic nodes

The landmarks which should be kept in mind for paraaortic lymphadenectomies (Figure 33) are as follows, from right to left:

- psoas muscle
- right ureter, which is medial to the psoas muscle, lateral to the inferior vena cava and crosses the bifurcation of the common iliac artery
- vena cava (which is lateral to the aorta)
- aorta and both common iliac arteries

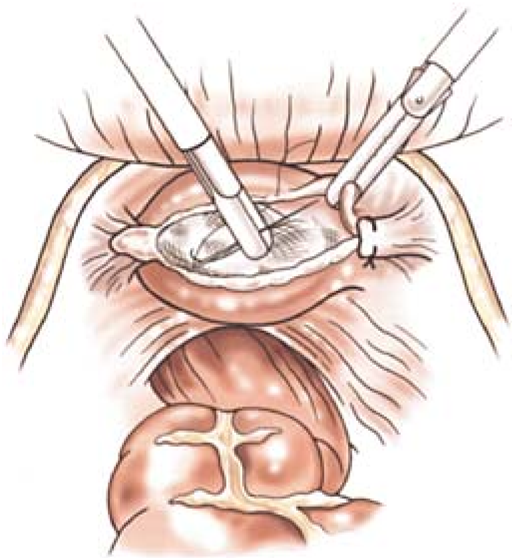


Figure 16

The vaginal cuff is closed in the middle

- below the bifurcation of the aorta superficially is the superior hypogastric nerve plexus and beneath it is the left common iliac vein crossing from the left to the right
- on the left side of the aorta are the inferior mesenteric artery, the ureter, sigmoid colon and its mesentery; the lumbar veins and artery are deep and can be seen after left lymphadenectomy
- on the far left is the left psoas muscle.

Pelvic nodes

The important landmarks for pelvic lymphadenectomy (Figure 34) are:

- laterally, the psoas muscle, the genitofemoral nerve, and the external iliac artery and vein
- distally, the deep circumflex vein, superior pubic ramus, and obturator internus fascia
- proximally, the common iliac bifurcation and bowel
- anteriorly, paravesical space, obturator nerve and superior vesical artery
- medially, the anterior division of the hypogastric artery and the ureter and paravesical space
- inferiorly, the sacral plexus, hypogastric vein, and pararectal space.

Operative procedure

Para-aortic lymphadenectomy

The room set-up, the patient's position, and the equipment may require minor variations. This includes additional 5 mm or 10 mm trocars and positioning the video monitor at the head of the operating table, or using two monitors, one on each side of the patient —one for the surgeon's view and the other for the

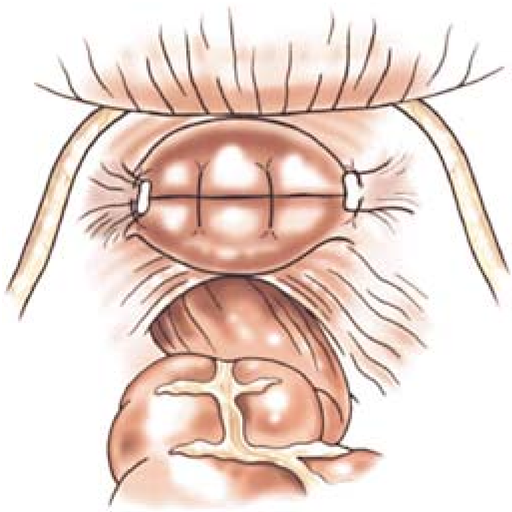


Figure 17

Final appearance

assistant's. The surgeon can stand on the right or left side of the patient, although some prefer to stand between the patient's legs. Besides the umbilical port, three to four additional ports are necessary for introduction of the grasping forceps, scissors, and clip applier or bipolar electrocoagulator. The location of the ancillary trocars is adjusted according to the surgeon's preference. The patient is rotated to the left side for better exposure of the para-aortic area.

After insertion of the ancillary instruments and evaluation of the para-aortic area, the aorta is identified under the peritoneum up to the level of the mesenteric root. An incision is made over the posterior peritoneum at the level of the aortic bifurcation and extended towards the right iliac artery. The peritoneal incision is extended to the root of the mesenteric artery and, in the case of ovarian cancer, to the root of the left renal vein. Using two atraumatic grasping forceps, the peritoneum on each side is lifted and retracted laterally. Using blunt and occasionally sharp dissection with the tip of the suction irrigator or scissors, the retroperitoneal fatty tissue is dissected and the retroperitoneal vessels are identified (Figure 35).

For left para-aortic lymphadenectomy the rectosigmoid colon is retracted laterally and, after identification of the inferior mesenteric artery and ureter, the nodal packet lateral to the aorta and above the left common iliac artery is resected using blunt and occasionally sharp dissection. Careful attention should be paid to avoid injury to lumbar vessels, the left common iliac vein, left ureter and inferior mesenteric artery. For ovarian cancer staging, the lymphadenectomy can be extended to the level of the left renal vein (Figures 36 and 37).

For resection of the paracaval nodes, the right ureter is identified and, while gentle traction is applied using atraumatic grasping forceps, the peritoneum and the ureter are retracted laterally over the psoas muscle. The nodal packet attached to the right common iliac artery is dissected off the vessels using blunt and occasionally sharp dissection. Using a laparoscopic Babcock clamp, the nodal packet is elevated and, using blunt and sharp dissection, the nodal packet is removed from the inferior vena cava. Care must be taken to avoid injury to the perforator veins. Clips or bipolar electrodesiccation can be used for achieving hemostasis. The level of the paracaval lymphadenectomy can be extended to the level of the right ovarian

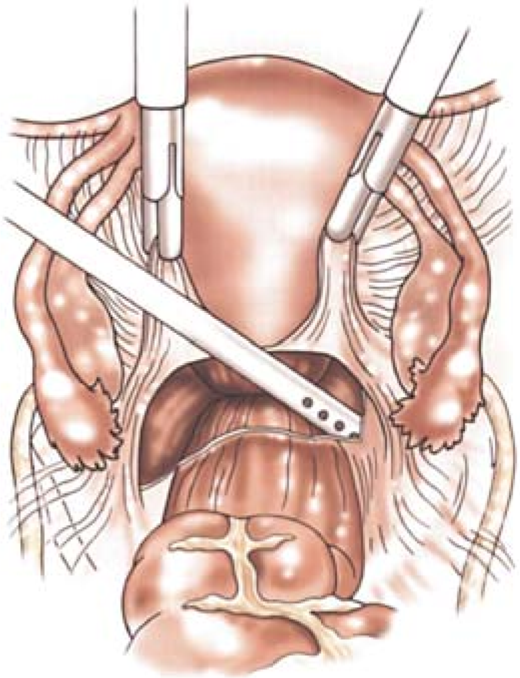


Figure 18

The cul-de-sac peritoneum is incised laparoscopically

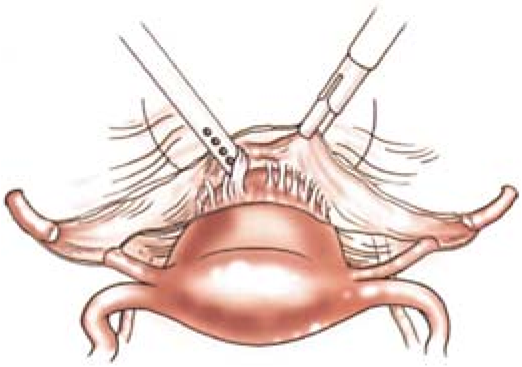


Figure 19

The vesicouterine ligament is dissected

vein and, at times, the ovarian vein can be clipped and dissected for a better approach to the nodal packet in this area (see Figure 37).

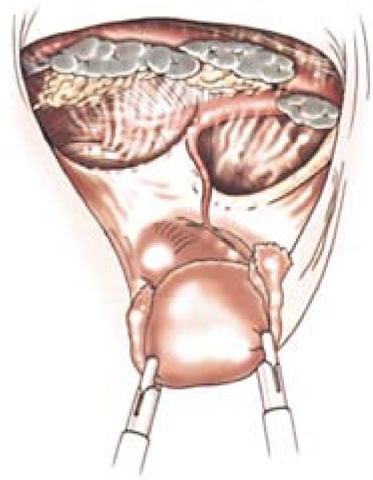


Figure 20

The paravesical space is developed

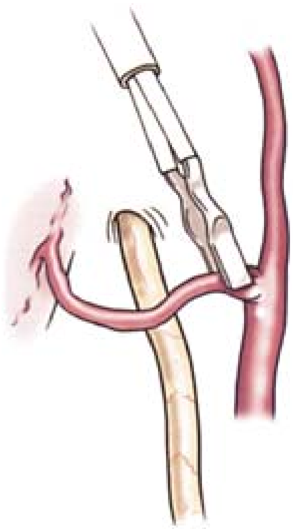


Figure 21

The uterine artery is identified and electrodessicated

Pelvic lymphadenectomy

Besides the primary intraumbilical trocar which is used for introduction of the video laparoscope, two ancillary 5 mm ports in the right and the left lower quadrants lateral to the inferior epigastric vessels at the level of the iliac crest and an additional 10mm port in the midline 5 cm above the symphysis pubis are required. The lymphadenectomy may be performed either before or after hysterectomy. The procedure begins with an incision of the peritoneum between the round and infundibulopelvic ligaments, parallel to

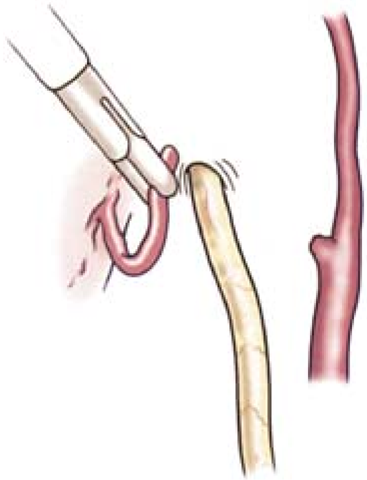


Figure 22

The uterine artery is transected

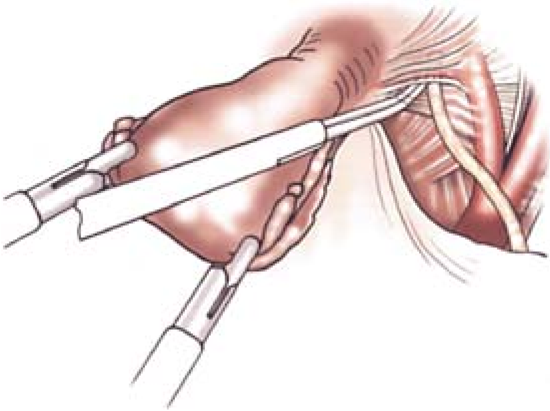


Figure 23

The parametrium is freed

the axis of the external iliac vessels (Figure 38). The round ligament is electrodesiccated and cut, the broad ligament between the round and the infundibulopelvic ligament is opened, and the psoas muscle, genitofemoral nerve, iliac vessels, and ureter are identified. Next the paravesical space is entered and widened by blunt dissection between the umbilical artery medially and external iliac vessels laterally. Caution should be exercised to avoid injuries to the external iliac vein and aberrant obturator veins (Figures 39 and 40).

The fat and the lymphatic pad between the psoas muscle and external iliac artery are elevated, dissected, and removed distally and proximally towards the circumflex vein and common iliac artery respectively. The nodal packet below the external iliac vein is grasped medially and, using blunt dissection, separated from the vein. While gentle traction is applied on the nodal packet medially, the obturator nerve is identified

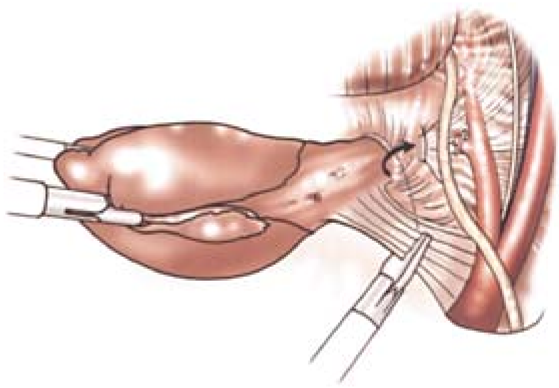


Figure 24

The dissection is taken to 2–3 cm below the cervix

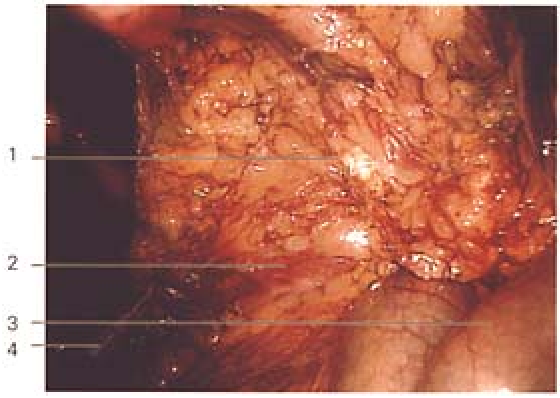


Figure 25

1 Omentum is under the stretch

2 Transverse colon

3 Small bowel

4 Omentectomy is started from the hepatic flexure

inferiorly and the obturator nodal packet is dissected and removed from the obturator nerve up to the level of the bifurcation of the external iliac artery; care is taken to avoid the hypogastric vein which often comes directly up from the pelvic floor. Inferiorly the nodal packet is removed at the level where the obturator nerve exits from the pelvis. The fatty and nodal tissue between the obturator nerve and the external iliac vein is grasped and thoroughly separated from the pelvic wall by blunt dissection using the suction irrigator or the closed tip of the grasping forceps. Clips can be applied before the removal of the nodal tissue. After removal, the pelvic bone and internal obturator muscle can be seen.

The lymphatic nodal package of the hypogastric artery is grasped and gently separated using blunt dissection from the external and internal iliac artery to the level of the division of the common iliac artery. Interiliac nodes between the external iliac artery and vein are removed (Figure 41).

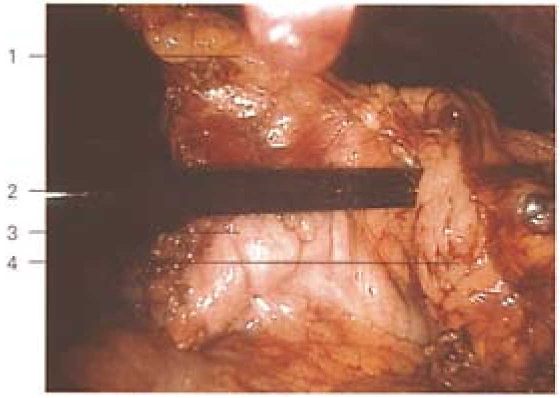


Figure 27

1 Omentum being elevated for exposure of transverse colo

2 Harmonic scalpel

3 Transverse colon

4 Splenic flexure and part of omentum

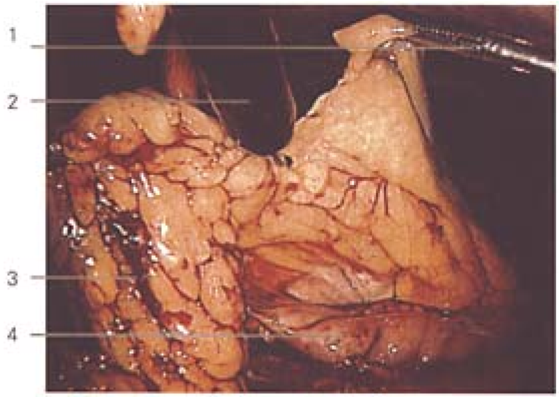


Figure 26

1 Grasping forceps elevate the omentum

2 Harmonic scalpel

3 Segment of detached omentum

4 Transverse colon

At the end of the procedure, the nodal package is removed through the trocar using a Babcock clamp or after placement inside the laparoscopic bag, and the area is thoroughly irrigated. Pneumoperitoneal pressure is decreased for evaluation of hemostasis; the peritoneum is not closed, and no retroperitoneal drain is applied.

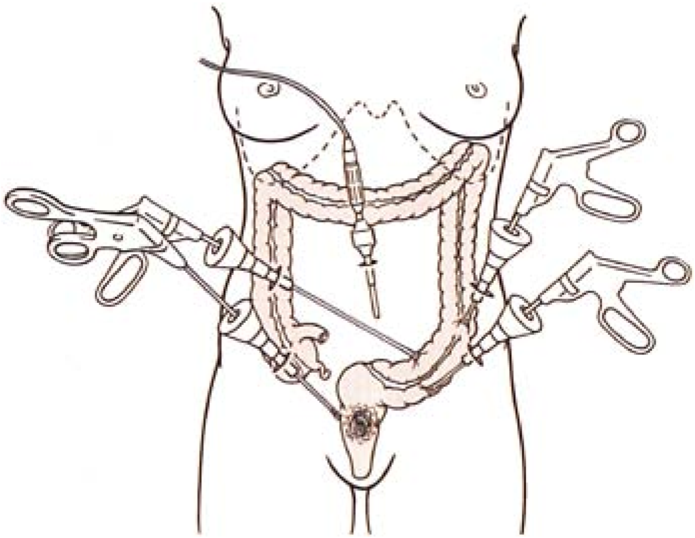


Figure 28

Portals for trocars

References

Childers J, Surwit E, Tran A, Hatch K (1993) Laparoscopic para-aortic lymphadenectomy in gynecologic malignancies, *Obstet Gynecol* **82:**741–7.

Dargent D, Mathevet P (1992) Hystérectomie élargie laparoscopico-vaginale, *J Gynecol Obstet Biol Reprod* **21:** 709–10.

Leahy PF (1989) Technique of laparoscopic appendectomy, *Br J Surg* **76:**616.

Morrow CP, Curtin JP (1996) Surgical anatomy. In: Morrow CP, Curtin JP, Osa EL, editors, *Gynecologic cancer surgery*, Edinburgh: Churchill Livingstone, 67–139, 181–268.

Nezhat C, Nezhat F (1991) Incidental appendectomy during videolaseroscopy, *Am J Obstet Gynecol* **165:** 559–64.

Nezhat C, Nezhat F, Silfen SL (1990) Laparoscopic hysterectomy and bilateral salpingo-ophorectomy using multifire GIA surgical stapler, *J Gynecol Surg* **6:**287.

Nezhat C, Nezhat F, Gordon S et al (1992) Laparoscopic versus abdominal hysterectomy , *J Reprod Med* **37:**247–50.

Nezhat C, Siegler A, Nezhat F et al (2000) The role of laparoscopy in the management of gynecologic malignancy. In: Nezhat C, Nezhat F, Luciano A, editors, *Operative gynecologic laparoscopy principles and techniques,* second edition, New York: McGraw-Hill, 301–27.

Piver MA, Rutledge FN, Smith JP (1974) Five classes of extended hysterectomy for women with cervical cancer, *Obstet Gynecol* **44:**265–70.

Querleu D, Leblanc E (1991) Laparoscopic pelvic lymphadenectomy in the staging of early carcinoma of the cervix, *Am J Obstet Gynecol* **164:**579–81.

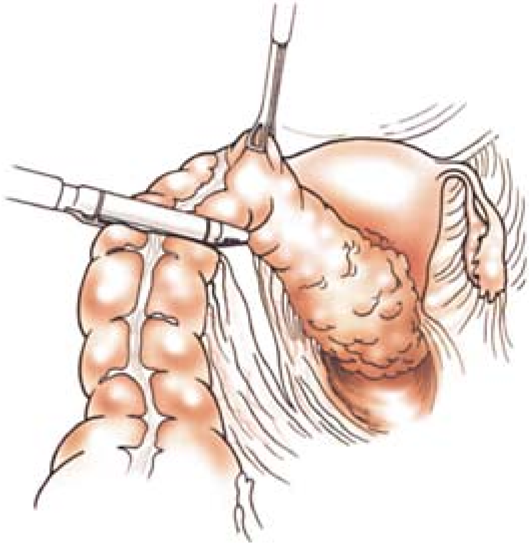


Figure 29

A linear stapling cutter is used to divide the bowel

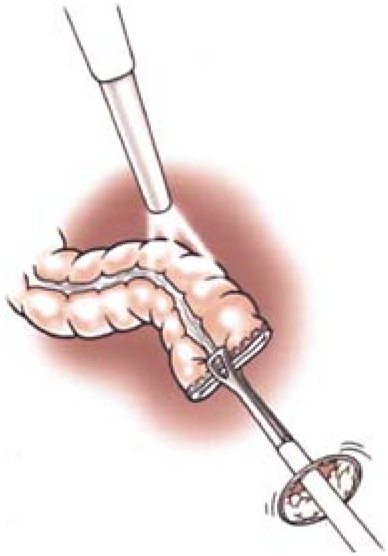


Figure 31

The proximal portion of the sigmoid colon is brought out through the incision

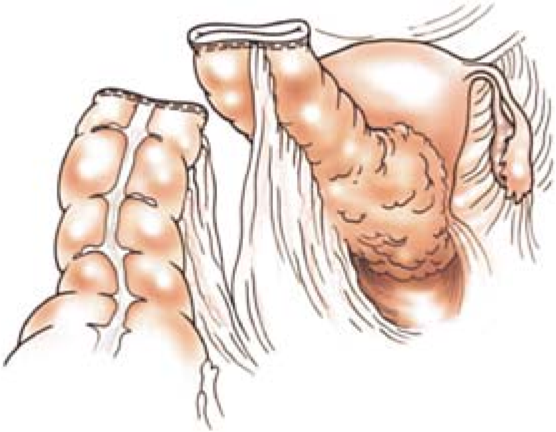


Figure 30

Division of the bowel

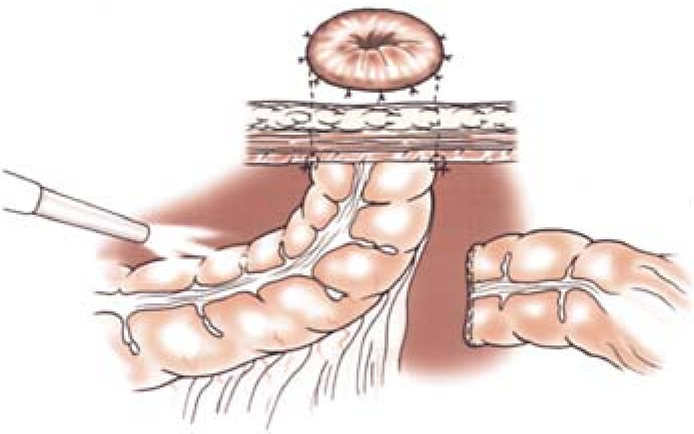


Figure 32

The serosa of the sigmoid colon is sutured to the peritoneum

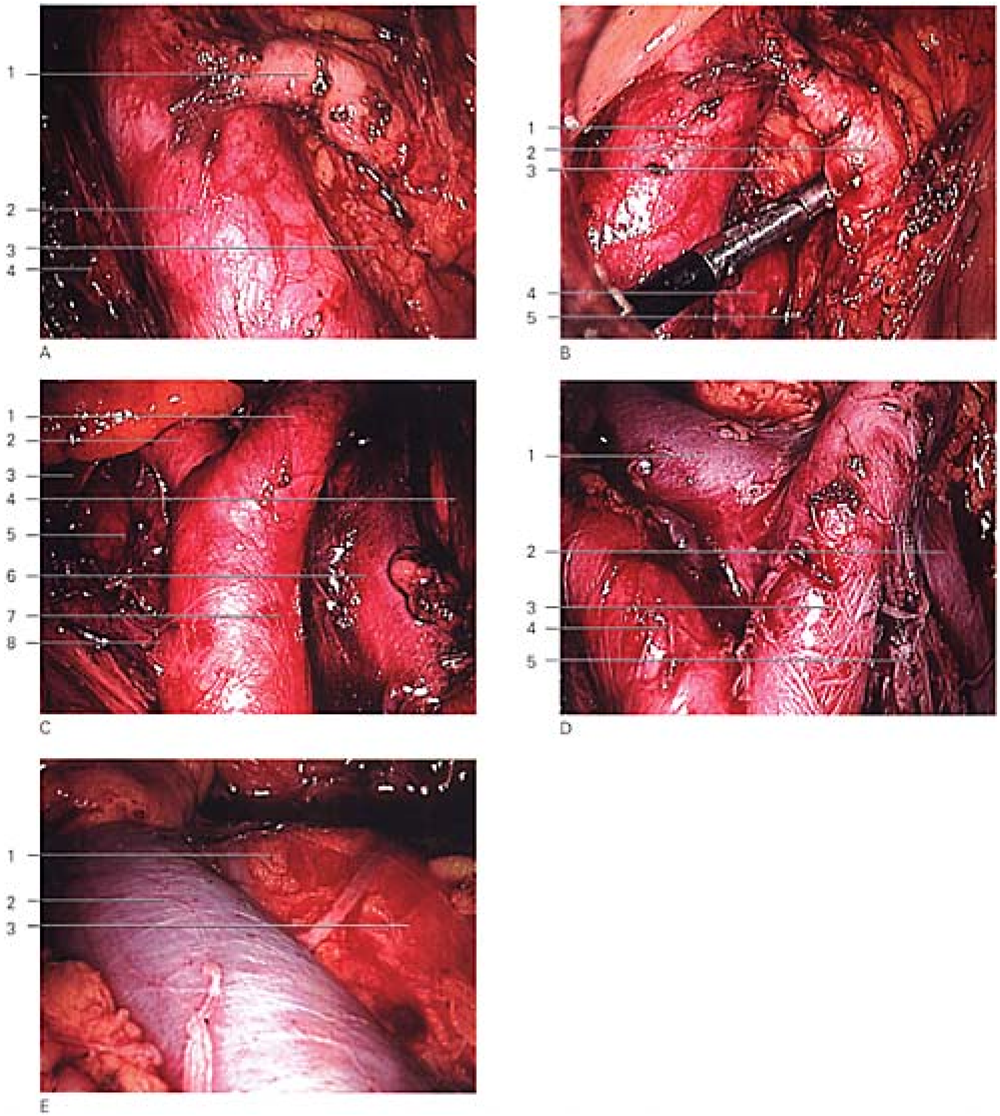


Figure 33

Retroperitoneal anatomy during para-aortic lymphadenectomy

A

1 Inferior mesenteric artery
2 Aorta
3 Left para-aortic nodes
4 Paracaval nodes

B Grasping forceps is used to retract inferior mesenteric artery for identification of left ureter

1 Aorta
2 Inferior mesenteric artery
3 Remaining left para aortic nodes under the inferior mesenteric artery
4 Left para-aortic area after lymphadenectomy

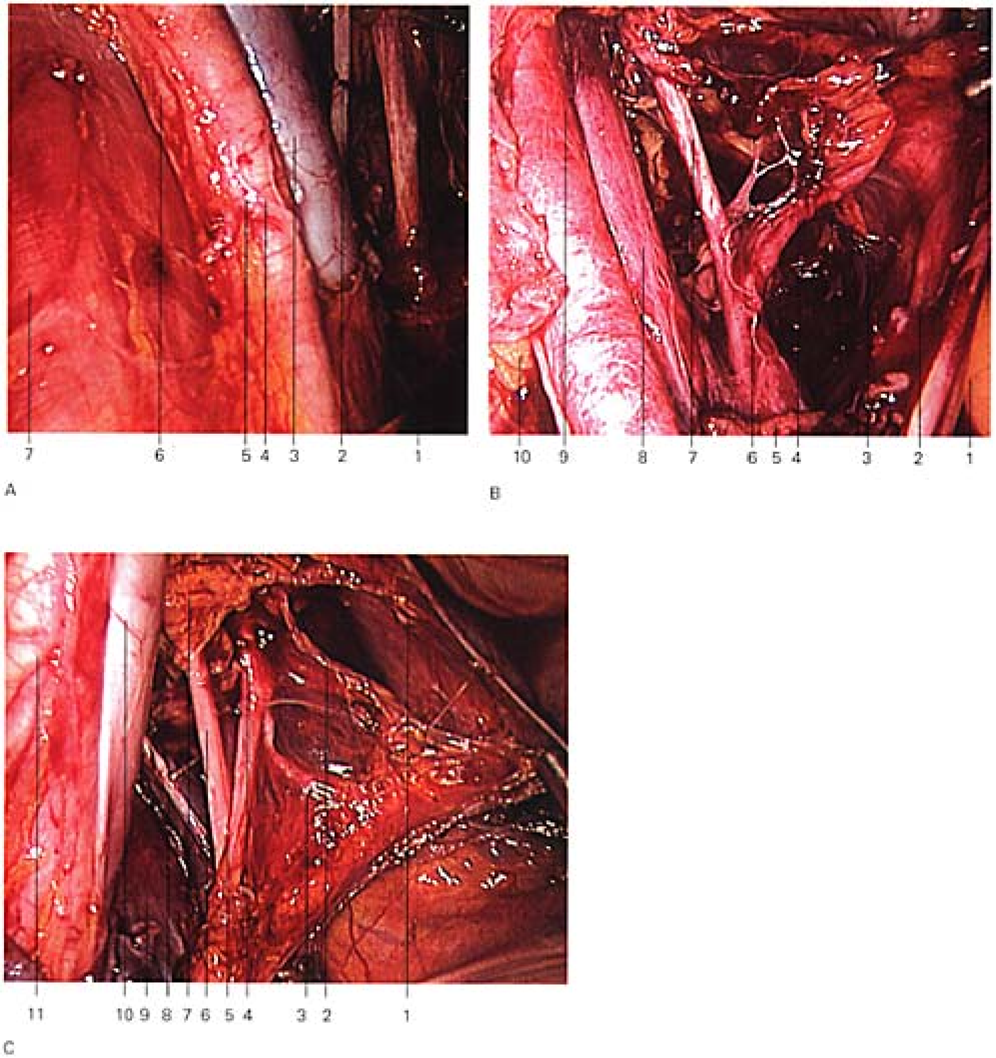


Figure 34

Retroperitoneal pelvic side wall anatomy dissection during pelvic lymphadenectomy

A

1 Obliterated hypogastric artery
2 Obturator nerve
3 External iliac vein
4 Left external lilac artery
5 Genitofemoral nerve
6 Left external iliac nodes
7 Left psoas muscle

B Grasping forceps retracts peritoneum medially

1 Peritoneum
2 Left ureter
3 Pararectal space

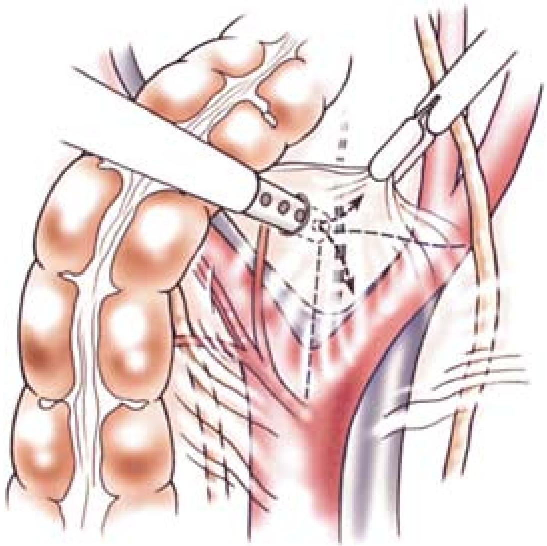


Figure 35

Exposure of aortic caval bifurcation

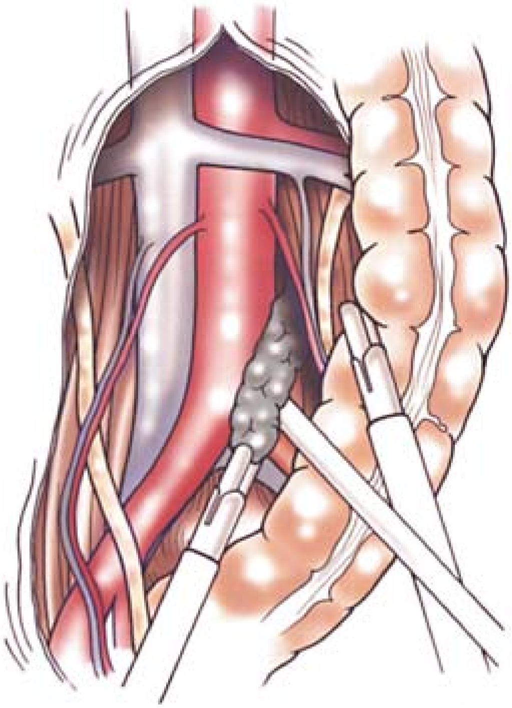


Figure 36

Renal vessel exposure

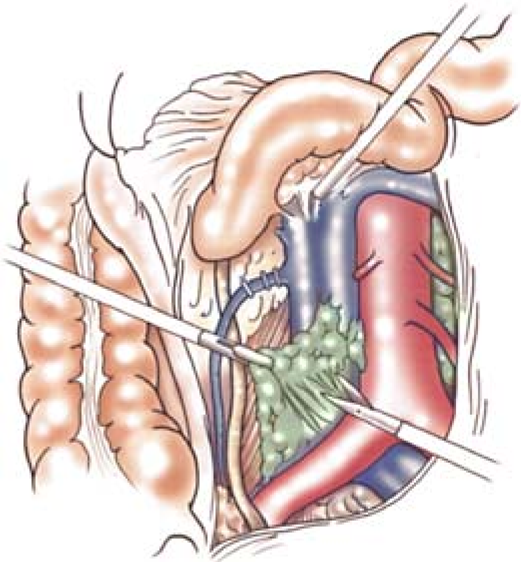


Figure 37

Caval exposure

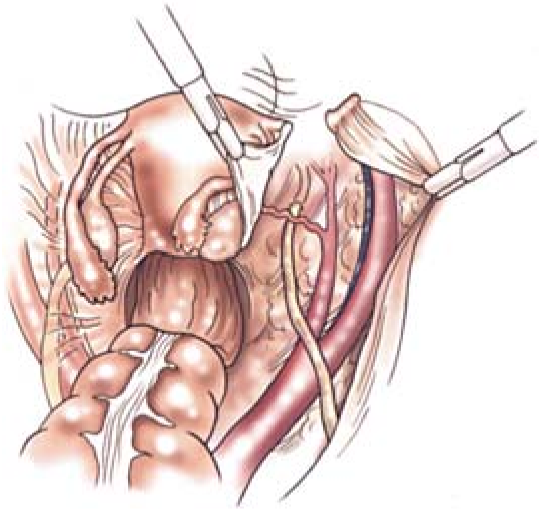


Figure 38

Pelvic side-wall exposure

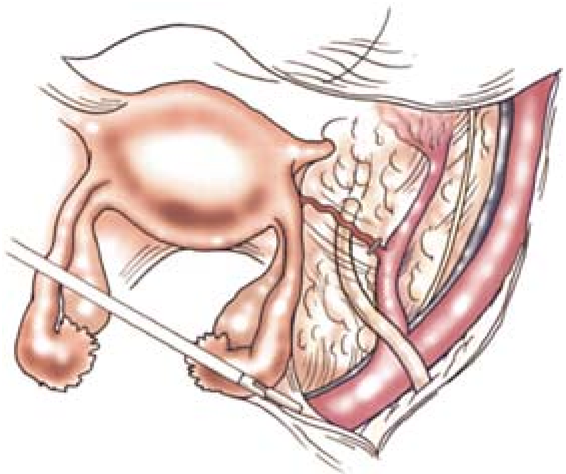


Figure 39

Obturator fossa exposure

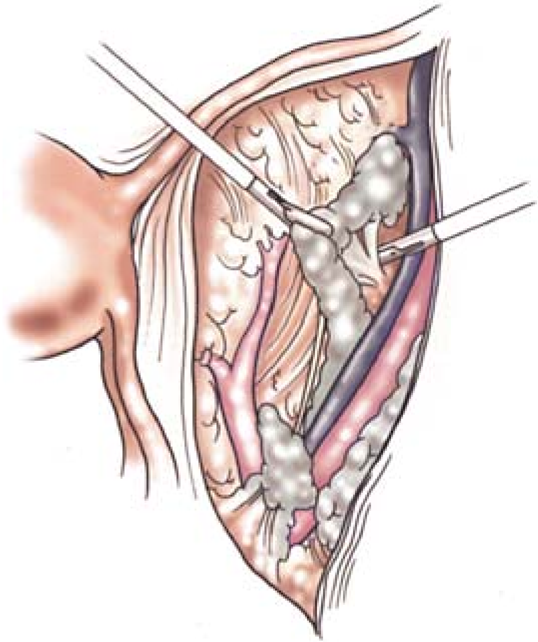


Figure 40

Obturator node removal

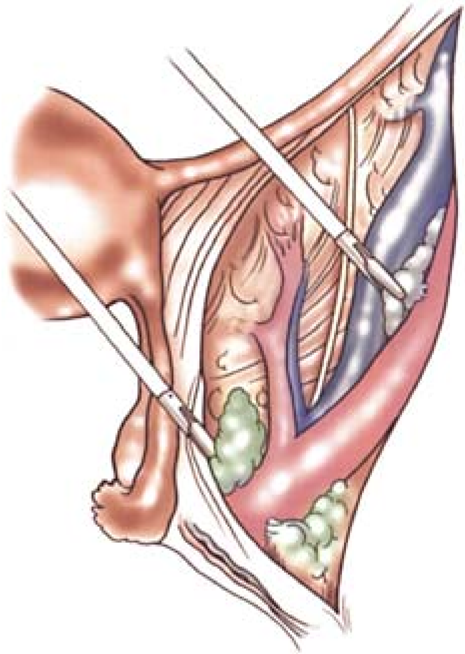


Figure 41

Interiliac-external iliac node removal

17
Bowel surgery

Eileen M Segreti

Charles Levenback

Introduction

The intestine is vulnerable to injury and obstruction as a result of involvement by gynecologic malignancies. Intestinal injury may also complicate the successful surgical or radiotherapeutic treatment of these diseases. This chapter focuses on common surgical procedures performed by gynecologic oncologists on the gastrointestinal tract during the management of gynecologic malignancies.

Small bowel surgery

Indications

Small bowel resection is often necessary to remove obstructed, perforated or tumor-infiltrated intestine. Resection of the involved small bowel is preferred; however if this is not feasible, a small bowel bypass may be necessary. For instance, bowel bypass may be necessary when the involved small bowel is densely adherent to a fibrotic area in an irradiated pelvis. In addition, a bypass procedure may be considered to palliate an intestinal obstruction in a woman with refractory ovarian cancer and a short life expectancy.

Anatomic considerations

The small bowel begins at the pylorus and ends at the cecum. The overall length averages 620 cm, and the normal range is 365–720 cm. The duodenum and jejunum are separated by the ligament of Trietz. The distinction between the jejunum and the ileum is more gradual. The small bowel is perfused by straight vessels that disperse into the anterior and posterior surfaces of the bowel. The straight vessels (vasa recta) emerge from the arcades of the superior mesenteric artery. In the ileum the straight vessels are surrounded by fat, which encroaches upon the bowel wall. In the jejunum, the vasa recta are more easily seen, as the mesenteric fat ends before it reaches the jejunal serosa. The venous drainage of the small bowel is to the superior mesenteric vein which is a tributary of the portal vein.

The autonomic nervous system, in conjunction with the gastrointestinal hormonal system, regulates peristalsis and bowel secretory action. The parasympathetic ganglia lie within the bowel wall, whereas the sympathetic ganglia lie close to the origin of the superior mesenteric artery

The small intestine has four layers. They are the mucosa, the submucosa, the muscularis and the serosa. The mucosa contains villi and crypts which greatly increase the absorptive surface area. The submucosa is a

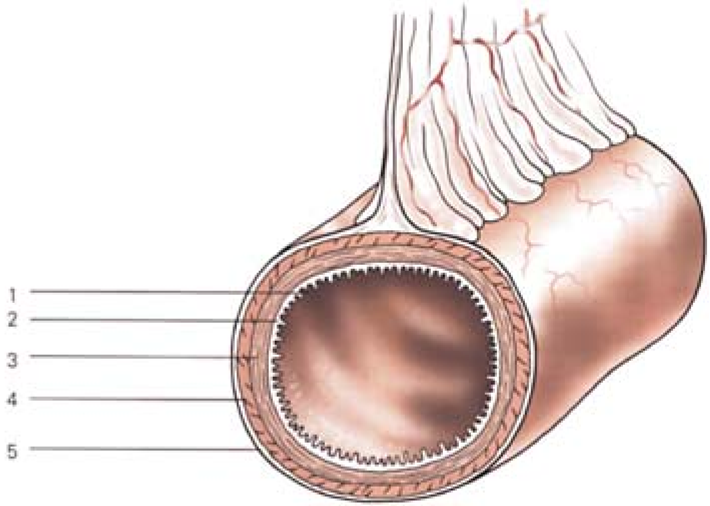


Figure 1

Layers of the small intestine

1 Mucosa

2 Submucosa

3 Inner circular muscle

4 Outer longitudinal muscle

5 Serosa

strong connective tissue layer important for structural integrity. It is especially vital to include this layer during bowel reanastomosis. The muscularis consists of an inner circular layer and an outer longitudinal layer. The serosa is the outermost layer and is a continuation of the mesothelium that lines the peritoneal cavity (Figure 1).

The terminal ileum is the site of absorption of the fat-soluble vitamins A, D, E and K, as well as vitamin B12. Extensive resection of the terminal ileum will necessitate vitamin supplementation. Every effort should be made to preserve as much bowel as possible. Severe malabsorption problems will occur if less than 200 cm is conserved.

Operative procedure

Resection

Small bowel resection, to be successful, must completely remove the damaged or involved intestinal segment. Intestinal continuity must then be re-established using healthy ends of bowel which are approximated without tension while maintaining a good blood supply. Tissues should be handled gently, and a watertight anastomosis should be achieved. If not precluded by complete or advanced small bowel obstruction, a mechanical and antibiotic bowel preparation should be administered to decrease the chance of infection or anastomotic breakdown.

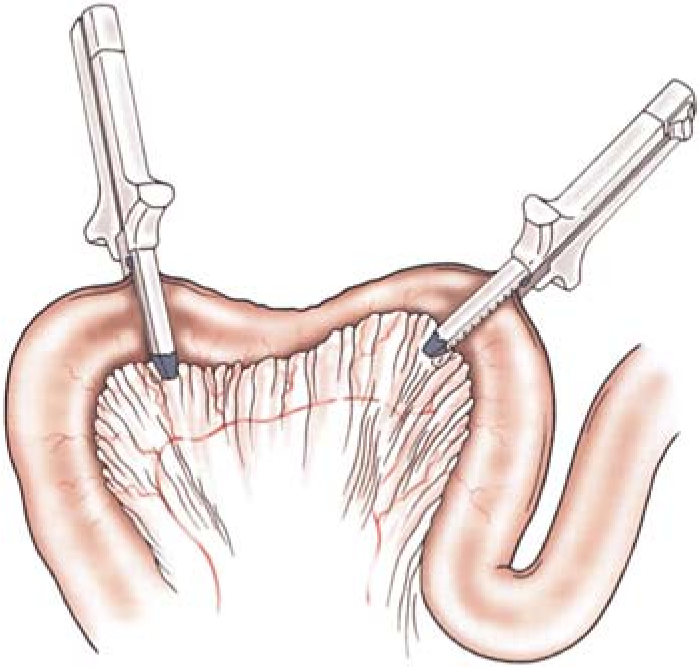


Figure 2

Positioning of clamps

There are several different methods of performing small bowel reanastomosis. Automatic gastrointestinal staplers can be used, or the anastomosis can be entirely hand-sewn. The damaged or obstructed portion of the small bowel is identified. The vascular arcades are visualized by transillumination. Rubber- or linen-shod, noncrushing intestinal clamps or Penrose drains can be used to occlude the bowel lumen on either side of the site of resection. A small defect is created in the mesentery proximal and distal to the affected bowel. Either staplers or bowel clamps are used to isolate the abnormal section of small intestine. The stapler or clamps are oriented obliquely to maximize the mesenteric side of the bowel and minimize the antimesenteric side (Figure 2). This maneuver will also create a larger lumen, thereby decreasing the chance of a subsequent stricture. The mesentery is scored with scissors or an electrocautery device, and the vessels are isolated between small clamps. The vessels are cut and secured with 2–0 sutures or a stapler such as the ligate-divide-staple (LDS) device.

Commonly, staplers are used to create a side-to-side, functional end-to-end, anastomosis. The ends of the small bowel are juxtaposed and inspected for viability. If there is any doubt as to bowel viability, the bowel is excised further until quality is acceptable. The anastomosis must be tension-free. The loops are mobilized as necessary to relieve any tension. The antimesenteric borders are lined up in parallel. Stay sutures are placed 5–8 cm from the closed bowel ends along the antimesenteric border. The corners of the antimesenteric staple line are then excised (Figure 3). This allows one arm of the stapler to be placed along the antimesenteric border of each limb of bowel (Figure 4). The stapler is closed and fired to place two double rows of titanium staples and incise an opening between the limbs (Figure 5). The staple line is then inspected for bleeding. Any bleeding area should be reinforced with an interrupted suture. Next, the remaining defect is grasped with Allis clamps and a thoracoabdominal (TA) stapler is set and fired to close

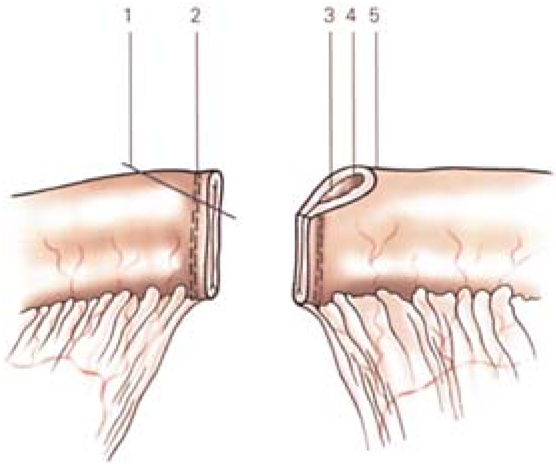


Figure 3

Preparation for anastomosis

1 Incision

2 Staple line

3 Bowel lumen

4 Mucosa

5 Serosa

the remaining enterotomy. The staple lines should overlap to prevent leakage at the anastomosis (Figure 6). Excess tissue above the TA stapler can be excised.

The small bowel can also be anastomosed end-to-end with a single or double layer of sutures. If the bowel lumens are of disparate sizes, an antimesenteric incision parallel to the length of the bowel can be made in the smaller lumen (Cheatle slit) to equalize the lumen sizes (Figure 7). If two layers are used, the inner layer is a continuous inverted layer of absorbable suture, and the outer layer is a series of interrupted, inverting silk seromuscular sutures. In a single-layer closure, either a continuous inverted or an interrupted inverted single-layer technique may be used (Gambee et al 1956). In the Gambee technique, 3–0 sutures are placed from the mucosa through the bowel wall to the serosa and back through serosa to mucosa. The knots are tied on the mucosal side, and the sutures are placed 3 mm apart. The last sutures should be held until all the sutures are placed. The last few knots must be tied on the serosal surface (Figure 8). Closure should be secure enough to prevent seepage of liquid. The mesenteric defect is then closed to prevent an internal hernia and subsequent bowel strangulation, without mesenteric vessel ligation.

A diseased terminal ileum may require extensive resection with ileoascending or ileotransverse enterocolostomy in an effort to avoid an anastomosis with irradiated tissues (Hoskins et al, 1987). An ileoileoenterostomy should probably be avoided within 10 cm of the cecum. The blood supply in this area may be marginal.

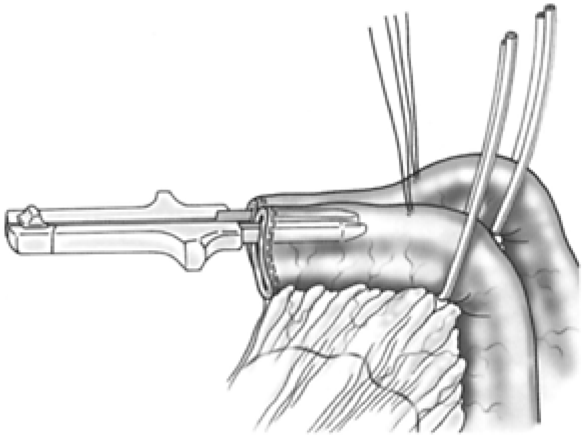


Figure 4

Positioning of stapler

Bypass

An alternative to small bowel resection is small bowel bypass, whereby an abnormal segment of bowel is bypassed by creating an anastomosis proximal to the abnormal area. This allows intestinal contents to progress beyond an area of obstruction. A side-to-side enteroenterostomy is created, using either staplers or a double- or single-layer suture technique (Figure 9). This procedure would leave the damaged loop adherent to the underlying viscera, yet still open to drain into the fecal stream. Alternatively, the bowel is divided proximally and distally to the damaged segment, and the damaged bowel is completely excluded from the intestinal stream. The proximal end of the bypassed limb is brought up to the skin as a mucous fistula. The distal limb should be transected immediately after the obstructed, adherent end to prevent a closed loop. The mucous fistula may be incorporated into the inferior aspect of the incision. A disadvantage of bowel bypass is that it may subsequently foster a blind loop syndrome as the disease process worsens. This syndrome is characterized by bacterial overgrowth with subsequent cramps, diarrhea, anemia and weight loss (Schlegel and Maglinte 1982). If a small bowel fistula is bypassed, it is important to isolate this bowel segment completely from the intestinal stream. A third option is to divide the bowel proximally to the damaged area and create an anastomosis distally.

Large bowel surgery

Indications

Partial colectomy, rectosigmoid resection and abdominal perineal resection are all used to treat gynecologic malignancies. These procedures may be integral to ovarian cancer debulking or treatment of radiation complications, or from a component of pelvic exenteration for cervical, endometrial, vaginal or vulvar cancer. If the sphincter or distal rectum is damaged or involved with tumor, a colostomy may be required to provide fecal continence. Stoma formation is required for either permanent or temporary fecal diversion. End colostomies are typically preferred for permanent stomas, as they are smaller and prone to fewer complications (Segreti et al 1996). Loop colostomies are preferred when stomal closure is anticipated or

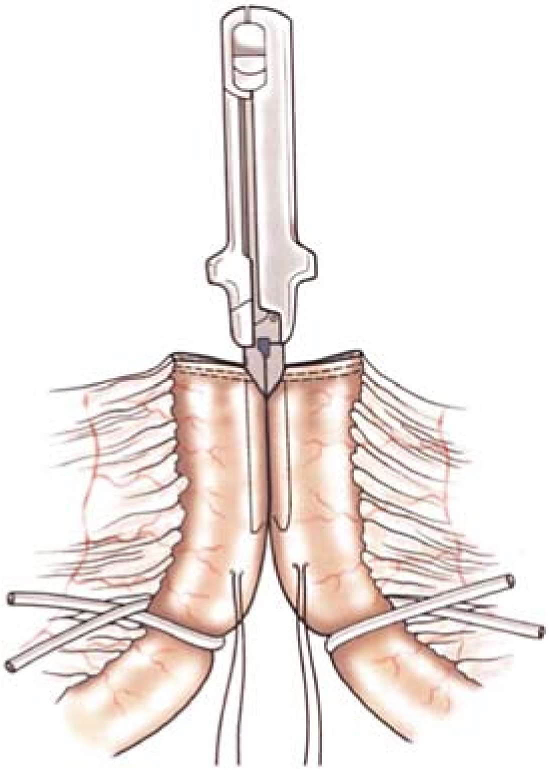


Figure 5

Stapling

large bowel obstruction occurs secondary to advanced, refractory ovarian cancer, and life expectancy is short. After a colostomy has served its purpose, allowing a distal anastomosis to heal or a fistula to be repaired, intestinal continuity is restored by closing the colostomy. Lastly, removal of the appendix may be useful in ovarian cancer debulking or urinary conduit construction, or to serve as prophylaxis against future infectious or neoplastic complications.

Anatomic considerations

The blood supply to the colon and rectum is derived from branches of the superior mesenteric, inferior mesenteric and internal iliac arteries. The right colon is supplied by the ileocolic artery, the right colic artery and a branch of the middle colic artery. The transverse colon is chiefly supplied by the middle colic artery, but there is a communication with the inferior mesenteric arterial system via the marginal artery of Drummond. The inferior mesenteric artery supplies the colon from the splenic flexure to the proximal rectum. The inferior mesenteric artery branches into the superior rectal artery, the sigmoidal arteries and the left colic artery. The distal rectum receives its blood supply from the paired middle and inferior rectal arteries which originate from the internal iliac artery system (Figure 10).

The appendix is the embryologic continuation of the cecum. Its location is identified by the confluence of the three taenia of the cecum. The position of the appendiceal tip relative to the cecum may vary. The tip

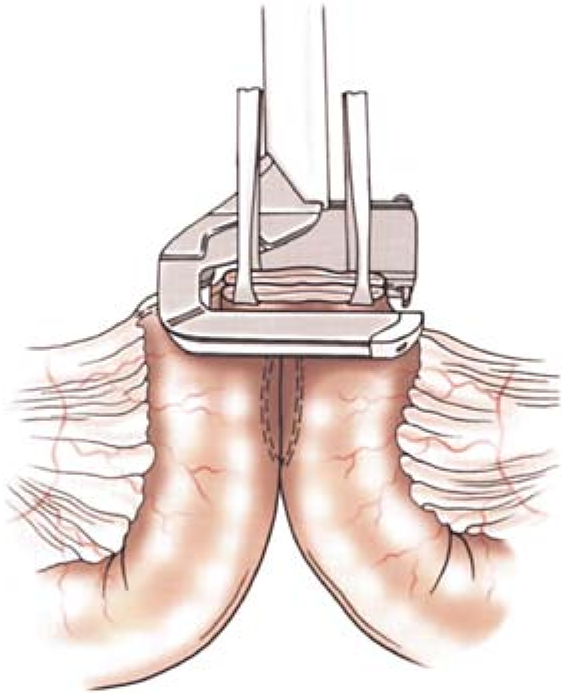


Figure 6

Positioning of thoracoabdominal stapler

may be found lateral to, medial to or behind the cecum. The mesentery of the appendix passes behind the terminal ileum. The blood supply to the appendix is derived from the appendiceal artery, which is a branch of the ileocolic artery.

The nerves to the colon parallel the blood supply, and consist of sensory afferent nerves and motor nerves from the autonomic system. The anal sphincter is under voluntary motor control. The colonic wall is more muscular than that of the small bowel. In addition, the longitudinal muscles are gathered in three places to form the taenia coli. The colon also has numerous fatty appendices epiploicae that hang from the taenia.

Operative procedures

The colon contains much more infectious material than the small bowel, and a thorough mechanical and antibiotic bowel preparation is very important prior to large bowel surgery. The principles of large bowel resection and reanastomosis are similar to those for small intestinal anastomosis and are based on the blood supply and the location of the diseased segment. Resection and reanastomosis of the colon and proximal rectum are performed equally well with either a hand-sewn or a stapled technique. For the distal rectum, the automatic end-to-end anastomosis circular stapling device has provided the ability to perform successful low and very low rectal anastomoses. Adequate mobility of the rectosigmoid must be achieved by incision along the lateral peritoneal reflection. The two ends of the bowel to be anastomosed must be mobile enough to lie adjacent to each other without tension. The largest stapling device that fits comfortably should be used. Sizers are available to measure the lumen. After resection of the diseased large bowel, a purse-string suture

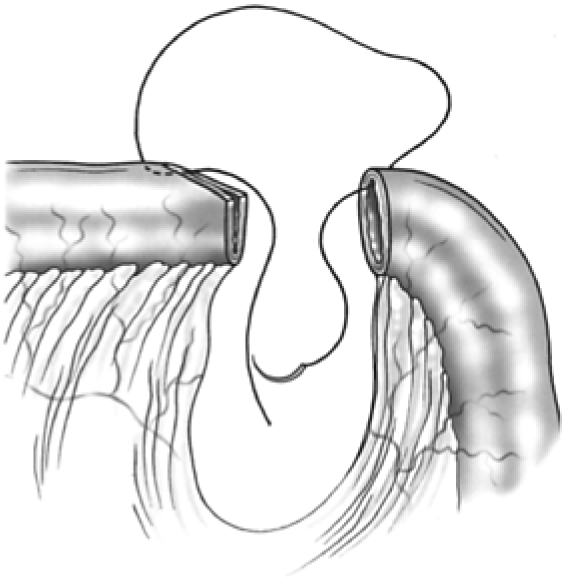


Figure 7

End-to-end anastomosis

is placed around the proximal lumen. This is easily performed with the purse-string instrument and a straight needle. The purse-string suture is then secured around the anvil of the stapler (Figure 11). The rectal stump can similarly be circumscribed with a purse-string suture. Alternatively, a stapler can be used to close the rectal pouch. A trocar attached to the stapler is used to puncture the closed rectal pouch at the site of the future anastomosis. The trocar is then removed, and the anvil shaft can be inserted into the stapler instrument. By turning the wing nut on the stapler handle, the two lumens are approximated. After releasing the safety catch, the handle is squeezed and two circular rows of staples are placed. A circular knife cuts the excess inverted tissue, and two 'donut' shapes are created. The wing nut is then turned in the opposite direction to open the instrument which is then withdrawn gently through the rectum. The two 'donuts' of tissue should be inspected and be complete (Figure 12). A defect in one of them is reason to redo or repair the anastomosis. The seal of the anastomosis can be tested by filling the pelvis with saline and injecting air into the rectum. Bubbles indicate an air leak that should be oversewn. The anastomosis can also be visually inspected with a sigmoidoscope.

Hand-sutured colonic anastomoses have classically been formed of two layers in the tradition of Lembert and Halsted. The two-layer closure consists of a running inverted layer of 3–0 chromic or polyglactic acid suture, followed by an outer layer of interrupted 3–0 silk Lembert sutures. Recently several investigators have reported using a one-layer inverting colonic closure with satisfactory results (Curley et al 1988, Max et al 1991, Ceraldi et al 1993). One-layer closures are faster than the two-layer technique and less expensive than the stapled closure. The single-layer closure is performed with 3–0 or 4–0 polypropylene or polyglyconate suture using a double-armed needle. The suture is begun at the mesenteric border of the bowel (Figure 13). The sutures are placed from outside in, including a larger amount of the serosa, muscularis and submucosa (approximately 5 mm) than the mucosa (minimal) to effect mucosal inversion.

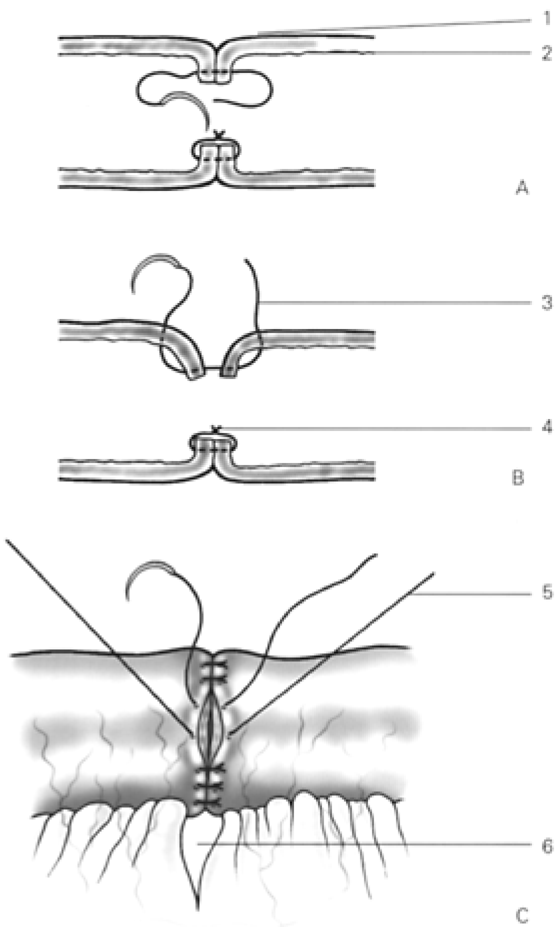


Figure 8

The Gambee technique

1 Serosa

2 Mucosa

3 Last suture

4 Lumen

5 Inverting suture held until all sutures in place

6 Defect to be dosed without vessel compromise

The knot is secured outside the bowel lumen. Each end of the suture is then continued around to the antimesenteric border, spacing the stitches 3–4 mm apart. The sutures are then tied together.

The thoracoabdominal stapler can also be used to create an end-to-end anastomosis by triangulation (Figures 14–19). Three stay sutures are placed equidistantly on each limb of the bowel. One stay suture should be located at the level of the mesentery, and the other two stay sutures should be placed to form an

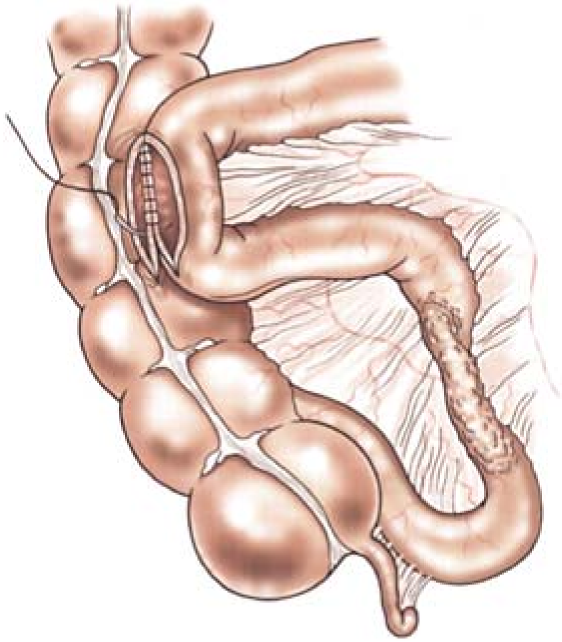


Figure 9

Side-to-side enterocolostomy

equilateral triangle. The back wall is stapled first, and the mucosa is inverted. The second row of staples is placed to overlap the first row. The last row of staples is placed, and the mucosa is everted. The diameter of the lumen is palpated to ensure adequate size.

The patient should meet with an enterostomal therapist for preoperative teaching and evaluation of the abdominal wall for stomal placement. Stomas should ideally pass through the rectus muscles and avoid abdominal wall folds or creases (Figure 20). The patient should be examined in both the sitting and standing position. Stoma placement in the waistline should be avoided. Obese patients have a significant amount of skin movement with position changes from supine to erect. This skin travel and the degree of tension it may place on the stoma in different positions must be considered when planning the stoma site.

A vertical laparotomy incision helps to provide adequate exposure. Prior to dividing the colon, the bowel is mobilized by dividing the lateral peritoneal attachments; adequate mobility must be achieved to provide a tension-free stoma. The distal bowel is resected or oversewn as a pouch. A 3 cm circular skin button is removed at the previously marked site. The subcutaneous tissues are bluntly separated. The anterior rectus sheath is incised in a cruciate fashion. The rectus muscles are split longitudinally with care taken to avoid the inferior epigastric vessels. The peritoneum is then incised and two fingers are passed through the abdominal wall. The stapled bowel end is grasped with a Babcock clamp and brought through the stomal aperture. Care is taken not to twist the mesentery. Excess fat and mesentery are trimmed from the stoma. The mesentery can be fixed to the parietal peritoneum to prevent internal herniation. The abdominal incision is then closed. The staple line on the bowel is excised, and the stoma is matured in a ‘rosebud’ fashion by inserting the needle into the skin 1 cm from the stomal edge, then running it up the bowel serosa and

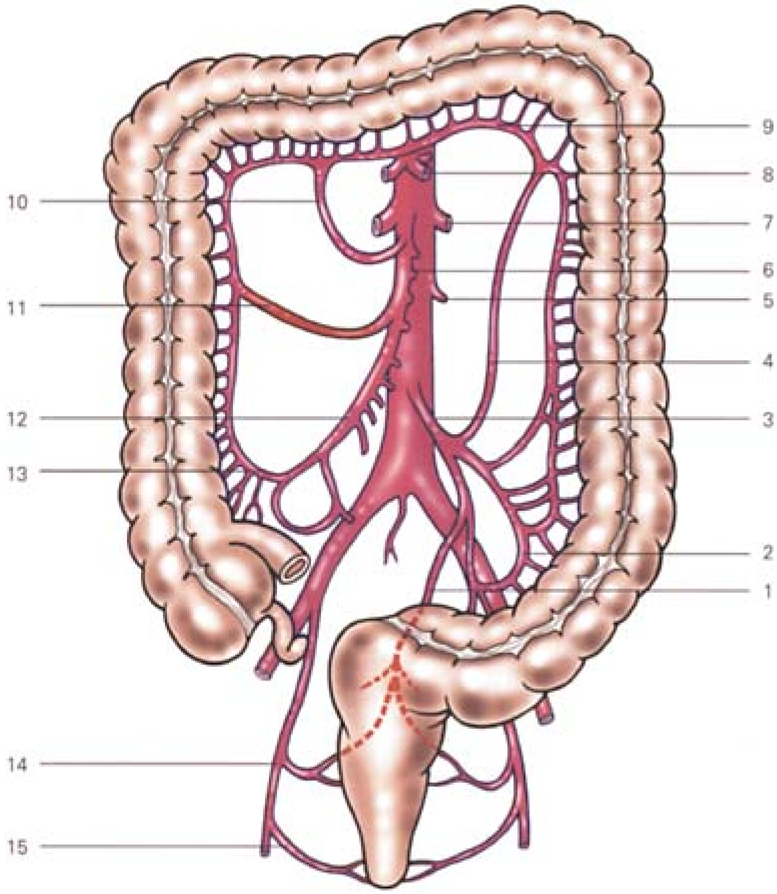


Figure 10

Blood supply to the colon and rectum

1 Superior rectal artery

2 Sigmoid artery

3 Inferior mesenteric artery

4 Left colic artery

5 Ovarian artery

6 Superior mesenteric artery

7 Renal artery

8 Coeliac trunk

9 Marginal artery

10 Middle colic artery

11 Right colic artery

12 Ileojejunal artery

13 Ileocolic artery

14 Middle rectal artery

15 Inferior rectal artery

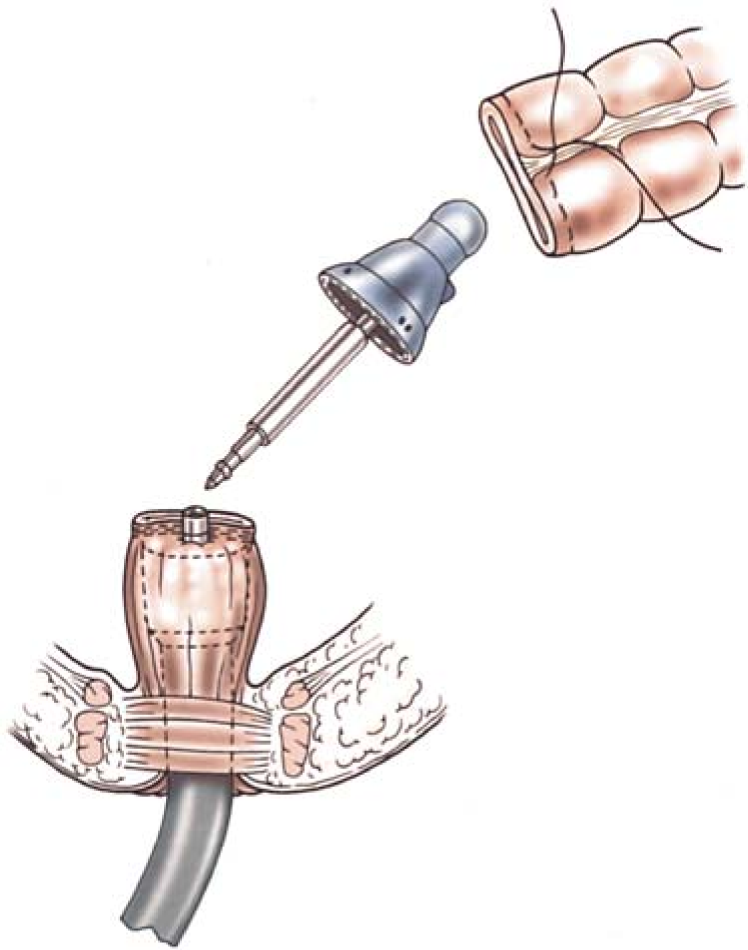


Figure 11

Positioning of purse-string suture

muscularis for one or two stitches, exiting on the mucosal side and securing the knot over the mucocutaneous junction (Figure 21).

A loop colostomy may be situated at either the proximal or distal transverse colon. If a loop colostomy is performed for palliation of large bowel obstruction secondary to advanced, refractory ovarian cancer, the distal transverse colon may be selected to maximize colonic length. However, if the purpose is to create a temporary diverting colostomy while an anastomosis heals, the proximal transverse colon is usually preferred. A 10–12 cm transverse skin incision is made in the right or left upper quadrant. The fascia is incised transversely, and the rectus muscles are separated longitudinally. The peritoneal cavity is entered sharply. When a large bowel obstruction is present, the transverse colon is easily identified owing to its dilatation. The adjacent omentum is dissected off the loop of colon. A defect is created in the mesentery to allow passage of a thin rubber drain, such as a Penrose, with which to lift and manipulate the colon. The fascial incision is then partially closed. A flat plastic bridge is passed through the mesenteric defect and

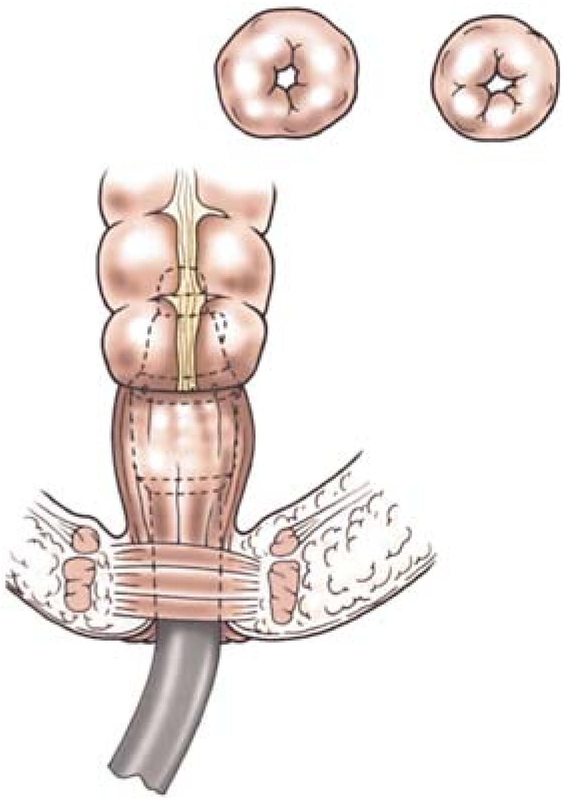


Figure 12

Two intact ‘donuts’ of tissue

secured to the skin with a nylon suture. The skin incision, if larger than needed for the stoma, may be partially closed with skin staples or non-absorbable sutures. The colon is then opened either longitudinally along the taenia, or at a transversely oriented angle. The bridge may be removed in 7–10 days (Figure 22).

A loop stoma is closed by incising the skin adjacent to the mucocutaneous junction, elevating the stoma with Allis clamps, and dividing the filmy attachments to the subcutaneous tissues. The fascial edge is then identified, and the plane sharply developed between the stoma and the fascial opening. The peritoneal adhesions are then lysed. The stomal edge can then be excised, and an extraperitoneal one- or two-layer closure can be performed. The loop is then dropped back into the peritoneal cavity and the fascia closed with delayed absorbable suture. The skin defect can be packed open and left to close secondarily, or alternatively staples can be used for immediate skin closure (Hoffman et al 1993).

Another option to close a loop colostomy is to use the thoracoabdominal stapler. After incision of the mucocutaneous junction, the edges of the stoma are grasped with Allis clamps. The colostomy edges are held together to form a line perpendicular to the long axis of the bowel: this will maximize the lumen diameter. The stapler is fired, and the excess tissue is excised as described above.

To close an end stoma, an exploratory laparotomy is usually needed to identify the distal limb and create a large bowel anastomosis. Laparoscopy may alternatively be used and an extraperitoneal closure effected, if the distal limb is nearby and can be mobilized adequately. The end stoma is excised in a similar

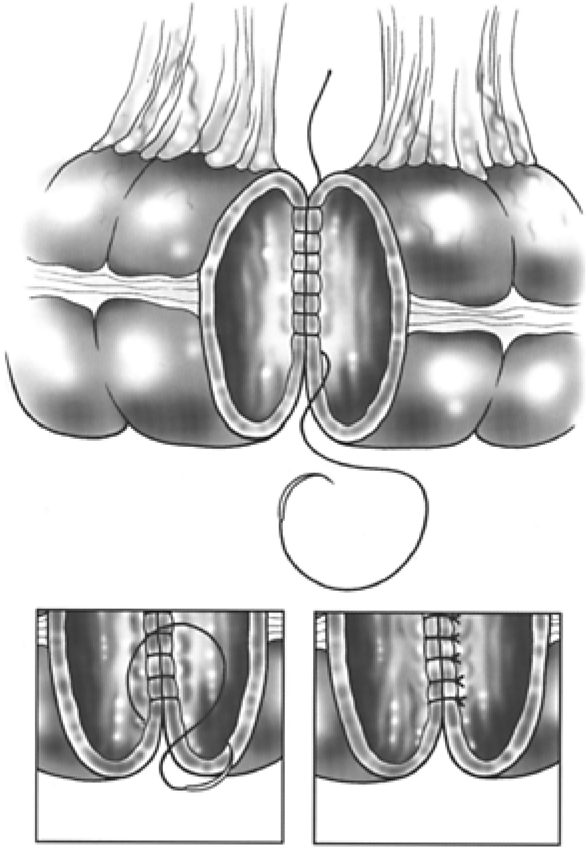


Figure 13

Single-layer anastomosis, with (inset left) continuous sutures and (inset right) interrupted sutures

manner to that described for a loop stoma. The mucocutaneous junction of the distal end is excised. A large bowel anastomosis is performed as previously described. Mesenteric defects are closed to prevent internal hernias.

Appendectomy is accomplished by isolating and ligating the blood supply to the appendix and closing or burying the stump of the appendix to prevent fecal spillage. If present, filmy adhesions from the appendix to the peritoneal surfaces are lysed. If the appendix is retrocecal, the cecum is mobilized by incising the peritoneal reflection. The appendiceal artery is isolated, doubly clamped, ligated and secured with 2–0 suture. The base of the appendix is then crushed between two straight hemostats. The specimen is excised between the hemostats, and the stump tied off with 2–0 suture (Figure 23). Alternatively, the ligated stump can be buried into the cecum with a Z stitch or purse-string suture. However, burial into the cecum may promote a mucocele or an abscess. Another approach after dividing and securing the appendiceal artery is to remove the appendix using the stapling device.

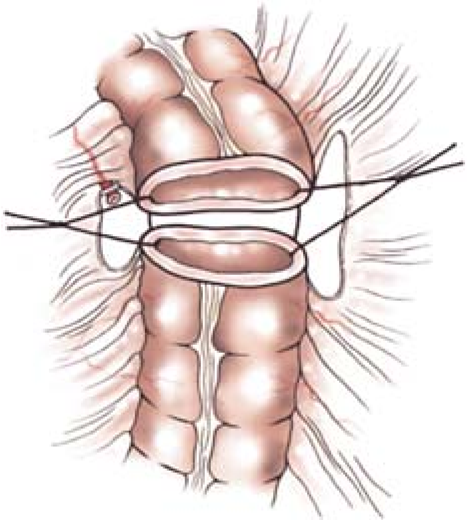


Figure 14

End-to-end anastomosis by triangulation

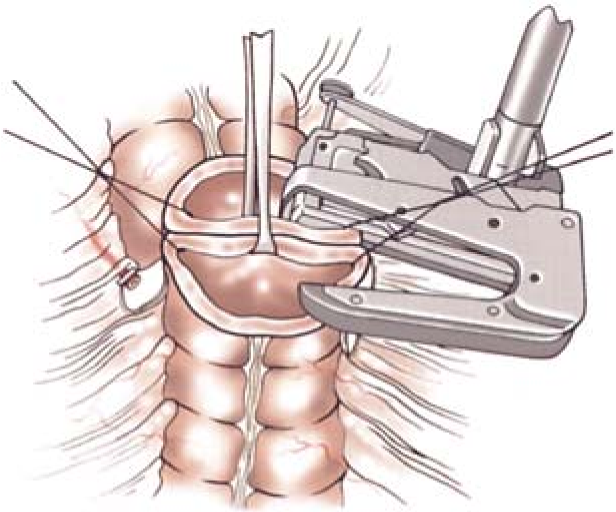


Figure 15

The posterior wall is stapled first

Enteral feeding and drainage procedures

Indications

Gastrostomy tubes are useful for drainage and decompression of the stomach and the small bowel, if a prolonged ileus is anticipated. Patients with end-stage ovarian carcinoma and small bowel obstruction may

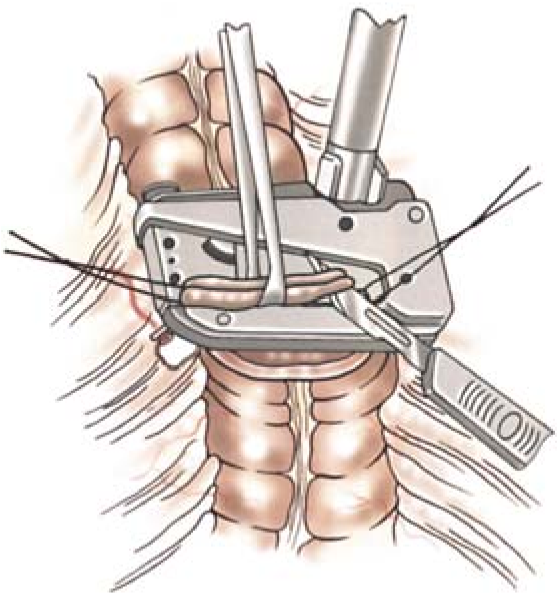


Figure 16

Excise the excess tissue

benefit from palliative gastrostomy tube placement. Gastrostomy tubes may also be used for postoperative enteral nutrition.

A needle jejunostomy can be used to provide enteral nutrition postoperatively. Tube jejunostomy is sometimes indicated to decompress or stent the small bowel.

Anatomic considerations

The blood supply to the stomach is derived from the celiac trunk. The greater curvature of the stomach is supplied by the right and left gastroepiploic arteries. The lesser curvature is supplied by the right and left gastric arteries. The right gastric artery and the right gastroepiploic artery are branches of the common hepatic artery. The left gastric artery is a branch of the celiac trunk, and the left gastroepiploic artery is a branch of the splenic artery. Routes of venous drainage include the gastric and gastroepiploic veins as well as small tributaries of the esophageal veins.

Operative procedure

Gastrostomy tube placement

Gastrostomy tubes can be placed percutaneously with endoscopic guidance or can be placed at the time of laparotomy. The stomach should be mobile enough to reach the anterior abdominal wall. At laparotomy, a specialized gastrotomy tube, or a Malecot, self-retaining flanged rubber urologic tube can be placed into the abdominal cavity via a left upper quadrant stab incision in the midclavicular line.

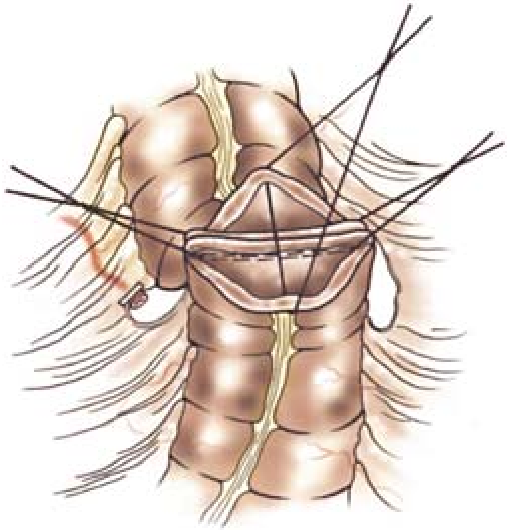


Figure 17

Place traction suture midway

Two concentric purse-string sutures of delayed absorbable material are placed in the anterior stomach seromuscular wall approximately 1 cm apart. Electrocautery is used to create an opening in the wall through which the Malecot tube is placed into the stomach. The inner purse-string suture is tied first, then the outer one, creating an inverted tunnel (Figure 24). Three or four interrupted 2–0 delayed absorbable sutures are placed to approximate the stomach to the anterior abdominal wall. After the abdomen is closed, the tube is secured to the skin with a nylon suture. If the tube is subsequently dislodged, it can often be immediately replaced through the gastrocutaneous fistula.

Needle jejunostomy

Needle jejunostomy is a useful method of providing enteral nutrition postoperatively. The technique entails creating an intramural tunnel in the jejunal wall, through which a catheter is placed into the lumen of the bowel. A purse-string suture 1 cm in diameter is placed but not tied in the antimesenteric side of the jejunum at least 12 cm from the ligament of Trietz. A mobile loop of jejunum that easily reaches the abdominal wall is chosen. A 5 cm long 14 gauge needle is inserted through the purse-string into the seromuscular layer for the entire length of the needle. The needle is then directed into the bowel lumen, and the feeding catheter and stylet are threaded through the needle. The needle is then removed. The catheter is advanced into the bowel for 20–25 cm and the stylet is removed. The purse-string suture is tied. Another 14 G needle is placed through the skin at an oblique angle similar to the angle of the catheter exiting from the bowel. The catheter is then pulled through the needle. The jejunum is fixed to the anterior abdominal wall with 2–0 silk suture to prevent dislodgement of the catheter. Similarly, the catheter is fixed to the skin to prevent kinking. Catheter position may be confirmed intraoperatively by injecting 10 ml of air and observing its passage into the jejunum. Radiographic confirmation of intraluminal tube placement can be achieved using water-based contrast. A low-viscosity elemental amino acid diet is used to prevent clogging of the needle jejunostomy tube. When jejunal feeding is no longer necessary the tube is removed percutaneously.

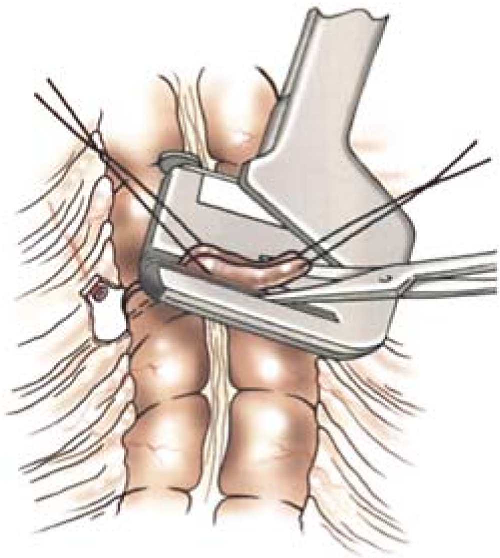


Figure 18

Excise redundant tissue after stapling

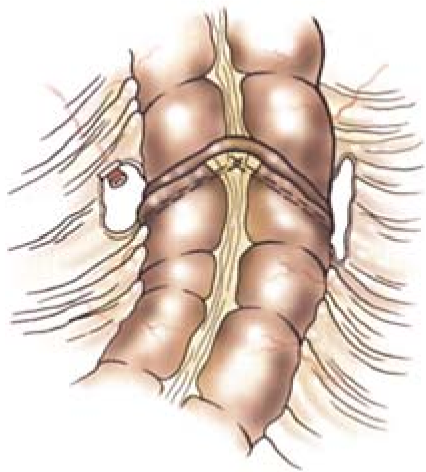


Figure 19

Completed reanastomosis

Baker tube jejunostomy

A tube jejunostomy can be utilized for intraoperative small bowel decompression as well as postoperative small bowel stenting to prevent obstruction. A Baker (International Hospital Products, Little Silver, NJ) tube jejunostomy is inserted at laparotomy using a modified Stamm technique similar to that used for gastrostomy tube placement. The Baker tube is placed in the abdominal cavity through a stab wound in the

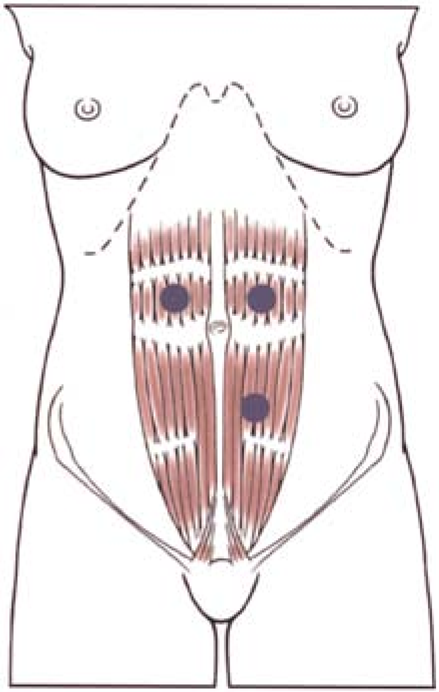


Figure 20

Ideal sites for stomas

abdominal wall. Two concentric purse-string sutures are placed in the antimesenteric edge of a mobile loop of jejunum. The balloon is inflated, and the tube is manually passed into the distal small bowel, through the ileocecal valve and into the ascending colon. The small bowel is then situated in the peritoneal cavity to prevent obstruction. The purse-string sutures are tied to create an inverted tunnel. The bowel is secured to the parietal peritoneum with a suture. If a Baker tube is used for decompression, making extra holes in the tube will facilitate drainage.

Bibliography

Ceraldi CM, Rypins EB, Monahan M, Chang B, Sarfeh IJ (1993) Comparison of continuous single layer polypropylene anastomosis with double layer and stapled anastomoses in elective colon resections. *Am J Surg* **59:**168–71.

Curley SA, Allison DC, Smith DE, Doberneck RC (1988) Analysis of techniques and results in 347 consecutive colon anastomoses. *Ann Surg* **155:**597–601.

Gambee LP, Garnjobst W, Hardwick CE (1956) Ten years experience with a single layer anastomosis in colon surgery. *Am J Surg* **92:**222–7.

Hoffman MS, Gleeson N, Diebel D, Roberts WS, Fiorica JV, Cavanagh D (1993) Colostomy closure on a gynecologic oncology service. *Gynecol Oncol* **49:**299–302.

Hoskins WJ, Burke TW, Weiser EB, Heller PB, Grayson J, Park RC (1987) Right hemicolectomy and ileal resection with primary reanastomosis for irradiation injury of the terminal ileum. *Gynecol Oncol* **26:**215–24.

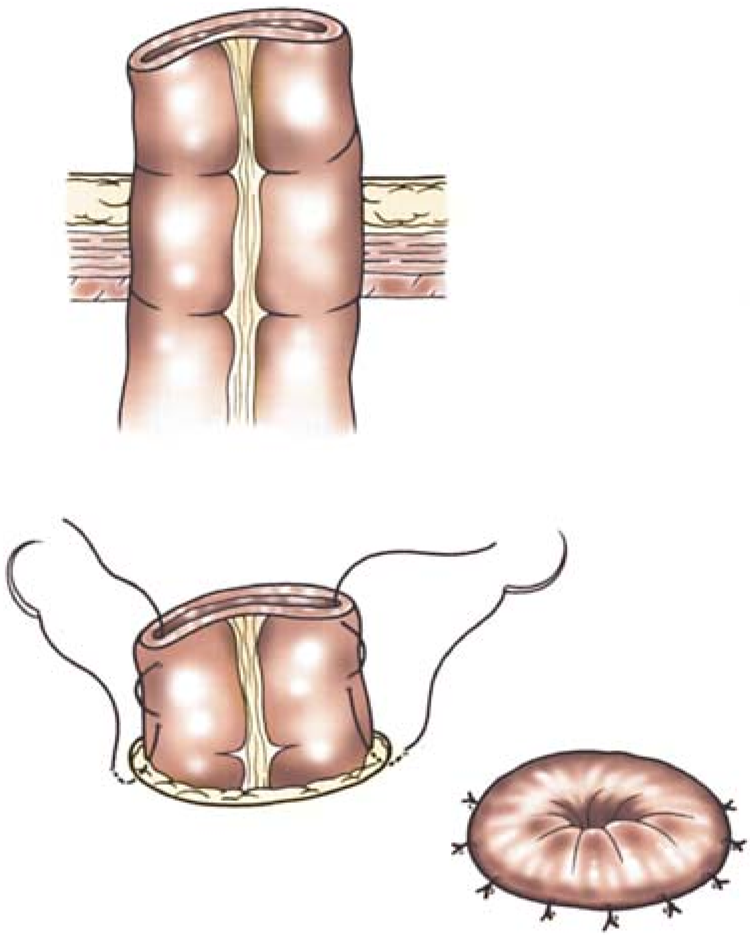


Figure 21

Maturation of the stoma in a ‘rosebud’ fashion

Max E, Sweeney WB, Bailey HR et al (1991) Results of 1,000 single-layer continuous polypropylene intestinal anastomoses. *Am J Surg* **162:**461–7.

Schlegel DM, Maglinte DDT (1982) The blind pouch syndrome. *Surg Gynecol Obstet* **155:**541–4.

Segreti EM, Levenback C, Morris M, Lucas KL, Gershenson DM, Burke TW (1996) A comparison of end and loop colostomy for fecal diversion in gynecologic patients with colonic fistulas. *Gynecol Oncol* **60:**49–53.

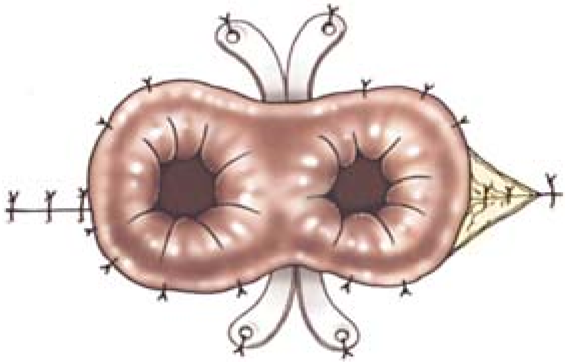


Figure 22

Use of a bridge in loop colostomy

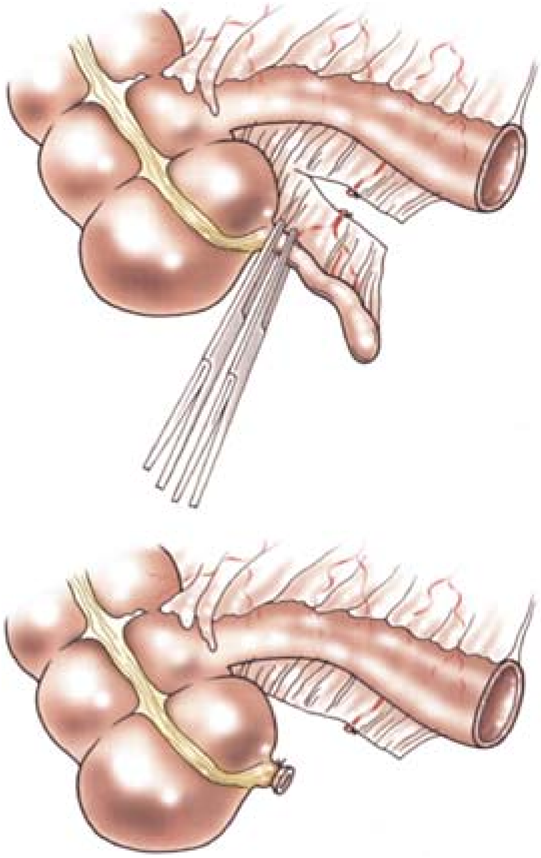


Figure 23

Use of hemostats in appendectomy

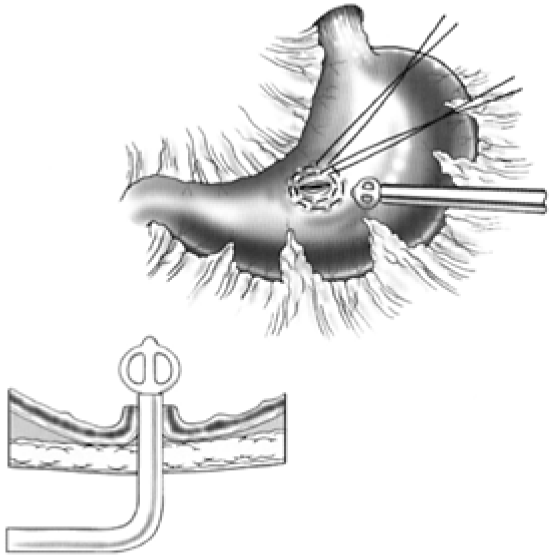


Figure 24

Gastrostomy tube placement

18
Urologic procedures

Jonathan A Cosin

Jeffrey M Fowler

Repair of ureteral injuries

Introduction

Ureteral injury occurs in 1–2% of all major gynecologic procedures. Pelvic irradiation, large pelvic tumors, endometriosis and the radicality of the procedures all increase the risk of damage. Ureteral obstruction can also occur as a result of any of the above processes, necessitating reimplantation. The underlying principles to be adhered to in repairing any ureteral injury are:

1. Adequate vascular supply.
2. Adequate surgical exposure.
3. Gentle tissue handling.
4. Tension-free suturing.
5. Placing the minimum number of sutures.
6. Stenting to allow the repair to heal.

Indications

The nature and extent of the injury, the overall health of the patient and the underlying disease process must all be considered when deciding upon the type of procedure to be performed.

Ureteroneocystotomy is the procedure of choice for injuries or obstruction within the pelvis at or below the level of the common iliac vessels. Bladder mobilization with a psoas hitch and/or bladder flap (Demel or Boari) may be required in order to yield a tension-free anastomosis. Ureteroneocystotomy is the preferred procedure where possible as the complication rate is lower than with ureteroureterostomy.

Ureteroureterostomy is required for injuries to the abdominal portion of the ureter when the proximal portion will not reach the bladder directly.

Anatomic considerations

Vascular supply

Bladder

The bladder receives its blood supply mainly from the superior and inferior vesical arteries, both of which are branches of the anterior division of the hypogastric artery. The obturator, uterine and vaginal arteries may all also send branches to the bladder.

Ureter

The ureter takes its blood supply from branches of major vessels which it courses near. This includes the aorta as well as the renal, ovarian, iliac (common and internal), vesical and uterine vessels.

Nerve supply

Bladder

The bladder is innervated by the vesical plexus which carries efferent and afferent autonomic fibers, both sympathetic and parasympathetic. The plexus arises from T11-L2 and courses through the base of the cardinal ligament.

Ureter

The renal (T9-T12), aortic (L1) and superior and inferior hypogastric (S2-S4) plexuses all contribute to the innervation of the ureter with autonomic fibers.

Muscles

Psoas

The psoas muscle originates from the anterior surface and lower borders of the transverse processes of the lumbar vertebral bodies and joins the iliac muscle to insert on the lesser trochanter of the femur. The muscle acts to flex the hip. It is innervated by fibers from L1-L3. Several important nerves are closely related anatomically to the psoas muscle. The iliohypogastric, ilioinguinal, lateral femoral cutaneous and femoral nerves all emerge from the lateral border of the muscle. The genitofemoral nerve arises anterolaterally and the obturator, accessory obturator and upper roots of the lumbosacral trunk all arise medially.

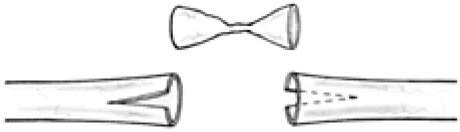


Figure 1

The injured segment is excised, ensuring that the ends to be approximated are well vascularized. Both ends are then spatulated to aid in preventing stenosis at the anastomosis site

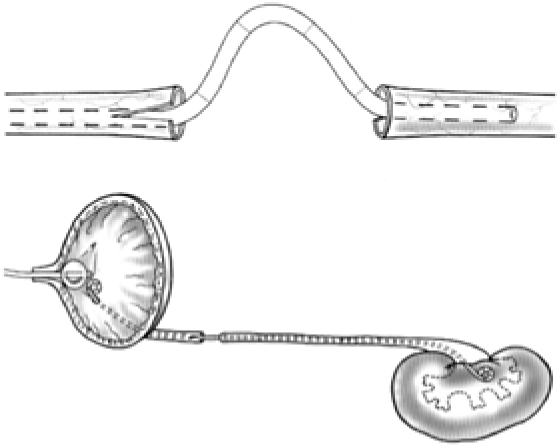


Figure 2

Repair should be stented for at least two to three weeks. An intravenous pyelogram or pull-back ureterogram is recommended prior to stent removal to ensure patency of ureter

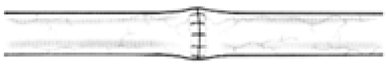


Figure 3

Ureteral repair is accomplished with four to six interrupted absorbable sutures

Operative procedure

Ureteroureterostomy

In cases of crush or similar injury, the injured ends of the damaged ureter are trimmed if necessary to reach viable bleeding tissues. This is generally not necessary for transection injuries. Each end is partially spatulated by making an incision of approximately 3–5 mm longitudinally in each ureter. These incisions should be 180° apart (Figure 1).

The ureter can be stented either by passing a stent through the injured ends towards both the bladder and the renal pelvis or by performing a cystotomy and passing a stent up through the ureter to the renal pelvis. This should be done before suturing the ureter. A closed suction drain should be placed in the operative field (Figure 2).

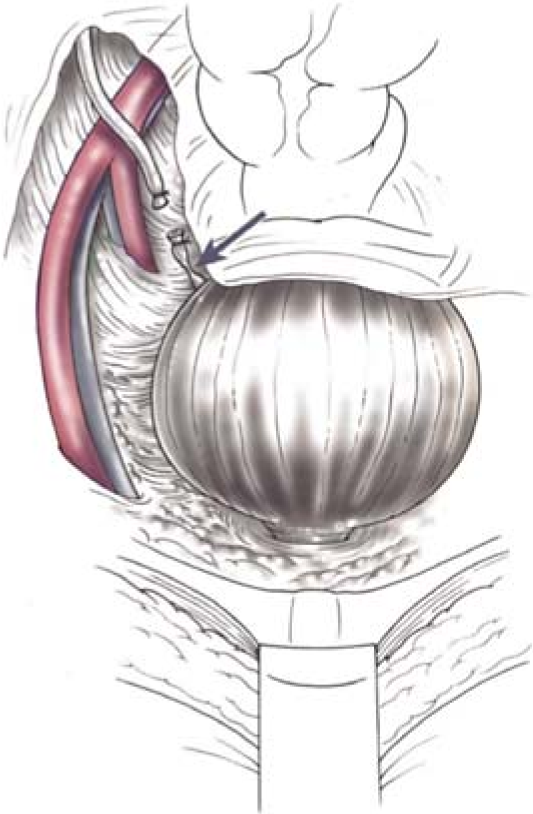


Figure 4

For ureteral injuries occurring in the pelvis, the ureter is divided and the distal end permanently ligated with non-absorbable suture

Interrupted 4–0 absorbable sutures (polyglycolic acid) are used to create the anastomosis. Care should be exercised to avoid tying the sutures too tightly or putting in too many sutures. Generally, four to six sutures are sufficient (Figure 3).

Ureteroneocystotomy with or without psoas hitch and bladder flap

In cases of crush injury or obstruction, ligate and divide the ureter as distally as possible, being mindful of the presence of fibrosis such as from radiation therapy. The distal stump is ligated with a permanent suture, such as 2–0 silk. If the ureter has been transected, the distal end should still be identified and ligated with a permanent suture. The proximal end is trimmed as necessary to ensure that the terminal ureter has adequate vascular supply to allow healing of the anastomosis. The ureter is also partially freed from its peritoneal attachments to provide mobility of the most distal segment. Care is taken to avoid disruption of the adventitial layer which carries the blood and nerve supply to the ureter (Figure 4).

If the ureter and the bladder can be placed in approximation without tension, then the surgeon may proceed with the anastomosis. Otherwise, an extending bladder flap may be necessary (see below).

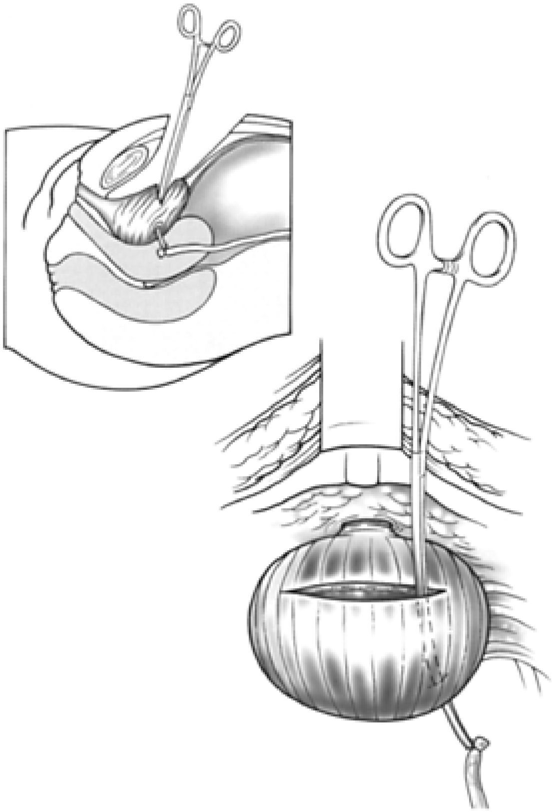


Figure 5

Working through an incision in the dome of the bladder, the ureter is brought through the bladder wall at a point that will ensure the most tension-free anastomosis

A longitudinal extraperitoneal incision is made in the dome of the bladder. At the conclusion of the repair, this is closed transversely to take further tension off the anastomosis. A finger or a long, curved instrument is then placed in the bladder to indicate the posterolateral position on the bladder that most closely approximates to the ureter, and a cystotomy is made at this point. The ureter is then brought through the incision (Figure 5).

The ureter is spatulated by making two 5 mm longitudinal incisions 180° apart (Figure 6). The angles of the incisions are sutured using 4–0 absorbable sutures (polyglycolic-acid) which are tagged with the needles left on. A 28–30 cm, 7 or 8 Fr single or double J is then passed up the ureter towards the renal pelvis.

The anastomosis is performed using 4–0 absorbable interrupted sutures which include the full thickness of the ureter, but only the mucosa and submucosa of the bladder (Figure 7). Generally six sutures are required, including the previously placed angle sutures. The cystotomy is then closed and a closed suction drain is placed in the area of the anastomosis. Closure may be accomplished with interrupted 4–0 absorbable sutures using through-and-through stitches. A second layer of 2–0 absorbable sutures should be placed incorporating the serosa and muscle but not the mucosa (Figure 8). Retrograde transurethral filling of the bladder should be performed to ensure a watertight seal. A two-layer running closure of the same layers is also acceptable. The ureteral stents may be removed in 2 weeks if a cystogram or intravenous pyelogram

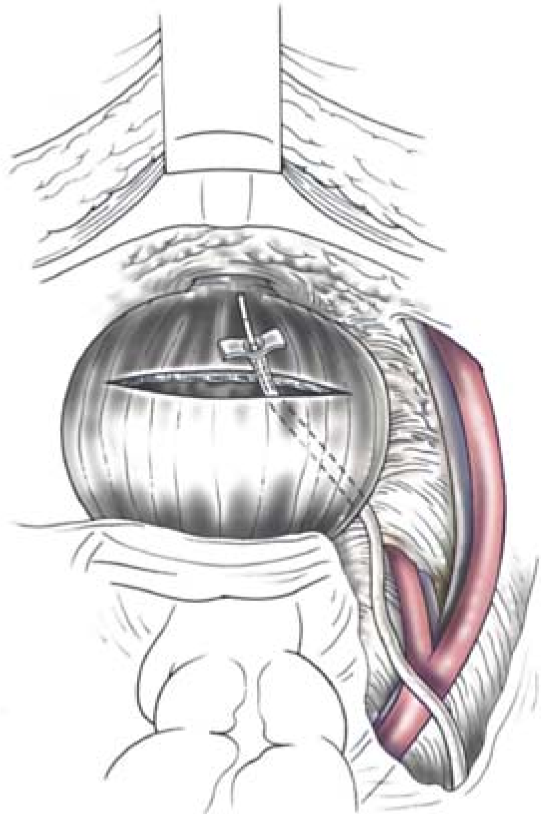


Figure 6

The ureter is spatulated and stented

demonstrates ureteral patency and no leaks. A follow-up intravenous pyelogram is recommended after 1 month to confirm patency, especially in patients who have received prior radiotherapy.

If the ureter and bladder do not approximate easily, then additional measures must be taken. Sufficient mobility of the bladder can often be obtained by developing the space of Retzius and dividing the anterior peritoneum and the lateral bladder attachments. The bladder can then be sutured to the psoas muscle to hold it closer to the ureter and to take up the tension that would otherwise be exerted on the repair. Use 2– 0 permanent suture, taking care to avoid damage to any of the nerves related to the psoas muscle.

In cases where still further mobility is required, an extending bladder flap such as those described by Boari (Figures 9–11) or Demel (Figures 12–14) may be used. The incisions are made and sutured as shown, resulting in the 'lengthening' of the bladder towards the ureter. Once this step is complete, the anastomosis is performed as described above.

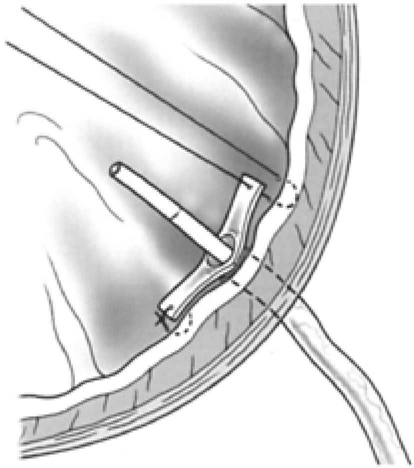


Figure 7

The anastomosis is created with interrupted absorbable sutures, full thickness through the ureter and partial thickness through the bladder

Urinary diversion

Introduction

Urinary diversion was first described in the mid 1800s. Many different tissues and techniques have been employed, each with their own inherent advantages and disadvantages. The major types now in use in gynecological practice are the intestinal conduits using either small or large bowel, and various versions of the ileocecal continent urinary reservoir.

Indications

In gynecology, most urinary diversions are performed as part of the reconstructive phase of a pelvic exenteration or because of severe irradiation injury to the bladder. The type of diversion employed depends on the surgeon’s preference, the patient’s overall health, the prognosis and the patient’s ability to perform the tasks necessary to catheterize a continent pouch.

The ileal conduit is the simplest diversion to perform. Care must be exercised in patients who have undergone radiotherapy as the vascular supply to the conduit may be compromised. The patient must also wear an appliance at all times.

Colonic conduits have the benefit that the segment may be taken from anywhere along the length of the colon. Anatomically, the sigmoid is the easiest part as it is ideally located for a urinary conduit. Like the ileum, however, it can be affected by prior radiotherapy. The transverse colon conduit avoids this problem, but because it is located in the upper abdomen, it is more difficult to perform the ureteral anastomoses.

Continent urinary reservoirs have the chief advantage that the patient is not required to wear an appliance continuously. The patient must be able to self-catheterize at least four times a day and irrigate the reservoir as needed. This can be particularly difficult for visually impaired, obese or elderly patients. The pouch is also more technically difficult and timeconsuming to construct.

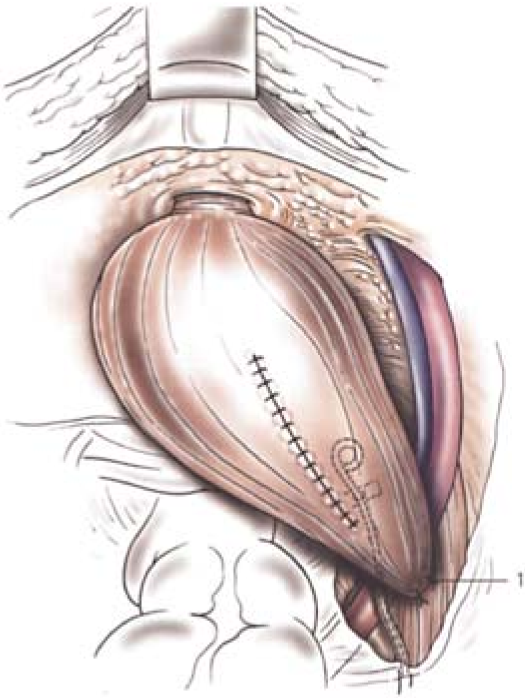


Figure 8

The cystotomy incision is closed. By making the incision transversely and closing longitudinally, the site of anastomosis can be brought closer to the ureter, thus relieving tension. A psoas hitch can then be performed (1; see text)

Anatomic considerations

Vascular supply

Ileum

The ileum receives its vascular supply from the ileocolic artery, which is a branch of the superior mesenteric artery (SMA). Collateral circulation is from the right colic artery, which is also a branch of the SMA. The terminal ileum is at particular risk of vascular insufficiency owing to the fact that it is supplied by the terminal branches of the ileocolic artery and collateral circulation is poor.

Colon

The colon is supplied by branches of the superior and inferior mesenteric arteries (IMA). The right and middle colic arteries arise from the SMA and supply the right and transverse colons respectively up to the splenic flexure. The left colic and sigmoid arteries are branches of the IMA and supply the left and sigmoid colon respectively. Collateral circulation to the sigmoid is via the superior rectal artery, a branch of the IMA, which anastomoses with the middle and inferior rectal arteries, both branches of the hypogastric artery.

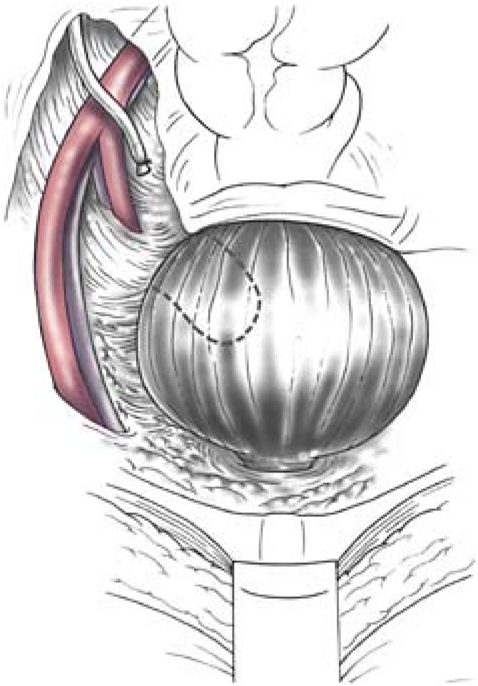


Figure 9

Boari flap: a U-shaped incision is made in the bladder

Nerve supply

Ileum

The ileum is innervated by the superior mesenteric plexus, which carries autonomic fibers from the vagus and thoracic splanchnic nerves.

Colon

The innervation of the colon is from the superior and inferior mesenteric plexuses, which carry autonomic fibers from the vagus, thoracic and lumbar splanchnic nerves.

Operative procedure

General considerations

Preoperative preparation should include a mechanical and antibiotic bowel preparation using a bowel cleansing solution such as Golytely (Schwarz Pharma, Inc., Milwaukee, WI, USA), and oral neomycin, erythromycin and an antifungal such as fluconazole. Perioperative antibiotics may also be required. A

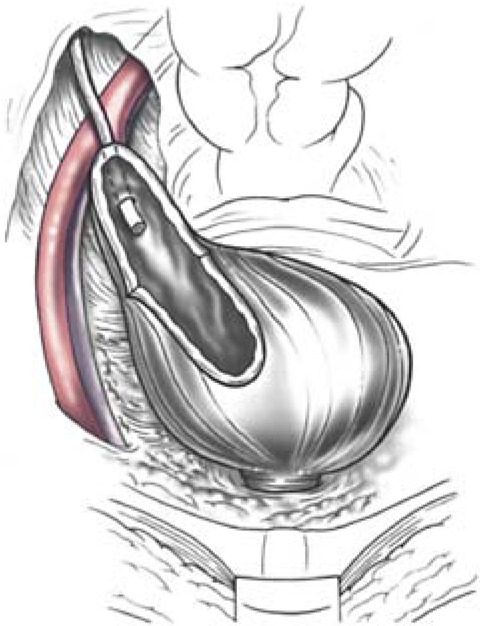


Figure 10

The flap is then ‘unrolled’ towards the undamaged ureter and the anastomosis performed. Care must be exercised not to perform the anastomosis too close to the cut edge of the bladder

preoperative renogram should be performed to assess baseline renal function in all patients receiving a continent conduit and in any other patient whose renal function is in question.

Our preference is to stent all ureters prior to performing the anastomosis. This eliminates the risk of sewing the ureter closed or of disrupting the sutures, which can occur when stenting is performed after suturing. Stents are held in place by placing a 5–0 or 6–0 plain gut suture through the ureter and the stent approximately 2 cm from the junction of the ureter and pouch. We also study all stents radiographically prior to removing them. Retrograde ‘stentograms’ can demonstrate leaks if present and strictures can be identified with a pull-back study. We generally study with intent to remove stents 2–3 weeks postoperatively.

A closed suction drain (e.g. Jackson Pratt) is placed behind the pouch or conduit in the area of the ureteral anastomoses in all patients. The major benefit is in the detection of anastomotic leaks. The drain is removed at the same time as the ureteral stents.

Ileal conduit

The ileum is carefully inspected for the presence of radiation injury, if applicable. Where injury is present, a colonic conduit is preferred. The conduit can be as short as 4–6 cm or as long as 10–12 cm. Shorter conduits are less prone to electrolyte disturbances, but may make it difficult or impossible to perform tension-free ureteroileal anastomoses. The ileal segment is transected at both ends using an intestinal stapler. The distal end should be at least 10 cm from the ileocecal valve. An ileoileal anastomosis restores bowel continuity. The mesentery is disrupted as little as possible (Figure 15).

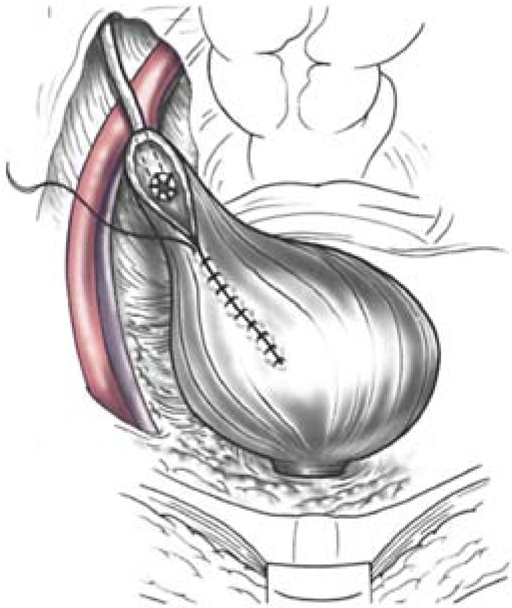


Figure 11

The flap is then closed. A psoas hitch may be performed to relieve any excess tension

The ureters are divided as far distally as is practical without involving diseased sections. The ureters and the conduit must be behind the ileal mesentery and the left ureter must be tunneled through the retroperitoneum behind the base of the sigmoid mesentery to bring it to the patient's right side (Figure 16).

The site for the anastomosis should be about 2 cm from the closed end of the conduit (Figure 17). A small (less than 1 cm) ellipse of tissue is removed from the wall of the ileum at the chosen site for the anastomoses. The ureteral ends are widened by first cutting them at an angle and then making a single longitudinal incision such that the ureteral opening corresponds to that in the bowel wall. Full-thickness sutures of 4–0 polyglycolic acid are used to perform end-to-side ureteroileostomies. Usually four to six sutures are sufficient (Figure 18).

A stoma is then created with the distal end of the ileal segment. The stoma is generally located in the right lower quadrant and is ideally marked preoperatively, taking into consideration the type of appliance to be used, the patient's body habitus and the location of her belt line when standing. A circle of skin is excised, the subcutaneous fat is either spread apart with retractors or excised, and a cruciate incision is made in the fascia. The fibers of the rectus muscle are bluntly separated and the posterior sheath and peritoneum are incised. The stoma should admit one to one and a half fingers if it is of adequate caliber. The stoma is everted into a 'rosebud' raised slightly above skin level. The proximal end is then sutured to the peritoneum overlying the sacral promontory.

Colonic conduit

Colonic conduits are usually 15–20 cm in length. Since the colon will contract once isolated, a segment somewhat longer than desired should be selected. Bowel continuity can then be restored or a colostomy can be created if the distal colon is to be removed as part of an exenterative procedure. The mesenteric incisions

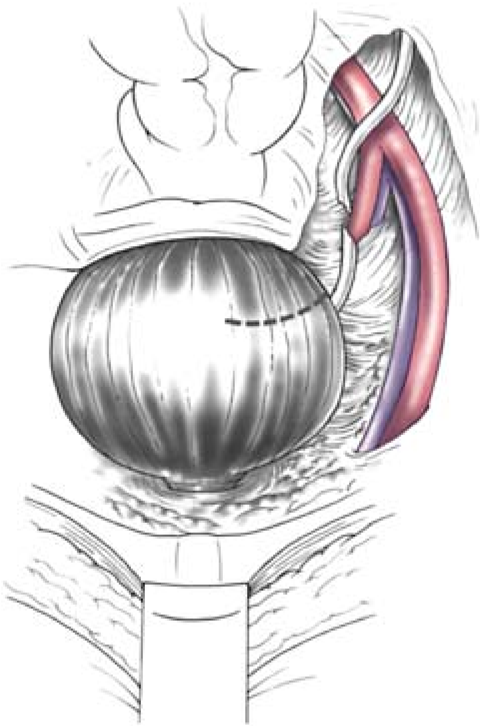


Figure 12

Demel flap: initial incision

should be of sufficient length to allow mobility of the conduit without interfering with the vascular supply to either the conduit or the remaining colon. The colonic anastomosis is performed anterior to the conduit. For a transverse colon conduit, the omentum must be dissected off the colon prior to isolating the conduit. The conduits should be isoperistaltic to prevent stasis, but can be constructed in an antiperistaltic fashion if anatomically necessary with no significant adverse effects.

The ureteral anastomoses are performed with 4–0 interrupted absorbable mucosa-to-mucosa sutures in separate teniae. Again, four to six sutures usually suffice. The right ureter must be brought over to the left side retroperitoneally and behind the sigmoid mesentery (for a sigmoid conduit). The ureters are spatulated as described above for ileal conduits. The ureteral anastomoses should be staggered by 2–3 cm so that one is more proximal than the other.

A stoma is created with the distal end of the conduit. The stoma is usually on the left side, but it can be on the right if dictated by anatomical concerns or if the patient has a colostomy as well. The stomal site must be larger than that for an ileal conduit and should admit at least two fingers. Finally, the proximal end is fixed to the psoas muscle with one or two interrupted permanent sutures.

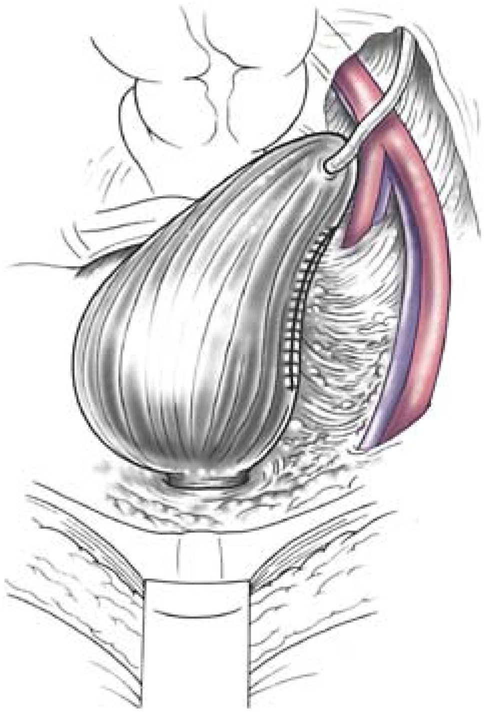


Figure 13

The bladder is opened and the lateral aspect brought into approximation with the injured ureter

Continent ileocolic reservoir

A 10 cm length of distal ileum and 32 cm of ascending and proximal transverse colon are isolated and mobilized. An ileotransverse enterocolostomy is performed in the standard fashion to restore bowel continuity. The appendix is removed at this time if it is present (Figure 19).

The colon is then folded on itself in a U configuration, bringing the transected end of the transverse colon in approximation to the cecum. Two interrupted stay sutures are used to maintain alignment of the colon. Electrocautery is used to make two small colotomies (2–4 cm) in the center of each segment of colon (Figure 20).

A PolyGIA stapler (US Surgical, Norwalk, CT, USA) is then used to detubularize the colon. Each arm is passed into adjacent colon segments towards one end of the reservoir. Once the stapler is articulated and fired, a common lumen is created with two rows of absorbable staples on each side of the incision line created by the knife within the instrument (Figure 21). A second instrument is then fired from this same point towards the opposite end of the reservoir, thus completing the detubularization process.

The continence mechanism is constructed by tapering the ileum and reinforcing the ileocecal valve (Figure 22). A 14 Fr red rubber catheter is placed in the ileum. Allis clamps are placed along the antimesenteric border to create countertension and a gastrointestinal stapler is used to taper the ileal segment so that the inside diameter approaches that of the catheter. More than one firing of the stapler may be required.

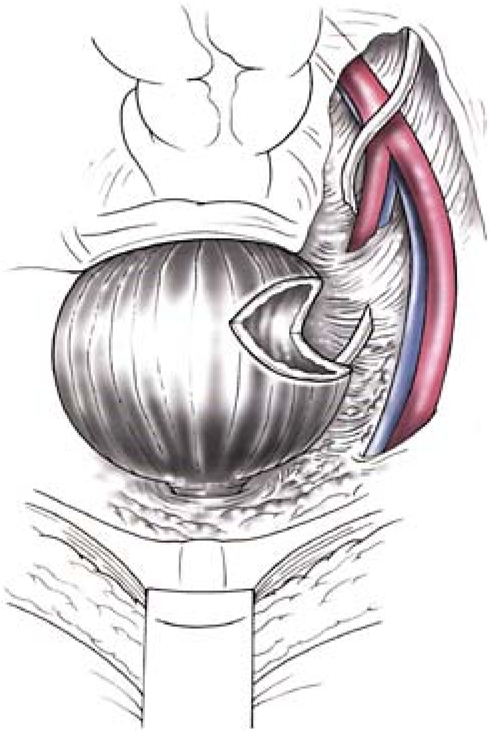


Figure 14

Anastomosis is performed and the bladder closed

Two or three purse-string sutures of 2–0 silk suture are then placed at the level of the ileocecal valve. The sutures are placed through the serosa and muscularis layers, but not through the mucosa (Figure 23).

Working through the unified colotomy in the center of the pouch, the ureters are then anastomosed to the pouch (Figure 24). A long, curved instrument is passed through the colotomy into the pouch to the intended location of the anastomosis. A colotomy is made at this point and the ureter is then drawn into the interior of the pouch. The ureters are spatulated and anastomosed from within the pouch with mucosa-to-mucosa interrupted 4–0 delayed absorbable sutures, full thickness through the ureter and partial thickness through the bowel (mucosa and submucosa only). Externally, the serosa of the bowel and the adventitia of the ureters are sutured together in a similar fashion with two or three sutures. The left ureter must be brought to the right side retroperitoneally behind the sigmoid mesentery.

Single J ureteral stents (7 Fr) are placed and fixed in position with a 5–0 or 6–0 plain gut suture which passes through the ureter and the stent approximately 2 cm from the junction of ureter and pouch. The stents are externalized through the anterior wall of the pouch and the abdominal wall, and the pouch is fixed to the anterior abdominal wall with permanent sutures. The external end of the right stent can be cut at a right angle and the end of the left stent can be cut at a 45° angle for easy differentiation later.

The 14 Fr red rubber catheter is exchanged for a triple-lumen Foley catheter of similar size. The Foley catheter is then left in place for 2 weeks until radiographic imaging confirms an intact system. At that stage the colotomy can then be closed with sutures or aTA-55 thoracoabdominal intestinal stapler. The ileum is also then externalized in the right lower quadrant. In some patients, the stoma can be placed in the

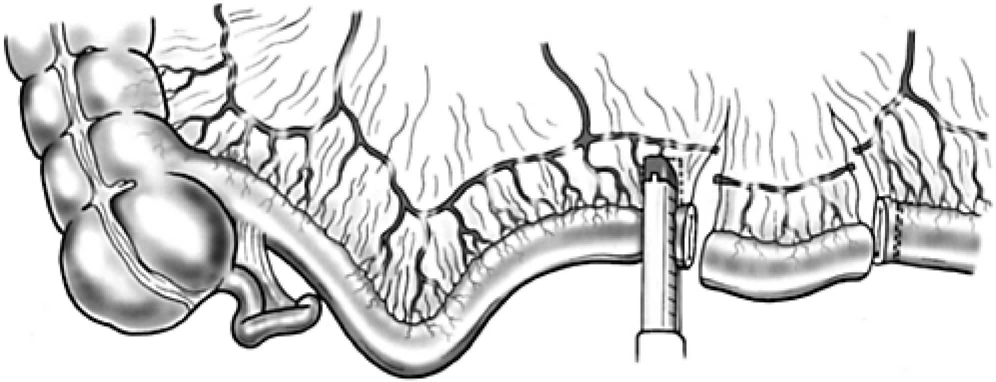


Figure 15

A segment of ileum is isolated sufficiently distant from the ileocecal junction to avoid the 'watershed' area

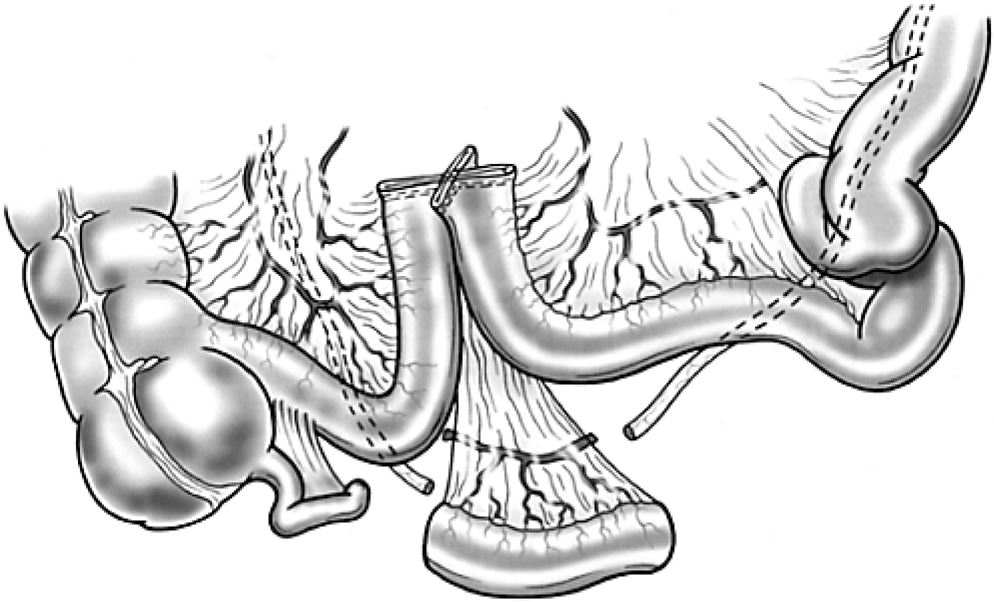


Figure 16

Bowel continuity is restored. The ureters are freed and brought through the retroperitoneum to the location of the conduit (generally, in the area of the sacral promontory)

umbilicus, which gives an excellent cosmetic result and makes catheterization easier as this is the thinnest portion of the abdominal wall. The continent stoma should not form a rosebud, but simply be everted flush with the skin. It is important that the course of the ileum be relatively straight to ease catheterization. A closed suction drain is placed behind the pouch and is removed with the ureteral stents.

Postoperative pouch drainage via intermittent low-pressure wall suction and irrigation can be performed via the Foley catheter. It is essential to monitor input and output of the pouch and to irrigate the pouch

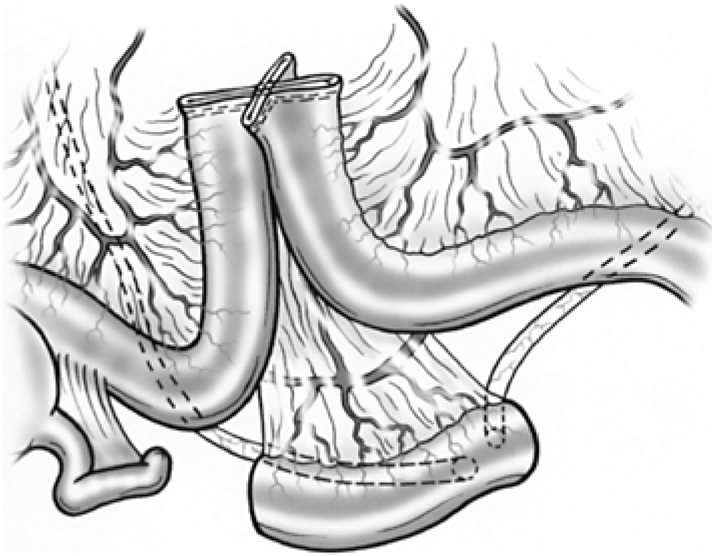


Figure 17

Ureteral anastomoses are performed about 2 cm from the closed end of the conduit

gently with 30–50 ml of normal saline frequently—as often as every 2–4 hours—in the immediate postoperative period to prevent mucus build-up. If output is significantly less than input, an ultrasound scan of the pouch can be done to ensure that it has not become overdistended. Urine output is followed separately from the stents which are connected to individual urimeters, carefully marked ‘left’ and ‘right’. The stents can also be irrigated with 10 ml of normal saline if urine output falls off. If there is no response to repeated irrigations, the stent should be studied radiographically to ensure proper placement and function. When the output decreases the pouch can be changed to gravity drainage, but the irrigations should continue at least four times a day with the irrigation fluid removed immediately.

A contrast study of the pouch and the ureters is performed about 2 weeks postoperatively. If all is normal, the stents are removed and the patient is then taught self-catheterization which initially should be performed every 2–4 hours. The patient should also continue to irrigate the pouch at least four times a day to prevent mucus build-up.

Bibliography

Cosin JA, Carter JR, Paley PJ et al (1997) A simplified method for detubularization in the construction of a continent ileocolic reservoir (Miami pouch), *Gynecol Oncol* **64:**436–41.

Hartenbach EM, Saltzman AK, Carter JR et al (1995) Nonsurgical management strategies for the functional complications of ileocolonic continent urinary reservoirs, *Gynecol Oncol* **56:**127–8.

Kock NG, Nilson AE, Nilsson LO et al (1982) Urinary diversion via continent ileal reservoir: clinical results in 12 patients, *J Urol* **128:**469–75.

Penalver MA, Darwich EB, Averette HE et al (1989) Continent urinary diversion in gynecologic oncology, *Gynecol Oncol* **34:**274–88.

Rowland RG, Mitchell ME, Bihrle R et al (1989) Indiana continent urinary reservoir, *J Urol* **137:**1136–9.

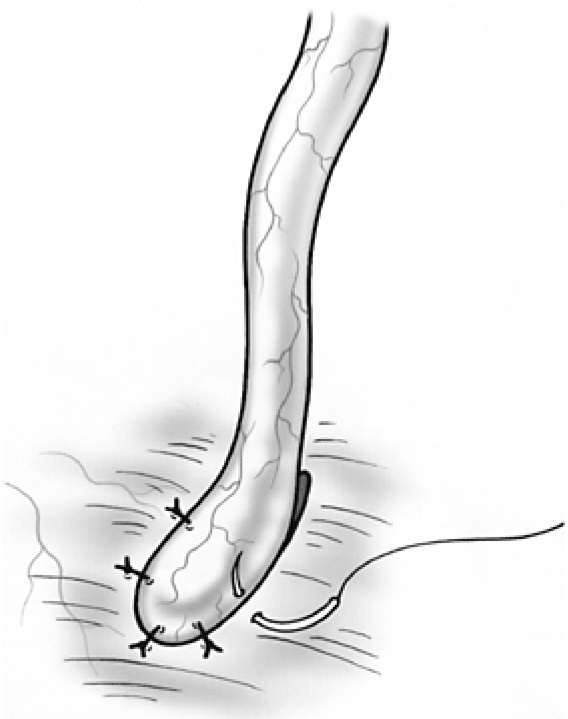


Figure 18

Detail of anastomosis. After removal of a small portion of the wall of the bowel the anastomosis is performed externally with full thickness, interrupted absorbable sutures

Symmonds RE (1976) Ureteral injuries associated with gynecologic surgery: prevention and management, *Clin Obstet Gynecol* **19:**623–44.

Wheeless CR Jr (1992) Recent advances in surgical reconstruction of the gynecologic cancer patient, *Curr Opin Obstet Gynecol* **4:**91–101.

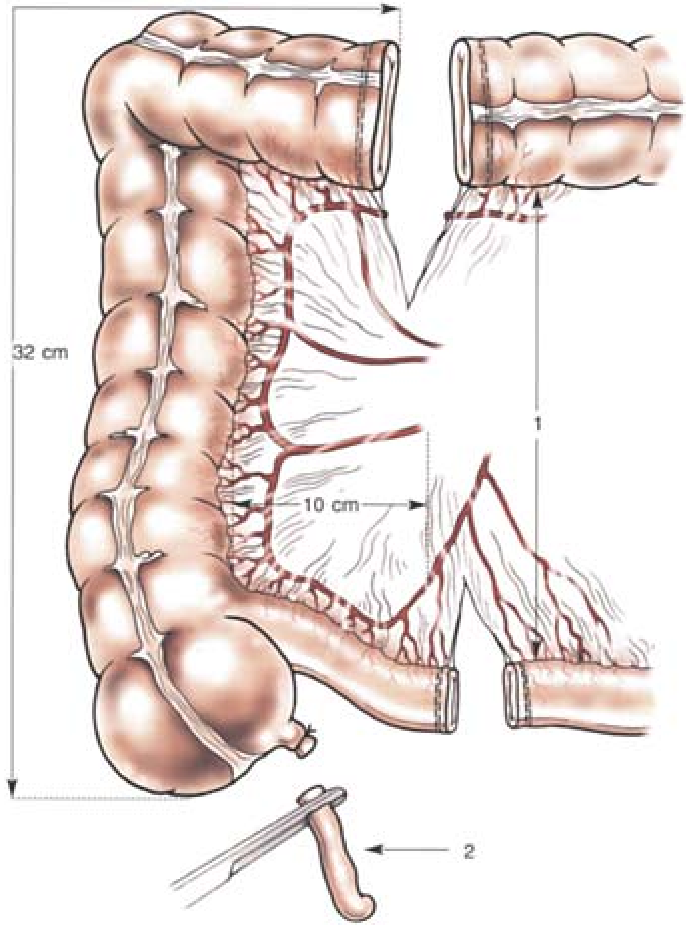


Figure 19

To begin a continent ileocecal reservoir the ileum is divided about 10 cm from the ileocecal valve and the colon is divided 32 cm from the cecum. If possible, this should be proximal to the middle colic artery. The appendix, if present, is removed

1 Anastomosis performed to restore bowel continuity

2 Appendectomy performed

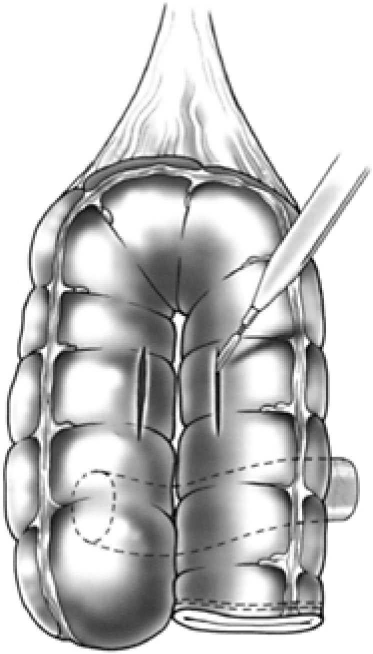


Figure 20

The colon is folded over on itself into a U and enterotomies are made

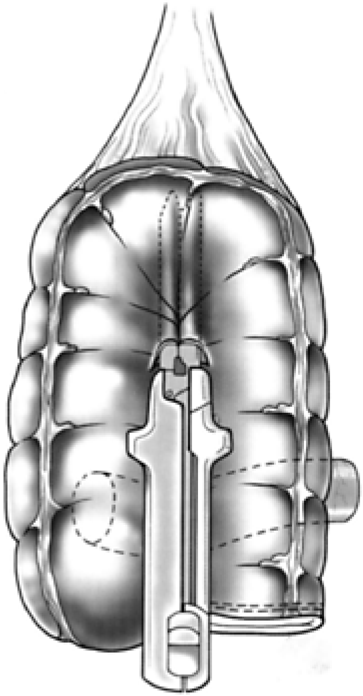


Figure 21

Detubularization is performed using a gastrointestinal stapler with absorbable staples. Two staplers are required, one towards each end of the conduit, as the staplers are not reloadable

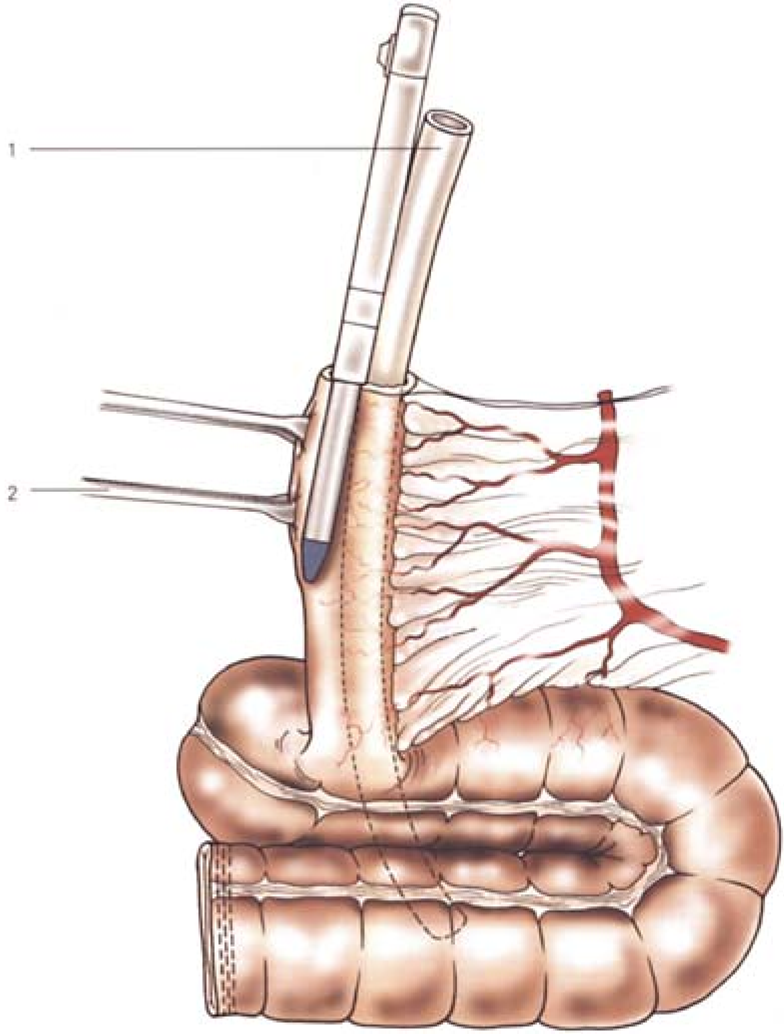


Figure 22

Using a standard gastrointestinal stapler, the ileal section is tapered over a 14 Fr red rubber catheter

1 Rubber catheter

2 Allis clamp

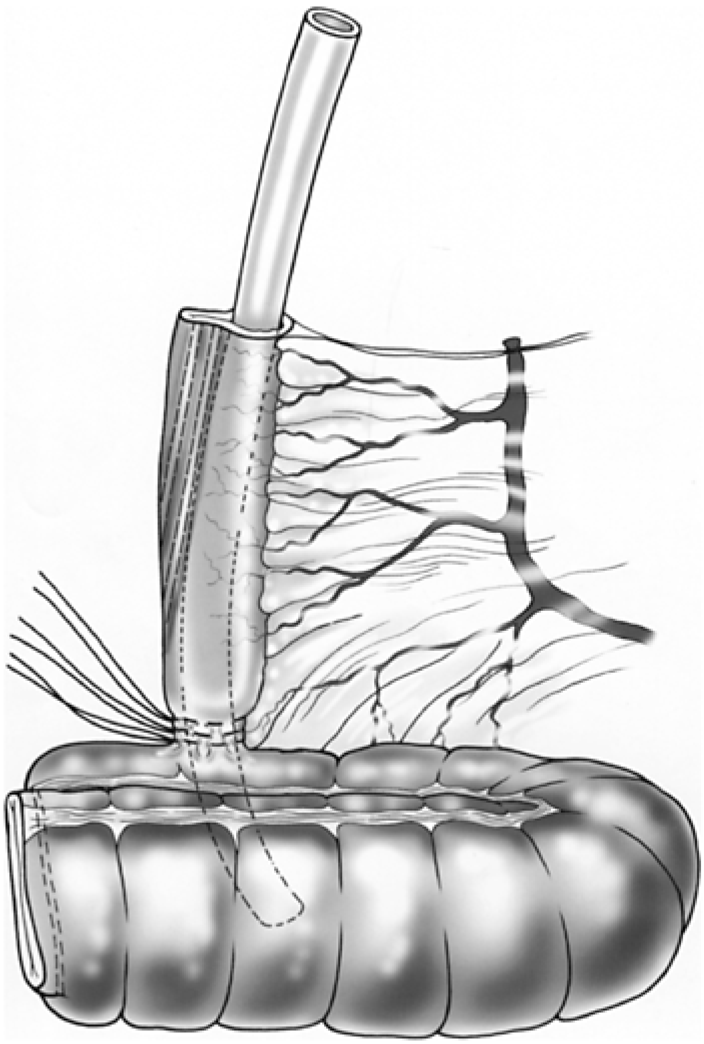


Figure 23

The ileocecal valve is reinforced with 2–3 pursestring sutures of non-absorbable suture such as silk

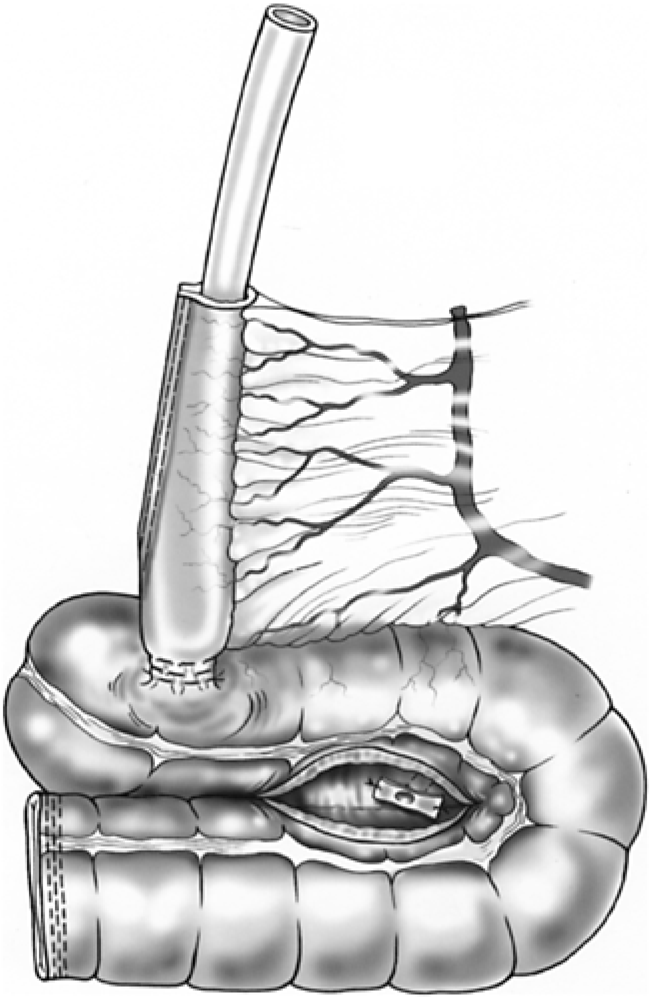


Figure 24

Working through the colotomy, the ureteral anastomosis is performed. After bringing the ureter through the wall of the conduit, the end is spatulated; interrupted absorbable sutures incorporating the full thickness of the ureter and partial thickness of the colon wall are used to performed the anastomosis

19
Fistula repair
Paul Hilton

Aetiology and epidemiology

Urogenital fistulas may occur congenitally, but are most often acquired from obstetric, surgical, radiation and malignant causes. The same factors may be responsible for intestinogenital fistulas, although inflammatory bowel disease is an additional important aetiological factor here. In most developing countries over 90% of fistulas are of obstetric aetiology, whereas in the UK and USA over 70% follow pelvic surgery.

Obstetric causes

The overwhelming proportion of obstetric fistulas in the developing world are complications of neglected obstructed labour. In the developed world, however, obstetric fistulas are associated with rupture of the uterus following previous caesarean section, or assisted vaginal delivery (Table 1).

Surgical causes

Genital fistula may occur following a wide range of surgical procedures within the pelvis (Table 1). It is often supposed that this complication results from direct injury to the lower urinary tract at the time of operation. Certainly on occasions this may be the case; careless, hurried or rough surgical technique makes injury to the lower urinary tract much more likely. However, of 112 cases of urogenital fistulas referred to the author over a recent 10-year period, 81 were associated with pelvic surgery and 62 followed hysterectomy; of these, only 4 (5%) presented with leakage of urine on the first day postoperatively. In other cases it is presumed that tissue devascularization during dissection, inadvertent suture placement, pelvic haematoma formation or infection developing postoperatively results in tissue necrosis with leakage developing most usually 5–14 days later. Overdistension of the bladder postoperatively may be an additional factor in many of these latter cases. It has recently been shown that there is a high incidence of abnormalities of lower urinary tract function in fistula patients; whether these abnormalities antedate the surgery, or develop with or as a consequence of the fistula, is unclear. It is likely that patients with a habit of infrequent voiding, or those with inefficient detrusor contractility, may be at increased risk of postoperative urinary retention; if this is not recognized early and managed appropriately, the risk of fistula formation may be increased.

Although it is important to remember that the majority of surgical fistulas follow apparently straightforward hysterectomy in skilled hands, several risk factors may make direct injury more likely (Table 2).

Radiation

The obliterative endarteritis associated with ionizing radiation in therapeutic dosage proceeds over many years and may result in fistula formation long after the primary malignancy has been treated. Of the 14 radiation fistulas in the author's series, the interval between fistula development and radiotherapy ranged from 1 year to 30 years. The associated devascularization in the adjacent tissues means that ordinary surgical repair has a high likelihood of failure, and modified surgical techniques are required.

Table 1 Aetiology of urogenital fistula in two series, from the north of England and from south-east Nigeria

Aetiology	**NE England** ***n*=112**	**SE Nigeria** ***n*=2389**
Obstetric		
Obstructed labour	1	1918
Caesarean section	1	165
Ruptured uterus	5	119
Forceps/ventouse	4	
Breech extraction	1	
Placental abruption	1	
Obstetric subtotal (percentage of total)	13 (11.6%)	2202 (92.2%)
Surgical		
Abdominal hysterectomy	45	33
Radical hysterectomy	10	
Urethral diverticulectomy	9	
Colporrhaphy	1	35
Vaginal hysterectomy	4	25
TAH and colporrhaphy	1	
TAH and colposuspension	1	
LAVH	1	
Cystoplasty and colposuspension	1	
Colposuspension	1	
Sling	1	
Needle suspension	1	
Cervical stumpectomy	1	
Subtrigonal phenol injection	1	
Transurethral resection (tb)	1	
Lithoclast	1	
Unknown surgery in childhood	1	
Suture to vaginal laceration		12

Aetiology	**NE England** ***n*=112**	**SE Nigeria** ***n*=2389**
Surgical subtotal	81 (72.3%)	105 (4.4%)
Radiation	14 (12.5%)	0 (0.0%)
Malignancy	0 (0.0%)	42 (1.8%)
Miscellaneous		
Catheter-associated	2	
Foreign body	1	
Trauma	1	11
Infection		7
Coital injury		22
Miscellaneous subtotal	4 (3.6%)	40 (1.7%)

LAVH, laparoscopically assisted vaginal hysterectomy; TAH, total abdominal hysterectomy; tb, tuberculosis

Malignancy

Excluding the effects of treatment, malignant disease itself may result in genital tract fistula. Carcinoma of cervix, vagina and rectum are the most common malignancies to present in this way. It is relatively unusual for urothelial tumours to present with fistula

Table 2 Risk factors for postoperative fistula

Risk factor	**Pathology**	**Specific example**
Anatomical distortion		Fibroids Ovarian mass
Abnormal tissue adhesion	Inflammation	Infection Endometriosis
	Previous surgery	Caesarean section Cone biopsy Colporrhaphy
Impaired vascularity	Malignancy Ionizing radiation	Preoperative radiotherapy
	Metabolic abnormality Radical surgery	Diabetes mellitus
Compromised healing		Anaemia Nutritional deficiency
Abnormality of bladder function		Voiding dysfunction

formation, other than following surgery or radiotherapy. The development of a fistula may be a distressing part of the terminal phase of malignant disease; it is nevertheless one deserving not simply compassion, but full consideration of the therapeutic or palliative possibilities. Bilateral permanent nephrostomies may give continence when all else fails.

Inflammatory bowel disease

Inflammatory bowel disease is the most significant cause of intestinogenital fistulas in the UK, although these fistulas rarely present directly to the gynaecologist. Diverticular disease can produce colovaginal fistulas and rarely colouterine fistulas, with surprisingly few symptoms attributable to the intestinal pathology. The possibility should not be overlooked if an elderly woman complains of faeculent discharge or becomes incontinent without concomitant urinary problems. Crohn’s disease appears to be increasing in frequency in the Western world, and a total fistula rate approaching 40% has been reported; in females the involvement of the genital tract may be up to 7%. Ulcerative colitis has a small incidence of low rectovaginal fistulas. In the author’s own series of rectovaginal fistulas, 65% are obstetric in origin, 21% relate to inflammatory bowel disease, 7% follow radiotherapy, and 7% are of uncertain cause.

Miscellaneous

Other miscellaneous causes of fistulas in the genital tract include infection (lymphogranuloma venereum, schistosomiasis, tuberculosis, actinomycosis, measles, noma vaginae), trauma (penetrating trauma, coital injury, neglected pessary or other foreign bodies) and catheter-related injuries.

Classification

Many different fistula classifications have been proposed, based on anatomical site; these are often subclassified into, simple fistulas (where the tissues are healthy and access good) or complicated fistulas (where there is tissue loss, scarring, impaired access, involvement of the ureteric orifices, or a coexistent rectovaginal fistula). Urogenital fistulas may be classified into urethral, bladder neck, subsymphysial (a complex form involving circumferential loss of the urethra with fixation to bone), midvaginal, juxtacervical or vault fistulas, massive fistulas extending from bladder neck to vault, and vesicouterine or vesicocervical fistulas. While over 60% of fistulas in the developing world are midvaginal, juxtacervical or massive (reflecting their obstetric aetiology), such cases are relatively rare in Western fistula practice; 50% of the fistulas managed in the UK are situated in the vaginal vault (reflecting their surgical aetiology).

Presentation

Fistulas between the urinary tract and the female genital tract are characteristically said to present with continuous urinary incontinence, with limited sensation of bladder fullness, and with infrequent voiding. Where there is extensive tissue loss, as in obstetric or radiation fistulas, this typical history is usually present, the clinical findings gross, and the diagnosis rarely in doubt. With postsurgical fistulas, however, the history may be atypical and the orifice small, elusive or occasionally completely invisible. Under these circumstances the diagnosis can be much more difficult, and a high index of clinical suspicion must be maintained.

Ureteric fistulas have similar causes to bladder fistulas, and the mechanism may be one of direct injury by incision, division or excision, or of ischaemia from strangulation by suture, crushing by clamp or stripping by dissection; the presentation may therefore be similarly variable. With direct injury leakage is usually apparent from the first postoperative day. Urine output may be physiologically reduced for some hours following surgery, and if there is significant operative or postoperative hypotension oliguria may persist longer. Once renal function is restored, however, leakage will usually be apparent promptly. With other mechanisms obstruction is likely to be present to a greater or lesser degree, and the initial symptoms may be of pyrexia or loin pain, with incontinence occurring only after sloughing of the ischaemic tissue, from around 5 days up to 6 weeks later.

Investigations

If there is suspicion of a fistula, but its presence is not easily confirmed by clinical examination with a speculum, further investigation will be necessary to confirm or exclude the possibility fully. Even where the diagnosis is clinically obvious, additional investigation may be appropriate for full evaluation prior to deciding treatment. The main principles of investigation therefore are:

- to confirm that the discharge is urinary/faecal
- to establish that the leakage is extraurethral rather than urethral
- to establish the site of leakage
- to exclude other organ involvement.

Biochemistry and microbiology

Excessive vaginal discharge or drainage of serum from a pelvic haematoma postoperatively may simulate a urinary fistula. If the fluid is in sufficient quantity to be collected, biochemical analysis of its urea content in comparison with that of urine and serum will confirm its origin. Urinary infection is surprisingly uncommon in fistula patients, although urine culture should be undertaken (especially where there have been previous attempts at surgery) and appropriate antibiotic therapy instituted.

Dye studies

Although other imaging techniques undoubtedly have a role (see below), carefully conducted dye studies remain the investigation of first choice. Phenazopyridine may be used orally, or indigo carmine intravenously, to stain the urine and hence confirm the presence of a fistula. The identification of the site of a fistula is best carried out by the instillation of coloured dye (methylene blue or indigo carmine) into the bladder through a catheter with the patient in the lithotomy position. The traditional ‘three swab test’ has its limitations and is not recommended; the examination is best carried out with direct inspection, and multiple fistulas may be located in this way. If leakage of clear fluid continues after dye instillation a ureteric fistula is likely, and this is most easily confirmed by a ‘two dye test’, using phenazopyridine to stain the renal urine and methylene blue to stain bladder contents.

Dye tests are less useful for intestinal fistulas, although a carmine marker taken orally may confirm their presence. Rectal distension with air via a sigmoidoscope may be of more value; if the patient is kept in a slight head-down position and the vagina filled with saline, the bubbling of any air leaked through a low fistula may be detected.

Imaging

Excretion urography

Although intravenous urography is a particularly insensitive investigation in the diagnosis of vesicovaginal fistula, knowledge of upper urinary tract status may have a significant influence on treatment measures

Figure 1

Intravenous urogram (with simultaneous cystogram) demonstrating a complex surgical fistula occurring after radical hysterectomy. After further investigation including cystourethroscopy, sigmoidoscopy, barium enema and retrograde cannulation of the vaginal vault to perform fistulography, the lesion was defined as a ureterocolovesicovaginal fistula

applied, and should therefore be looked on as an essential investigation for any suspected or confirmed urinary fistula. Compromise to ureteric function is a particularly common finding when a fistula occurs in relation to malignant disease or its treatment (by radiation or surgery).

Dilatation of the ureter is characteristic in ureteric fistula, and its finding in association with a known vesicovaginal fistula should raise suspicion of a complex ureterovesicovaginal lesion (Figure 1). While essential for the diagnosis of ureteric fistula, intravenous urography is not completely sensitive; the presence of a periureteric flare is, however, highly suggestive of extravasation at this site.

Retrograde pyelography

Retrograde pyelography is a more reliable way of identifying the exact site of a ureterovaginal fistula, and may be undertaken simultaneously with either retrograde or percutaneous catheterization for therapeutic stenting of the ureter (see Chapter 5).

Cystography

Cystography is not particularly helpful in the basic diagnosis of vesicovaginal fistulas, and a dye test carried out under direct vision is likely to be more sensitive. It may, however, occasionally be useful in achieving a diagnosis in complex fistulas or vesicouterine fistulas.

Fistulography

Fistulography is a special example of the x-ray technique commonly referred to as sinography. For small fistulas a ureteric catheter is suitable, although if the hole is large enough a small Foley catheter may be used to deliver the radio-opaque dye; this is particularly valuable for fistulas for which there is an intervening abscess cavity. If a catheter will pass through a small vaginal aperture into an adjacent loop of bowel its nature may become apparent from the radiological appearance of the lumen and haustrations, although further imaging studies are usually required to demonstrate the underlying pathology.

Barium enema, barium meal and follow-through

A barium meal, a barium enema or both may be required for the evaluation of the intestinal condition when a fistula is present above the anorectum. Aside from confirming the presence of a fistula, evidence of malignant or inflammatory disease may be identified.

Ultrasonography, CT and MRI

Ultrasonography, computerized tomography (CT) and magnetic resonance imaging (MRI) may occasionally be appropriate for the complete assessment of complex fistulas. Endoanal ultrasound scans and MRI are particularly useful in the investigation of anorectal and perineal fistulas (see Chapter 4).

Examination under anaesthesia

Careful examination, if necessary under anaesthesia, may be required to determine the presence of a fistula, and is deemed by several authorities to be essential for definitive surgical treatment. It is important at the time of examination to assess the available access for repair vaginally and the mobility of the tissues. The decision between the vaginal and abdominal approaches to surgery is thus made; when the vaginal route is chosen, it may be appropriate to select between the more conventional supine lithotomy, with a head-down tilt, and the prone (reverse) lithotomy position with head-up tilt. This may be particularly useful in allowing the operator to look down onto bladder neck and subsymphysial fistulas, and is also of advantage in some massive fistulas in encouraging the reduction of the prolapsed bladder mucosa.

Endoscopy

Cystoscopy

Although some authorities suggest that endoscopy has little role in the evaluation of fistulas, it is the author’s practice to perform cystourethroscopy in all but the largest defects. Although in some obstetric and radiation fistulas the size of the defect and the extent of tissue loss and scarring may make it difficult to distend the bladder, nevertheless much useful information is obtained. The exact level and position of the fistula should be determined, and its relationships to the ureteric orifices and bladder neck are particularly important. With urethral and bladder neck fistulas the failure to pass a cystoscope or sound may indicate that there has been circumferential loss of the proximal urethra, a circumstance which is of considerable importance in determining the appropriate surgical technique and the likelihood of subsequent urethral incompetence.

The condition of the tissues must be carefully assessed. Persistence of slough means that surgery should be deferred, and this is particularly important in obstetric and postradiation cases. Biopsy from the edge of a fistula should be taken in radiation fistulas, if persistent or recurrent malignancy is suspected. Malignant change has been reported in a longstanding benign fistula, so where there is any doubt at all about the nature of the tissues, biopsy should be undertaken. In endemic areas evidence of schistosomiasis, tuberculosis and lymphogranuloma may become apparent in biopsy material, and again it is important that specific antimicrobial treatment is instituted prior to definitive surgery.

Sigmoidoscopy and proctoscopy

Sigmoidoscopy and proctoscopy are important for the diagnosis of inflammatory bowel disease, which may not have been suspected before the occurrence of a fistula. Biopsy specimens of the fistula edge or any unhealthy-looking area should always be obtained.

Preoperative management

Before epithelialization is complete an abnormal communication between viscera will tend to close spontaneously, provided that the natural outflow is unobstructed. Bypassing the sphincter mechanisms, for example by urinary catheterization or defunctioning colostomy may encourage closure. The early management is of critical importance, and depends on the aetiology and site of the lesion. If surgical trauma is recognized within the first 24 hours postoperatively immediate repair may be appropriate, provided that extravasation of urine into the tissues has not been great. The majority of surgical fistulas, however, are recognized between 5 days and 14 days postoperatively, and should be treated with continuous bladder drainage. It is worth persisting with this line of management in vesicovaginal or urethrovaginal fistulas for 6–8 weeks, since spontaneous closure may occur within this period.

Obstetric fistulas developing after obstructed labour should also be treated by continuous bladder drainage, combined with antibiotics to limit tissue damage from infection. Indeed, if a patient is known to have been in obstructed labour for any significant length of time, or is recognized to have areas of slough on the vaginal walls in the puerperium, prophylactic catheterization should be undertaken.

Immediate management should also include attention to palliation and skin care, nutrition, physiotherapy, rehabilitation and overall patient morale. Surgical fistula patients are usually previously healthy individuals who entered hospital for what was expected to be a routine procedure, and end up with symptoms infinitely worse than their initial complaint. Obstetric fistula patients in the developing world are social outcasts. Whatever the cause, these women are invariably devastated by their situation. It is vital that they understand the nature of the problem, why it has arisen, and the plan for management at all stages. Confident but realistic counselling by the surgeon is essential and the involvement of nursing staff or counsellors with experience of fistula patients is also highly desirable. The support given by previously treated sufferers can also be of immense value in maintaining patient morale, especially where a delay prior to definitive treatment is required.

General principles of surgical treatment

Timing of repair

The timing of surgical repair is perhaps the single most contentious aspect of fistula management. While shortening the waiting period is of both social and psychological benefit to patients who are always very distressed, one must not trade these issues for compromise to surgical success. The benefit of delay is to allow slough to separate, and inflammatory change to resolve. In both obstetric and radiation fistulas there is considerable sloughing of tissues, and it is imperative that this should have settled before repair is undertaken. In radiation fistulas it may be necessary to wait 12 months or more. In obstetric cases most authorities suggest that a minimum of 3 months should be allowed to elapse, although others have advocated surgery as soon as slough is separated.

Figure 2

Fistula repair instruments

With surgical fistulas the same principles should apply, and although the extent of sloughing is limited, extravasation of urine into the pelvic tissues inevitably sets up some inflammatory response. Although early repair is advocated by several authors, again most would agree that 10–12 weeks postoperatively is the earliest appropriate time for repair.

Pressure from patients to undertake repair at the earliest opportunity is always understandably great, but is never more so than in the case of previous surgical failure. Such pressure must however be resisted, and 8 weeks is the minimum time that should be allowed between attempts at closure.

Route of repair

Many urologists advocate an abdominal approach for all fistula repairs, claiming the possibility of earlier intervention and higher success rates in justification. Others suggest that all fistulas can be successfully closed by the vaginal route. Surgeons involved in fistula management must be capable of both approaches, and have the versatility to modify their techniques to select that most appropriate to the individual case. Where access is good and the vaginal tissues sufficiently mobile, the vaginal route is usually most appropriate. If access is poor and the fistula cannot be brought down, the abdominal approach should be used. Overall, more surgical fistulas are likely to require an abdominal repair than obstetric fistulas, although in the author's series of cases from the UK, and those reviewed from Nigeria, two-thirds of cases were satisfactorily treated by the vaginal route regardless of aetiology.

Instruments

All operators have their own favoured instruments, although those described by Chassar Moir and Lawson are eminently suitable for repair by any route (Figure 2). The following are particularly useful:

- series of fine scalpel blades on the no. 7 handle, especially the curved no. 12 bistoury blade
- Chassar Moir 30° angled-on-flat and 90° curved-on-flat scissors
- cleft palate forceps
- Judd-Allis, Stiles and Duval tissue forceps
- Millin's retractor for use in transvesical procedures, and Currie's retractors for vaginal repairs

- Skin hooks to put the tissues on tension during dissection
- Turner-Warwick double curved needle holder— particularly useful in areas of awkward access, and has the advantage of allowing needle placement without the operator’s hand or the instrument obstructing the view.

Dissection

Great care must be taken over the initial dissection of the fistula, and this stage should probably take as long as the repair itself. The fistula should be circumcised in the most convenient orientation, depending on size and access. All things being equal a longitudinal incision should be made around urethral or midvaginal fistulas; conversely, vault fistulas are better handled by a transverse elliptical incision. The tissue planes are often obliterated by scarring, and dissection close to a fistula should therefore be undertaken with a scalpel or scissors. Sharp dissection is easier with countertraction applied by skin hooks, tissue forceps or retraction sutures. Blunt dissection with small pledgets may be helpful once the planes are established, and provided it takes place away from the fistula edge. Wide mobilization should be performed, so that tension on the repair is minimized. Bleeding is rarely troublesome with vaginal procedures, except occasionally with proximal urethrovaginal fistulas. Diathermy is best avoided, and pressure or underrunning sutures are preferred.

Suture materials

Although a range of suture materials have been advocated over the years, and different opinions still exist, the author’s view is that absorbable sutures should be used throughout all urinary fistula repair procedures. Polyglactin (Vicryl, Ethicon, Edinburgh, UK) 2–0 suture on a 25 mm heavy tapercut needle is preferred for both the bladder and vagina, and polydioxanone (PDS, Ethicon, Edinburgh, UK) 4–0 on a 13 mm round-bodied needle is used for the ureter; 3–0 sutures on a 30 mm round-bodied needle are used for bowel surgery, polydioxanone for the small bowel, and either polydioxanone or braided polyamide (Nurolon, Ethicon, Edinburgh, UK) for large bowel reanastomosis.

Operative technique

Vesicovaginal fistula repair

Dissection and repair in layers

Two main types of closure technique are applied to the repair of urinary fistulas: the classical saucerization technique described by Sims in 1852, and the much more commonly used dissection and repair in layers. Figures 3–7 demonstrate the latter form of repair in a posthysterectomy vault fistula.

Tissue forceps or traction sutures are applied to bring the fistula more clearly into view, and obtain optimal access for repair. Infiltration with 1 in 200 000 adrenaline helps to reduce bleeding, and may aid dissection by separating tissue planes to some degree. With small lesions it may be helpful to identify the fistula with a probe or Fogerty catheter, so that the track is not ‘lost’ after dissection. The fistula is then circumcised in a transverse elliptical fashion, using a no. 12 scalpel blade (Figure 3); this should start posteriorly, and be completed on the anterior aspect. The dissection is then extended using scissors; Chassar

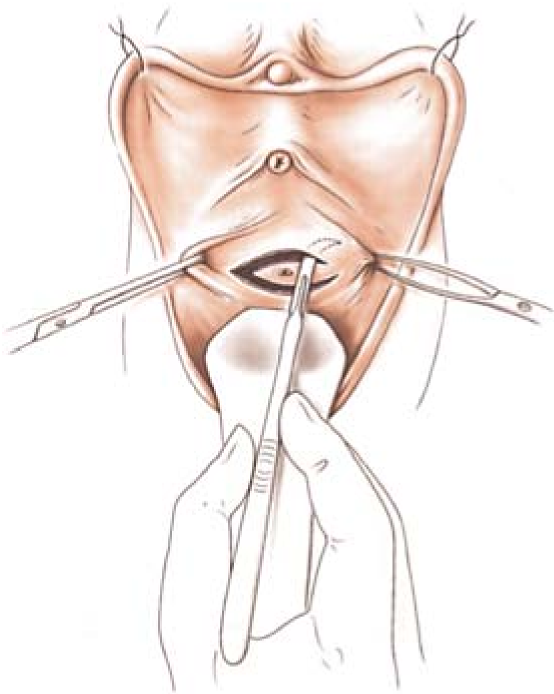


Figure 3

Traction sutures or tissue forceps allow the fistula to be brought into a more accessible position; the fistula is then circumcised in a transverse elliptical fashion, using a no. 12 scalpel blade

Moir 30° angled-on-flat and 90° curved-on-flat scissors are particularly useful in this respect (Figure 4). The vaginal walls should be undermined so that the underlying bladder is mobilized for 1–2 cm beyond the fistula edge. The vaginal scar edge may then be trimmed, although most often it is simply inverted within the repair. Sutures must be placed with meticulous accuracy in the bladder wall, care being taken not to penetrate the mucosa which should be inverted as far as possible. The repair should be started at either end, working towards the midline, so that the least accessible aspects are sutured first. Interrupted sutures are preferred and should be placed approximately 3 mm apart, taking as large a bite of tissue as feasible. Stitches that are too close together, or the use of continuous or purse-string sutures, tend to impair blood supply and interfere with healing. Knots must be secure with three hitches, so that they can be cut short, leaving the minimum amount of suture material. With dissection and repair in layers the first layer of sutures in the bladder should invert the bladder edges (Figures 5, 6); the second adds bulk to the repair by taking a wide bite of bladder wall, but also closes off dead space by catching the back of the vaginal flaps (Figure 7). After the repair has been tested, a third layer of interrupted mattress sutures is used to evert and close the vaginal wall, consolidating the repair by picking up the underlying bladder wall (Figure 8).

Saucerization

The saucerization technique involves converting the track into a shallow crater, which is closed without dissection of bladder from vagina using a single row of interrupted sutures (Figure 9). The method is only

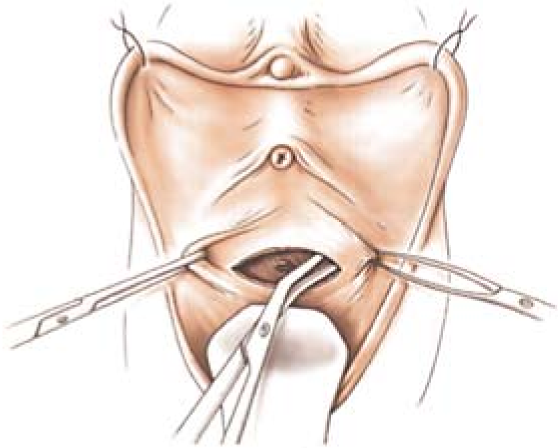


Figure 4

The dissection is then extended using scissors; the vaginal walls should be undermined so that the underlying bladder is mobilized for 1–2 cm beyond the fistula edge

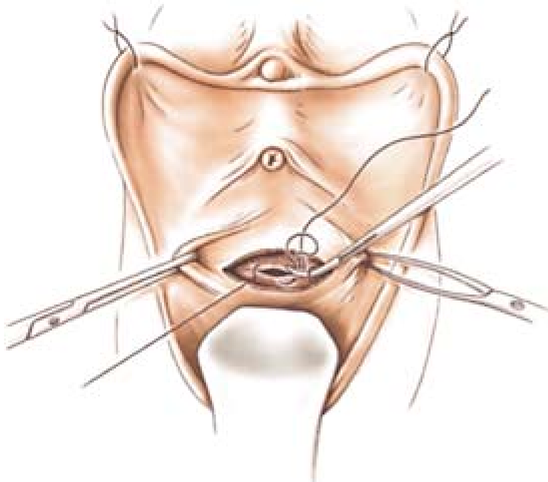


Figure 5

The repair is started at either end, working towards the midline, so that the least accessible aspects are sutured first

applicable to small fistulas, and perhaps to residual fistulas after closure of a larger defect; in other situations the technique does not allow secure closure without tension.

Vaginal repair procedures in specific circumstances

The conventional dissection and repair in layers as described above is entirely appropriate for the majority of midvaginal fistulas, although modifications may be necessary in specific circumstances. In juxtacervical fistulas in the anterior fornix, vaginal repair may be feasible if the cervix can be drawn down to provide

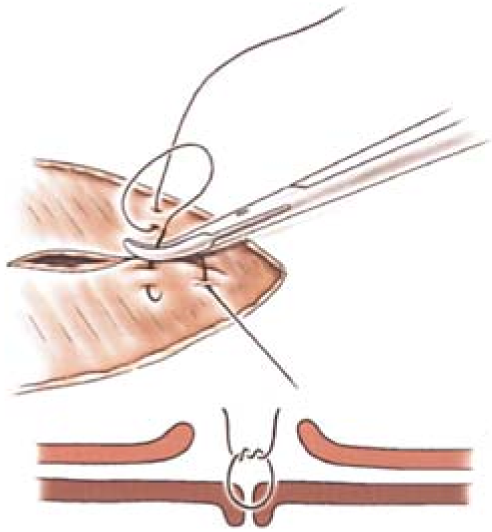


Figure 6

The first layer of sutures in the bladder inverts the bladder edges

access. Dissection should include mobilization of the bladder from the cervix. The repair should be undertaken transversely to reconstruct the underlying trigone and prevent distortion of the ureteric orifices; the second layer of the repair is used to roll the defect onto the intact cervix, for additional support (Figure 10).

Vault fistulas, particularly those following hysterectomy, can again usually be managed vaginally. The vault is incised transversely and mobilization of the fistula is often aided by deliberate opening of the pouch of Douglas. The peritoneal opening does not need to be closed separately, but is incorporated into the vaginal closure.

With subsymphysial fistulas involving the bladder neck and proximal urethra as a consequence of obstructed labour, tissue loss may be extensive, and fixity to underlying bone a common problem. The lateral aspects of the fistula require careful mobilization to overcome disproportion between the defect in the bladder and the urethral stump. A racquet-shaped extension of the incision facilitates exposure of the proximal urethra. Although transverse repair is often necessary, longitudinal closure gives better prospects for urethral competence.

Where there is substantial urethral loss, reconstruction may be undertaken using the method described by Chassar Moir or Hamlin and Nicholson. After a U-shaped incision is made on the anterior vaginal wall, extending from the posterior edge of the fistula to the intended position of the external meatus, a strip of anterior vaginal wall is constructed into a tube over a catheter (Figure 11). Plication of muscle behind the bladder neck is probably important if continence is to be achieved. The interposition of a labial fat or muscle graft not only fills up the potential dead space, but provides additional bladder neck support and improves continence by reducing scarring between bladder neck and vagina.

With very large fistulas extending from bladder neck to vault, the extensive dissection required may produce considerable bleeding. The main surgical difficulty is to avoid the ureters. They are usually situated close to the superolateral angles of the fistula, and if they can be identified they should be catheterized.

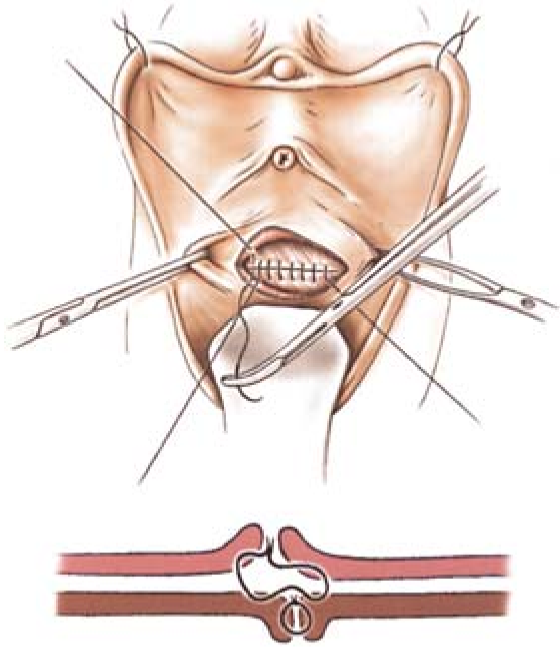


Figure 7

The second layer of sutures adds bulk to the repair by taking a wide bite of bladder wall, and closes off dead space by catching the back of the vaginal flaps

Straight ureteric catheters passed transurethrally, or double pigtail catheters, may both be useful in detecting the intramural portion of the ureters internally; nevertheless, great care must be taken during dissection.

Radiation fistulas present particular problems, in that the area of devitalized tissue is usually considerably larger than the fistula itself. Mobilization is often impossible, and if repair in layers is attempted the flaps are likely to slough; closure by colpocleisis is therefore required (Figure 12). Some have advocated total closure of the vagina although it is preferable to avoid dissection in the devitalized tissue entirely, and to perform a lower partial colpocleisis converting the upper vagina into a diverticulum of the bladder. It is usually necessary to fill the dead space below this with an interposition graft (Figures 13, 14).

Abdominal repairs

Transvesical repair

Repair by the abdominal route is indicated when high fistulas are fixed in the vault and are therefore inaccessible *per vaginam.* Transvesical repair has the advantage of being entirely extraperitoneal. It is often helpful to elevate the fistula site by a vaginal pack, and the ureters should be catheterized under direct vision. The technique of closure is similar to that of the transvaginal flap-splitting repair except that for haemostasis the bladder mucosa is also closed, using a continuous suture (Figure 15).

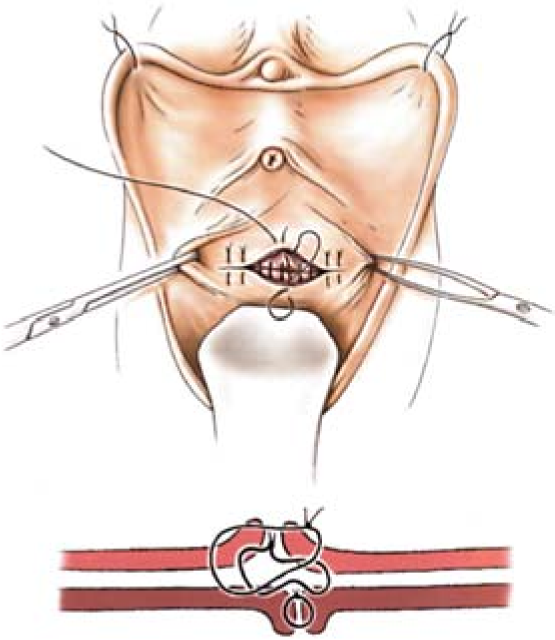


Figure 8

After the repair has been tested, a third layer of interrupted mattress sutures is used to evert and close the vaginal wall, consolidating the repair by picking up the underlying bladder wall

Transperitoneal repair

It is often said that there is little place for a simple transperitoneal repair, although a combined transperitoneal and transvesical procedure is favoured by urologists and is particularly useful for vesicouterine fistulas following caesarean section. A midline split is made in the vault of the bladder; this is extended downwards in a racquet shape around the fistula (Figure 16). The fistulous track is excised and the vaginal or cervical defect closed in a single layer (Figure 17). The bladder is then closed in one or two layers; either continuous or interrupted sutures may be employed. The interposition of an omental graft may also be considered if there is doubt over the integrity of the repair; this is also particularly appropriate when the technique is used for the repair of radiation fistulas.

Ureteric reimplantation

For ureteric fistulas not manageable by stenting, reimplantation is considered preferable to reanastomosis of the ureter itself, which carries a greater risk of stricture. Several techniques are described for ureteroneocystostomy, and the choice will depend on the level of the fistula and the nature of the antecedent pathology. For ureteric lesions within the pelvis, mobilization of the bladder from the opposite pelvic side-wall may be all that is required to allow reimplantation without tension. Otherwise the most widely used techniques are reimplantation using a psoas hitch (Figure 18), or the creation of a flap of bladder wall, the Boari-Ockerblad technique (Figure 19) (see further Chapter 15). There are few lesions that are too high for these approaches, although where there is significant deficiency it may be necessary to perform an end-to-

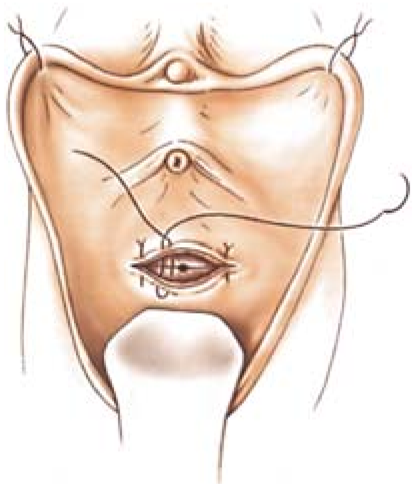


Figure 9

The saucerization technique involves converting the track into a shallow crater, which is closed without dissection of bladder from vagina using a single row of interrupted sutures

side anastomosis between the injured ureter and the good contralateral ureter, i.e. a transureteroureterostomy, or to interpose a loop of small bowel.

Interposition grafting

Several techniques have been described to support fistula repair in different sites (see also Chapter 21). In each case the interposed tissue serves to create an additional layer in the repair, to fill dead space, and to bring new blood supply into the area. The tissues used include:

- Martius graft—labial fat and bulbocavernosus muscle passed subcutaneously to cover a vaginal repair; this is particularly appropriate to provide additional bulk in a colpocleisis and in urethral and bladder neck fistulas may help to maintain competence of closure mechanisms by reducing scarring (see Figure 13).
- Gracilis muscle passed either via the obturator foramen or subcutaneously is used as above (see Chapter 21).
- Omental pedicle grafts may be dissected from the greater curve of the stomach and rotated down into the pelvis on either the right or left gastroepiploic arteries; this may be used at any transperitoneal procedure, but has its greatest advantage in postradiation fistulas (see Chapter 11).
- Peritoneal flap graft is an easier way of providing an additional layer at transperitoneal repair procedures, by taking a flap of peritoneum from any available surface, most usually the paravesical area.

Rectovaginal fistula repair

For the majority of rectovaginal fistulas, defunctioning of the bowel is not required. For recurrent fistulas, for those associated with active inflammatory bowel disease, or for ileo- or colovaginal fistulas, a preliminary defunctioning colostomy may be appropriate. Although surgeons vary in the extent to which

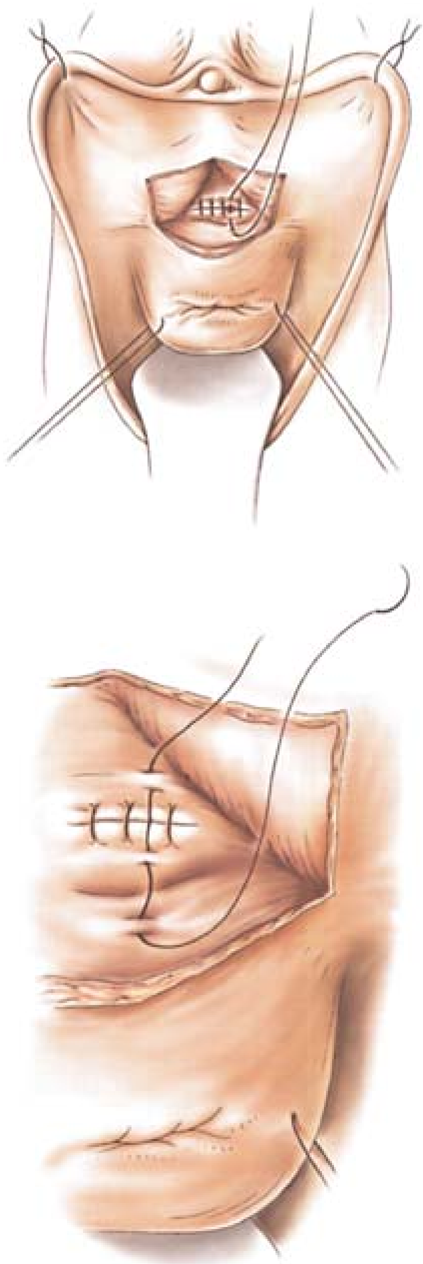


Figure 10

Vaginal repair of a juxtacervical fistula may be feasible if the cervix can be drawn down to provide access; dissection includes mobilization of the bladder from the cervix, and the repair should be undertaken transversely to reconstruct the underlying trigone and prevent distortion of the ureteric orifices. The lower diagram shows this in greater detail

they prepare the bowel prior to rectovaginal fistula repair, it is the author's preference to carry out formal

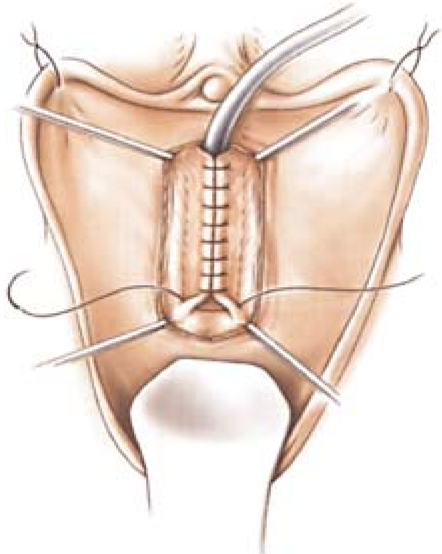


Figure 11

In urethral reconstruction a strip of anterior vaginal wall is constructed into a tube over a catheter

preparation in all cases of intestinogenital fistula, whatever the level of the lesion. A low-residue diet should be advised for a week prior to admission, followed by a fluid-only diet for 48 hours preoperatively. Polyethylene glycol 3350 (Klean-Prep, Norgine Ltd, Harefield, Middlesex, UK) four sachets in 4 litres of water over a 4-hour period, or alternatively sodium picosulphate (Picolax, Ferring Pharmaceuticals Ltd, Langley, Berks, UK) 10 mg repeated after 6 hours, is given orally on the day before operation. Bowel wash out should be carried out on the evening before surgery, and if the bowel content is not completely clear this procedure should be repeated on the morning of surgery.

Although dissection and repair in layers is appropriate for lesions high in the vagina the majority of rectovaginal fistulas low in the vagina are best repaired by converting them into a ‘complete perineal tear’ during the course of dissection (Figure 20). It is nevertheless important to be aware that a large proportion of anal sphincter defects follow inadequately performed operations on fistulas, and sphincter division is not to be embarked upon lightly. After excision of the fistula track and perineal scar, the vagina should be separated from the rectum (close to the fistula) and the prerectal fascia sufficiently to allow closure without tension. If intact, the cut ends of the external sphincter should be secured with stay sutures; if disrupted, the ends should be sought by dissection into the pararectal tissues. Only when all layers to be repaired are clearly dissected and identified should the repair be commenced.

The rectal wall is closed with a continuous suture using 3–0 polydioxanone, commencing above the limit of the dissection. The first layer includes muscularis (including the internal sphincter) and submucosa, but does not enter the bowel lumen. A second layer of sutures may be placed more superficially into the muscularis, although simply reconstructing the prerectal fascia over the rectal repair as an alternative is entirely appropriate.

The external sphincter should then be repaired using 3–0 polydioxanone or prolene sutures. The conventional end-to-end technique with a series of vertical mattress sutures has been found to be unsatisfactory in many cases, and the overlapping repair technique developed by Parks is perhaps particularly appropriate where there is sphincter deficiency in addition to the fistula (Figure 21). The repair

Figure 12

In colpocleisis for the treatment of a radiation fistula by the vaginal route, the dissection should be commenced well away from the fistula edge, aiming to be in normally vascularized tissues as far as possible. Several rows of sutures may be required

is accomplished by a series of interrupted sutures transfixing both layers of muscle, to achieve 2 cm overlap where possible. The superficial transverse perineal muscles are then reapproximated, and the vaginal wall is closed to the level of the hymenal ring, using continuous 2–0 polyglycolic acid. The perineal body may then be further built up using the medial fibres of the levator ani and bulbocavernosus muscles, before the perineal skin is closed. If interposition grafting is thought to be necessary, the Martius graft is the most appropriate for use in low rectovaginal fistula repair.

Postoperative management

Fluid balance

Nursing care of patients who have undergone urogenital fistula repair is of critical importance, and obsessional postoperative management may do much to secure success. As a corollary, however, poor nursing may easily undermine what has been achieved by the surgeon. Strict fluid balance must be kept, and an adequate daily fluid intake should be maintained until the urine is clear of blood. Haematuria is more persistent following abdominal surgery than vaginal procedures, and intravenous fluid is therefore likely to be required for longer in these patients.

Bladder drainage

Continuous bladder drainage in the postoperative period is crucial to success, and nursing staff should check catheters hourly throughout each day, to confirm free drainage and check output. Bladder irrigation and

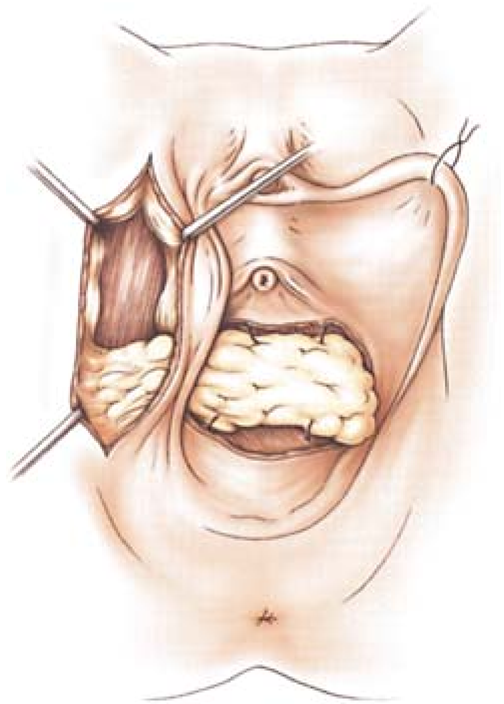


Figure 13

A Martius labial fat graft may often be necessary to fill dead space

suction drainage are not recommended. Views differ as to the ideal type of catheter. The calibre must be sufficient to prevent blockage, although whether the suprapubic or urethral route is used is to a large extent a matter of individual preference. The author's usual practice is to use a 'belt and braces (suspenders)' approach of both urethral and suprapubic drainage initially, so that if one becomes blocked free drainage is still maintained. The urethral catheter is removed first, and the suprapubic retained, and used to assess residual volume, until the patient is voiding normally.

The duration of free drainage depends on the fistula type. Following repair of surgical fistulas, 12 days is adequate. With obstetric fistulas up to 21 days' drainage may be appropriate, and following repair of radiation fistulas 21–42 days are required. If there is any doubt about the integrity of the repair it is wise to carry out dye testing prior to catheter removal. Where a persistent leak is identified free drainage should be maintained for 6 weeks.

Mobility and thromboprophylaxis

The biggest problem in ensuring free catheter drainage lies in preventing kinking or drag on the catheter. Restricting patient mobility in the postoperative period helps with this, and some advocate continuous bed rest during the period of catheter drainage. If this approach is chosen patients should be looked on as being at moderate to high risk for thromboembolism, and prophylaxis must be employed (see Chapter 4).

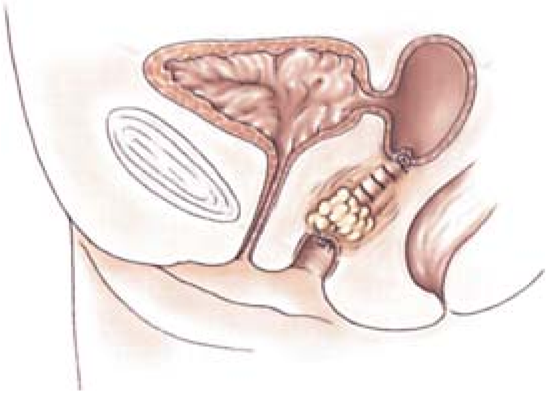


Figure 14

The vaginal or vulval skin is closed with interrupted sutures to cover the fat graft

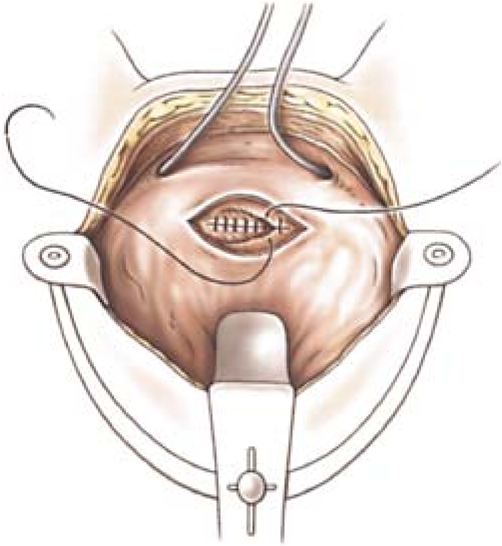


Figure 15

Transvesical fistula repair. After its mobilization from the overlying bladder wall, the vagina has been closed with a single layer of inverting interrupted sutures. The Figure shows the bladder being closed with a similar layer of interrupted sutures, picking up the vagina also to close dead space. A continuous suture will be inserted into the urothelium for haemostatic purposes

Antibiotics

Antibiotic cover is advised for all intestinovaginal fistula repairs. If prophylactic antibiotics are not used at urogenital fistula repair, catheter urine specimens should be collected for culture and sensitivity every 48 hours; only symptomatic infection need be treated in the catheterized patient.

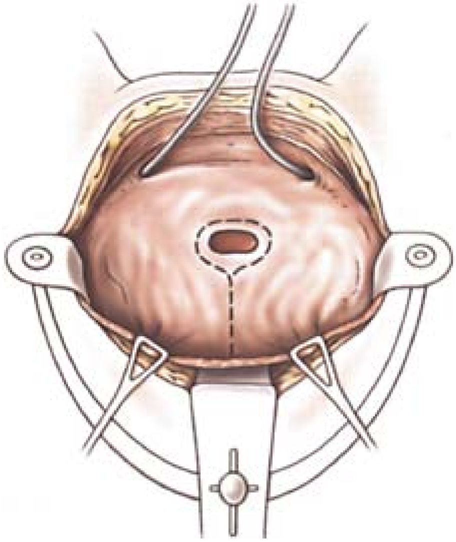


Figure 16

Transperitoneal transvesical repair. A midline split is made in the vault of the bladder, and is extended downwards in a racquet shape around the fistula

Bowel management

If patients are restricted to bed following urogenital fistula repair, a laxative should be administered to prevent excessive straining at stool. Following abdominal repair of an intestinovaginal fistula patients should either have a nasogastric tube inserted or be restricted to nil by mouth until they are passing flatus; the majority prefer the latter approach. Once oral intake is allowed, or following vaginal repair of a rectovaginal fistula, a low-residue diet should be administered until at least the fifth postoperative day. Some authorities advocate total parenteral nutrition throughout the first week postoperatively for all intestinovaginal fistulas. Enemas and suppositories should be avoided, although a mild aperient such as dioctyl sodium (docusate sodium) is advised to ease initial bowel movements.

Subsequent management

On removal of catheters most patients will feel the desire to void frequently, since the bladder capacity will be functionally reduced after being relatively empty for so long. In any case it is important that the bladder does not become overdistended, and hourly voiding should be encouraged and fluid intake limited. It may also be necessary to wake patients once or twice during the night for the same reason. After discharge from hospital patients should be advised gradually to increase the period between voiding, aiming to achieve a normal pattern by 4 weeks postoperatively.

Tampons, pessaries, douching and penetrative sex should be avoided until 3 months postoperatively.

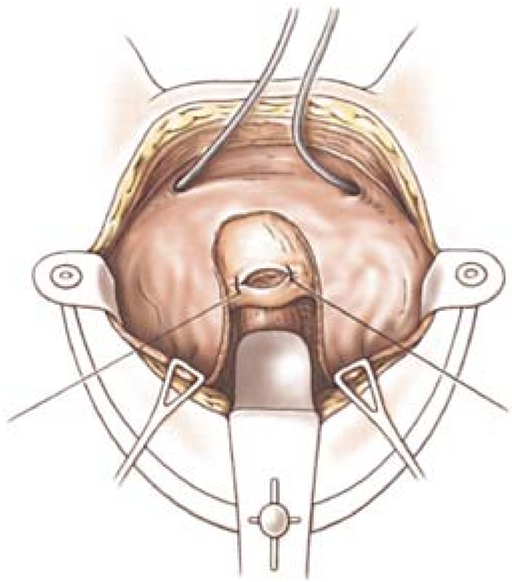


Figure 17

Transperitoneal transvesical repair. The fistulous track is excised and the vaginal or cervical defect closed in a single layer; the bladder is then closed in either one or two layers. An omental interposition graft may also be inserted, particularly when the technique is used for the repair of radiation fistula

Bibliography

Bladou F, Houvenaeghel G, Delpero J, Guerinel G (1995) Incidence and management of major urinary complications after pelvic exenteration for gynecological malignancies, *J Surg Oncol* **58:**91–6.

Chassar Moir J (1967) *The vesico-vaginal fistula*. London: Baillière.

Emmert C, Köhler U (1996) Management of genital fistulas in patients with cervical cancer, *Arch Gynecol Obstet* **259:** 19–24.

Hamlin R, Nicholson E (1969) Reconstruction of urethra totally destroyed in labour, *BMJ* **2:**147–50.

Hawley P, Burke M (1985) Anal sphincter repair. In: Henry M, Swash M, editors. *Coloproctology and the pelvic floor. Pathophysiology and management.* London: Butterworth; pp. 252–8.

Hilton P (1997) Fistulae. In: Shaw R, Souter W, Stanton S, *Gynaecology*. Edinburgh: Churchill Livingstone; pp. 779–801.

Hilton P (1997) Post-operative urogenital fistulae are best managed by gynaecologists in specialist centres, *Br J Urol,* **80 (suppl. 1):**35–42.

Hilton P (1998) Urodynamic findings in patients with urogenital fistulae, *Br J Urol,* **81:**539–42.

Hilton P (2000) Bladder drainage. In: Stanton SL, Monga AK, editors. *Clinical urogynaecology*. Edinburgh: Churchill Livingstone; 541–50.

Hilton P, Ward A (1998) Epidemiological and surgical aspects of urogenital fistulae: a review of 25 years experience in Nigeria, *Int Urogynecol J,* **9:**189–94.

Hudson C (1968) Malignant change in an obstetric vesico-vaginal fistula. *Proc Roy Soc Med,* **61:**121–4.

Jonas U, Petri E (1984) Genitourinary fistulae. In: Stanton S, editor. *Clinical gynecologic urology,* St Louis: CV Mosby; pp. 238–55.

Kelly J, Kwast B (1993) Epidemiologic study of vesico-vaginal fistula in Ethiopia, *Int Urogynecol J* **4:**278–81.

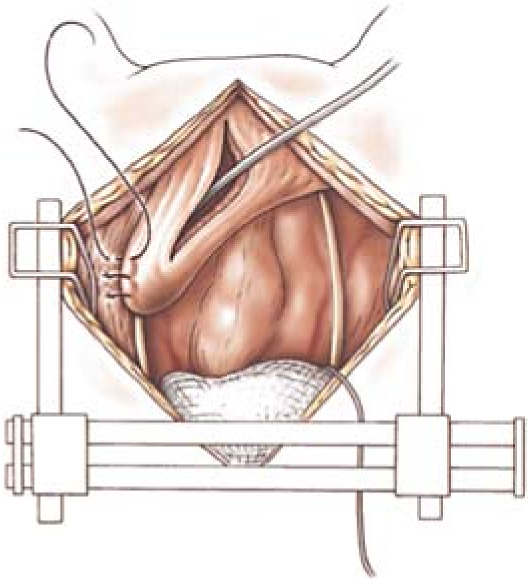


Figure 18

Ureteric re-implantations. Where the bladder cannot easily be mobilized sufficiently, a psoas hitch may allow reimplantation without tension

Kiricuta I, Goldstein A. (1972) The repair of extensive vesicovaginal fistulas with pedicled omentum: a review of 27 cases, *J Urol* **108:**724–7.

Lawson J (1972) Vesical fistulae into the vaginal vault, *Br J Urol* **44:**623–31.

Lawson J (1978) The management of genito-urinary fistulae, *Clin Obstet Gynaecol* **6:**209–36.

Lawson J, Hudson C (1987) The management of vesico-vaginal and urethral fistulae. In Stanton S, Tanagho E, editors, *Surgery for female urinary incontinence.* Berlin: Springer; pp. 193–209.

Lee R, Symmonds R, Williams T (1988) Current status of genitourinary fistula, *Obstet Gynec* **71:**313–19.

Parks A, McPartlin J (1971) Late repair of injuries of the anal sphincter, *Proc Roy Soc Med* **64:**1187–9.

Sultan A, Kamm M, Hudson C, Bartram C (1994) Third degree obstetric anal sphincter tears: risk factors and outcome of primary repair, *BMJ* **308:**887–91.

Waaldijk K (1989) The surgical management of bladder fistula in 775 women in Northern Nigeria. MD Thesis, University of Amsterdam.

White A, Buchsbaum H, Blythe J, Lifshitz S (1982) Use of the bulbocavernosus muscle (Martius procedure) for repair of radiation-induced recto vaginal fistulas, *Obstet Gynecol* **60:**114–18.

World Health Organization (1989) *The prevention and treatment of obstetric fistulae: a report of a Technical Working Group*. Geneva: WHO.

Yeates W (1987) Uretero-vaginal fistulae. In: Stanton S, Tanagho E, editors. *Surgery for female urinary incontinence,* Berlin: Springer, pp. 211–17.

Zacharin R (1988) *Obstetric fistula*. Vienna: Springer.

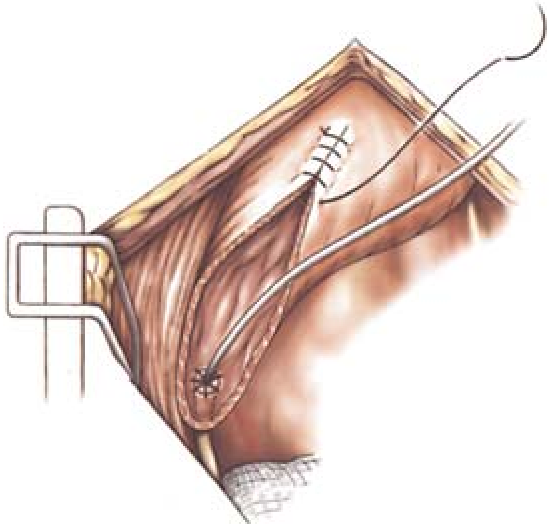


Figure 19

For high ureteric injury the Boari-Ockerblad technique may be appropriate, utilizing a flap of bladder wall to fill the deficiency

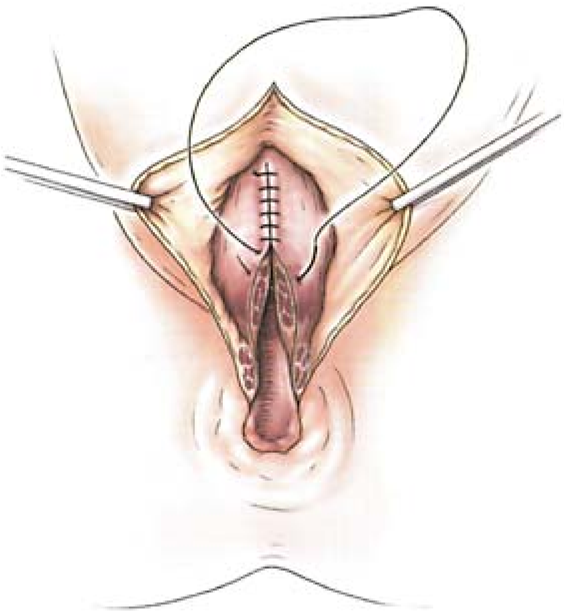


Figure 20

Repair of a low rectovaginal fistula. After the lesion has been converted into a ‘complete perineal tear’, the tissues are widely mobilized. The rectal wall is closed using a continuous suture

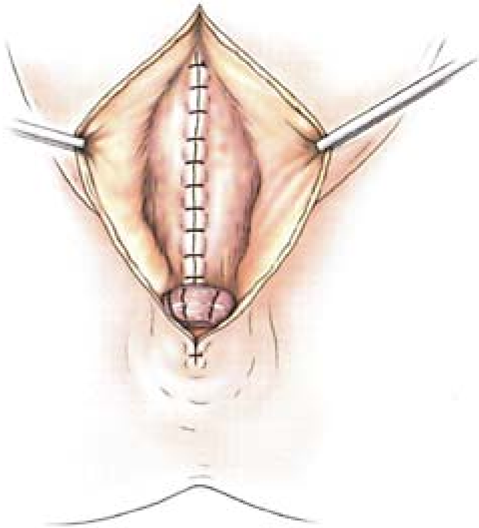


Figure 21

The ‘overlapping’ technique of sphincter repair

20
Treatment of vascular defects and injuries

Karl A Illig

Kenneth Ouriel

Introduction

The pelvis and groin contain a complex web of blood vessels. Given the magnitude of resection often needed when treating pelvic malignancies, it is not uncommon to be faced with the need to address major vascular issues. These fall into three general categories: inadvertent injuries requiring repair; planned resection as part of tumor excision, requiring reconstruction; and caval interruption to prevent pulmonary embolism.

It should be remembered that preservation of life through control of hemorrhage takes priority over preservation of blood flow to the limbs.

Indications

The primary indication for vascular repair is, of course, a vascular injury. Major blood vessels may at times need to be resected along with the specimen as part of en bloc extirpation. Not every defect requires reconstruction, however.

The aorta and common and external iliac arteries form the blood supply to the legs, and must always be reconstructed if the limb is to remain viable. If direct reconstruction is not possible, an 'extra-anatomic' (femoral-femoral or axillary-femoral) bypass can be constructed to preserve limb blood flow. Venous bleeding can be much more serious than arterial bleeding, primarily because the thin walls and prodigious tributaries make control and repair difficult. Collateral drainage, also, is rich. These two concepts suggest that virtually any vein, including the cava, can be ligated if absolutely necessary. At times a venous reconstruction will be required, but urgency is less than after ligation of arterial structures.

Anatomic considerations

The two hypogastric (internal iliac) arteries and the inferior mesenteric artery (IMA) together supply blood flow to the pelvis, including the buttocks, left colon, and terminal spinal cord. It is a near-absolute requirement that at least one of these three vessels be preserved. The IMA is frequently the least important source of pelvic blood flow; every effort should be made, however, to preserve at least one hypogastric artery. Within these guidelines, essentially any other vessel can be ligated with impunity.

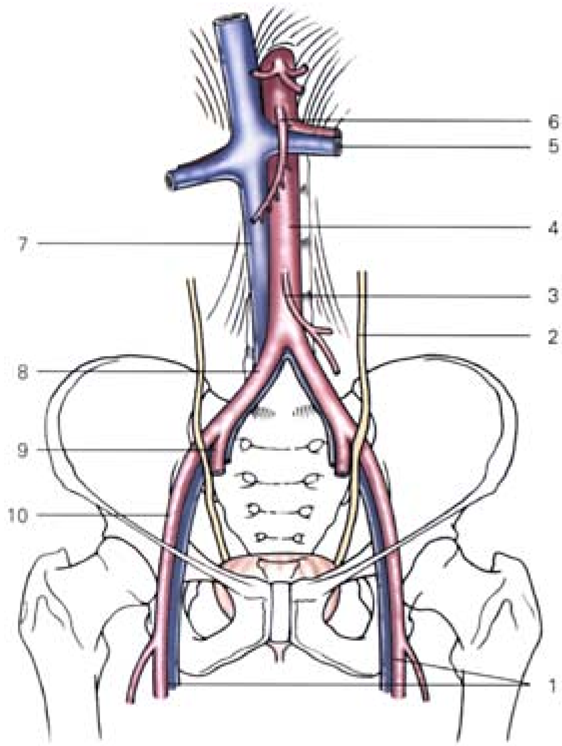


Figure 1

Abdominal and pelvic vasculature

1 Femoral artery and vein

2 Ureter

3 Inferior mesenteric artery

4 Aorta

5 Renal artery and vein

6 Superior mesenteric artery

7 Inferior vena cava

8 Common iliac artery and vein

9 Internal iliac artery and vein

10 External iliac artery and vein

The anatomy of the lower abdominal, pelvic and groin vasculature is illustrated in Figures 1 and 2. Remember that arteries are thick-walled, resistant to tearing, and easier to repair than veins. Veins, by contrast, are thin-walled, do not hold their shape, and tear easily.

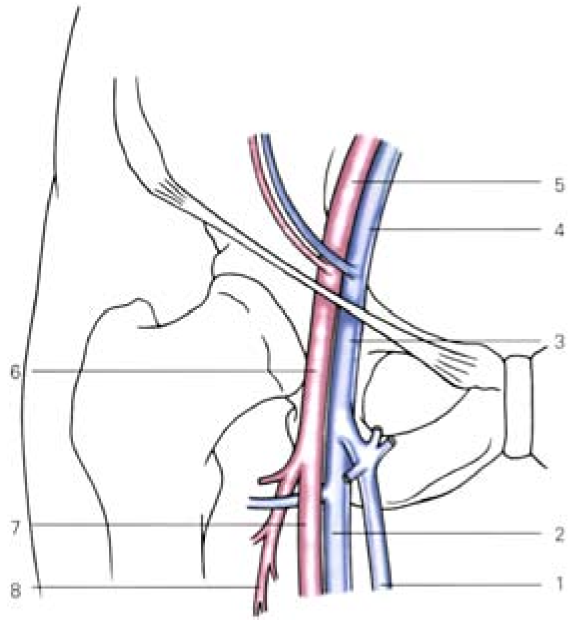


Figure 2

Vasculature of the groin

1 Saphenous vein

2 Superficial femoral vein

3 Common femoral vein

4 External iliac vein

5 External iliac artery

6 Common femoral artery

7 Superficial femoral artery

8 Deep femoral artery (profunda)

The veins tend to lie behind the arteries (Figure 3). This is critically important at the region of the aortic bifurcation and proximal iliac arteries, where dissection behind the arteries (circled area) or within the aortic bifurcation can easily precipitate massive, life-threatening venous hemorrhage.

In general, trying to control an injury directly is counterproductive. For arterial injuries, proximal and distal control at sites remote from the bleeding are required (Figure 4). Direct clamping can sometimes be problematic, for example in the hypogastric arteries. In these cases control can be accomplished by intraluminal balloon catheter occlusion. For venous injuries, direct pressure or packing while the situation is sorted out is much more useful than trying to see the injury or control it with a clamp. Direct manipulation with rigid instruments will often extend the tear and worsen the situation.

For vessel repair, autologous tissue is usually preferred (especially in a potentially infected field), although this ‘rule’ must often be violated. An option in unfavorable situations is to route a graft through an

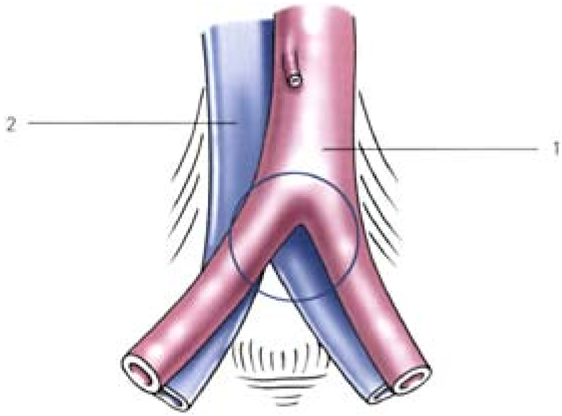


Figure 3

Aortic bifurcation—a danger area (circled)

1 Aorta

2 Vena cava

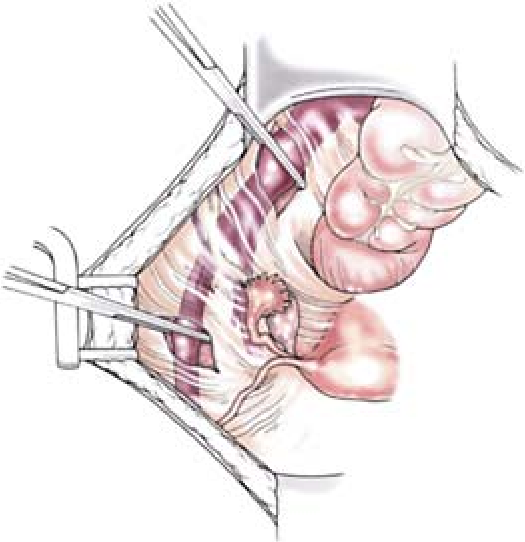


Figure 4

Control at sites remote from the bleeding is essential for arterial injuries

unviolated, ‘extra-anatomic’ plane. If vessel resection is planned or possible, include a source of autogenous vein (e.g. a leg, circumferentially prepared) in the surgical field (Figure 5).

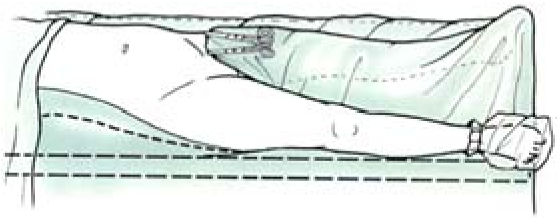


Figure 5

Draping to gain access for saphenous vein harvest

Operative procedure

The best procedure to follow in any unplanned vascular injury is first to control the bleeding with direct pressure; this may be accomplished with a finger or by packing with a sponge. Once the bleeding is controlled, get help (in terms of both additional staff and specialist advice, when needed) and formulate a plan before anything further is done.

Arterial control and repair

When dealing with an arterial injury or planned resection and repair, proximal and distal control are vitally important—this point cannot be overemphasized. In general, circumferential dissection of the aorta and common iliacs is counterproductive because of the risk of venous injury; dissection limited to the sides is usually sufficient. If the aorta is to be clamped, dissection should be carried down to the spine. In all arterial surgery, a dissection plane directly on the arterial adventitia is easiest and safest (Figure 6). Systemic heparin (125 units/kg) should be administered before clamping if bleeding is not diffuse; anticoagulation is reversed after blood flow is re-established with protamine sulfate (1 mg per 100 units of heparin administered).

The ureter passes over the iliac bifurcation (Figure 7), making continuous exposure of the top of the iliac vessels problematic.

Small lacerations of the major vessels, especially if oriented transversely to the vessel axis, can be repaired using monofilament, nonabsorbable suture (3–0 or 4–0 for the aorta, 5–0 for the iliac arteries). When the artery is diseased, the needle should be passed from inside to outside to avoid dislodging intraluminal plaque. All knots should be extraluminal (Figure 8). Direct repair of longitudinal injuries in the iliac (or smaller) vessels will usually narrow the lumen, so patch repair is preferred (Figures 9 and 10).

Any defect involving actual tissue loss, especially encompassing the entire circumference of a vessel, will usually require an interposition graft and is beyond the scope of this discussion.

Venous control and repair

Major venous injuries, somewhat paradoxically, can be more life-threatening than arterial defects. Veins are thin-walled, do not hold their shape, and are often less accessible. When faced with a major venous injury (dark, nonpulsatile bleeding), the first step is to apply gentle pressure. The temptation to control the injury with forceps or a clamp, even if the tear is apparently visible, should be resisted; doing so will often extend the tear and often convert a remediable situation into one that is very serious indeed. Several options are available. First, pressure itself will often solve the problem; if you are fortunate, resist the temptation to fiddle any further! Don't look, don't dissect, just accept your good fortune and move on. Second, pressure

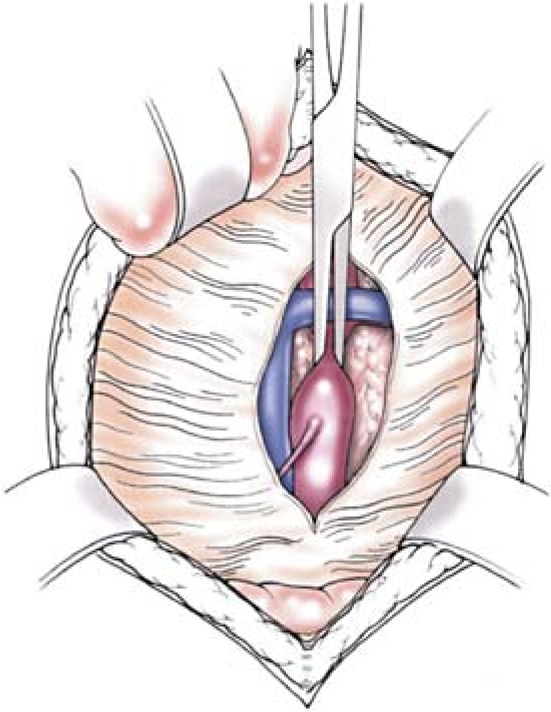


Figure 6

Exposure of the infrarenal aorta (duodenum is retracted laterally and superiorly). Note that the aorta itself is well cleared

proximally and distally, without any dissection (e.g. digitally or with sponge-sticks), can control the bleeding enough to make the defect visible. Third, blind suturing is sometimes acceptable if no critical structures (such as the ureter) are near. Finally, ligation is usually safe and well tolerated, especially if the patient's life is at risk.

In these situations, obtaining help, in terms of both experienced assistants to provide exposure and vascular surgical assistance, is of utmost importance, as is gaining control of the hemorrhage without doing further damage so that a plan can be formulated and carried out.

Vascular patches

Most longitudinal defects, even if no tissue is resected, will result in a narrowed lumen if repaired primarily. Thus, patch angioplasty is required for repair of most longitudinal defects in the iliac or smaller vessels.

Autologous tissue is preferred, especially in the presence of a potentially infected field. The greater saphenous vein is an excellent choice, as is the hypogastric artery It is important that the endothelial surface should be oriented luminally If, in a clean field, autologous tissue is not available, Dacron or polytetrafluoroethylene (PTFE) can be used. Fine monofilament nonabsorbable suture material is used. A continuous suture is perfectly adequate. Exposure is best achieved by starting at one end and placing the first two or three stitches in a 'parachute' fashion before bringing the patch in contact with the vessel (see Figure 9). The first ('heel') suture should be mattressed so that the needle always passes from inside to

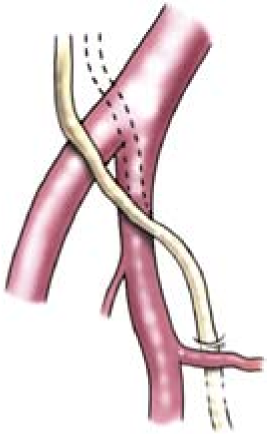


Figure 7

Ureter and the iliac bifurcation

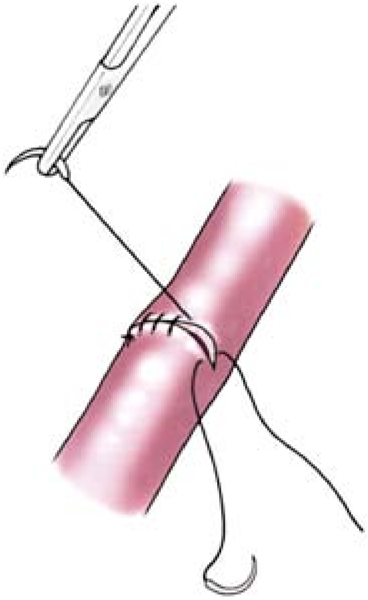


Figure 8

Suture technique for closure of a transverse arteriotomy

outside the artery. The suture is then continued around the patch and the knot tied along a long end of the patch (see Figure 10).

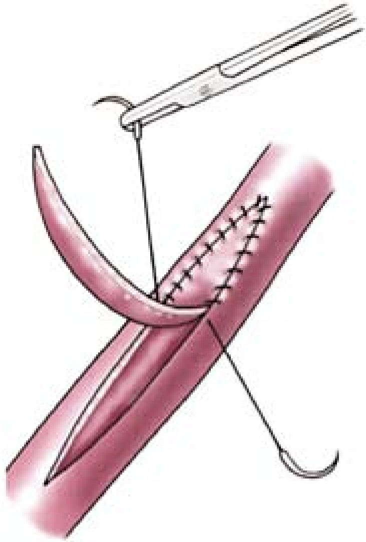


Figure 9

Initial stages of longitudinal arteriotomy: patch closure

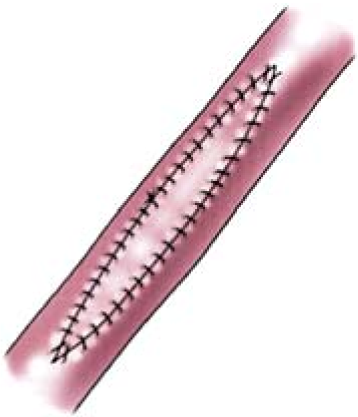


Figure 10

Completed closure

Caval interruption

Malignancy has long been known to be associated with hypercoagulability. When combined with pelvic surgery, immobilization and often advanced age, the risk of deep venous thrombosis and pulmonary embolus is frequently high enough to warrant prophylactic caval interruption. Caval interruption can be performed by placement of one of variety of intraluminal devices percutaneously via the groin or subclavian vein into the infrarenal cava. During laparotomy, however, the cava can be effectively interrupted by means of an external clip.

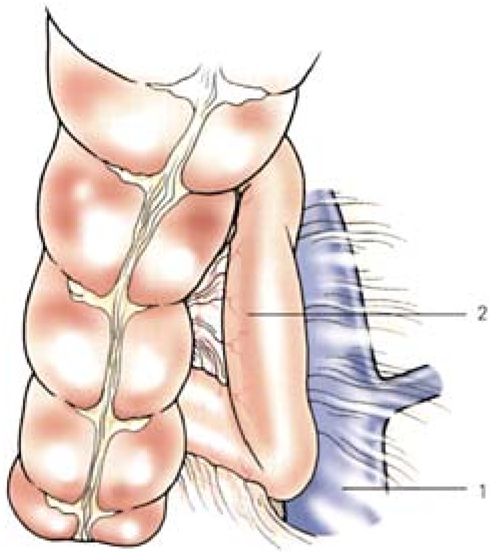


Figure 11

Location for the clip

1 Inferior vena cava

2 Colon and duodenum being mobilized to right

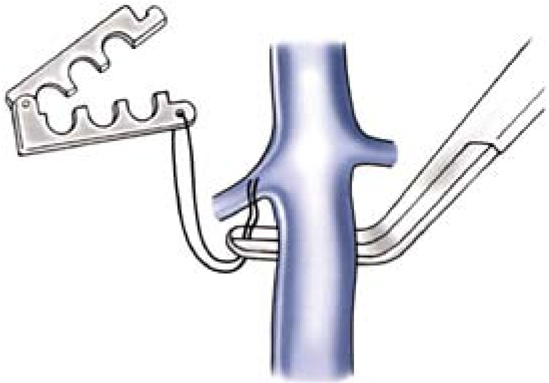


Figure 12

A clamp is used to grasp the string attached to the DeWeese-Adams clip

The clip is applied to the inferior vena cava (IVC) below the level of the renal veins (Figure 11). The cava is exposed by mobilizing the right colon and the duodenum in the avascular plane (Kocher maneuver). Circumferential exposure along a short length of the IVC is required.

A large right-angled clamp is gently passed behind the cava and used to grasp the string attached to the bottom jaw of the clip (Figures 12–l4). The bottom jaw is then gently brought behind the cava, and the string tied over the notch on the top, bringing the jaws together over the cava. This creates multiple small channels, each incapable of allowing a significant embolus to pass. Even though pulmonary embolus is

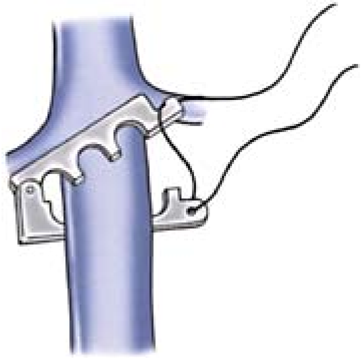


Figure 13

The clip is brought around the inferior vena cava

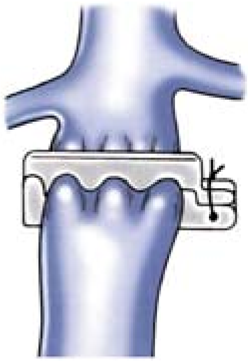


Figure 14

The clip in position

prevented with a high degree of certainty, if a deep venous thrombosis of the leg is present, anticoagulation is best continued (if not contraindicated) in an attempt to reduce the risk of extension of clot and post-phlebitic sequelae.

Bibliography

Ballew KA, Philbrick JT, Becker DM (1995) Vena caval filter devices, *Clinics in Chest Med* **16:**295–305.
Ouriel K, Rutherford RB (1998) *Atlas of vascular surgery: operative procedures*. Philadelphia: WB Saunders Co.
Rutherford RB (1993) *Atlas of vascular surgery: basic techniques and exposures* . Philadelphia: WB Saunders Co.

21
Plastic reconstructive procedures

Peter G Cordeiro

Richard R Barakat

Introduction

Surgical cure demands adequate disease-free margins. Since large debulking procedures are often necessary, reconstructive techniques must be available for the completion of therapy. Several different techniques can be used for the reconstruction of the pelvis and perineum. The rectus abdominis muscle flap is a very versatile flap, useful in covering many defects. It is highly reliable, with a consistent vascular supply and muscular development. The gracilis flap has been popular for many years for vaginal reconstruction, but it is somewhat less reliable. The pudendal thigh flap is relatively simple and has the distinction of being at least partially sensate. The final two flaps described here are the simplest but no less useful: the bulbocavernosus flap is particularly suitable for obstetric as well as oncologic defects on the vesicovaginal and rectovaginal septa; while advancement flaps may be the easiest of these techniques and the most often used to release tension on many different incisions.

Anatomic considerations

Vascular supply

Skin vascularization may be direct or indirect. Direct vessels travel along nerve fibers, between muscles and along fascial planes to enter the skin. Indirect vessels arise from named vessels as perforators of the fascia from the underlying muscle. Free flaps, which require microsurgical anastomoses, depend on the direct vascular supply. Peninsular flaps (e.g. advancement flaps) may have a well-defined blood supply or depend upon intrafascial and suprafascial blood flow through the preserved skin bridge. Island flaps (e.g. gracilis flap) require a well-defined vascular pedicle to support the indirect blood supply to the overlying skin. Certain muscles used for flaps have a single dominant vascular pedicle (e.g. epigastric vessels for the rectus abdominis) or one dominant vascular pedicle with several minor ones (e.g. the medial femoral circumflex or femoral artery for the gracilis muscle) (Figures 1 and 2). It may not therefore be possible to identify a distinct blood supply for the gracilis flap. Some surgeons recommend confirming perfusion prior to completion of this flap. Pedicled flaps are also characterized by the ability to convert a nonterminal artery (e.g. the inferior epigastric artery) into a terminal artery. This is due to the blood flow reversal possible in the venae comitantes. The pudendal thigh flap, a peninsular flap, derives its blood supply mostly from the posterior labial vessels and the anastomotic channels involving the medial femoral circumflex and the

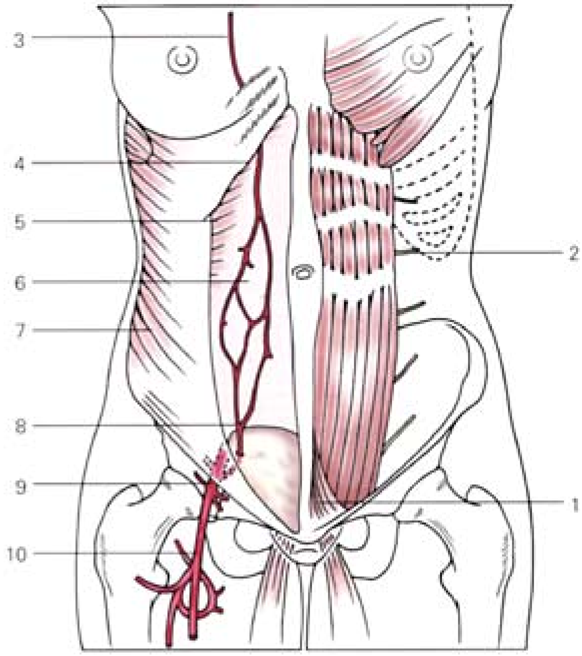


Figure 1

Sources of possible vascular pedicles

1 Pyramidalis muscle

2 Intercostal nerve

3 Internal mammary artery

4 Superior epigastric artery

5 Internal oblique muscle

6 Posterior rectus sheath

7 External oblique muscle

8 Arcuate line

9 Inferior epigastric artery

10 Femoral artery

obturator arteries. The bulbocavernosus flap is supplied by the external pudendal arteries. Knowledge of the vascular anatomy will allow better planning of the available territories for covering defects.

Nerve supply

No major nerve should be encountered during these reconstructive procedures. Although the gracilis muscle is innervated by a branch of the obturator nerve, it is usually not identified as a distinct structure. As with all surgical procedures, some loss of sensation will be encountered in the operative field. Because

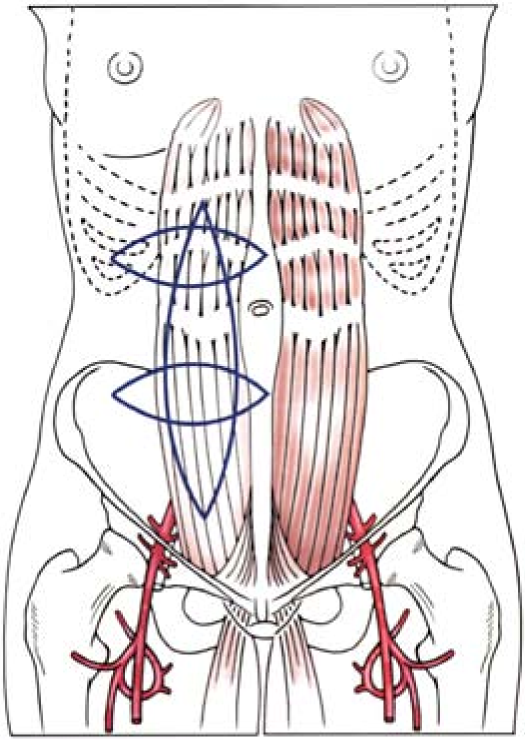


Figure 2

Possible elliptical skin islands

reconstructive surgery involves the retention of a large skin island after it is severed from its nerve supply (e.g. the rectus flap), the patient may be more aware of this deficiency than after nonreconstructive surgery. The orientation of the pudendal thigh flap may allow retention of some sensation.

Muscles involved

The rectus abdominis muscle inserts in the pubic tubercle and arises from the sixth, seventh and eighth ribs. It plays a role in protecting the abdominal contents, breathing and defecating, and stabilizes the pelvis during walking. The gracilis muscle arises from the pubic tubercle and inserts onto the medial tibia pes anserinus. It helps to stabilize the knee and laterally rotates the thigh. The bulbocavernosus muscle runs along the underside of the labia minora from the clitoris posteriorly. Loss of these muscles is usually compensated for by the remaining muscles in their functional group so that no significant motor defect remains.

Bony landmarks

A useful landmark in gynecologic reconstructive surgery involves the identification of the gracilis flap. A line drawn from the pubic symphysis to the medial epicondyle should approximate the anterior border of the gracilis muscle.

Indications

The rectus abdominis muscle is used for upper vaginal reconstruction, coverage of the pelvis, and defects of the pubic, inguinal and perineal regions. The gracilis myocutaneous flap is used primarily for coverage of perineal defects and reconstruction of the vagina when all or most of the distal vagina is absent.

The pudendal thigh flap is a useful fasciocutaneous flap for repairs of the perineum, vulva and vagina. A total vaginal reconstruction can be performed using bilateral pudendal flaps.

The bulbocavernosus flap is used for repair of fistulas, including radiation-induced defects, involving the vagina, rectum, bladder, and urethra.

Full-thickness cutaneous advancement flaps are used to reduce skin tension to permit closure of defects of varying sizes following vulvar surgery.

Operative procedure

The rectus abdominis flap

The flap is dissected with the patient supine or in the lithotomy position. Skin islands may be designed in a wide variety of shapes and orientations as long as a significant portion of the skin and subcutaneous tissues are centered over the muscle. In most cases an elliptical skin island is oriented vertically over the muscle (Figure 2). For vaginal reconstruction, a more transversely oriented skin island may be designed above or below the level of the umbilicus, depending on the placement of ostomy sites. The skin islands should approximate the dimensions of the defect to be covered.

The skin incision is carried down to the level of the anterior rectus sheath; subcutaneous tissue and skin are then elevated off the sheath to allow an incision through the fascia to be made 1 cm from the lateral edge of the muscle (Figure 2). The dissection is then carried around the anterior and lateral surfaces of the muscle to the posterior surface. Care is taken to minimize injury to the tendinous intersections while mobilizing the muscle. The muscle can be divided above the level of the costal margin if needed. The muscle is then dissected away from the abdominal wall in a distal to proximal direction along the posterior rectus sheath towards the inferior epigastric pedicle. Several large intercostal perforators are ligated laterally and the deep inferior epigastric pedicle (artery and two venae comitantes) is then identified and dissected out of its origin from the iliac vessels (Figure 3). The insertion of the muscle into the pubic symphysis can be left intact or detached, depending on the arc of rotation that is required. For vaginal reconstruction the skin island can be tubed and shaped into a pouch. It is then sutured to the remaining vaginal cuff from above. If perineal coverage is necessary, the flap can be tunneled in the subcutaneous plane over the inguinal ligament into the perineum or groin as needed (Figure 4). The donor site is closed primarily by approximating the remaining 1 cm cuff of anterior rectus sheath to itself with a large, non-absorbable suture. If necessary, skin and subcutaneous tissue flaps can be mobilized to reapproximate the skin flaps in the abdominal donor site.

The gracilis flap

The patient is usually placed in the lithotomy position for resections in this area. The hips are flexed and abducted. The medial thigh is prepared circumferentially down to the knee allowing access to the medial group of muscles. Figure 5 shows the underlying anatomy

An elliptical skin island measuring up to 6 cm 3 20 cm is outlined over the proximal two-thirds of the muscle (Figure 6). The anterior border of the incision lies on a line drawn between the pubic tubercle and the semitendinosus tendon. A separate, small access incision may be made distally if needed to identify the muscle tendon.

The skin is incised anteriorly down to the medial group of muscles. The sartorius muscle is identified and retracted superiorly. The gracilis tendon can now be identified distally, usually through a separate short distal incision, and the tendinous insertion divided (Figure 7). The posterior incision is made down to the muscle, taking care not to undermine perforators from the muscle to the skin or to shear the cutaneous aspect of the flap off the muscle. The flap is then elevated from distal to proximal on the thigh. One or two large perforators to the muscle are ligated distally. The main pedicle is identified entering the proximal third of the gracilis muscle in the space between the adductor longus and adductor magnus muscles (Figure 8), approximately 8–10 cm below the pubic tubercle. Once the pedicle is identified and preserved, the proximal muscle can be dissected and, if necessary, the origin from the pubic symphysis may be divided. The entire myocutaneous flap can then be tunneled through the subcutaneous skin bridge into the vaginal defect (Figure 9) and exteriorized through the introitus (Figure 10). The bilateral flaps are sutured to each other in the midline (Figure 11). The neovagina is shaped into a pouch by approximating the anterior, posterior, and distal skin edges of the flaps (Figure 12); this can then be inserted into the pelvic space that is left after the exenteration. The proximal end of the neovagina is sutured to the introitus (Figure 13).

Fasciocutaneous neurovascular pudendal thigh flaps

The fasciocutaneous flap is based on the posterior labial arteries, which are a continuation of the perineal artery. The posterior aspect of this flap is innervated by the posterior labial branches of the pudendal nerve and the perineal branches of the posterior cutaneous nerve of the thigh.

The patient is placed in the lithotomy position. A flap 3–6 cm wide and 10–15 cm long can be designed within the medial groin crease just lateral to the labia majora and the defect. Bilateral flaps can be designed for total vaginal reconstruction. The perineal defect is partially closed anteriorly and posteriorly leaving an entrance of suitable size into which the neovagina will be inserted (Figure 14).

The skin and subcutaneous tissues are incised as well as the deep fascia overlying the muscles of the medial thigh compartment as they insert onto the pubis and ischium (Figure 15). The flap is then elevated from distal to proximal in the subfascial plane over the adductor muscles in order to avoid injury to the neurovascular pedicle (Figure 16). The large distal branches of the perineal and pudendal vessels are identified and preserved. Often the dissection is carried into the fat of the ischiorectal fossa in order to achieve adequate rotation and mobilization of the flap. The flap can then be rotated into the defect. The donor site is closed primarily in layers. A neovaginal pouch can be reconstructed by suturing the lateral margins of bilateral flaps to each other (Figure 17); the neovagina is then transposed into the rectovesical space and the proximal ends sutured into the new vaginal introitus.

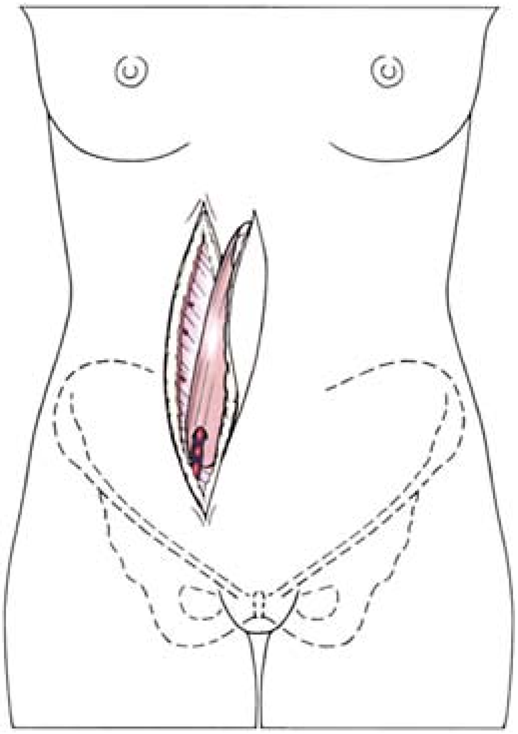


Figure 3

Rectus abdominis myocutaneous flap elevated. Note the inferior epigastric pedicle entering the caudal aspect of the flap

The bulbocavernosus flap

The procedure is performed with the patient in the lithotomy position. An elliptical skin island, usually oriented vertically, is created over either labium majus (Figure 18). The skin incision over the labium majus is carried down to the bulbocavernosus muscle in the anterior vulva. Skin, subcutaneous tissue, and muscle are then mobilized on a posterior vulvar pedicle (Figure 19). A tunnel is created from the vaginal wall to the base of the myocutaneous flap and the flap is pulled through the tunnel to the fistula site (Figure 20). The skin edges of the flap are sutured to the vaginal mucosa with the muscle of the pedicle projecting into the bladder or rectum, where it will develop an epithelial lining. The labial incision is then closed (Figure 21).

Full-thickness cutaneous advancement flaps

Cutaneous advancement flaps (V-Y procedure, Z-plasty) are useful to close wounds under tension, where mobilization of adjacent skin and subcutaneous tissue can reduce skin tension and allow adequate skin approximation.

The procedure is performed with the patient in the lithotomy position. Skin islands of varying sizes and shapes can be created adjacent to the defect as long as the patient has a good microvasculature (Figure 22). The skin and subcutaneous tissue are mobilized from the underlying fascia of the transverse perineal muscle

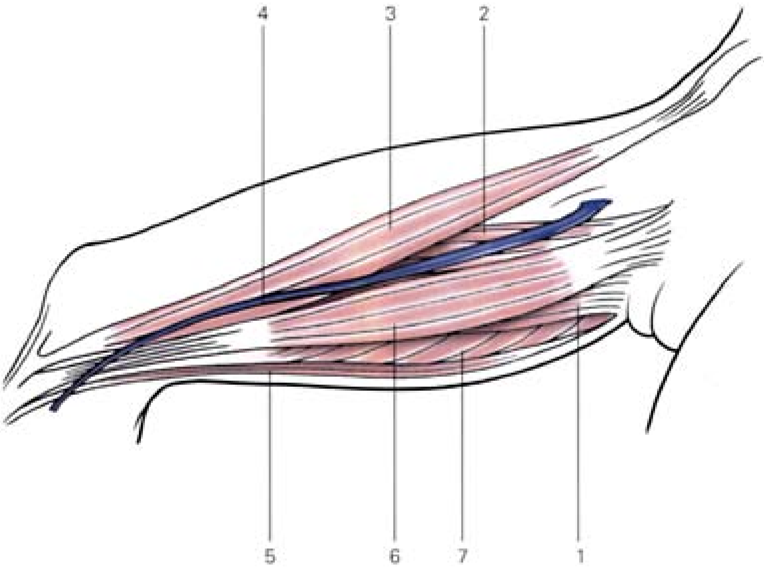


Figure 4

The anterior rectus fascia is approximated

(Figure 23). The size of the pedicle graft is tailored to the size of the defect. The pedicle flap is undermined and in a Z-plasty is rotated through 90° to fill the defect (Figure 24). Once the flap is rotated, the remaining skin edges are united (Figure 25). In a V-Y procedure the initial wedge (Figure 26) is advanced to fill the gap and then closed as a Y (Figure 27). Prolene 4– 0 sutures should be used for these closures.

Bibliography

Martello JY, Vasconez HC (1995) Vulvar and vaginal reconstruction after surgical treatment for gynecologic cancer, *Clin Plast Surg* **22:**129–40.

McCraw JB, Massey FM, Shanklin KD et al (1976) Vaginal reconstruction with gracilis myocutaneous flaps, *Plast Reconstr Surg* **58:**176–83.

Tobin GR, Day TG (1988) Vaginal and pelvic reconstruction with distally based rectus abdominis and myocutaneous flaps, *Plast Reconstr Surg* **83:**62–73.

Tobin GR, Pursell SH, Day TG Jr (1990) Refinements in vaginal reconstruction using rectus abdominis flaps, *Clin Plast Surg* **17:**705–12.

Wee JT, Joseph VT (1989) A new technique of vaginal reconstruction using neurovascular pudendal thigh flaps. A preliminary report, *Plast reconstr Surg* **83:**701–9.

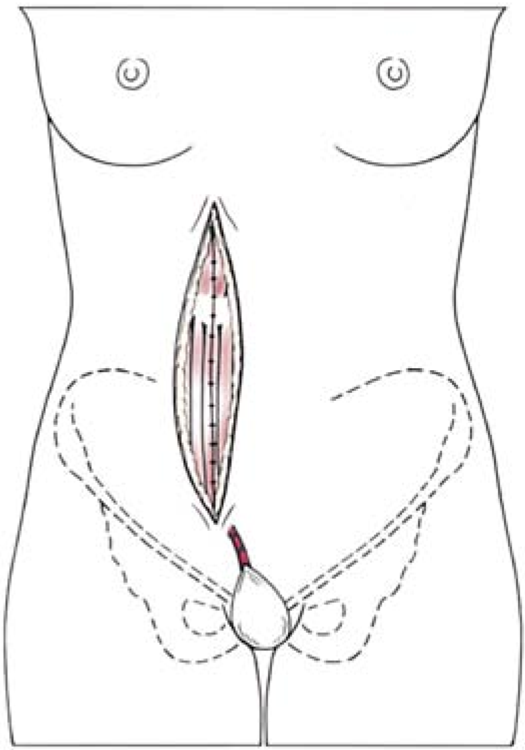


Figure 5

Underlying anatomy of medial thigh

1 Adductor magnus muscle

2 Adductor longus muscle

3 Sartorius muscle

4 Great sartorius muscle

5 Semitendinosus muscle

6 Gracilis muscle

7 Semimembranosus muscle

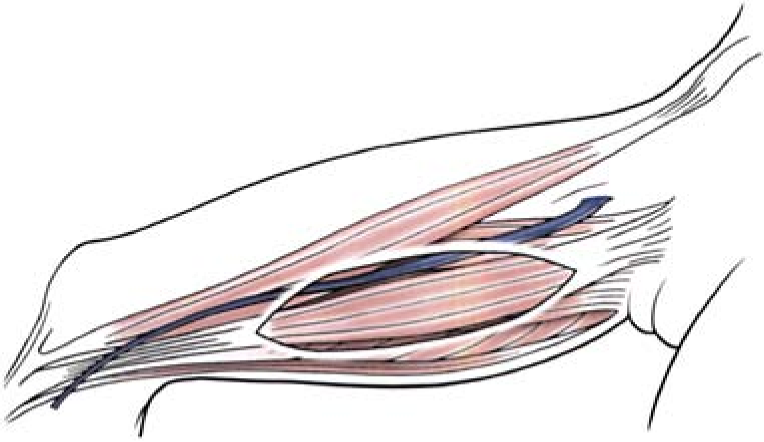


Figure 6

Outline of skin island over proximal two-thirds of gracilis muscle

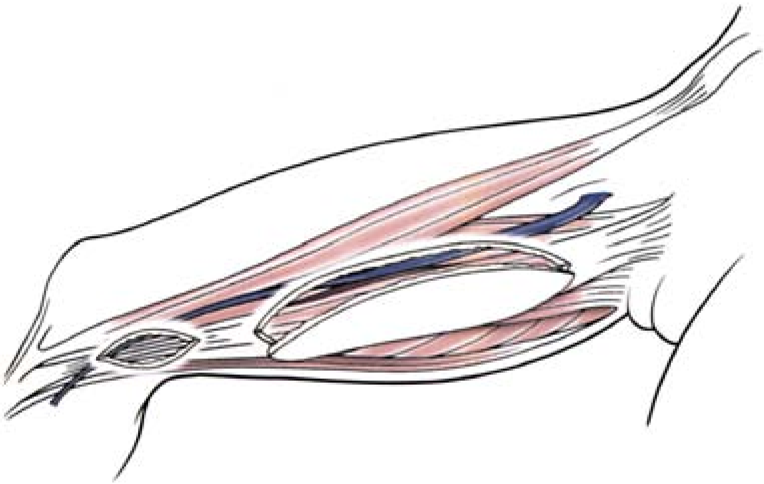


Figure 7

Skin and cutaneous skin island incised and distal gracilis muscle identified near knee

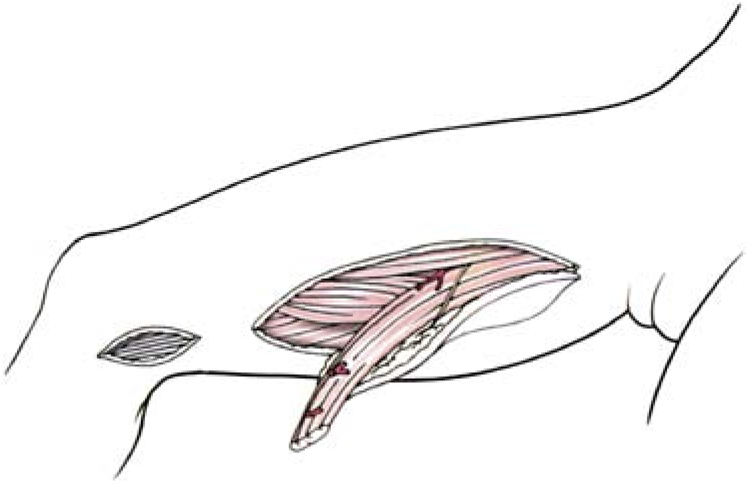


Figure 8

Myocutaneous flap elevated. Note neurovascular pedicle entering into proximal third of muscle

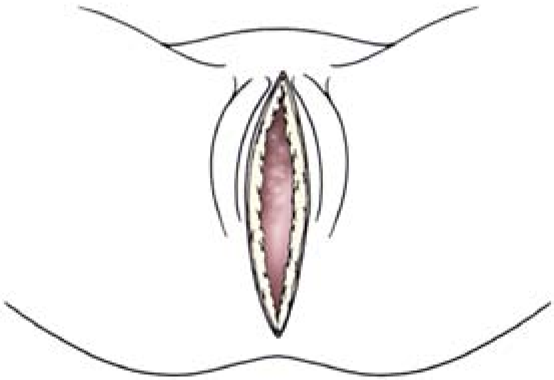


Figure 9

Typical defect in perineum after total pelvic exenteration

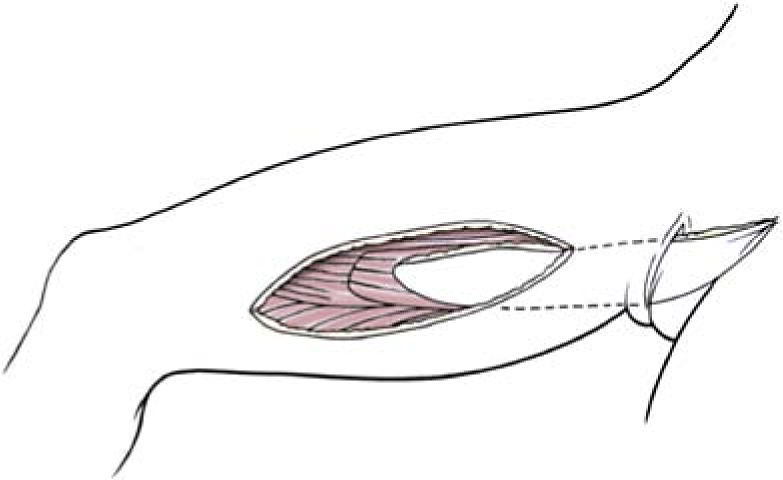


Figure 10

Myocutaneous flap exteriorized through the introitus

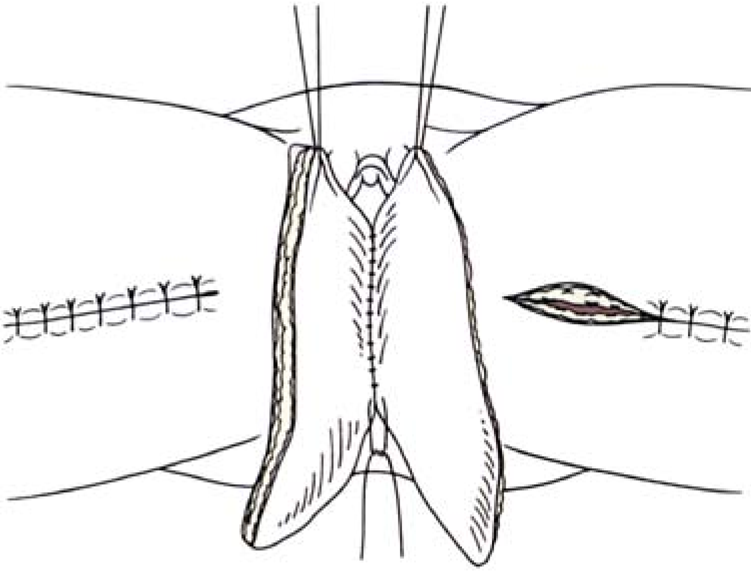


Figure 11

Bilateral gracilis myocutaneous flaps sewn together

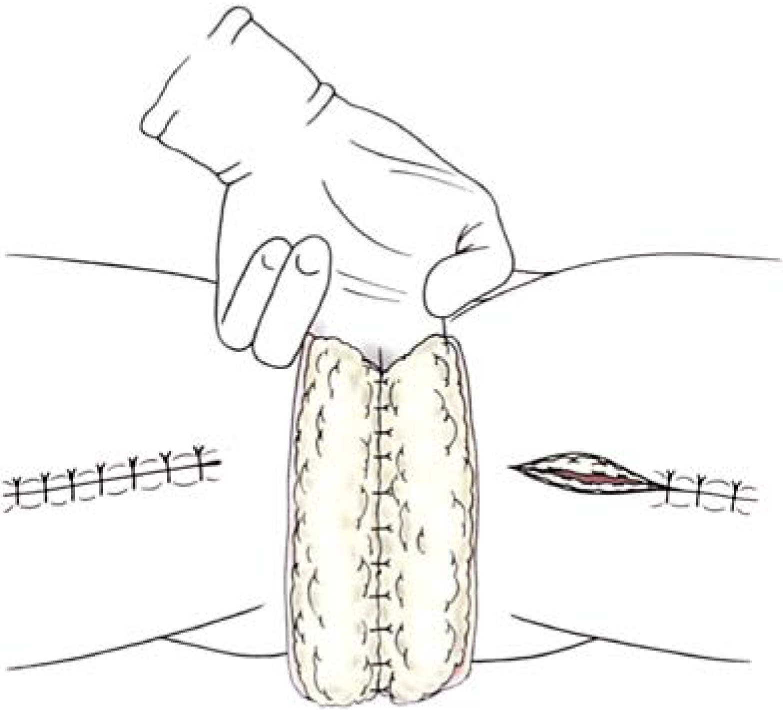


Figure 12

Bilateral flaps shaped into a pouch

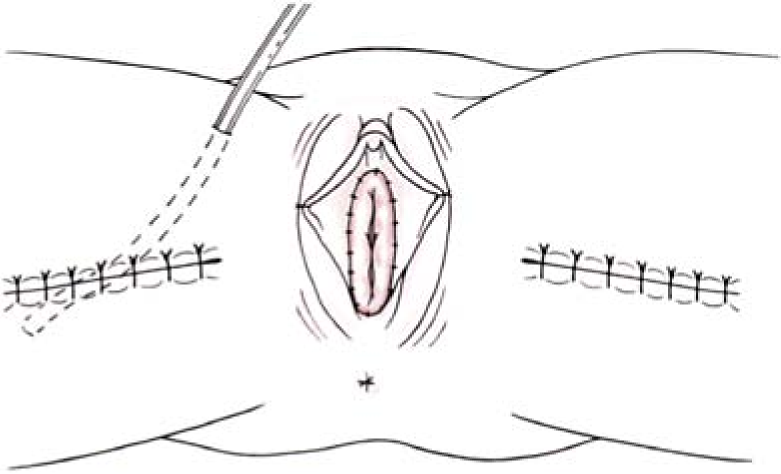


Figure 13

Neo-vaginal pouch inserted into pelvic space and sutured to the introitus

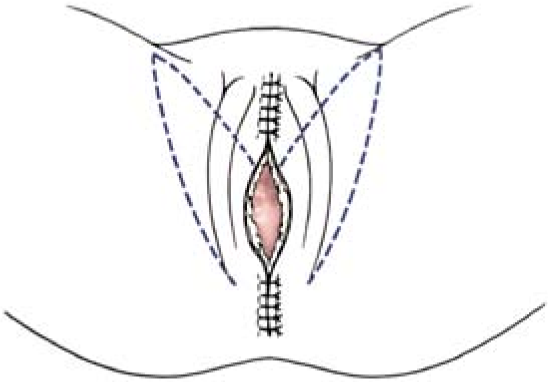


Figure 14

Partial anterior and posterior defect repair

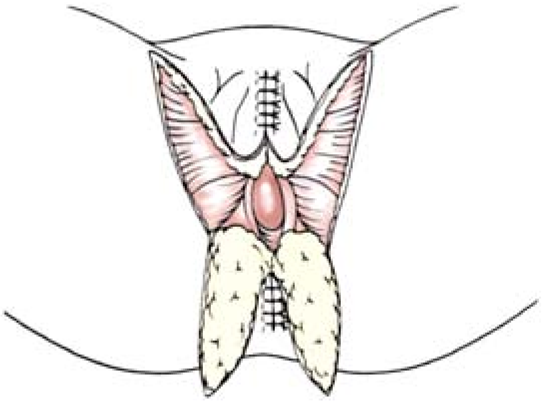


Figure 15

Skin subcutaneous tissue and deep fascial incision

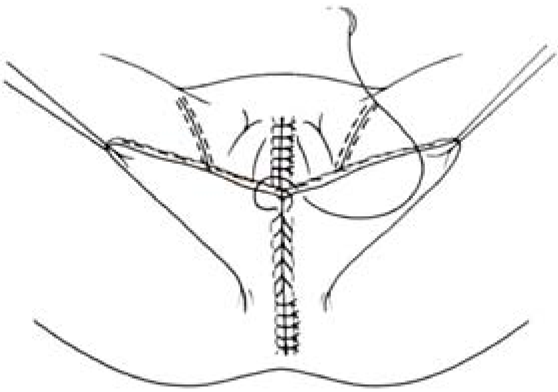


Figure 16

Flap elevation

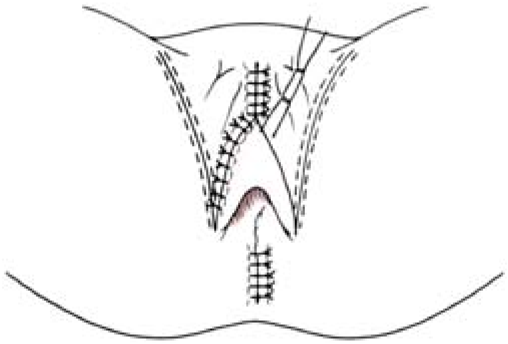


Figure 17

A suture of lateral margins of bilateral flaps to each other

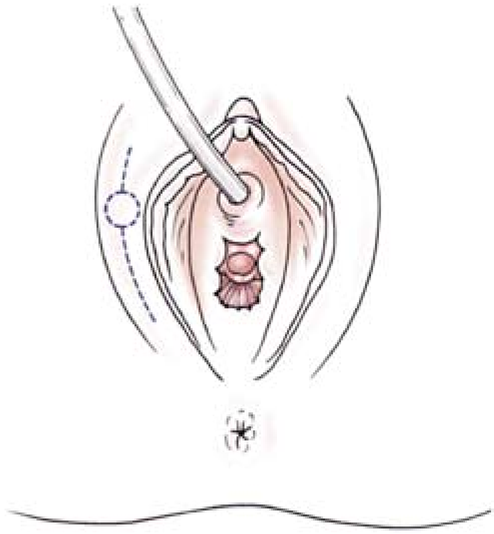


Figure 18

Skin island on labium majus

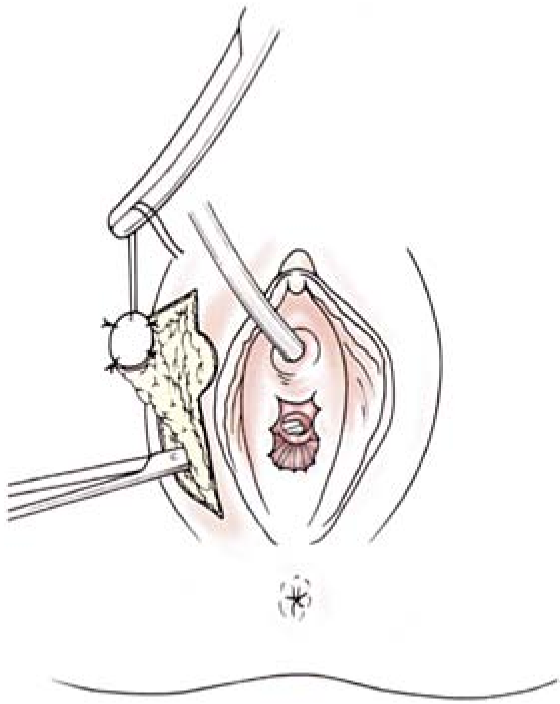


Figure 19

Mobilization of skin island

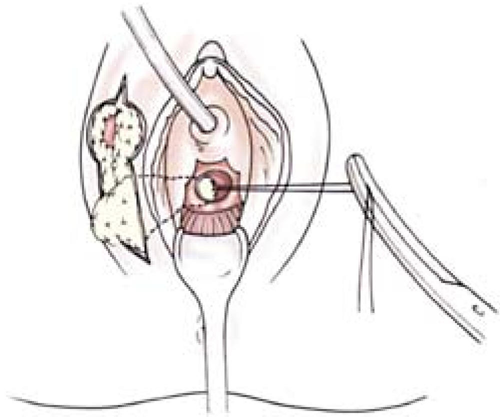


Figure 20

Tunnel from vaginal wall to base of myocutaneous flap

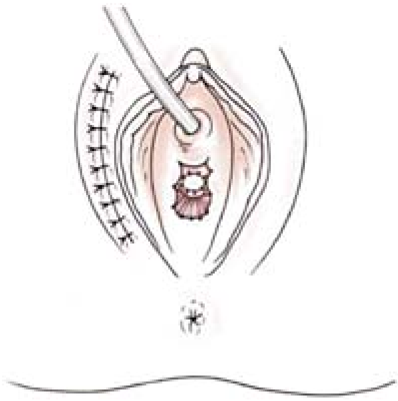


Figure 21

Closure of labium majus and flap sutured to vaginal mucosa

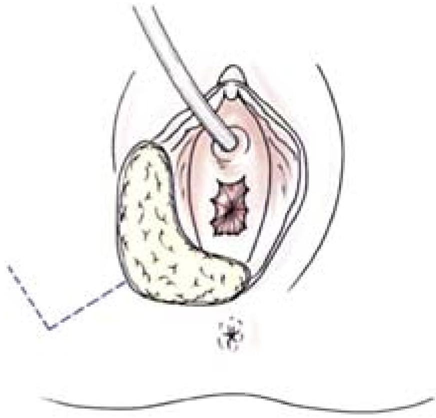


Figure 22

Z-plasty

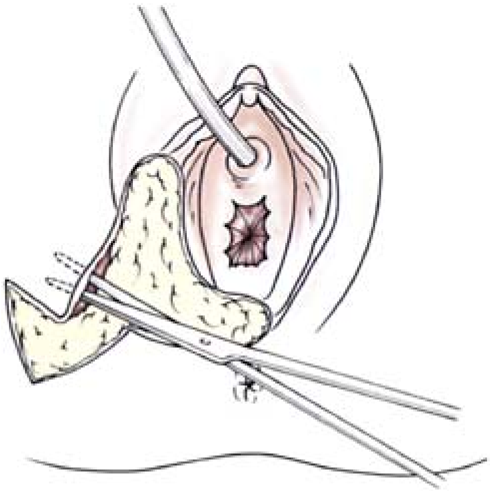


Figure 23

Z-plasty mobilization

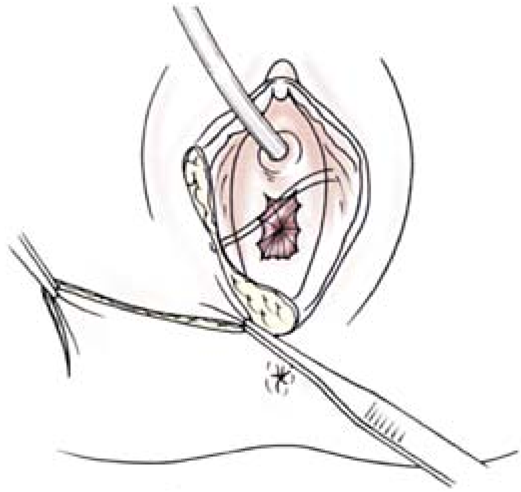


Figure 24

90% rotation of flap

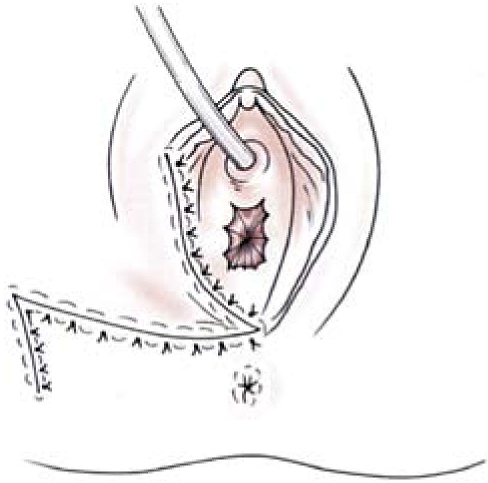


Figure 25

End result

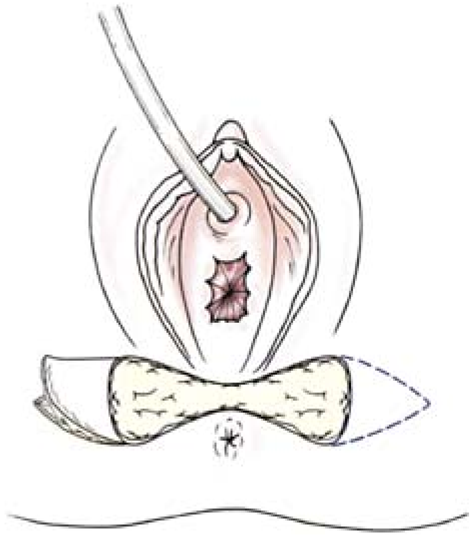


Figure 26

V-Y procedure

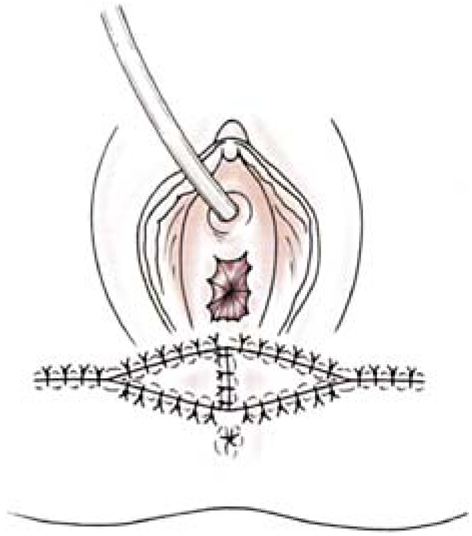


Figure 27

End result

22
Pain management

Andrew Lawson

Introduction

This chapter deals with the management of pain in gynaecological malignancy. It does not deal with the management of pain arising from surgical intervention but with pain resulting from the effects of the tumour and its treatment (Figure 1).

Pain in patients with malignancy may be caused by the erosive effects of the tumour itself or by treatment, for example radiation plexopathy following deep x-ray therapy, or constipation secondary to opioid drug administration. Patients may complain of pain resulting from muscle spasm or musculoskeletal problems which may be secondary to the illness, such as occurs in prolonged immobilization. Patients may therefore complain of various different types of pain. Tumour erosion, muscle spasm and bony secondaries will tend to produce nociceptive pain—pain secondary to actual or potential tissue damage. This may be sharp and stabbing, cramping or throbbing. Neuropathic pain—pain resulting from a lesion in or damage to the nervous system—is characteristically shooting, lancinating or burning. It is often associated with paraesthesias and dysaesthesias. The severity of pain may increase in proportion to either tumour mass or the occurrence of new metastases. A tumour enlarging within a fibrous capsule causes continuous pain, which is gradual in onset, tending to start with an ache. Those involving a hollow viscus, however, such as the small intestine, cause cramp-like or colicky abdominal pains. Tumours may become inflamed or infected, which will also produce pain. Tumour necrosis may produce sudden increases in pain. Tumours may invade bone, either by direct growth into it or by metastatic spread, though most gynaecological tumours rarely metastasize to bone. Vulval and cervical carcinomas may invade bone directly.

The female pelvic organs are in close proximation to a wide variety of structures within the pelvis, both neurological and vascular. Thus, local infiltration by a cervical, endometrial and/or ovarian tumour may cause pain due to pressure on any of the structures within the pelvis. The pelvis also acts as conduit for the neurovascular supply to the lower limb and consequently nerve involvement may occur at the sites of entry and exit from the pelvis as well as within. For example, the sciatic nerve may be affected by malignant infiltration, not only proximal to the sciatic foramen but also in its nerve roots, where it is formed as part of the sacral plexus. The femoral nerve on the pelvic side-wall may be damaged due to either haematoma or malignant infiltration, as may the obturator nerve. Pressure on or obliteration of lymphatic drainage may produce lymphoedema of the lower limb. Compression of the venous supply to the lower limb may produce venous oedema, leading to pronounced swelling which may be unilateral and may be exquisitely painful.

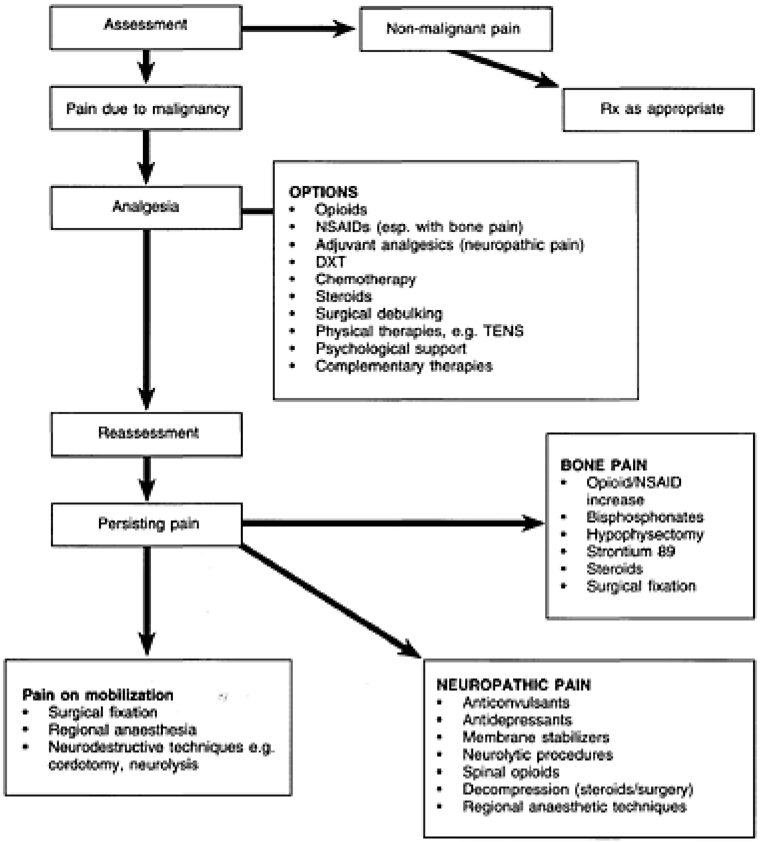


Figure 1

Algorithm for the management of continuing pain in patients with gynaecological malignancy. DXT, deep x-ray therapy; NSAID, nonsteroidal anti-inflammatory drug; TENS, transcutaneous electrical nerve stimulation

Initial management of pain

In patients with gynaecological malignancy who have not had a curative surgical procedure, it is unlikely that simple analgesics alone will provide satisfactory pain relief. In the author's opinion, patients such as

Table 1 Opioid drugs in severe pain: equianalgesic dose for 70 kg adults

Drug	IM (mg)	PO (mg)	Interval (hours)
Dextromoramide	7.5	10	1.5–3
Diamorphine	5	N/A	2–3
Hydromorphone	1.5	7.5	2–3
Methadone	10	10–15	8–48
Morphine	10	40–60	2–4

Drug	IM (mg)	PO (mg)	Interval (hours)
Oxycodone	N/A	30	4–6

1 Pethidine is not recommended for prolonged use due to metabolite toxicity.
2 The dose used should be titrated to patient response.
3 Subcutaneous and intravenous infusions are recommended where oral intake is limited and dose requirements are high.
4 The maximum dosage is limited only by side-effects.

these who have pain should be treated with opioid analgesics from the start. Slow-release morphine preparations and/or regular oral morphine preparations remain the ‘gold standard’ of pain relief in patients with malignant disease. There is no convincing evidence that any of the newer analgesics have significant advantages over morphine. In the UK and in other parts of the world, diamorphine (diacetylmorphine, heroin) is commonly used as an analgesic agent. Table 1 lists opioid drugs and dosage regimens.

Opioids may also be given by the subcutaneous route either intermittently or using a syringe driver. Fortunately, effective management of pain is achievable for the majority of patients with gynaecological malignancy who are using opioid-based analgesic drugs in combination with drugs for the treatment of neuropathic pain. For those with pain resistant to standard treatments, perseverance and referral to a specialist at a chronic pain centre is likely to result in an improved quality of life.

To optimize analgesia, patients should at the same time be prescribed nonopioid analgesics. Paracetamol (acetaminophen) is widely prescribed in the UK and overseas and has the advantages of being available without prescription. Patients with bone infiltration may also respond to nonsteroidal anti-inflammatory drugs such as indomethacin, diclofenac and ketorolac. Care should taken in patients with impaired renal, hepatic or cardiovascular function and in those who have reversible airways obstruction. Steroids may be beneficial in reducing the compressive effects of tumours.

Neuropathic pain

Patients who have nerve involvement may well respond to the usage of antidepressant, anticonvulsant

Table 2 Drug treatment of neuropathic pain

Class	Drug	Daily dose (mg)	Route
Tricyclic antidepressants	Amitriptyline	10–150	PO/IM
Clomipramine	10–150	PO	
	Desipramine	10–150	PO
	Doxepin	12.5–150	PO/IM
	Imipramine	12.5–150	PO
Selective serotonin re-uptake inhibitors (SSRIs)	Fluoxetine	20–60	PO
Parozetine	10–40	PO	
Anticonvulsants	Carbamazepine	100–1200	PO
	Clonazepam	2–10	PO
	Gabapentin	300–1200	PO
Membrane stabilizers	Mexiletine	150–1500	PO

and membrane-stabilizing agents, all of which have been demonstrated to be efficacious in the treatment of neuropathic pain. Pain due to radiation damage to the sacral plexus is likely to be resistant to standard analgesic techniques and in such circumstances antidepressants and membrane-stabilizing agents may be the first-line drugs of choice (Table 2).

Interventional techniques in gynaecological malignancy

Epidural and spinal opiates

Where standard routes of analgesic administration have failed, the epidural route using a percutaneous epidural catheter can provide optimal analgesia. The benefits of opioid administration by the spinal route have been acknowledged for some time and there is clear evidence that some patients find epidural analgesia of a higher quality with a diminished incidence of unwanted side effects such as nausea, drowsiness and constipation. Epidural catheters can be inserted percutaneously and brought out through the skin or attached to a number of subcutaneous administration devices (Figure 2). Subcutaneous pumps have been used to facilitate epidural and spinal analgesia, as have subcutaneous ports through which opiates can be given on a daily or more frequent basis.

All opiates currently on the market have been used in the epidural space. The most commonly used are morphine and (in the UK) diamorphine. Opiates have been given also in combination with local anaesthetic drugs to improve the quality of analgesia. This may be particularly helpful in terminal cases where there is extreme and intractable pelvic and neuropathic pain. Drugs such as clonidine, midazolam and baclofen have also been given epidurally in such circumstances.

Superior hypogastric plexus block

The superior hypogastric plexus is formed by the union of the lumbar sympathetic chains in branches of the aortic plexus in combination with the parasympathetic fibres originating in the ventral routes of S2-S4, which form the pelvic splanchnic nerve, some fibres of which ascend from the inferior hypogastric plexus to join the superior hypogastric plexus. The superior hypogastric plexus is situated anterior to the lower part of the body of the fifth lumbar vertebra and the upper part of the sacral promontory. It is retroperitoneal and is often called the presacral nerve. The superior hypogastric plexus gives off branches to the ovarian plexuses.

Technique

The patient is placed prone and two 20 or 22 gauge needles are advanced from a point roughly 5–7 cm lateral to the L4/L5 interspace to a point just anterior to the L5/S1 interspace. These needles are inserted under fluoroscopic or CT guidance, and injected contrast material demonstrates that the needles are anterior to the vertebral body and not in any of the vascular structures. Following aspiration, neurolytic solution of aqueous phenol 8–10 ml is injected, or for local anaesthetic blockade, 10–20 ml 0.5% bupivacaine (Figure 3).

Blockade of ganglion impar

Ganglion impar block has been described for the treatment of intractable perineal and pelvic pain where the sympathetic nerve seems to predominate. The ganglion impar is a retroperitoneal structure located at the level

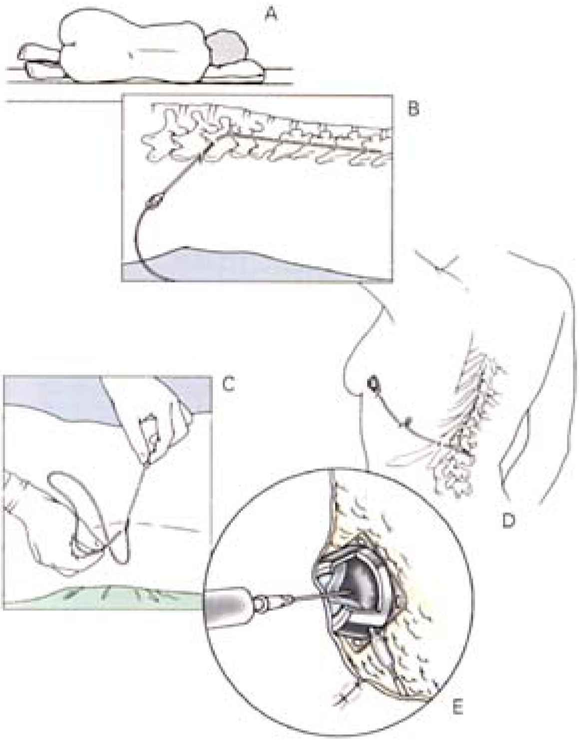


Figure 2

Insertion of tunnelled epidural catheter. (A) Position of patient: insertion marked at L2. (B) Insertion of 16-gauge epidural catheter via a Tuohy needle. (C) Second incision over 11th rib allows the catheter to be moved over the anterior chest wall. (D) Portal attached to catheter after tensioning loop and second tunnel. (E) Injection technique.

of the sacrococcygeal junction. The technique involves placement of a needle through the skin under x-ray control to lie anterior to the coccyx close to the sacrococcygeal junction. Retroperitoneal location of the needle is demonstrated by the injection of contrast medium. Local anaesthetic and/or neurolytic solutions can then be injected. Care must be taken to ensure that puncture of the rectum and accidental trans-bone injection into the epidural space are avoided (Figure 4).

Presacral neurectomy

Presacral neurectomy has been used for the control of intractable pelvic pain, whether due to malignancy or chronic pelvic pain syndromes. The technique involves the division of the superior hypogastric plexus at the L5/S1 region as described above. The presacral nerves can be divided as an open procedure or via the laparoscope. Laparoscopic presacral neurectomy is probably the technique of choice (Figures 5 and 6). Bowel preparation is indicated preoperatively to decompress the bowel. Under direct vision an incision is made in the peritoneum over the lateral sacral promontory and dissecting forceps are used to dissect out the hypogastric plexus. It may then be ligated, cut or cauterized (Figure 7).

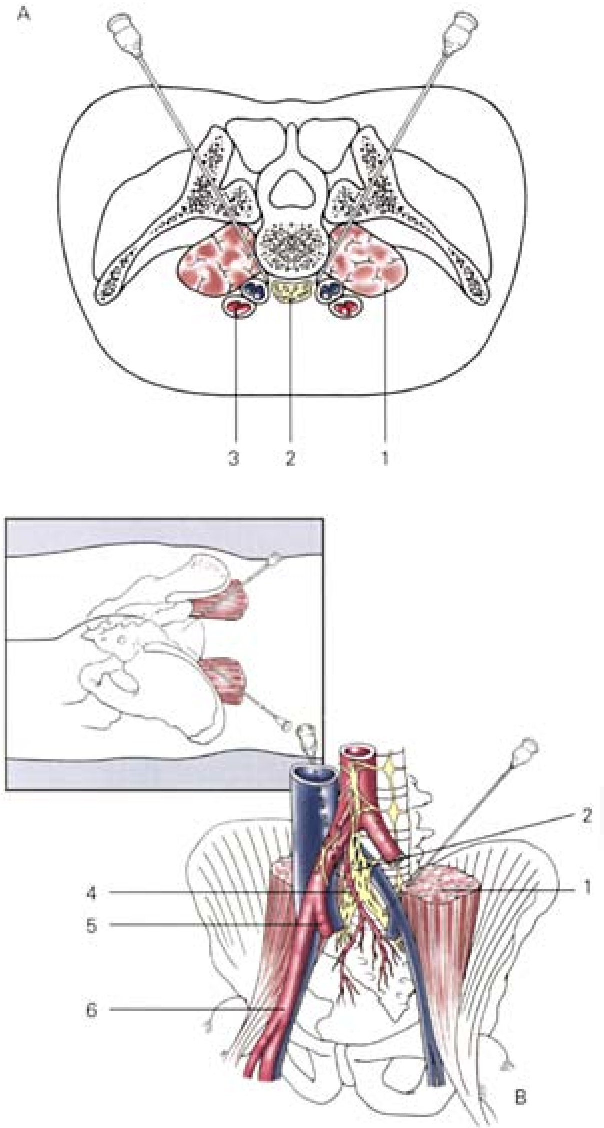


Figure 3

Superior hypogastric plexus block

(A) Sagittal section at L5; (B) pelvic anatomy

1 Psoas major muscle

2 Superior hypogastric plexus

3 Bifurcation of iliac vessels

4 Superior rectal artery

5 Internal iliac artery and vein

6 External iliac artery and vein

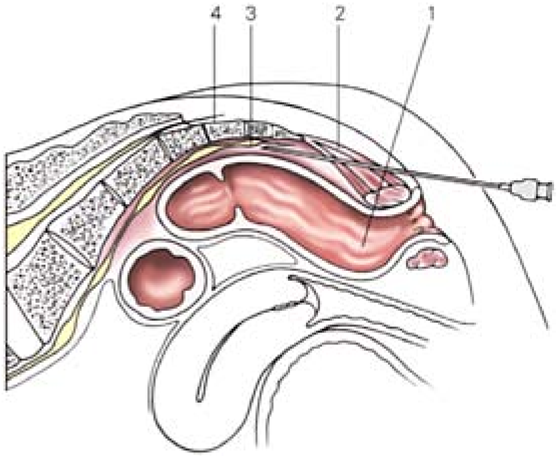


Figure 4

Blockade of ganglion impar

1 Rectum

2 Anococcygeal ligament

3 Ganglion impar

4 Sacrococcygeal junction

Bibliography

Bonica JJ (1990) *The management of pain.* Malvern: Lea & Febiger, second edition.

Cousins MJ, Bridenbaugh PO (1996) editors. *Neural blockade in clinical anaesthesia and the management of pain.* Philadelphia: Lippincott/Williams & Wilkins, third edition

Doyle D, Hanks GW, MacDonald N (1997) editors. *The Oxford textbook of palliative medicine.* Oxford: OUP, second edition.

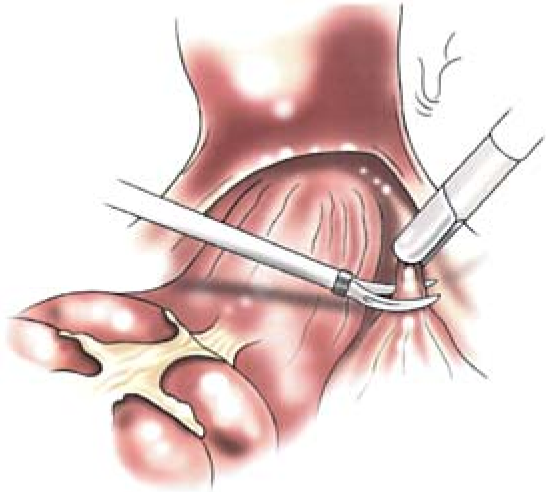


Figure 5

Presacral neurectomy: opening the presacral space

Figure 6

Presacral neurectomy: opened spaces

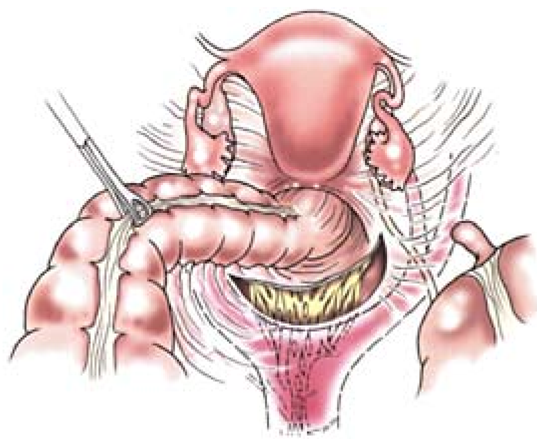


Figure 7

Sacral plexus exposed

23
Doctor-patient communication

J Richard Smith

Mark Bower

Unlike the rest of this book, this final chapter does not concern itself with practical surgical techniques; instead it looks at the problems of communication between the patient and her gynaecological oncologist. Entire books have been devoted to this subject and it may seem presumptuous even to attempt to address this in a brief chapter. However, we feel that the bare bones of good communication are extremely simple and may be summed up as imparting the truth and nothing but the truth in a compassionate manner.

In gynaecological oncology patients face a frightening diagnosis and an uncertain future. It is increasingly recognized that patients wish to know their diagnosis and to be kept informed of the progress of treatment. This has resulted in a revolution in the approach to patient-doctor communication. The era of professional paternalism, protecting patients from the diagnosis and remaining unrealistically optimistic to the dying patient, is over. With this change in approach has come a realization that effective communication skills are not innate but can be taught, learnt, retained and used to improve patient care. More and more health-care professionals, including gynaecological oncologists, are receiving training in communication with patients, their families and other professionals.

This increased communication with cancer patients has costs to health-care professionals that need to be appreciated and addressed. The improved communication brings health-care professionals closer to the patient and may increase feelings of inadequacy when faced with insoluble issues and of failure when patients die. Gynaecological oncologists dealing with dying patients and their families risk ‘burn-out’; although the medical profession is notoriously resistant to external help, a team spirit, adequate training through communication workshops and peer support are important elements in tackling this problem.

Many junior doctors identify breaking bad news as their greatest fear and their top problem in communicating with patients. In many cases doctors continue to carry this anxiety with them through years of clinical practice. Why do doctors fear breaking bad news? Obviously the information causes pain and distress to our patients and their relatives, making us feel uncomfortable. We fear being blamed and provoking an emotional reaction. Breaking bad news reminds us of our own mortality and fears of our own death. Finally, we often worry about being unable to answer a patient’s difficult questions since we never know what the future holds for either our patients or ourselves. Breaking bad news to patients should not involve protecting them from the truth but rather imparting the information in a sensitive manner at the patient’s own pace.

The setting for this conversation should be considered carefully. A confidential, quiet and comfortable location should be used rather than a busy gynaecology ward with neighbouring patients eavesdropping. An interruption-free period of 20–30 minutes should be allocated and the patient should be asked if she wishes anyone else to be present. Many patients will already be aware of how serious their condition is and will have guessed the diagnosis. Thus an initial screening question asking what the patient believes to be the matter may change the interview from breaking to confirming bad news. Subsequently, the conversation may be viewed as a series of cycles repeated for each piece of information imparted. An initial warning shot from the doctor ('I am afraid that the biopsy result was not normal') should be followed by a pause to enable the patient to respond or curtail the conversation. Further information can then be given and the patient again asked if she wishes to know any more. In this way it is the patient, not the doctor, who determines the quantity of information delivered and who controls the conversation without realizing it.

In general, prognostication with respect to 'duration of remaining life' and the quoting of 5-year mortality

Table 1 The four-cusp approach to patient communication

	Cusp 1	***Cusp 2***	***Cusp 3***	***Cusp 4***
Status	Potentially curable	Living with cancer	Pre-terminal	Terminal
Duration	Weeks to years	Months to years	Weeks to months	Days
Treatment	Radical surgery Adjuvant therapy	Palliative chemotherapy or radiotherapy	Supportive care	Terminal care
Aims	Cure Prolong survival	Prolong survival Improve QoL	Improve QoL	Improve QoL End-of-life issues

QoL, quality of life.

statistics is rarely helpful. Few of us are able to explain the implications of skewed distributions, medians and confidence intervals in a way that is easily understood by patients. Moreover, many of us have enough optimism to believe that we will fall on the lucky side of whatever statistic is quoted, however fallacious this belief. The last thing that we should do is to destroy all hope. Many patients will ask for predictions as to length of or guarantees of survival, often hoping for reassurance. In these circumstances it is always easier to give the false reassurance but the temptation must be avoided as you will not be doing your patient a favour in the long run. Despite these restrictions, all consultations ideally should end on a positive note, the motto being 'never say *never*'. Even in the bleakest of situations, setting short-term achievable goals leaves patients with aims for the future and hope. This maxim applies to both the patient and—where the patient agrees—the next of kin.

It is desirable to communicate at each stage in a private setting and preferably to the patient and her next of kin at the same time. Failing this, a discussion should take place with the patient and be followed at a future date by a joint consultation between doctor, patient and her next of kin. It is rarely appropriate to allow relatives to 'protect' the patient by withholding information or over-optimistically lying. These issues can become particularly difficult when dealing with cultural differences. This act of collusion needs to be explored with relatives, on the basis that the patient needs to understand what is happening to her. With careful negotiation including an acknowledgment of the views of the relatives, access to the patient can usually be secured to determine the patient's own understanding of her illness. It is then common to discover that the patient is well aware of the diagnosis and is herself colluding to spare the relatives. In such circumstances honest discussion may reduce anxiety and resolve the relationship difficulties within the family.

In addition to keeping the patient abreast of developments it is vital to involve the whole multidisciplinary team so that the patient and her relatives hear the same message from all the health-care professionals. The roles of individuals within the team and their boundaries of care may lead to friction within teams. Philosophical differences in treatment approaches need to be explored. Frequent team meetings and open discussion that avoids a hierarchical structure will enhance team spirit and reduce tensions. Occasionally an external facilitator may be helpful to coordinate such meetings.

The following pages set out what could be described as a four-cusp approach which may be useful in discussions on treatment strategies and prognosis (Table 1). We have been surprised at how often patients have taken away the scraps of paper used to demonstrate this four-cusp approach. In addition we have noticed that our junior staff who frequently lack experience in talking through those difficult issues with patients find this a helpful frame-work. The cusps are illustrated by case examples.

The ‘four-cusp’ approach

Cusp 1:
potentially curable

The first cusp applies to most patients from the time of the first visit to the clinic when the surgeon imparts the probable diagnosis and discusses with the patient the plan of action to achieve staging and hopefully removal of the tumour. It is rare to feel totally confident that a tumour is incurable before surgery; one may suspect it, but rarely can one know until the histology is confirmed and the staging completed. An honest appraisal of the possibilities is required, coupled with a plan of action. This should include date of surgery, length of time in hospital, and when final and definitive histological and cytological reports will become available. It is almost always possible to achieve these results within 2 weeks of the first visit to the clinic. The patients thus know they will have a good idea where they stand by a specific date. The concept of cancer staging should be explained and that the stage and type of tumour will influence the necessity for further treatment with radiotherapy or chemotherapy. We usually explain that, if we achieve treatment by surgery alone there is a presumption of cure. This, however, can only be confirmed by the passage of time, and the longer all remains well the higher is the likelihood that cure has been achieved. A high level of positivity and a buoyant approach are usually applicable both before and after surgery for those with complete resection of tumour, although the need for careful follow-up and the possibility of relapse should be discussed.

Case 1

A woman is referred to the gynaecological oncology clinic with postcoital bleeding and a suspected cervical cancer. On examination a small cervical tumour is found which is approximately 2–3 cm in diameter. The uterus and cervix are mobile and there are no other detectable abnormalities. A colposcopy and biopsy are performed.

Following the examination, the consultation should continue, usually by asking the patient if she has any idea what she thinks the diagnosis might be. Many patients will state their worst fear, namely cancer; others will say they have no idea. This is generally the point at which to communicate that you also believe the diagnosis to be one of cancer and that the biopsy will confirm or exclude this within the next few days. It is then possible to say that the initial examination suggests that this is an eminently curable cancer, and to outline the plan of action: firstly the patient will be admitted on a specific date within the next week for staging of the tumour and on a subsequent date, probably within the next 2 weeks, for definitive surgery. Explain that there are four stages of cervical cancer, that stage 1 is the best and stage 4 the worst. Tell the patient that the first admission will take one day and will deliver an answer which she will probably know later that same day. Explain that you believe the tumour to be stage 1 and therefore highly curable, probably by surgery alone, but possibly requiring further treatment with chemoradiotherapy. Ask the patient to have her next of kin present at the post-staging ward round if they are not there at the clinic. The patient should be invited to ask any questions and encouraged to write down any questions she thinks of when she is home and to ask them when she is admitted.

It is our practice to copy the letter written to the referring doctor to the patients themselves. We undertook a survey of patient acceptability of this practice, and of over one hundred patients surveyed all believed it was helpful and none chose not to receive further copies of future letters.

Carefully organized and coordinated staging protocols allow women rapid access to results, reducing delays and hence minimizing the anxiety caused by waiting for results. The patient will have the usual prestaging investigations such as radiographic scans and will then be admitted for a staging examination under anaesthesia. These findings along with the histology are communicated to the patient that day. The date for radical hysterectomy is then set and an explanation of this given, including the prognostic significance of nodal status and its impact on likely adjuvant therapy. The discussion may be supplemented with patient information leaflets (either written in-house or available from patient support groups). However, this information should never replace the discussion between the patient and her gynaecologist but rather complement it. It should be explained that, although we will have a good idea where the patient stands immediately following surgery, definitive answers require histological confirmation and that this usually takes 7 days. It is usually better to predict a longer wait for histological results than one expects, since patients' anxieties naturally rise when they believe their results to be imminent, and if for any reason results are delayed this only further increases anxiety.

The operation is then performed and either the same day or the following day an explanation is given. A few days later the full histological picture is given.

Scenario 1: the histology report shows complete resection of a 2 cm well-differentiated squamous carcinoma with adequate resection margins and negative nodes.

This patient can be told that you believe cure has been achieved, and while long-term follow-up is warranted you expect to see her in the clinic for the next 5–10 years (depending upon individual protocol) and to discharge her from care at this time 'fit and well'.

Scenario 2: the histology report shows complete resection of a moderately differentiated squamous cervical carcinoma with 3 positive metastatic nodes out of 40 removed.

This information is imparted and the patient is told that although there is complete removal of tumour further treatment is required with combination chemoradiotherapy. Such patients can be told that you believe cure is likely and that this is a 'belt and braces (suspenders)' approach, but that there is no denying they do have a higher chance of relapse than if their nodes had been negative. The concept of adjuvant therapy following radical surgery may be explained as an insurance policy to mop up any tumour cells that could have escaped the surgery.

Case 2

A 55-year-old women is referred by her general practitioner with abdominal swelling which she has noted in the last few weeks. She has no other symptoms. Abdominal examination reveals fluid in the abdomen on percussion. Vaginal examination is suggestive of a mass arising from the right adnexa, probably ovarian in origin, and nodules are felt in the pouch of Douglas.

The patient is informed that there are findings suggestive of an ovarian mass and that these require urgent investigation. The patient should be told that you suspect cancer and that the investigations you are about to request will go some way to eliciting a diagnosis.

Haematological and biochemical tests are ordered, as are tumour markers, an ultrasound scan with colour flow Doppler, and a CT scan of abdomen and pelvis to detect lymphadenopathy. The patient is reviewed shortly thereafter and the risk of malignancy index is used. The findings are highly suggestive of a stage 1c ovarian cancer.

Staging of ovarian cancer is explained to the patient, together with the fact that there are three possible outcomes from the operation which will be communicated to her immediately postoperatively:

- complete macroscopic resection of tumour
- resection of tumour down to nodules less than 1–2 cm in diameter
- inadequate debulking.

The latter two possibilities seem unlikely, bearing in mind the optimistic findings of the investigations. Full staging will be arrived at a few days after surgery when all the cytological and histological results will be available. Patient consent is obtained for a total abdominal hysterectomy, bilateral salpingo-oophorectomy, omentectomy and debulking as required.

Scenario 1: at surgery a smooth-walled cyst is found with some free fluid in the pelvis. There is no evidence of any tumour elsewhere in the abdomen on macroscopic examination.

Postoperatively the patient can be told that she falls into the first category (fully macroscopically resected tumour) and a few days later the histological report confirms a well-differentiated ovarian epithelial carcinoma, with negative cytology from washings and peritoneum. The patient is informed that she has a stage la tumour and should have no further problems. She remains at cusp 1.

Scenario 2: at surgery the abdomen is opened and 500 ml of straw-coloured fluid is aspirated and sent for cytology. Abdominal exploration reveals small studs of tumour on the diaphragm and a small omental deposit. A total hysterectomy, bilateral salpingo-oophorectomy and omentectomy are performed with minimal residual tumour left at the end of the operation.

The patient is informed postoperatively that she falls into the second category, namely tumour debulked to less than 1 cm, and that she probably has a stage 3 tumour depending on results and almost certainly will require further treatment. A few days later the histological and cytological reports confirm that this clinical impression was correct. The patient is informed and chemotherapy planned. She should be informed that she has now entered the second cusp, living with cancer', that she may regain the first cusp following chemotherapy, but that only time will tell.

Cusp 2:
living with cancer

The second cusp is for treated patients who are in remission but are unlikely to be cured—i.e. 'living with cancer'—but not terminal. Again a positive approach is appropriate, but the long-term goals are less optimistic. The patient should be informed that it is impossible to determine how long she will remain in remission, that we certainly have many patients who are alive many years after chemotherapy and a few who have returned to the first cusp, i.e. presumed cured. Sadly, we also have some who have not survived as long. The golden rule is that the longer one is in complete remission, the better the prospects become. The biggest difficulty is that neither the patient nor the doctor knows which category she is in until time elapses, but it is important that both can see that it is well worth following through with treatment.

The patient described in scenario 2 above then undergoes chemotherapy.

Scenario 1: the patient goes into complete remission for 5 years.

This patient is one of the lucky ones and has possibly returned to cusp 1.

Scenario 2: the patient goes into complete remission which lasts for 3 years and then at the followup joint oncology clinic is found to have a raised serum level of CA125 and a palpable nodule in the pouch of Douglas. Staging investigations reveal radiological evidence of a solitary nodule. She therefore has a second laparotomy: complete excision of the tumour is achieved, followed by a further course of chemotherapy. Again the patient enters complete remission.

She can be told that she appears to have a relatively non-aggressive tumour and can expect to remain in the second cusp for a good time longer.

Scenario 3: following the first-line chemotherapy the patient achieves a partial remission which lasts for 5 months when she re-presents at follow-up to the joint oncology clinic with a rising serum CA125 level and abdominal swelling. Radiological investigation suggests that there are widespread metastatic peritoneal nodules.

This patient may be given the choice of whether to be observed until she develops symptoms or to have second-line chemotherapy. The role of chemotherapy is to palliate symptoms rather than prolong survival in this context and the balance between the possible benefits and toxicities of the chemotherapy should be explored with the patient. The patient declines further chemotherapy and then deteriorates over the next few weeks. She needs to be informed that she has moved to the third cusp.

Cusp 3:
pre-terminal phase

The third cusp applies to patients with virtually no chance of cure, who have entered the 'pre-terminal phase'. It is important that the patient is informed and made aware that she has a limited time left to her, and that she is given the opportunity to 'put her house in order'—see relatives and friends, make a will, etc. No patient should ever be told that there is nothing more that can be done for her. She should be informed that while she has virtually no chance of cure, and aggressive treatments to obtain cure are not appropriate, there are plenty of measures available to ameliorate symptoms such as pain, nausea or upset bowels. The therapies that are appropriate at this phase of the disease are supportive measures to improve the quality of her life without causing toxicity.

Scenario: a patient with carcinoma of the cervix presents 3 years after radical radiotherapy for a stage 3 tumour. She is passing urine permanently per vaginam. *On investigation and examination under anaesthesia she is found to have extensive recurrence of tumour both in the para-aortic region and on the pelvic side wall. In addition she has a large unrepairable cystovaginal fistula. She also has deteriorating renal function.*

The patient is informed that she has recurrent cancer and there are no curative treatments available. She says she had guessed that anyway and is clearly very angry. She is then asked the vital question for the third cusp: what in addition to the fact that she is dying is most bothering her? To this she replies that she accepts death as inevitable and this does not make her angry—what makes her angry is her permanent incontinence which is preventing her from going out and seeing family and friends. She is referred to the interventional radiologist and bilateral nephrostomy tubes are inserted, which render her dry. The patient goes home and returns 4 weeks later, in a terminal condition. She has entered the fourth cusp. She does, however, inform us that she has had a great 4 weeks, been to the pub every day and seen all her friends. She dies 24 hours later.

Cusp 4:
terminal phase

The terminal phase of life lasts from hours to days and all interventions are only designed to 'ease the passing'. Patients in general need no telling that this is where they have arrived, although the relatives may need help in understanding it. Care is focused on emotional support rather than medical intervention, and frequently most of the patient's medication can be stopped apart from analgesia. The death of a patient whose physical symptoms are well controlled and who is spiritually calm is an achievable goal to which we should all strive.

Bibliography

Fallowfield LJ (1993) Giving sad and bad news. *Lancet* **341:**476–8.

Maguire P, Faulkner A (1988a) Communication with cancer patients 1: Handling bad news and difficult questions. *BMJ* **297:**907–9.

Maguire P, Faulkner A (1988b) Communication with cancer patients 2. Handling uncertainty, collusion and denial. *BMJ* **297:**972–3.

Nordin A (1999) editor. *Gynaecological cancer. Patient pictures.* Oxford: Health Press.

Slevin ML (1987) Talking about cancer. How much is too much? *Br J Hosp Med* **July:**56–9.

Index