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SURGERY OF THE URETER

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233 Figures
with more than 400 illustrations

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Introduction

There has been great progress in ureteral surgery in the last twenty years. The predominant indication is still calculous obstruction but reparative and plastic surgery of the ureter for congenital and acquired lesions are among the most interesting advances in modern urology.

The essential goal of this surgery is to ensure free flow of the urine from the kidney to the bladder and so to preserve or improve kidney function which is always affected or threatened by any defect in the excretory pathway. The ideal is to re-establish a closed circuit flow from kidney to bladder by repair or substitution of the ureteral conduit so as to avoid as far as possible the disabilities that result from diversion of the urine to the skin surface or to the intestine.

This objective can now be achieved in the treatment of most of the diseases of the ureter when the relevant kidney is sufficiently healthy to merit conservation. The techniques used are not necessarily new but the advent of antibiotics has made it possible to avoid or reduce the risks of infection, pyelonephritis, or pyonephrosis that so often complicated such surgery in earlier times. Progress in the investigation of renal function and of the excretory tract has brought a better understanding of the physio-pathology of the urinary apparatus and more accurate judgement of the results of reparative surgery.

This surgery is based on certain principles that are worth recalling. Contrary to the view that prevailed for too long, based in part on misinterpretation of experimental work, the need to maintain continuity of the neuro-muscular conduit in order to preserve ureteral peristalsis is a myth. The ureter may be divided at any point: if the uretero-ureteral anastomosis is performed correctly there will be no defect in the function of either the ureter or the kidney above. It is true that such an anastomosis may create a disturbance of the dynamics of the excretory tract due to functional disharmony between the two parts of the conduit, that may be revealed by distension of the pelvis and calyces, but this disorder is only temporary, functional and reversible. We have even made two or three segmental resections of the same ureter without affecting its function. This concept that section or resection of the ureter is innocuous has been verified by urokymography, cineradiography and by analysing the long term results over a period of more than 15 years. It is the key to all reparative surgery of the ureter, surgery that was held back for too long by the unjustified anxiety to preserve the continuity of the conduit.

Another important point is that there is nothing peculiar or specific about the ureter, in the sense that it can be replaced by the ureter from the other kidney, in part or in whole, or by other segments of the urinary tract derived from the renal pelvis or bladder, or even by a foreign ureter in renal allotransplantation. Anastomosis of donor and recipient ureter results in perfect function of the excretory tract despite the double origin. In a very early allograft (1960) we used the part of the ureter remaining after removal of the kidney four years previously and demonstrated for the first time that a healthy, non-functioning ureter was perfectly capable of returning to full function after a very considerable interval. We confirmed this fact some years ago by the successful use of a ureter that had not functioned for 18 years (congenital renal atrophy). Furthermore, when there is no tissue available in the urinary tract itself to replace the ureter, the smooth muscle of the intestinal tract, ileum, colon or appendix, is perfectly capable of replacing one or both ureters partially or completely without any untoward effect on renal function.

The great technical possibilities in this ureteral surgery have considerably reduced the indications for urinary diversion and intemperate nephrectomy.

General Considerations

Whatever the nature of the ureteral surgery, certain general concepts are important in preventing or limiting complications, whether early or late.

I. The entire ureter from renal pelvis to bladder may be isolated without any fear of ischaemic necrosis because of the sub-mucous anastomotic network that runs the entire length of the ureter. It is nevertheless important to preserve adventitial vascularization by avoiding as far as possible any unnecessary denudation of the ureter, especially in dealing with ureters whose blood supply may have been affected by physical agents such as, for example, radiation.

II. Inflammation of the ureter, with infiltration and thickening of the wall and functional inertia, is perfectly compatible with reparative surgery and return of normal function; but it may be unwise to place too much reliance on such recovery and it may be preferable to perform a resection so that healthy tissue can be used for the anastomosis.

III. In the majority of cases, a post-operative urine leak has no ill effect on the ureter when the urine is sterile and the leak is drained. On the other hand, lack of post-operative drainage and the development of peri-ureteritis introduce a certain risk of secondary stricture. For this reason, suture lines should be leak-proof as far as possible and drainage must be continued for several days in order to avoid inflammation and infection of the peri-ureteral cellular tissue, complications that may be masked by the use of antibiotics.

IV. What is the place of urinary diversion in ureteral surgery? Whenever surgery is performed on a ureter below an obstructed, infected kidney, urinary drainage is essential and this can be affected either by nephrostomy or by ureterostomy "in-situ", either direct or transvesical, or by an indwelling ureteral catheter. The choice of method of drainage depends on local conditions and the part of the ureter concerned. When there is little or no distension of the renal pelvis and no infection it may be possible to dispense with urine drainage but in our view drainage is still desirable in the surgery of congenital malformations to avoid early post-operative distension of the urinary tract above the anastomosis. In such cases ureterostomy in-situ is an excellent method of very temporary diversion.

V. After all ureteral surgery, urography should be performed some months after operation and subsequently for several years in order to obtain information about the condition of the kidney and its excretory tract. Secondary reintervention may be successful and is preferable to late nephrectomy.

VI. Reparative surgery is always indicated when the relevant kidney is solitary or the other kidney is inadequate, but the indications are less easy to define when the other kidney is absolutely normal. There is no doubt about the indications when there is a good kidney above the ureteral lesion but if this kidney has very poor function it is wiser to perform elective nephrectomy. To judge the functional value of this kidney and the possibilities of its recovery, a temporary diversion for several weeks may sometimes be necessary before making a decision between repairing the ureter and removing the kidney.

I. The Surgical Approach to the Ureter

In the majority of cases the surgeon has to approach one part of the ureter. For each of the anatomic segments of the ureter, lumbar, iliac, pelvic and terminal, many elective extra-peritoneal approaches have been described and these are the most widely used in modern surgery. The particular approach to be adopted will depend on the individual surgeon and on the lesion to be treated.

More rarely, although more commonly than in the past, *the entire ureter has to be exposed.* The wide, lateral, extra-peritoneal exposure of Albarran-Israel is not to be recommended because it does too much damage to the abdominal wall. This leaves a choice for total ureterectomy between two approaches, an extra-peritoneal approach through two separate incisions, one in the loin and the other pelvic, more often used in children (in total heminephro-ureterectomy for malformation, for example) and the median transperitoneal approach

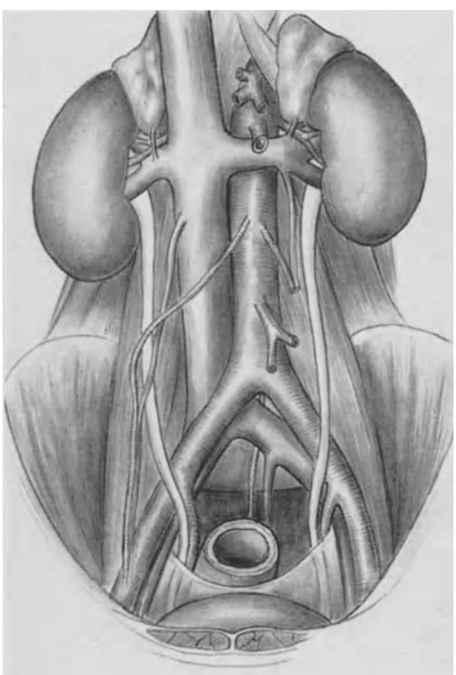


Fig. 1. Anatomic relations of the ureter—general view from in front

Fig. 2. Pelvic ureter in the male (from in front)

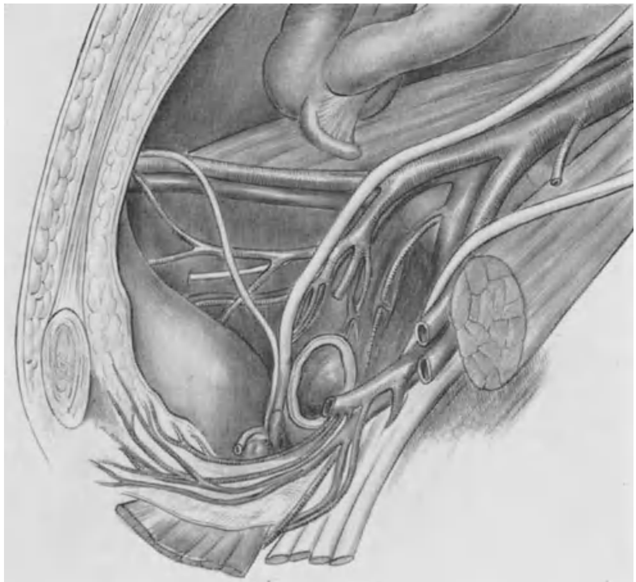


Fig. 3. Pelvic and terminal ureter in the male (oblique). (After GREGOIRE)

Fig. 4. Pelvic ureter in the female (from in front)

more often used in adults where the ureterectomy is generally followed by substitution surgery.

Whatever the surgical approach to the ureter, the difficulties encountered can be very variable. While the healthy ureter is easily recognised by its pale appearance, its vascular pattern and very characteristic peristaltic contractions, recognition is not always easy. Diseased ureters have been mistaken for a vein, sympathetic trunk, iliac artery or even for a loop of intestine. When there is extensive peri-ureteritis it may be very difficult to recognise the ureter and to isolate it from the surrounding tissue. Lastly, it must always be remembered that the ureter may be displaced by a tumour or pulled far from its normal course by the scar tissue of previous surgery and the possibility of congenital abnormalities such as duplex ureter and ectopic ureter must also be borne in mind.

Pre-operative radiologic studies are obviously necessary to locate the position and probable appearance of the ureter and it may also be very helpful to pass a catheter up the ureter before surgery.

1. Exposure of the Lumbar Ureter

The lumbar ureter, running from the renal pelvis to the iliac ureter, lies deep and not far from the vertebral column. It descends in front of the psoas, lateral to the great vessels. In its lower part it becomes more superficial and more lateral, lifted up by the projection of the iliac vessels. During this course it lies immediately behind the posterior parietal peritoneum. It receives its blood supply from a branch of the renal artery and from small ureteral arteries, coming directly from the aorta, that run in the meso-ureter. In the region of the lower pole of the kidney it is crossed by the spermatic or ovarian vessels on the right but on the left these vessels run anterior and medial to the ureter.

Any of the surgical exposures of the kidney can be used to approach the first part of the ureter. The antero-lateral transverse approach in particular is very suitable for operations on the pelvi-ureteral junction or the first part of the ureter. There are, however, more specific approaches to the ureter. The lumbar ureter can be approached by the transperitoneal route, as can all segments of the ureter, by the classic route through the loin, by more limited incisions or by the posterior route.

A. Lumbar, Extraperitoneal Approach

This is the classic incision through the loin, placed a little lower than the incision for kidney surgery. Rib resection is not usually necessary. The patient is placed on his side, lying on a block to open up the space between the costal margin and the iliac crest. The incision is begun immediately below the 12th rib, at the angle between the rib and the erector spinae muscles, and is continued downwards and forwards for 10 to 15 cm, parallel to the 12th rib, to avoid damage to the 12th intercostal bundle (Figs. 5 and 6). The incision goes through the

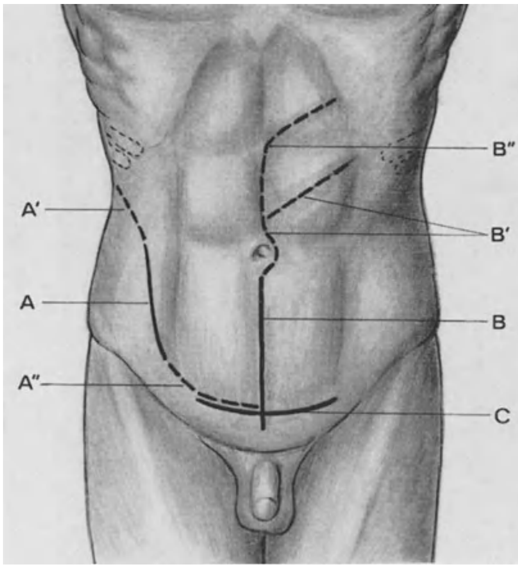


Fig. 5

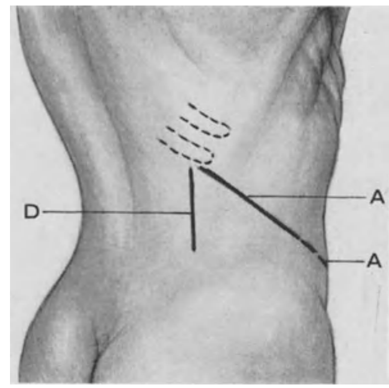


Fig. 6

Fig. 5. The various incisions for approaching the ureter. Seen from in front. *A* Lateral iliac extra-peritoneal approach. *A'* Lumbar approach. *A''* Lateral pelvic extra-peritoneal approach. *B* Midline trans-peritoneal approach. *B'* Barraya incision. *B''* Quenu incision. *C* Transverse suprapubic incision (approach to terminal ureter)

Fig. 6. Surgical approaches to the ureter. Postero-lateral aspect. *A* Lateral iliac approach. *A'* Lumbar approach. *D* Posterior approach

latissimus dorsi, the external oblique and internal oblique muscles and then through the easily recognised pearly aponeurosis of the transversalis behind and the transversalis muscle in front (Figs. 7 and 8). Bleeding points are secured as the incision proceeds. The fascia of Zuckerkandl is opened posteriorly to expose the renal bed over the projecting lower pole of the kidney and this incision is carried forward to the lower part of the wound and, at the same time, the peritoneum is pushed forward out of the way. The wound is spread by a self-retaining retractor. The ureter is sought at the bottom of the wound, behind the posterior parietal peritoneum, in the extraperitoneal tissue, in front of the bulge of the psoas, below and medial to the lower pole of the kidney, taking care to avoid damage to the gonadal vessels (Fig. 9).

In approaching the lower part of the lumbar ureter it is not necessary to open the renal bed. The ureter can be sought directly, deep in the extraperitoneal areolar tissue but clinging to the peritoneum. Once the ureter has been found, a tape passed around it will facilitate dissection upwards or downwards. The incision should be sutured with absorbable material (plain or chronic catgut) if the renal pelvis or ureter has been opened. The suture may be in one or two layers but care must be taken to avoid any dead space between the muscle layers that might be a source of haematoma or abscess.

This loin approach may be quite extensive with considerable muscle damage and may cause local muscle weakness and there may also be segmental paralysis

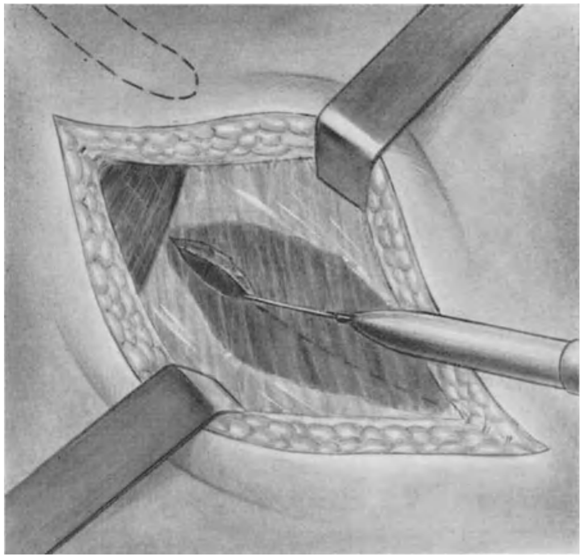


Fig. 7. Exposure of the lumbar ureter—lumbar approach. Incision of the external oblique

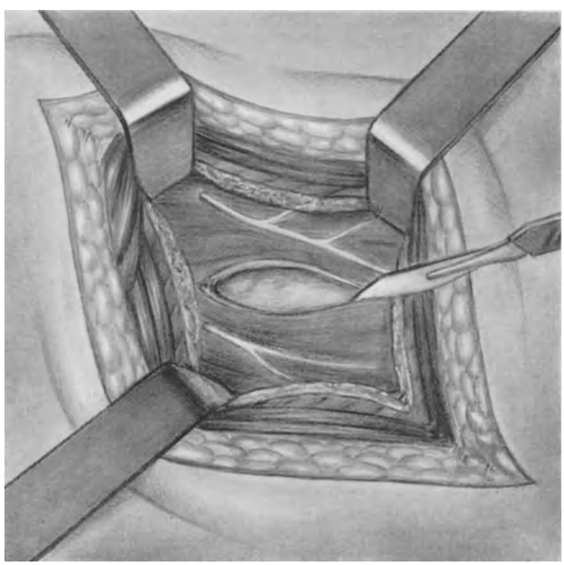


Fig. 8. Exposure of the lumbar ureter—lumbar approach (continued). Incision of the transversalis

of the abdominal wall if there has been accidental damage to the 12th intercostal nerve. The damage is mainly cosmetic but is nonetheless a visible disadvantage of this type of incision. Neuralgia or zones of analgesia due to nerves being caught in sutures or scar tissue are not unusual.

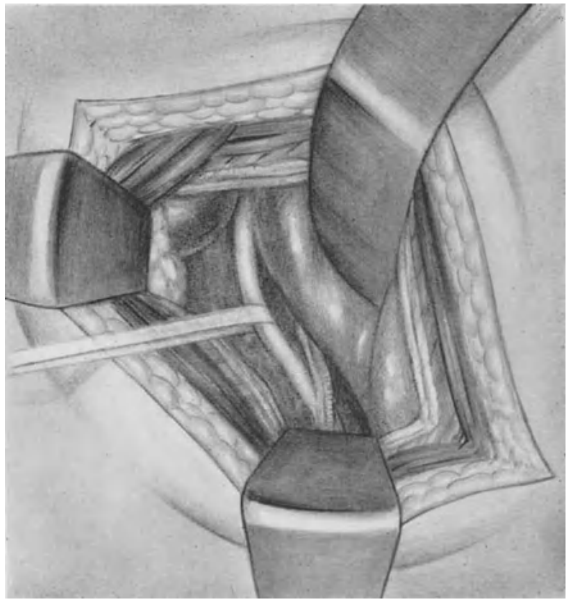


Fig. 9. Exposure of the lumbar ureter—lumbar approach (concluded). Identification of the ureter

B. "Limited", Muscle-Splitting Approach to the Lumbar Ureter

In the relatively few cases where a very restricted approach may be adequate, an attempt can be made to avoid the imperfections of the previous incision by a smaller incision in which no muscle fibres are cut and there is less risk of damage to parietal nerves.

The incision may be lumbar or antero-lateral, oblique or vertical. In each muscle plane, the perimysium is incised in the direction of the muscle fibres and these fibres are split and separated but not cut.

The muscle-splitting incision used by Dos Santos for lumbar sympathectomy, in which only the transversalis aponeurosis is cut, can be a very satisfactory approach to the lumbar ureter.

Incisions of this type do minimal damage to the abdominal wall but they have the disadvantage of a very restricted and deep approach to the ureter that is difficult to enlarge and when problems arise the situation may become difficult to control.

C. Posterior Approach

This approach has the same object, the same advantages and disadvantages and is open to the same criticism as the restricted antero-lateral approach just described. It provides a restricted view of the posterior aspect of the kidney, the renal pelvis and the first few centimeters of the lumbar ureter. This vertical posterior lombotomy was used by Simon in 1869 and with various modifications

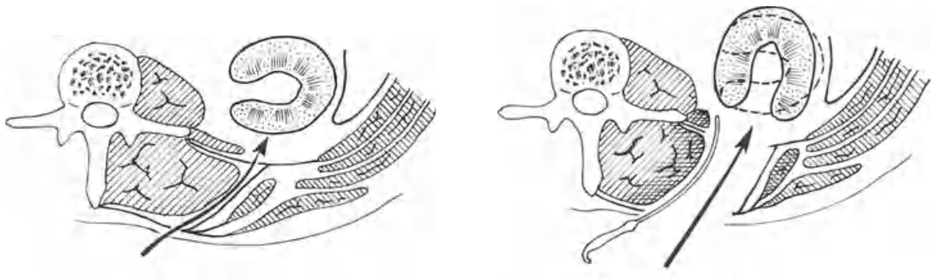


Fig. 10a and b. Exposure of the lumbar ureter—posterior approach (after J. M. GIL VERNET). (a) Incision through the muscles. (b) Exposure of the renal hilum and the first part of the ureter

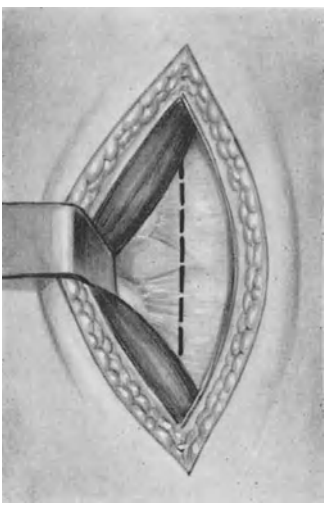


Fig. 11. Exposure of the lumbar ureter—posterior approach (after PAPIN). Incision of the aponeurosis

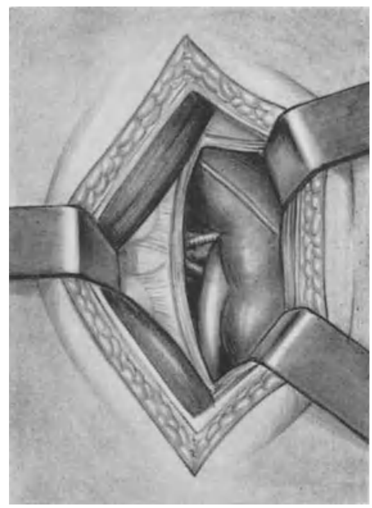


Fig. 12. Exposure of the lumbar ureter—posterior approach (continued). The ureter displayed

by PEAU, OLLIER, BRUNO, RICHER and DARGET; it then fell somewhat into disuse until espoused anew by GIL VERNET in 1964 (Fig. 10).

Subsequently, the posterior route was found convenient and relatively atraumatic for removing small contracted kidneys in patients on maintenance dialysis or before transplantation and in this context it has the advantage that both kidneys can be removed without changing the position of the patient.

This approach can be used for simple surgery of the first part of the ureter, such as a ureterolithotomy. The patient is placed in a ventral or ventro-lateral position. A vertical incision is made four fingers lateral to the spinous processes, from the upper border of the 12th rib to the iliac crest (Fig. 6). The lumbar aponeurosis is incised vertically and the lumbar muscle mass retracted medially.

The aponeurosis of the transversalis is incised and the quadratus lumborum muscle is split with care to avoid the 12th intercostal bundle and the genitofemoral nerve (Fig. 11). The retro-renal fascia is then opened to expose the renal bed. The ureter is directly accessible at the lower part of the renal pelvis (Fig. 12). Closure is in two layers, the transversalis aponeurosis and the latissimus dorsi.

2. Exposure of the Iliac Ureter

This is the middle part of the ureter and the easiest to find because there is a constant landmark where it crosses the common iliac vessels and also because the ureter is relatively superficial in this region.

a) Extraperitoneal Iliac Approach

The patient is tilted slightly to the opposite side with a mild Trendelenburg tilt. The incision begins 3 cm medial to the iliac spine and runs downwards and forwards parallel to the inguinal ligament but on the right side it must be

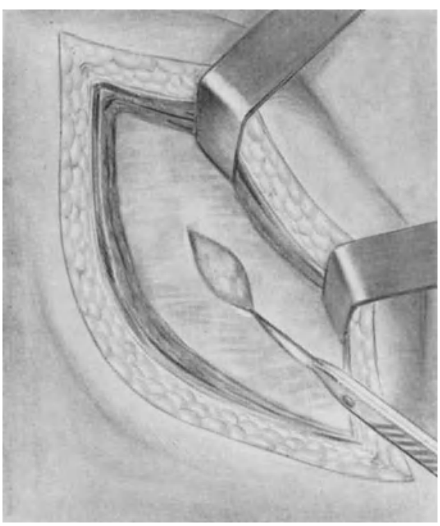


Fig. 13. Exposure of the iliac ureter—lateral extra-peritoneal approach. Muscle planes opened—incision of the fascia

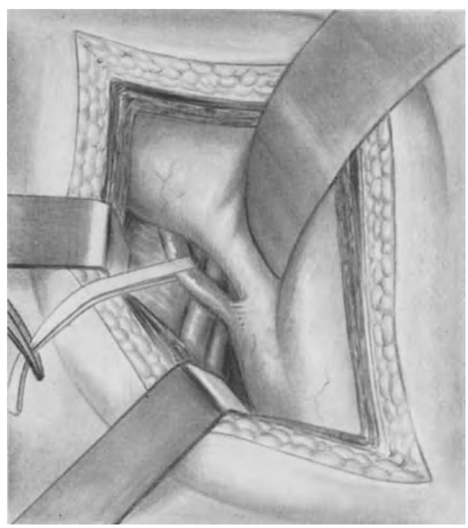


Fig. 14. Exposure of the iliac ureter—lateral extra-peritoneal approach (continued). The ureter displayed

kept lateral to any appendicectomy scar to avoid peritoneal adhesion (Fig. 5). The incision goes through skin, subcutaneous tissue and the aponeurosis of the external oblique. A somewhat shorter incision is made through the internal oblique and transversalis muscles. Then a small, buttonhole, incision in the transversalis fascia reveals the extra-peritoneal fat (Fig. 13). A finger is passed through this buttonhole to push the peritoneum upwards and downwards away from the transversalis fascia so that the division of the internal oblique and transversalis muscles can be extended to the full length of the incision while the peritoneum is retracted above and below with a sponge. The iliac vessels are discovered, by palpation if necessary in obese subjects. The ureter is sought between the posterior peritoneum and the iliac vessels and is recognised by its direction, its appearance and its characteristic movement. A tape is placed around the ureter for easier dissection and separation of spermatic or ovarian vessels (Fig. 14).

When the ureter is adherent it is important to remember its close relationship to the common and internal iliac veins.

b) Modifications

This iliac incision can, if necessary, be enlarged downwards to expose the pelvic ureter. The incision is extended downwards and medially towards the supra-pubic region, dividing the inferior epigastric vessels between ligatures and taking care not to damage the spermatic cord. The rectus sheath can be divided transversely and the muscle retracted medially.

If it is required to expose only the upper part of the iliac ureter, the muscles may be split instead of being cut, as in the McBurney incision for appendectomy.

3. Exposure of the Pelvic Ureter

This is always the most difficult part of the ureter to approach. The ureter passes along the wall of the true pelvis in a wide curve and rapidly becomes very deep. It is included in dense connective tissue, surrounded by a network of blood vessels, lymphatics and nerves; it is crossed by the vas deferens, the vesical vessels and by the uterine artery at the base of the broad ligament. The structures may be difficult to identify and display owing to disease processes and in men because the pelvis is narrow. Obesity adds still further to the operative difficulties.

The pelvic ureter is usually approached extraperitoneally. The incision may be lateral or midline suprapubic (Fig. 5).

A. Lateral Extraperitoneal Approach

This is the approach to the iliac ureter extended downwards, curving to the midline just above the pubis, dividing the epigastric vessels and the anterior and posterior sheath of the rectus muscle, with care to avoid damage to the spermatic cord. The ureter is revealed by medial retraction of the peritoneum (Fig. 15). If the ureter is difficult to find because of obesity, peri-ureteritis or previous surgery, it should be sought at the fixed landmark where it crosses the iliac vessels and then followed down towards the bladder, keeping in contact with its anterior aspect. It is not necessary to isolate the ureter in its entire course. If it is necessary to expose the ureter below the point where it is crossed by the

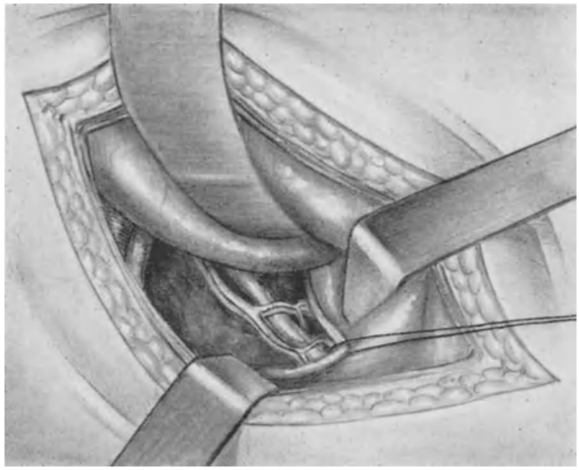


Fig. 15. Exposure of the pelvic ureter—lateral extra-peritoneal approach

superior vesical pedicle, this pedicle must be divided between ligatures and complete hemostasis should be achieved before dissection is continued down to the bladder.

The inguinal approach is a variant of this lateral extra-peritoneal approach but it is seldom used because the approach is limited and it is rarely indicated.

The inguinal canal is opened and the conjoint tendon divided. Then the transversalis fascia is opened and the epigastric vessels divided between ligatures. The peritoneum is retracted upwards. The vas deferens in men and the round ligament in women will lead the operator to the terminal ureter.

B. Midline Extraperitoneal Approach

A midline incision is made down to but not through the peritoneum. The retro-pubic space is opened and the peritoneum retracted upwards. The retraction of the peritoneum is continued laterally on the side where the ureter is to be exposed, to enter the lateral vesical space and expose the lateral aspect of the bladder. The pelvic ureter lies very deep in dense fatty areolar tissue filling the angle between the bladder and the lateral wall of the pelvis and it is crossed in front by the vesical vessels. It can be helpful to begin by identifying the ureter much higher, where it crosses the iliac vessels.

This is a fairly narrow approach that can be very deep and difficult in an obese patient or where there is extensive peri-ureteritis but it does have certain advantages. Damage to the abdominal wall is minimal because no muscles are divided. The main advantage is that both ureters can be approached through the same incision. A further advantage is that it can, where necessary, be combined with a transperitoneal approach as extensive as may be needed (for insertion of an ileal conduit, for example) and also the bladder can be opened, providing a combined approach to the terminal ureter.

4. Exposure of the Terminal Ureter

The terminal ureter includes the juxta-vesical ureter, the intramural ureter and the ureteral meatus. These last four or five centimeters of ureter are extremely deep and surrounded by a vascular network. Where endoscopic techniques are inadequate, this part of the ureter can be approached surgically along the lateral aspect of the bladder, across the bladder or by a combination of the two, and much more rarely through the vagina.

A. Lateral, Paravesical Approach

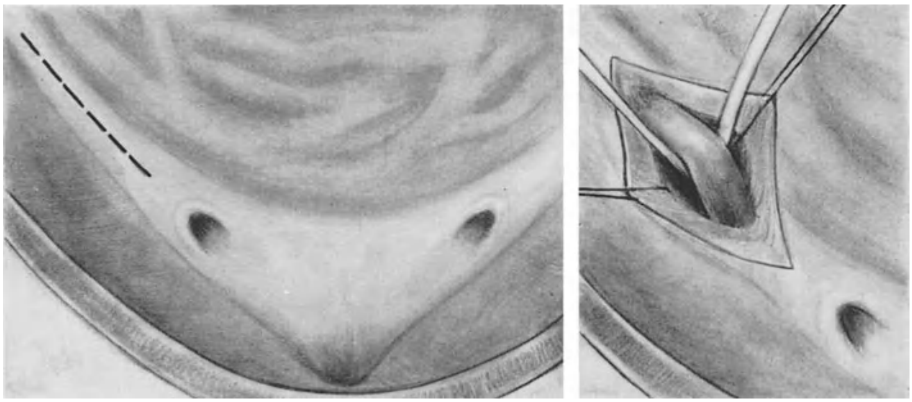
This is the approach to the pelvic ureter extended to the lowest extremity. Whether the incision is midline, suprapubic or lateral, this extra-peritoneal approach to the terminal ureter between the lateral aspect of the bladder and the wall of the pelvis is fraught with difficulty as the ureter runs behind the broad ligament or the vesico-prostatic vessels.

B. Transvesical Approach

The bladder is exposed, either by a vertical supra-pubic incision or by a horizontal incision of the Pfannenstiel type. The bladder is opened below the peritoneal reflexion. The ureteral meatus, the intramural ureter and the last few cms of the pelvic ureter can be approached through the bladder. Two technical variants can be used depending on the site of the lesion, meatal or supra-meatal. In *the meatal route* the meatus and intramural ureter are slit on their anterior aspect or alternatively the meatus and the intramural ureter may be dissected out and the ureter pulled through into the bladder cavity as in the first stage of terminal ureterectomy.

When the meatus and the distal part of the intramural ureter are normal, the juxta-vesical ureter can be approached by the *supra-meatal route* (Fig. 16). The postero-lateral wall of the bladder is incised above the ureteral orifice in a direction passing obliquely upwards and laterally, following the course of the ureter indicated by an indwelling ureteral catheter.

When the bladder wall is divided, the ureter is found in dense connective tissue containing many blood vessels and it can be incised or resected or some anti-reflux procedure may be performed. A simple ureterotomy (to remove a stone) can be sutured and the bladder wall closed. In order to preserve the anti-



a b

Fig. 16a and b. Exposure of the terminal ureter—trans-vesical approach. (a) Supra-trigonal incision. (b) The ureter displayed

reflux function of the uretero-vesical junction, any such supra-meatal incision should not go closer than half a cm to the meatus and must be very carefully sutured; the important point is to maintain a good posterior support for the intramural section.

C. Combined Approach (Intra- and Extra-Vesical)

Complete control of the terminal ureter is possible with this median extra-peritoneal approach. It combines the advantages of both the previous approaches with little extra work. The transvesical identification of the ureter makes the lateral vesical stage of the dissection much easier. This is the route of choice for anti-reflux uretero-vesical reimplantation.

D. Vaginal Approach

The indications for the vaginal approach to the ureter are very few, practically limited to ureterotomy for a large fixed stone. The object is to expose the ureter where it crosses the lateral vaginal fornix.

The patient is placed in the full lithotomy position; the cervix is grasped with a forceps and drawn to the opposite side. The vagina is incised either by antero-lateral colpotomy or by anterior transverse colpotomy. The bladder is separated from the vagina by blunt dissection and this dissection is carried as high as possible. The ureter is identified by touch, by feeling either the stone or an indwelling ureteral catheter. The ureter is approached from its postero-lateral aspect to avoid damage to the anterior aspect or to the uterine vessels (Fig. 17).

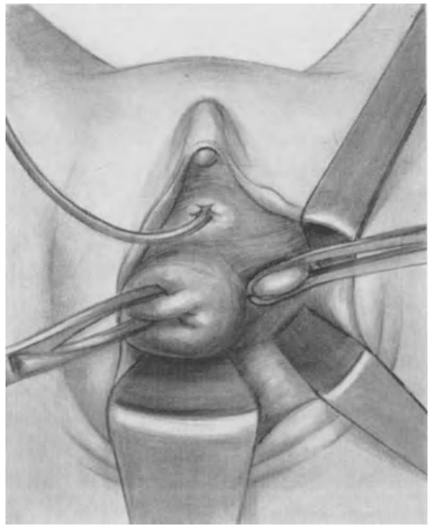


Fig. 17. Exposure of the terminal ureter—vaginal approach

In practice, this approach is difficult and hemorrhagic if the ureter is of normal size. It is, however, a very simple approach for removing a large stone in the ureter that can be felt easily on vaginal examination; in one case, we found it very easy to remove stones in the lower end of both ureters. Contrary to what might be feared, there seems to be no risk of uretero-vaginal fistula.

5. Transperitoneal Exposure of the Ureter

The transperitoneal approach provides easy access to every part of the ureter (Figs. 18 and 19).

A. Segmental Exposure

It is rarely necessary to utilise this approach to gain access to a single segment of the ureter, lumbar, iliac or pelvic. In such cases it is not justifiable to cross the peritoneal cavity unless previous surgery by an extra-peritoneal route has made it likely that a further approach by the same route would be difficult or dangerous. The transperitoneal route may also be indicated if there is a need to explore intra-peritoneal viscera at the same time or to expose both ureters at different levels in the same operation. It may happen that the need to explore the ureter is not obvious until laparotomy.

Fig. 18. Intra-peritoneal relations of the right ureter

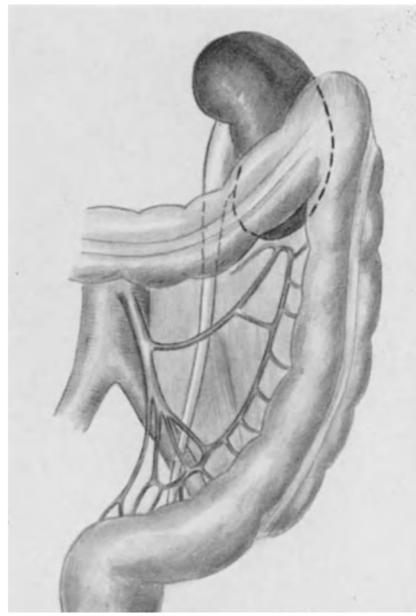


Fig. 19. Intra-peritoneal relations of the left ureter

a) The Lumbar Ureter

can in the theory be approached, to a limited extent, across the right or left meso-colon. But this incision gives very limited exposure and runs the risk of damage to the colic vessels. If it is necessary to approach the lumbar ureter in the course of a laparotomy it is preferable to make an incision in the para-colic gutter and reflect the colon medially. On the right side it is necessary also to make a small reflection of the duodenum and pancreas because the second stage of the duodenum is immediately in front of the uppermost part of the ureter.

b) The Iliac Ureter

is very easy to approach transperitoneally. With the small intestine packed up out of the way, the point where the ureter crosses the iliac vessels at the pelvic brim is once more the accurate anatomic landmark. In principle, the right ureter crosses the external iliac artery just after its origin while the left ureter crosses the common iliac artery just above its bifurcation. On the right, the ureter is visible through the peritoneum but on the left it is masked by the pelvic mesocolon and may be approached either across the mesocolon or, preferably, to avoid vascular damage, by reflecting the pelvic colon and mesocolon medially so as to approach the ureter extra-peritoneally.

c) The Pelvic Ureter

should also be identified first of all where the ureter crosses the iliac vessels and the dissection is carried downwards by incising the lateral pelvic peritoneum on the right side and by following the reflection of the root of the pelvic mesocolon on the left side. In the male, the vas deferens will be encountered reflected with the peritoneum. In the female, the ureter passes behind the broad ligament and the anterior and posterior folds of this ligament must be incised with or without section of the round ligament. There is no special feature about the dissection of the terminal ureter but the wide exposure makes this dissection somewhat easier.

Whatever part of the ureter may be approached transperitoneally, it goes without saying that the surgery on the ureter must be completed by extra-peritoneal drainage (a lateral drain for the lumbar and iliac segments, a suprapubic midline or lateral drain for the pelvic ureter) and the peritoneum should be closed carefully and as completely as possible.

B. Exposure of Entire Ureter

The transperitoneal route is most commonly used nowadays to approach the entire length of one or both ureters. Thus it is the usual approach for partial or complete entero-ureteroplasty. A midline incision from the xiphoid to the pubis can be used in narrow-chested subjects. If the patient has a wide thorax it is better, in approaching the lumbar ureter and renal pelvis, to make the upper part of the incision oblique as described by BARRAYA and QUENU.

II. Ureterolysis

"Freeing the ureter" is rarely practiced today as an isolated operation. The operation was designed to remove bands and adhesions and ureteral kinks, disorders that were throught to be associated with nephroptosis in the lumboiliac region and with adnexal disease in the pelvic region in women. It is now recognized that ureteral angulation due to a vascular formation or fibrous band is very rarely a true pathologic entity so that an operation designed solely to correct such kinks is pointless in most cases and can be justified only if actual obstruction has been clearly documented by serial urographic studies at intervals of several months. The surgeon will thus avoid blaming the ureter for a certain number of painful syndromes whose psychosomatic nature explains both the success and the failure of the ureterolyses and associated nephropexies so frequently practiced in former times.

A. Simple Ureterolysis

Ureterolysis is not entirely obsolete and may be indicated in various circumstances:

1. Liberation of the pelvi-ureteric junction is the first stage in all operations for *congenital hydronephrosis*. In certain very exceptional cases, dissection of the sometimes very dense fibrous tissue that surrounds the pelvi-ureteral junction may reveal the junction to be free, wide, unobstructed and contractile and in such cases resection may not seem necessary. In certain very carefully chosen cases, ureterolysis alone has given good results, sometimes associated with nephropexy.

2. The lumbo-iliac ureter may be strangled by dense fibrous tissue arising
– from the fibrosis around a tuberculous *spinal abscess*;
– from the resolution of *retroperitoneal hematoma*, traumatic or spontaneous;
– from the dense peripheral sclerosis of an *aortic or iliac aneurysm*.

In all these cases there may be an indication for simple ureterolysis.

3. *The ovarian vein syndrome*, in the rare cases where it is authentic, may require no more than simple ureterolysis.

4. *The complications of gynaecologic surgery* may require early intervention on a blocked ureter, before there is irreversible kidney damage. Simple ureterolysis may be all that is required if the wall of the ureter is not seriously damaged. In other cases it will be preferable to resect the stenosed segment with end-to-end anastomosis of the ureter or reimplantation of the ureter into the bladder.

5. At any level, extrinsic fibrous stenosis following previous ureteral surgery may benefit from simple surgical liberation of the ureter.

6. In retroperitoneal fibrosis, where the lumbar and iliac ureters are strangled, causing progressive renal damage, it is not enough simply to free the ureters but they must also be transposed into the peritoneal cavity.

B. Ureterolysis with Intraperitoneal Transposition of the Ureters

a) Indications

The chief indication is *idiopathic retroperitoneal fibrosis*. In the majority of cases it is necessary to free both ureters, even though one of the kidneys may still appear unobstructed. In very advanced cases, preliminary nephrostomy may be required to relieve the renal failure. Cavography and lymphography should be performed in all cases before surgery so as to define the extent of venous and lymphatic obstruction.

Neoplastic periureteritis obviously presents an unfavourable situation but even here it may be worth while freeing one or both of the ureters as a first stage so that kidney function can be preserved while the tumor is treated. In practice, it is not always easy to distinguish between benign idiopathic retroperitoneal fibrosis and neoplastic periureteritis before surgery; at operation the naked-eye appearance is much the same in both conditions and frozen section biopsy is necessary to establish the diagnosis with certainty.

b) Technique

The best approach to the two ureters displaced medially by the sclerosing process is through a midline incision from xiphoid to pubis. In the rare cases where only one ureter is to be explored (previous nephrectomy, for example) it is better to direct the upper part of the incision obliquely towards the costal margin (Barraya incision) to give better exposure of the kidney and the colic flexure.

An incision is made in each paracolic gutter. On each side, the colon, with its mesocolon, is reflected medially to expose the retroperitoneal space containing the ureter. The first part of this reflection of the colon is easy but it becomes progressively more difficult as the dissection approaches the median fibrous zone which, most often in the lower lumbar region and in the iliac region, surrounds the large vessels and ureters (Fig. 20).

It is at this stage that the dissection of the ureter becomes delicate. Because of the lamellar formation characteristic of retroperitoneal fibrosis, the surgeon finds himself opening numerous cleavage planes that all seem alike and many may run into the actual wall of the ureter or of the vena cava. With care, the operator should be able to find the right plane of cleavage, liberating a supple ureter without damaging the wall of the ureter or compromising its blood supply. It is good practice to take several biopsies of the retroperitoneal tissue during this slow and careful dissection.

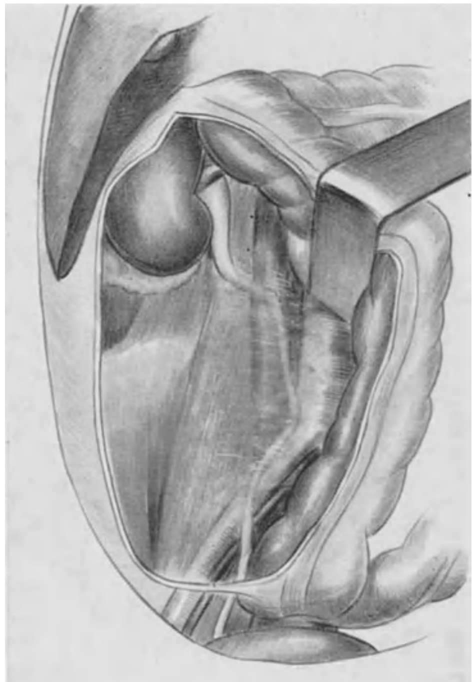


Fig. 20. Ureterolysis with intra-peritonealisation of the ureter for retro-peritoneal fibrosis. Exposure of the ureter and retroperitoneal tissues after reflection of the right colon

The ureterolysis can be continued on downwards through a lateral incision in the pelvic peritoneum and it most cases the dissection becomes very much easier in the pelvis.

When the ureter has been freed from the renal pelvis to the paravesical region it should be "intraperitonealized", provided that its entire wall seems viable and displays a good contractility. The ureter is laid in the peritoneal cavity and the paracolic gutter of the peritoneum is sutured behind it. Each ureter is now displaced laterally, lying within the peritoneal cavity in the lateral paracolic gutter (Fig. 21).

The critical zones are the openings through which the ureter enters and leaves the peritoneal cavity. Above, the first part of the lumbar ureter is displaced laterally to a considerable degree, passing under or in front of the lower pole of the kidney. At the lower end an opening must be made in the latero-vesical pelvic peritoneum. In placing the ureter in the peritoneal cavity it is very important to avoid any constriction, kink or torsion at the points of entry and exit.

Drainage is not normally necessary. A fine, soft, silastic catheter may be left in the ureter for the first week. The abdominal wall is closed with unabsorbable sutures.

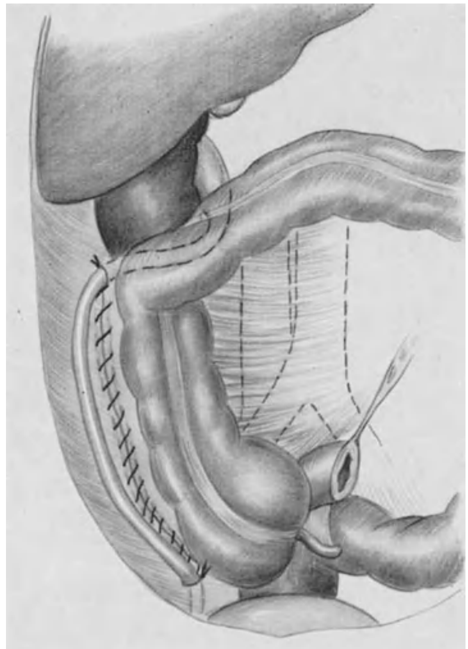


Fig. 21. Ureterolysis with intra-peritonealisation of the ureter (continued). Ureter freed and placed within the peritoneal cavity—suture of the lateral para-colic gutter

c) Modifications

HEWITT and his colleagues make a midline abdominal incision and then incise the posterior parietal peritoneum in the midline, between the duodenum and the inferior mesenteric vein; this incision is carried down to the sacral promontory. The duodenum is reflected to the right and the ureterolysis is effected by this route but the exposure is poor and there is a risk of damage to the blood supply of the gut. HEWITT does not place the ureters within the peritoneal cavity but displaces them laterally after the ureterolysis and interposes a layer of retroperitoneal fatty tissue, taken laterally, between the ureters and the fibrotic zone.

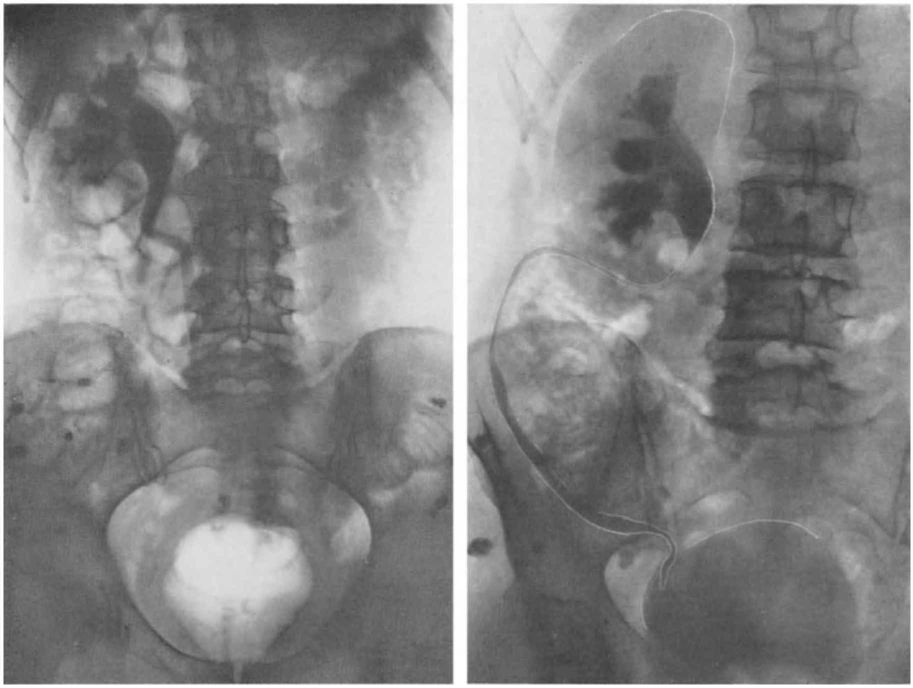
TRESIDDER and his collaegues prefer to wrap the freed ureters in a long flap of omentum.

d) Results and Limitations of the Operation

The results of ureterolysis with intraperitonealization of the ureters are in general very good, at least in the short term (Fig. 22). The prognosis depends on two factors:

– whether the retroperitoneal fibrosis is neoplastic or benign,
– he degree of renal damage by back pressure at the time of surgery.

The surgery is not always technically possible. The ureter may be damaged at one or more sites during the ureterolysis. Even if the ureter remains intact, after a difficult dissection the wall of the ureter at many places may be thinned,



a b

Fig. 22a and b. Intra-peritonealisation of the ureter for retro-peritoneal fibrosis. Woman aged 50 years. 1967: onset of left loin pain. September, 1967: destroyed left kidney removed. Biopsy of retro-peritoneal tissue revealed benign liposclerosis. 1968: Progressive dilatation of the right upper urinary tract: I.V.P. (75 mins) (a). Serum creatinine 1.6 mg per 100 ml. January 1969: Ureterolysis with intra-peritonealisation of the right ureter. March 1973: Condition excellent. I.V.P. (30 mins) (b). Urine sterile. Serum creatinine 1.0 mg per 100 ml

discolored, poorly vascularized and inert. Either way, if such a ureter is placed within the peritoneal cavity there is a risk of fistula with an intraperitoneal urinary leak. Resection of an isolated segment is sometimes possible but under these conditions the surgeon may hesitate to intraperitonealize the ureter.

In these circumstances there is a strong indication to make a substitute for the ureter. It is possible to replace the ilio-lumbar segment of the right ureter with the appendix but in most cases the only reasonable solution is total ileo-ureteroplasty, placing an ileal loop from the renal pelvis to the bladder. This technique is applicable also in cases where ureterolysis is impossible or would appear to run too great a risk to the major vessels. The ileal graft is placed within the peritoneal cavity and only the anastomoses between the ileum and pelvis and ileum and bladder are outside the peritoneal cavity. This is a very safe procedure (see Chapt. VI).

III. Ureterotomy

Only longitudinal ureterotomy will be considered in this chapter; there is nothing special about complete transverse division of the ureter which is merely part of a nephrectomy or a preliminary manoeuvre in ureterostomy, uretero-rrhaphy or replacement of the ureter.

It has been known for a long time that a longitudinal incision in the ureter heals rapidly and that the scar does not produce stenosis or any disorder of motility.

Three kinds of longitudinal ureterotomy are used:

– in most cases the incision goes through the full thickness of the ureteral wall, as, for example, to remove a stone (ureterolithotomy) or to drain a ureter (ureterostomy in-situ).

– much more rarely it is associated with ureteral intubation in the treatment of stricture.

– in certain exceptional cases, the ureterotomy is extramucosal (for parietal fibrosis with stricture).

1. Ureterolithotomy

Surgery is not indicated for every ureteral stone. The common indications include dilatation of the ureter and pelvis above the stone or serious embarrass-ment of kidney function, the size of the stone, its fixity, induced or associated ureteral lesions, secondary infection, stone in the ureter draining a single kidney, with or without anuria, and failure of an attempt at endoscopic extraction.

The difficulty of the operation depends on the position of the stone and on ureteral and peri-ureteral lesions. Because of the possibility that the stone may move it is essential to verify the position of the stone by a plain radiograph if the stone is opaque or by retrograde ureteropyelography if the stone is radio-lucent; for preference this radiography should be performed on the operating table.

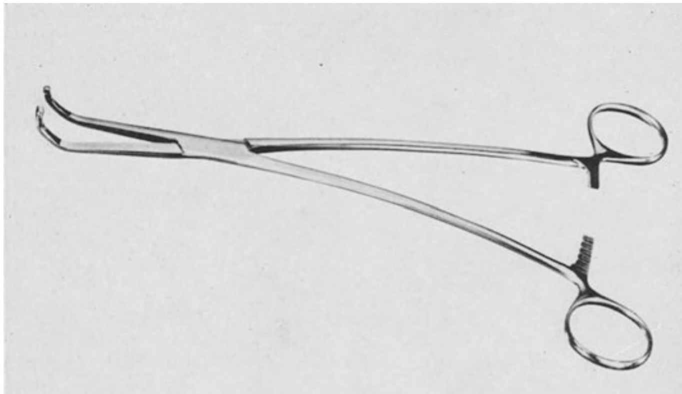


Fig. 23. Küss ureteral forceps

Stone in the iliac ureter is the easiest to approach surgically and the details of the operative technique can be taken as the basis for every type of uretero-lithotomy.

A. Iliac Ureterolithotomy

The approach is by the lateral extraperitoneal iliac route.

a) Finding and Controlling the Stone

The stone is easy to find when it is large and the tissues are healthy so that palpation is easy. It is more much difficult if the tissues have been infiltrated by periureteritis and fibrosis. In such cases the ureter must be identified where it crosses the iliac vessels and followed downwards until the stone is found, but even then direct palpation may be difficult if the ureteral wall is thickened.

When the ureter is identified and the stone has been localized, it is essential to control the stone, especially if the ureter above the stone is very dilated, because there is a risk that the stone may be dislodged during manipulation of the ureter and may move back up to the kidney. This control can be achieved by a tape passed around the ureter above the stone, and possibly below it as well. We have designed a special forceps for this purpose that will block the ureter without injuring its walls. This special forceps is also very useful in presenting the stone for the incision in the ureter (Fig. 23). If there is extensive peri-ureteral fibrosis, no attempt should be made to isolate the ureter because it is very adherent to the iliac vessels and these vessels may be damaged in dissection.

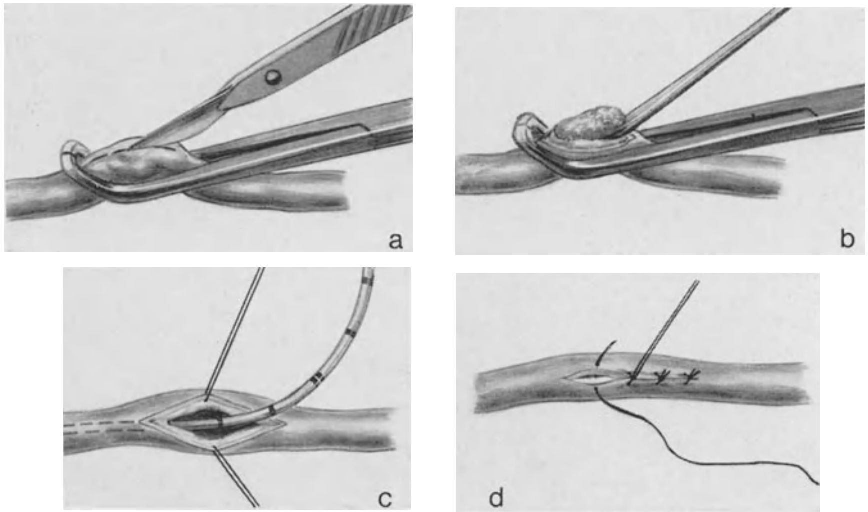


Fig. 24a–d. Longitudinal ureterotomy. (a) The incision. (b) Extraction of the stone. (c) Passage of ureteral catheter. (d) Suture

b) Ureteral Incision and Removal of the Stone (Fig. 24)

Large taped sponges are placed to protect the operative field from infected urine and stone debris before making the actual ureterotomy. Longitidunal incision onto the stone is the technique most often used and the easiest because the stone forms a block for the blade of the knife. Our special ureteral forceps is used rather than finger and thumb to present the stone and then a knife with a small narrow blade is used to cut longitudinally down onto the stone. It is important to carry this incision to both extremities of the stone, and sometimes even beyond, so that the stone can be extracted easily, especially when the stone is irregular with numerous sharp points impacted in the mucosa. A long incision in the ureter heals just as well and just as quickly as a short incision, with no subsequent effect on ureteral function. The stone should always be removed very gently to avoid fragmentation or damage to the ureteral wall, complications that are more likely to happen if the incision is too short. A blunt spatula is preferable to forceps.

When the stone has been removed, the lips of the ureterotomy are closed with fine catgut but before doing this it is a good plan to verify ureteral permeability by passing a catheter up to the kidney and down to the bladder and washing out the ureter with saline containing, if necessary, an antibiotic.

c) Suture of the Ureter

Should the ureterotomy incision be sutured after removing the stone? It is well known that a longitudinal incision in the ureter will heal spontaneously if there is no obstruction to the ureter below the incision and there is good drainage.

There is, however, evidence that healing in this fashion may lead to peri-ureteritis and subsequent fibrosis that can cause stricture. Except where the ureter is very friable and rigid, and sutures tend to cut out, suture is always worthwhile to obtain rapid and cleaner healing and to diminish the risk of peri-ureteritis by preventing urinary leak as far as possible. The suture is performed with interrupted 000 or 0000 catgut, either plain or chromic, in a single layer, picking up only the muscular wall so as to achieve good invagination of the mucosa.

d) Drainage

The extraperitoneal tissue in the region of the ureterotomy is drained by a strip of corrugated rubber. The drain can be removed gradually after three days.

Should a ureteral catheter be left in place? No urinary drainage is needed after simple removal of a stone from a healthy ureter if there is no infection. If the kidney is very distended, the urine infected and the ureteral wall diseased, it is better to leave a ureteral catheter in place for about ten days. This can be led throught the bladder and urethra or placed as a ureterostomy "in-situ" entering the ureter several cms below the site of the stone.

B. Modifications

This basic technique may have to be modified because of the position of the stone, lesions in the ureter, kidney disease or previous surgery.

a) The Position of the Stone

Lumbar Ureterotomy

In the vast majority of cases the lumbar ureter is approached by an extraperitoneal loin incision. The vertical posterior route has been used for some stones in the first part of the ureter provided that they seem to be fixed. Especially if the stone is small, it is essential to be sure that the ureter above the stone is controlled before stone the is palpated, because if the stone is allowed to move back up into one of the calyces the operation becomes vastly more difficult.

Pelvic Ureterotomy

A stone in the pelvic ureter can be approached by the lateral extraperitoneal route or by a midline extraperitoneal incision. It is always more difficult to remove a stone from the pelvic ureter than from the iliac or lumbar ureter: the pelvic ureter is deep and access is made difficult by important anatomic structures such as the genital vessels. Ureteritis and peri-ureteritis can make the dissection very laborious and bloody with ever increasing difficulty in identifying the ureter and finding the stone. Adequate retraction (with care to avoid injury to the femoral nerve), good light, a sucker and, above all, patience are essential aids. In these cases where the stone is deep in the lower pelvic ureter and difficult to find with the extraperitoneal approach, it may be helpful to open the anterior aspect of the ureter higher up and to prolong this incision downwards as far as the stone, if necessary as far as the intramural ureter, unless the surgeon is lucky enough to be able to push a smooth stone upwards in a dilated ureter.

Stone in the Terminal Ureter

(Juxta-Vesical, Intramural or Meatal)

The transvesical approach, with suprameatal incision of the bladder wall and ureter is the simplest and quickest when the stone can be felt through the bladder wall. In more difficult cases where a juxta-vesical calculus cannot be identified transvesically, *the combined* extraperitoneal midline approach resolves all the problems with the combination of opening the bladder and the lateral vesical approach.

A stone jammed in the meatus seldom requires open surgery; it can usually be extracted endoscopically, after meatotomy if necessary. Open surgery is indicated only when the endoscopic approach fails; then the bladder is opened and a small incision made in the meatus, the stone is removed and, if it seems necessary, the meatus is repaired over a catheter.

The vaginal approach has been used by some workers, ourselves included, for a fixed stone close to the bladder that is palpable on vaginal examination. There is a theoretical risk of uretero-vaginal fistula but such a fistula has never been reported. The exposure of the ureter is difficult.

b) Ureteral Lesions

may necessitate a change in surgical tactics.

Some ureteral lesions are secondary to the lithiasis. If there is acute ureteritis or periureteritis with inflammation and edema, a ureteral catheter should be left in for two weeks and the patient should be given steroids and antibiotics. If the stenosing lesion in the region of the stone appears already organised and fibrous it is better to do a segmental resection of the diseased segment with immediate end-to-end anastomosis of the ureter; this is better than leaving a ureteral lesion that may cause chronic obstruction with infection and recurrence of stone. This type of surgery is very suitable in the lumbar or iliac ureter but in the pelvic ureter it may be better to perform ureteroneocystostomy or a terminal transvesical resection of the pure pull-through type. With more extensive lesions in the pelvic ureter it may be preferable to replace the ureter by a tubed bladder flap.

Other ureteral lesions may be pre-existing or associated (such as stricture of tuberculous or other origin and congenital mega-ureter). In these cases the ureterotomy is only the first stage; the essential is to cure the ureteral lesion. Similarly, if the ureter is blocked with stone after plastic surgery or partial replacement, the ureter or its replacement may have to be revised.

c) Repeated Ureterotomy

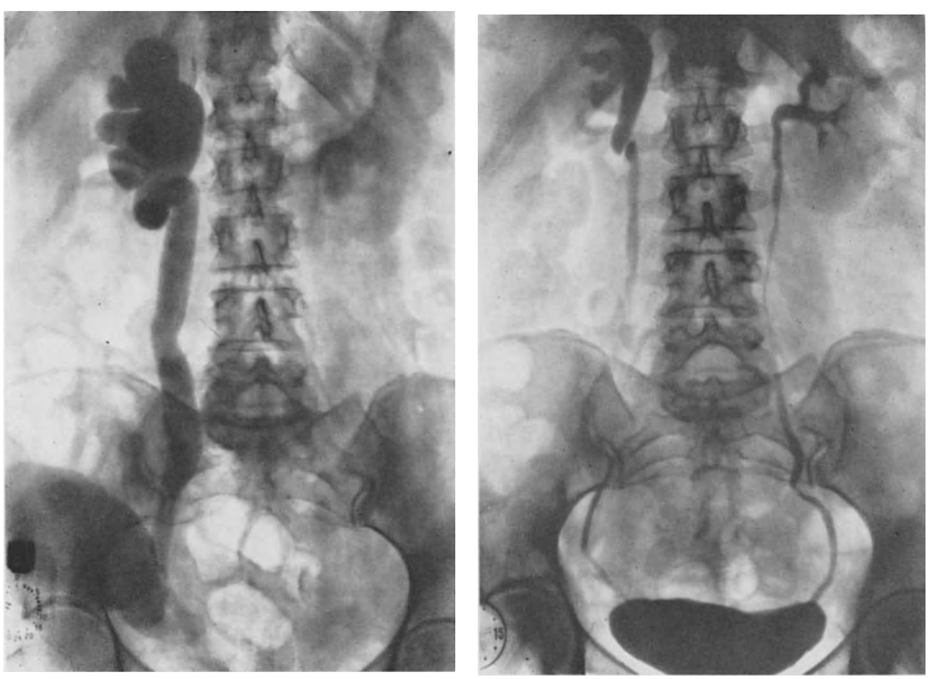
When surgery has to be repeated it is generally advisable to use a different incision or to make at least part of the approach through clean territory. For repeated ureterotomy, the transperitoneal route may be indicated.

In such cases there are often significant fibrous lesions in the ureter and it may be advisable to do a segmental resection.

C. Post-Operative Course – Complications – Results

Recovery from a ureterolithotomy is usually straightforward. Despite an apparently watertight closure of the ureter, it is common to find some drainage of urine in the first two or three days. If drainage persists, a ureteric catheter should be passed through a cystoscope and left in place for several days. Care should be taken to ensure rapid sterilization of the urine. There may be partial retention in the pelvis and calyces with loss of tone of the upper ureter for some weeks and if there is secondary infection this is indicated by fever and loin pain; this is also an indication for temporary drainage by a ureteral catheter if it is not rapidly brought under control by antibiotics and steroid therapy.

Complications are most often due to failure to recognise ureteral lesions. There may be a persistent fistula due to some obstruction or secondary stenosis due to too optimistic preservation of the damaged segment of the ureter (Fig. 25).



a b

Fig. 25a and b. Complications of pelvic uretero-lithotomy. Woman aged 56 years. (a) I.V.P. 18 days after pelvic ureterotomy for large oxalic stone with inflammatory ureteritis: urinary leak with dilatation of the ureter above. (b) I.V.P. three months later (treatment: indwelling ureteral catheter for 10 days and antibiotic therapy): return to normal

Long term follow up, with periodic urography as in all cases of lithiasis, will show a return to normal ureteral morphology and function in the majority of cases.

2. Ureterotomy for Stenosis

Stenosis of the ureter is a much less common indication for longitudinal ureterotomy, first used by HEYES, MARION and FEY. The work of DAVID DAVIS (1943 to 1951) on intubated ureterotomy revealed the remarkable ability of the ureter to reconstitute a circumferential loss of substance. The experimental work of LAPIDES, BOYARSKY and DUQUE showed that regeneration of the mucosa takes three weeks, whereas six weeks are required for regeneration of the urethral muscle.

Peri-ureteral fibrosis is often considerable and is a common cause of failure, a failure that some workers have attempted to avoid by covering the gap in the ureter by a peritoneal patch. Longitudinal ureterotomy with a splinting catheter was often practised at a time when complete division of the ureter was regarded unfavourably but there is little indication for this surgery today. Intubated ureterotomy may be followed by recurrence of stricture and it imposes the need for periodic endoscopic calibration and the consequent danger of infection may imperil the function of the kidney above.

In our view, when there is an established stricture of the ureter, segmental ureterectomy with ureterorrhaphy or reimplantation of the ureter into the bladder, or, if too much ureter is lost, ureteral replacement provides solutions that are more elegant and preferable because of the greater chance of definitive cure.

3. Extramucosal Ureterotomy

Inspired by HELLER's operation for achalasia of the cardia, and by extramucosal pylorotomy, this operation is designed to "open" the muscle fibres

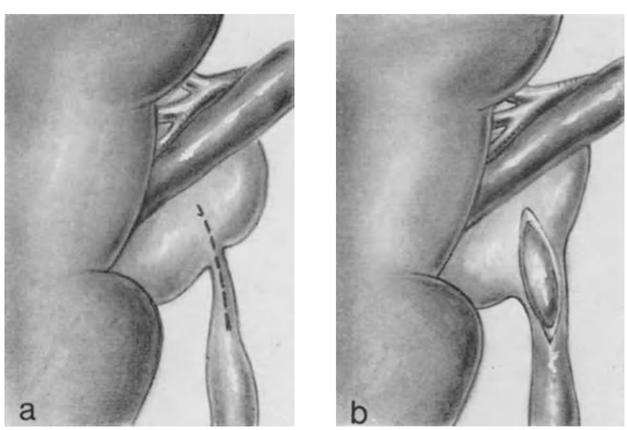
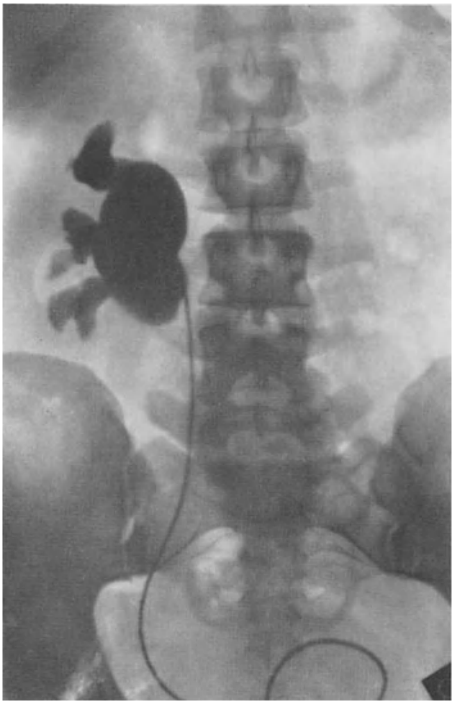


Fig. 26a and b. Extra-mucosal ureterotomy. (a) Line of incision. (b) Result



a

b

c

Fig. 27a—c. Result of extra-mucosal ureterotomy for congenital hydronephrosis in a solitary kidney (followed for 28 years). (a) Pre-operative pyelogram (April 1944). (b) I.V.P. 7 years later (July 1951). (c) I.V.P. 28 years later (May 1972) (serum creatinine 1.4 mg per 100 ml) of a ureteral stenosis, leaving the mucosa intact, ensuring adequate calibre with a large ureteral catheter (Fig. 26). The operation is possible only if the mucosa is healthy and not adherent to the muscle, a situation that obtains only in uninfected congenital stenoses. It is an operation that has rarely been used, in some cases of atresia of the first part of the ureter or at the pelvi-ureteral junction, in the treatment of congenital hydronephrosis and in such cases it has met with some success. We had a particularly striking success in one such case followed up for 20 years, a case of congenital hydronephrosis in a solitary kidney (Fig. 27).

IV. Ureteral Anastomosis

The ureter can be anastomosed to itself or to another ureter, to the renal pelvis or calyces above or to the bladder below[1].

1. Uretero-Ureteral Anastomosis

Such anastomoses may be made between two segments of the one ureter or between a ureter and the ureter of the opposite side.

A. End-to-End Anastomosis

An anastomosis can be formed between the two ends of the ureter sectioned or partially resected, either accidentally or deliberately. It was formerly thought that section of the ureter interrupted neuro-muscular conduction and the contraction wave with inevitable ureterectasis and hydronephrosis and progressive destruction of the kidney, but this hypothesis is now known to be false. It is now well established from hundreds of successful operations that end-to-end suture of the ureter can produce complete restoration of normal function after a transient period of functional asynergy of the two ureteral segments.

Following the first circular ureterorrhaphy with end-to-end anastomosis, performed by SCHOPF in 1886, many procedures were devised at the end of the last century for re-establishing the continuity of the ureter, such as ureterorrhaphy by invagination (POGGI, 1887), ureterorrhaphy by end-to-side invagination (VAN HOOK, 1893), and side-to-side anastomosis (MONARI, 1896) to cite but a few. These procedures were devised to limit post-operative urinary leak as far as possible but they now seem unnecessarily complex

Direct end-to-end anastomosis, the simplest and yet most effective technique, is now employed universally.

a) Operative Technique

Because the anastomosis must be made without any tension, the two ends of the ureter must be freed sufficiently so that they can be brought together

[1] Anastomosis of the ureter to the skin and intestine is considered in the chapters on urinary diversion and ureteral replacement.

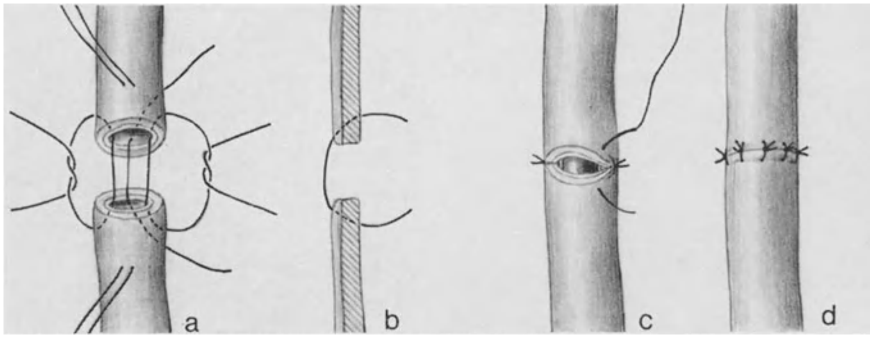


Fig. 28a—d. End-to-end anastomosis. (a) Commencement of suture. (b) Section of the wall. (c) Anterior layer. (d) Suture completed

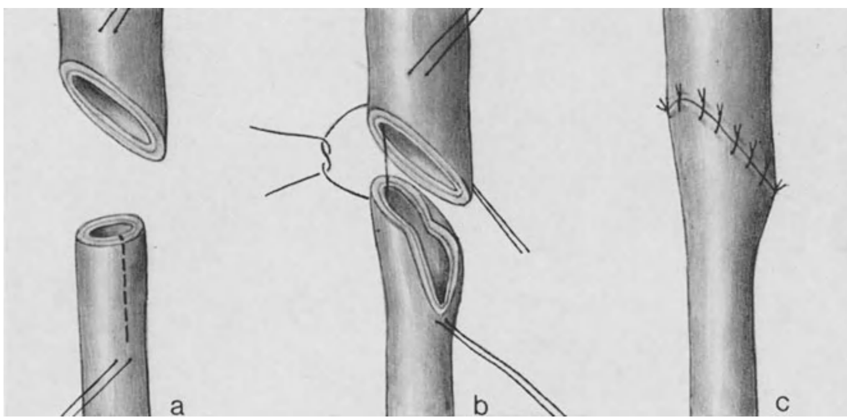
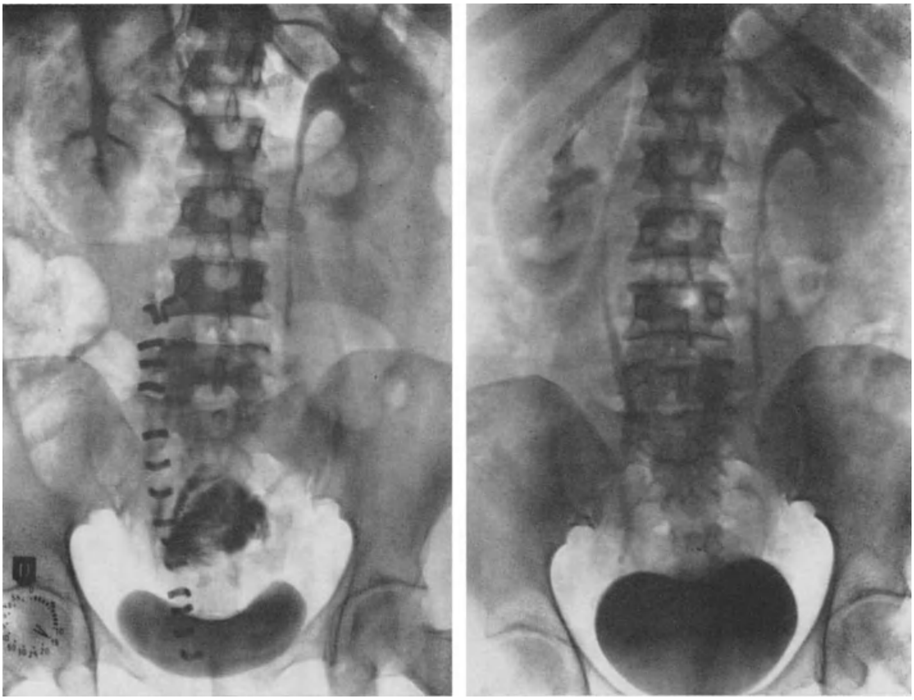


Fig. 29a—c. End-to-end anastomosis: alternative technique where there is a great disparity in size. (a) Incision of the distal end. (b) Beginning the suture. (c) Suture completed (spatulated)

without any traction. The line of section may be transverse or oblique, the latter giving a wider anastomosis. Suturing is performed in one layer with interrupted stitches of plain or chromic 000 or 0000 catgut mounted on a curved atraumatic needle. Each stitch is through the full thickness of the ureter, preferably with the exception of the mucosa. It is important to prevent any prolapse of the mucosa and the sutures are tied on the outer aspect of the ureter. The number of sutures depends on the diameter; for a ureter of normal calibre, six or seven sutures suffice in general to produce a watertight anastomosis. It is important that the ends of the ureter are divided cleanly and inflammatory infiltration of the ureteral ends is not a contraindication. If there is a marked difference in the size of the ends of the cut ureter it is perfectly simple to spatulate the anastomosis (Fig. 29). It is important to avoid any torsion of the ureteral segments.

Four to five cm is about the limit of the length of ureter that can be resected without tension on the anastomosis. If a slightly greater length of ureter has to be removed, it may be necessary either to lower the kidney (in dealing with



a b

Fig. 30a and b. End-to-end anastomosis. Woman aged 35 years. Bilateral ureteral lesions following gynaecologic surgery (for bilateral hydrosalpinx): ligature of the right ureter and injury to left pelvic ureter. (a) I.V.P. 24 hours after gynaecologic surgery: right kidney not functioning, left ureteral fistula. (b) I.V.P. 8 months after ureteral repair: end-to-end anastomosis of the right ureter after resecting 1 cm of ureter; lateral repair of the left ureter

the upper lumbar ureter) or to mobilize the lower pelvic ureter (in resections of the ilio-pelvic ureter). Higgins' operation, in which the lower end of the ureter is elevated with the ureteral orifice on a bladder flap is complicated and little used.

In these cases where the amount of ureter resected makes satisfactory end-to-end anastomosis impossible, it is better to use one of the procedures for ureteral replacement (see Chap. VI).

End-to-end anastomosis after a planned resection is generally performed through a lateral extraperitoneal incision. If the section or resection of the ureter has formed part of a laparotomy, the anastomosis is carried out transperitoneally but an extraperitoneal drain is placed down to the region of the suture.

Drainage of the kidney, during the phase of atony and temporary retention that follows any ureteral anastomosis (but to varying degrees), is generally ensured by a ureteral catheter. This catheter may be inserted at the time of the anastomosis, before completing the anterior layer, and the lower end of the catheter can be retrived from the bladder by a cystoscope or it may emerge as a ureterostomy in-situ below the anastomosis where this is sufficiently high; alternatively the catheter may be placed endoscopically at the end of the operation. The catheter is left in place for eight to ten days. The function of the catheter is urinary drainage and not calibration of the anastomosis and the catheter should not be a tight fit. When the anastomosis is performed on a healthy ureter and there is no distension of the kidney above, there is no need to use a ureteral catheter.

In our experience of several hundred cases, the results of end-to-end ureteral anastomosis, an operation unjustly decried for far too long, are in general excellent. Many of these cases have been followed for 20 years and more, and the results show that nephrectomy or urinary diversion for accidental division of a ureter must be condemned and they provide every justification for segmental resection of the ureter (Fig. 30).

B. End-to-Side Anastomosis

These uretero-ureteral implantations, or uretero-ureterostomies, consist in implanting a divided ureter either into the ureter on the other side (crossed uretero-ureterostomy) or into the neighbouring ureter in cases of ureteral duplication (homolateral uretero-ureterostomy).

These operations are seldom indicated. They constitute a mode of replacement of a lower ureter that is ectopic, destroyed or removed, by using another ureter. For this reason they will be considered in the chapter on replacement ureteroplasty (cf. Chap. VI).

2. Uretero-Pelvic and Uretero-Calyceal Anastomosis

After excision of lesions of the first part of the ureter it may be necessary to reimplant the ureter into the renal pelvis or calyces.

A. Uretero-Pelvic Anastomosis

This may be terminal, after resection of the pyelo-ureteral junction, or side-to-side without resection or interruption of the continuity of pelvis and ureter. These operations are essentially associated with the treatment of congenital hydronephrosis. Our purpose here is not to consider all the very numerous techniques of plastic repair or reconstruction of the pyelo-ureteral junction used in the treatment of hydronephrosis: they are described in another volume of this encyclopaedia. We shall merely describe, from a purely technical viewpoint, resection of the pyelo-ureteral junction followed by anastomosis of the ureter to pelvis as performed by us since 1951. It is in fact our treatment of choice for congenital hydronephrosis due to pyelo-ureteral obstruction but it can also be used for any stenosing, inflammatory or neoplastic lesion of the junction or the proximal ureter. Much more rarely, a side-to-side anastomosis may be indicated.

Fig. 31. Uretero-pelvic anastomosis after resection of the pelvi-ureteral junction (Küss). Exposure of pelvis and junction

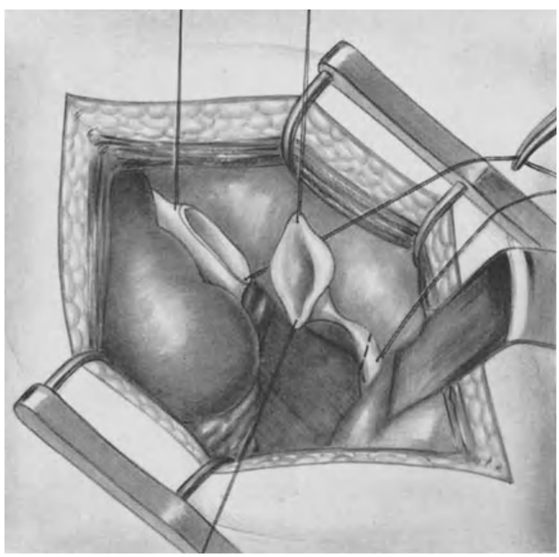


Fig. 32. Uretero-pelvic anastomosis after resection of the pelvi-ureteral junction (Küss) (continued). Section of pelvis and ureter

a) Uretero-Pelvic Anastomosis after Resection of Pelvi-Ureteral Junction

The junction is exposed by a loin incision resecting the 12th rib. The lower pole of the kidney is freed and the perirenal fat is used to retract the kidney to reveal the hilar region; the attachments of the upper pole are left intact because

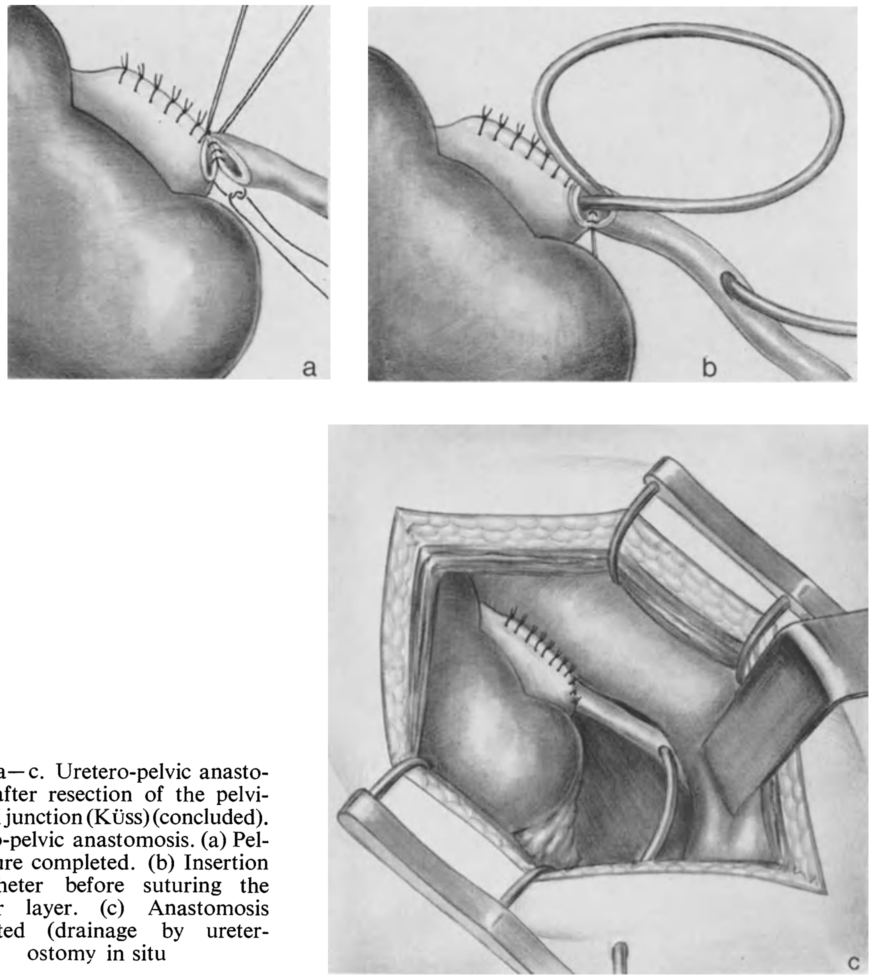


Fig. 33 a—c. Uretero-pelvic anastomosis after resection of the pelviureteral junction (Küss) (concluded). Uretero-pelvic anastomosis. (a) Pelvic suture completed. (b) Insertion of catheter before suturing the anterior layer. (c) Anastomosis completed (drainage by ureterostomy in situ

all this surgery is performed with the kidney in its normal site. The renal pelvis and the proximal ureter are dissected with care to keep some distance away from the wall of the ureter and pelvis so as to preserve the vascular network as far as possible (Fig. 31).

Two marker sutures of 000 catgut are placed, one on the anterior aspect of the ureter below the junction (or the lesion) to prevent subsequent torsion, the other on the upper border of the renal pelvis. The pelvis is resected to a varying extent (Fig. 32), preserving a small gutter at the lower part. Interrupted sutures of plain or chromic 000 catgut take a wide bite of muscle but a very small bite of the mucosa and the upper part of the pelvis is closed first. The uretero-pelvic anastomosis (Fig. 33) is carried out at the dependent part of the pelvis; the individual sutures are further apart on the pelvis than on the ureter, so as to widen the opening of the ureter whose calibre is often markedly diminished after section (due to localized spasm). The knots are tied on the outer aspect.

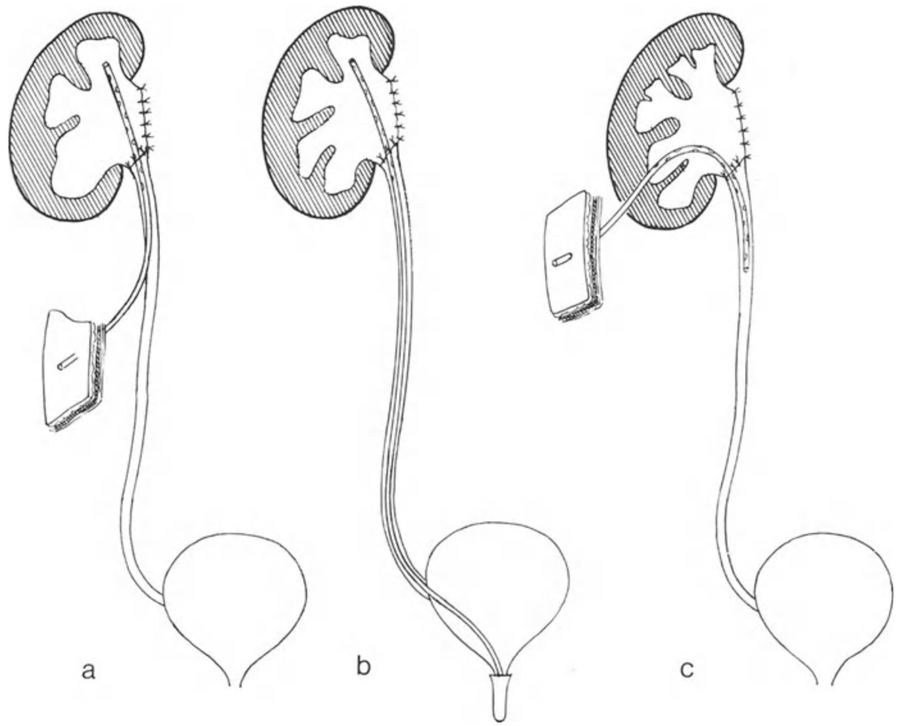


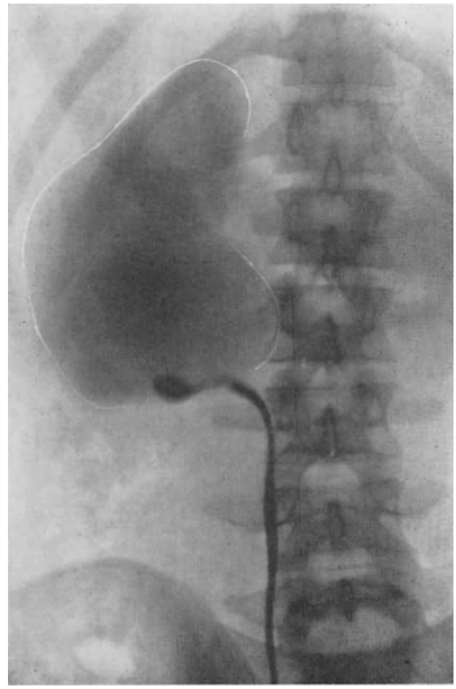
Fig. 34a—c. The various possible types of drainage after resection of the pelvi-ureteral junction for hyponephrosis. (a) Ureterostomy in situ. (b) Ureteral catheter. (c) Nephrostomy

If a urinary drain is used, it is placed in position before the anterior layer of suture is completed. The wound is closed with a soft rubber drain down to the region of the anastomosis.

Drainage of the kidney (Fig. 34) is not essential if the kidney is not dilated and not infected; there is in principle no need to splint a uretero-pelvic anastomosis. However, if the kidney is very dilated or infected it should be drained either by a soft silastic nephrostomy tube or by a ureterostomy in-situ emerging several cms below the anastomosis. If the surgeon opts for nephrostomy and there is any risk of kinking at the site of anastomosis, it is advisable to use in addition a ureteral catheter passed through the kidney parenchyma and down through the anastomosis, or a combined catheter of the Cummings type can be used. The time the drain is left in place depends on the degree of dilatation of the kidney and its recovery (Figs. 35 and 35′).

Fig. 35a—d. Resection of pyelo-ureteral junction for congenital hydronephrosis in a solitary kidney. Man aged 23 years who had undergone left nephrectomy for congenital hydronephrosis in July, 1964. (a) I.V.P. March 1965: tonic hydronephrosis. (b) Pre-operative retrograde uretero-pyelogram. (c) I.V.P. 2 years after resection of pyelo-ureteral junction (1967). (d) I.V.P. 7 years after surgery (1972). Normal renal function. Urine sterile

a



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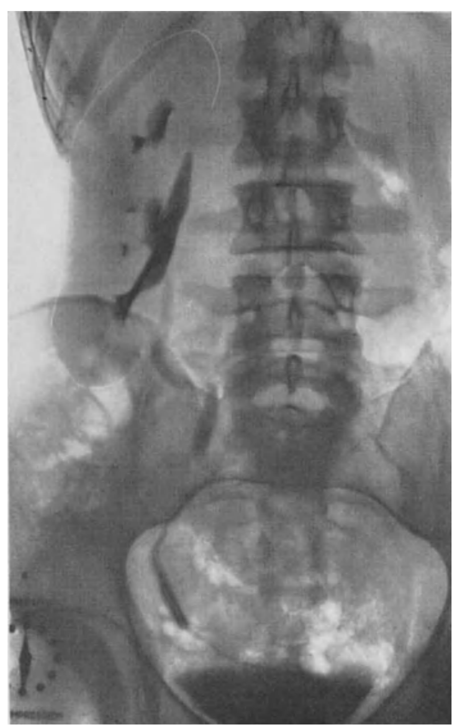
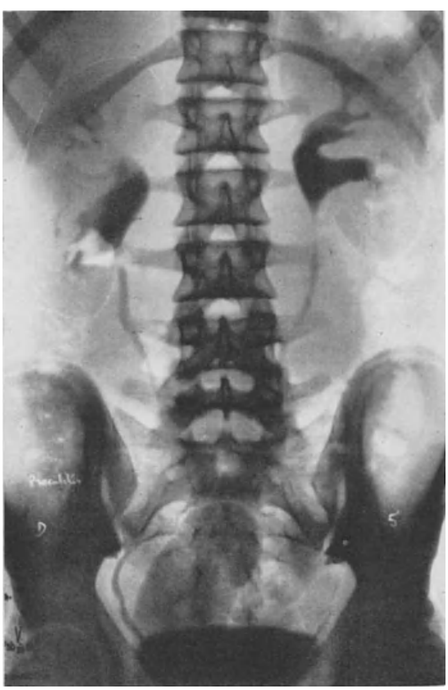


d

Fig. 35a—d

a

b



c

Fig. 35'a—c. Resection of pyelo-ureteral junction for congenital hydronephrosis. Boy aged 7 years. (a) I.V.P. (film taken at one hour): huge right hydronephrosis; renal parenchyma appearing very thin. (b) I.V.P. (film 6 hours after injection): the pelvis is now seen and is tonic but there is very poor emptying. (c) I.V.P. (25 minute film) 8 years after resection of the right pyeloureteral junction. Excellent symmetrical growth of the renal parenchyma on both sides

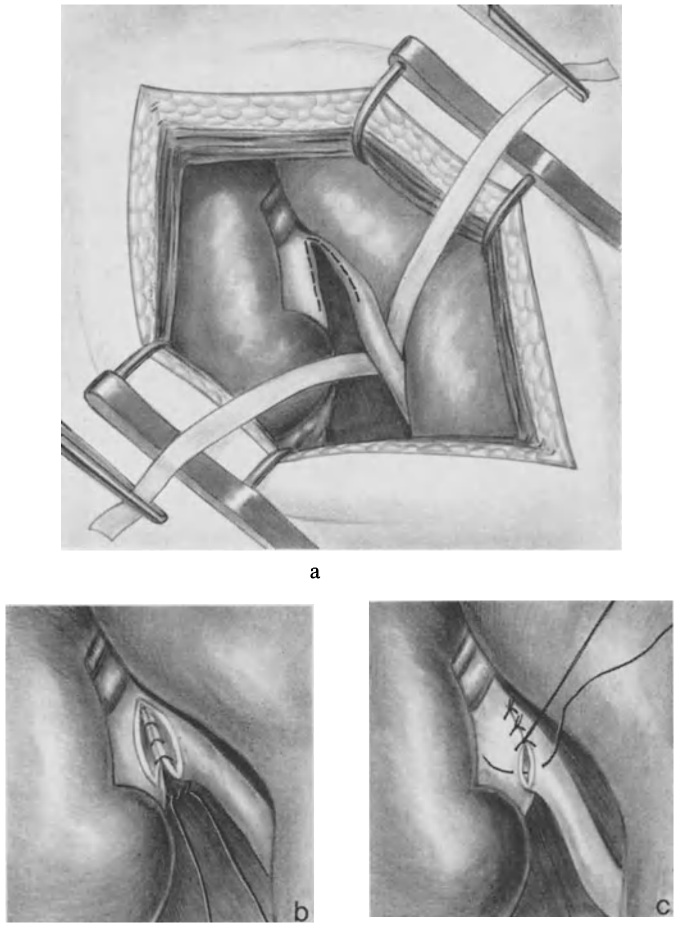


Fig. 36a—c. Uretero-pelvic anastomosis without resection of the junction. (a) Lines of incision. (b) Posterior layer. (c) Anterior layer

b) Uretero-Pelvic Anastomosis without Resection (Side-to-Side)

This is only rarely indicated and then only when the ureter is inserted high in the renal pelvis and is more dilated than a normal ureter. In the few cases in which we have performed this operation, we have always preferred an anastomosis including the junction, creating a complete pyelo-ureteral continuity that is easy to catheterize if need be, rather than an anastomosis by-passing the intact pelvi-ureteral junction. An angled incision is made in the pelvis and ureter, initially with the point of the knife and continued with fine scissors to include the junction.

The anastomosis is made with interrupted 000 catgut and the knots are tied externally (Fig. 36).

The wound is closed in the ordinary way with a drain that can be removed gradually from the fourth post-operative day.

B. Uretero-Calyceal Anastomosis

These are performed much more rarely than uretero-pelvic anastomosis and only when indicated by certain special anatomic circumstances.

Some isolated cases were reported by PAGEL (1955) and by MANETTI and SIRACUSANO (1956) who also carried out an experimental study on ten dogs, by CIBERT (1956), JAMESON (1957), SINGER (1962) and MACAULAY (1963). COUVELAIRE and his collaborators published 15 cases in 1964.

a) Operative Technique

The operation consists in implanting the lumbar ureter, divided in a healthy zone, into the lowest calyx or the lowest of the remaining calyces.

Approach

These are often secondary operations and the patient may already have a nephrostomy. It is then helpful to choose an approach different from that used in the previous surgery. We recommend the anterior transperitoneal route; it not only provides a different and wider exposure of the lesions, after retracting the colon, but it also permits intestinal ureteroplasty if the envisaged uretero-calyceal anastomosis proves impossible.

Finding and Dividing the Ureter (Figs. 37 and 38)

The first stage is dissection, or at least inspection, of the hilar region. Any lesions in the pelvis and first part of the ureter are defined and the need for uretero-calyceal implantation is confirmed. The ureter is freed and divided through a healthy segment.

Approach to the Lower Calyx

This may be very easy when the calyx is very dilated and the parenchyma is thin; simple incision over the calyx provides an adequate preparation for insertion of the ureter but the operator must make certain that this calyceal cavity has a wide communication with the other calyces. If the renal parenchyma is thick, or the kidney is surrounded by dense perinephritis, the approach to the lower calyx may be difficult even when the calyx is dilated. A simple incision is then inadequate for proper anastomosis; a wide crater must be excavated in the renal parenchyma down to the calyceal wall, which is identified by puncture if necessary, and the crater must be sufficiently wide at its apex for easy suturing. Meticulous hemostasis is ensured in the parenchymal wound. The ureter will lie very free in the crater (Fig. 38). It is sometimes necessary to have recourse to wide nephrotomy of the lower pole of the kidney to gain access to the calyx. It is then preferable to resect the parenchyma to avoid the risk of secondary constriction of the initial part of the ureter, and in effect to carry out a lower polar partial nephrectomy (Figs. 41, 42). The wound in the calyx is then partially sutured in preparation for a spatulated anastomosis of the ureter (Fig. 43).

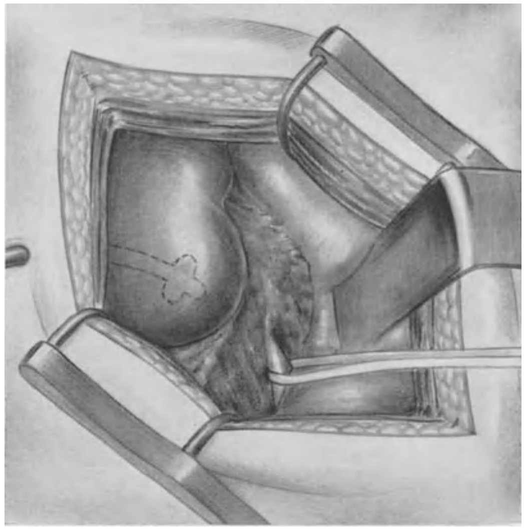


Fig. 37. Uretero-calyceal anastomosis. Finding the ureter

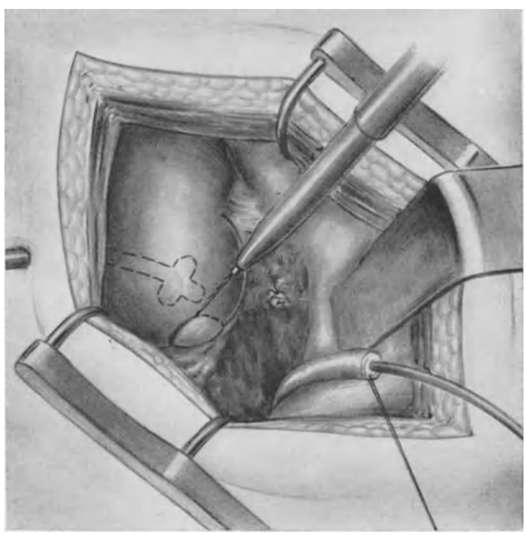


Fig. 38. Uretero-calyceal anastomosis (continued). Division of the ureter and exposure of the lowest calyx

The same procedure is applied to a middle calyx if there is a more extensive lower polar nephrectomy.

Uretero-Calyceal Anastomosis (Fig. 39)

Like all ureteral anastomoses it is performed by careful apposition with interrupted sutures of fine chromic catgut, taking more of the ureteral muscle

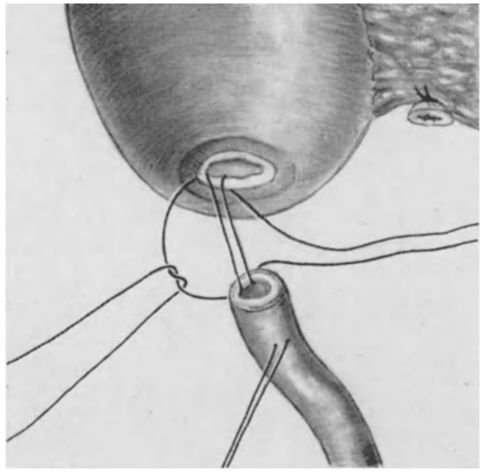


Fig. 39. Uretero-calyceal anastomosis (continued). Detail of the suture

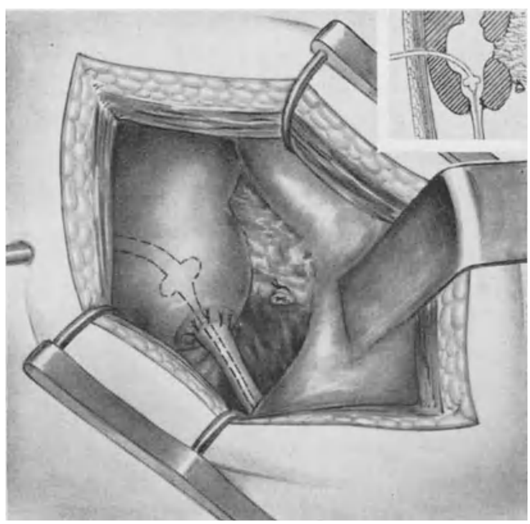


Fig. 40. Uretero-calyceal anastomosis (concluded). Suture completed; a Cummings catheter is in place—Inset: the drainage arrangement

than of the mucosa and with wider bites of the calyceal wall (and not the adjacent parenchyma). The sutures are placed further apart on the calyx than on the ureter so as to open the anastomosis as widely as possible.

Urinary Drainage (Fig. 40)

It is necessary to place a large ureteral catheter (16 or 18 F), preferably with multiple perforations. This catheter can be led out as a ureterostomy in-situ; after 12 to 14 days it can be replaced, if necessary, by a catheter passed through

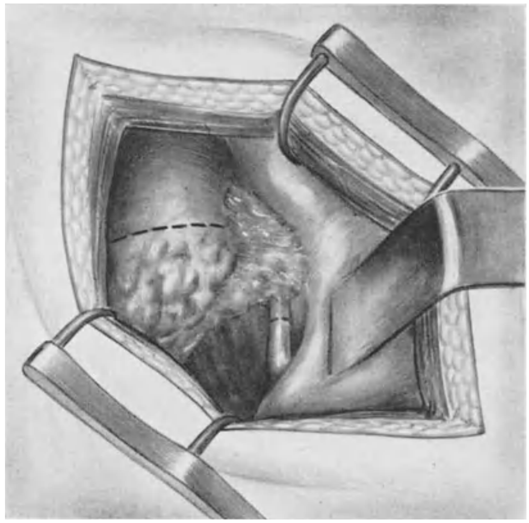


Fig. 41. Uretero-calyceal anastomosis: alternative technique with lower polar nephrectomy. Exposure of the lesions—level of sections

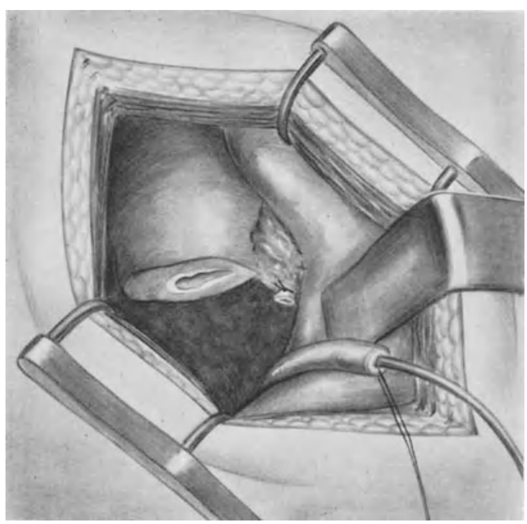


Fig. 42. Uretero-calyceal anastomosis with lower polar nephrectomy (continued). Renal and ureteral sections

a cystoscope. If the kidney is very dilated, this drainage may not be adequate and then a temporary nephrostomy may be indicated, using a multifenestrated silastic tube in addition to the ureteral catheter placed as a ureterostomy in-situ or across the kidney substance. A catheter of the Cummings type may also be used.

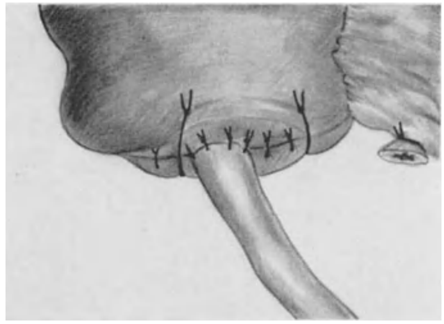


Fig. 43. Uretero-calyceal anastomosis with lower polar nephrectomy (concluded). "Racket" suture

Closure of the Wound

The peritoneum is closed over the operative site and lateral drainage is provided by a soft rubber drain placed extraperitoneally.

Post-Operative Course

The wound drain is removed gradually after the fourth day. The ureteral catheter is left in place for about two weeks; a nephrostomy tube can be removed at the end of the third week after making the usual checks that the ureter is patent.

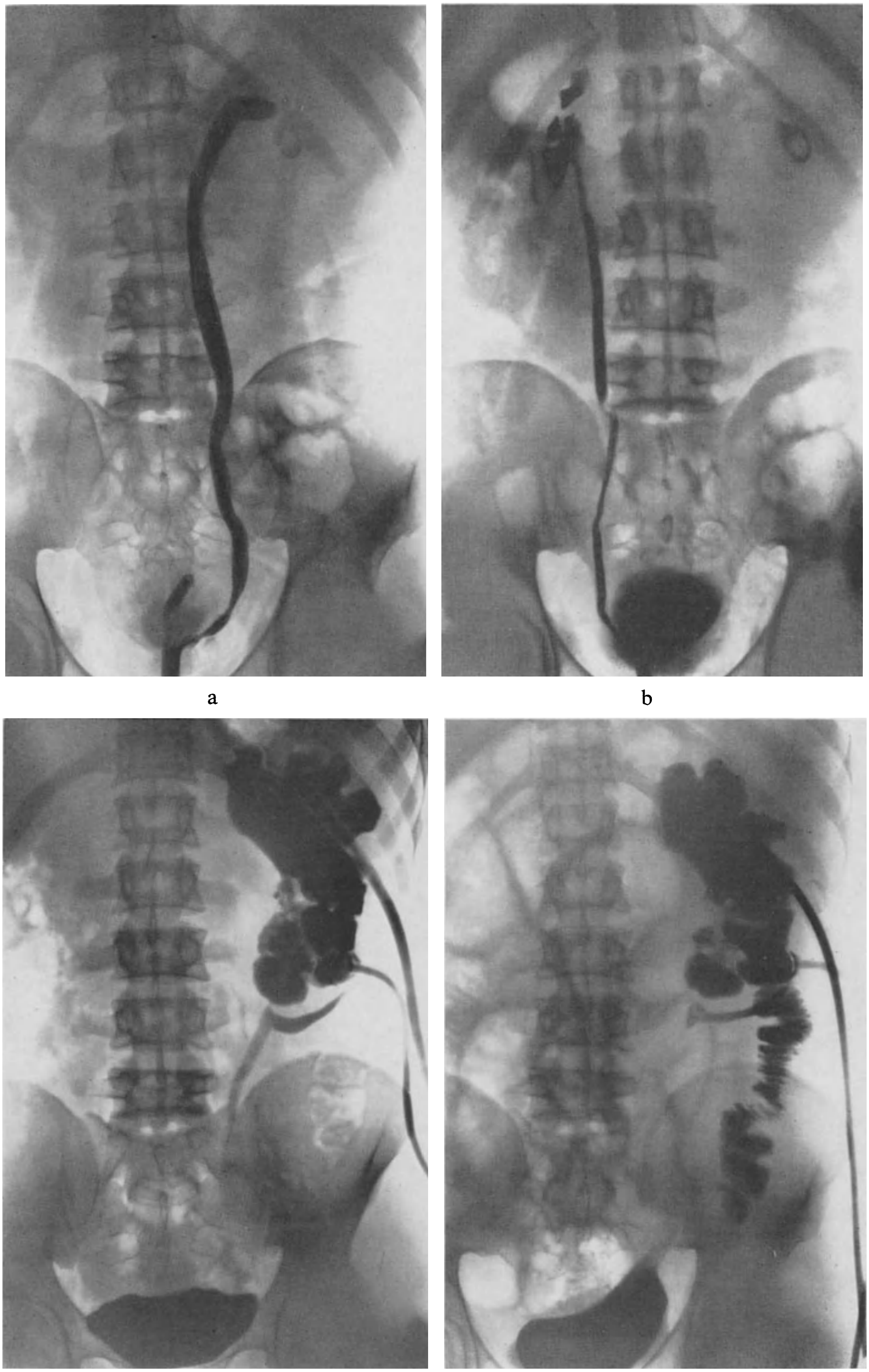
b) Indications – Results

The operation of uretero-calyceal implantation has very limited indications, including destruction or stenosis of the renal pelvis at the pelvi-ureteral junction or the impossibility of displaying the hilum of the kidney. Like all major reparative surgery of the excretory tract, it presupposes conservation of a certain amount of kidney function and the absolute necessity of preserving this function – as with a solitary or functionally predominant kidney. Two further conditions are essential:

– The disease must be limited to the first part of the ureter and the rest of the ureter and the lower urinary tract should be normal.

– There must be free communication between the calyces.

Fig. 44a–d. Double uretero-calyceal anastomosis in a solitary functional kidney. Man aged 28 years. Rapidly progressive renal failure with oliguria; large distended left kidney palpable. (a) Left retrograde ureteropyelogram: almost complete intra-hilar obstruction with lithiasis. (b) Right retrograde ureteropyelogram: small, atrophic, non-functioning kidney. (c) Antegrade pyelogram 5 weeks after double uretero-calyceal anastomosis (and double nephrostomy). The renal hilum could not be exposed because it was embedded in fibrous tissue and there was no pelvis; the kidney was reduced to large cavities that did not communicate with each other. The lower uretero-calyceal anastomosis is patent but the upper one is stenosed. (d) Drainage restored by total ileal-ureteroplasty with double ileo-calyceal anastomosis, upper and lower. Antegrade pyelogram before removal of nephrostomy tubes. Good result two years later; recovery of fair degree of stable renal function (blood urea 70 mg per 100 ml; endogenous creatinine clearance 30 ml/mn)



a b

c Fig. 44a—d d

It follows that there are virtually only two indications for uretero-calyceal implantation:

a) Destruction or cicatricial stenosis of the renal pelvis and pelvi-ureteral junction after pyelolithotomy. This happens mainly in repeated and difficult pyelotomy when the renal pelvis has been damaged by stone. The pelvis is retracted into the renal sinus by perihilar fibrosis, surrounding the vessels so that any further dissection is dangerous or impossible. Sometimes a failed attempt at plastic repair has led to nephrostomy. These lesions may be aggravated further by recurrence of stone.

b) Tuberculous stenosis of the renal pelvis. Here there is a danger that the stenosing cicatricial retraction may also involve the necks of the calyces so that it is necessary to provide separate drainage of each of the obstructed calyces. Even when uretero-calyceal anastomosis may appear indicated and practicable it may be rendered difficult by tuberculous lesions of the renal parenchyma so that it may be necessary to perform partial nephrectomy to an unforeseeable shape and extent.

The uretero-calyceal anastomosis, a technique that is simple in itself, is thus a difficult operation in most cases because of the lesions that make it necessary. There may be many complications in the post-operative period including loin fistula after removal of catheters, abscess, progressive stenosis and renal retention, at least partly infected. Antibiotics, steroids, endoscopic dilatation of the anastomosis and especially renal lavage and instillations may help to get over the difficulties. But late failure due to stenosis occurs in about 30 per cent of cases. In general, the best results of the anastomosis occur when the renal parenchyma is thin (and thus probably in the kidneys with worst function). Conversely, the uretero-calyceal implantation often fails when the renal parenchyma is thick: apart from the greater technical difficulties, fibrosis of the wound in the renal parenchyma surrounds the ureter with dense fibrous tissue, producing a stenosis below the anastomosis. This is why a lower polar nephrectomy is, despite the sacrifice of renal parenchyma, preferable to making a crater in the parenchyma with the risk of subsequent strangulation of the ureter.

Despite its limited indications and possibilities, uretero-calyceal anastomosis is a valuable technique in certain cases and may avoid the need for permanent external diversion. It has proved very successful in some cases, especially with dilated kidneys. If much ureter is lost and the kidney cannot be mobilized the operation may be impossible. In such cases, if the patient is to be spared the infirmity of permanent nephrostomy, it is better to perform ureteral replacement surgery. The appendix has occasionally been used to replace the first few cms of the ureter and it may be anastomosed to a calyx in the same way as a ureter. Total ileo-ureteroplasty is the real solution to the problem, with its wider ileo-calyceal anastomosis less subject to stenosis, and there is also the possibility of anastomosing the ileum to several of the calyces, the only technique that will preserve the kidney when the stenosing lesions have involved the necks of the calyces (Fig. 44).

3. Uretero-Vesical Anastomosis: Ureteroneocystostomy

First performed in dogs in 1837, by POGGI, implantation of the ureter into the bladder was first proved effective in 1888 by the experiments of PAOLI and BUSACCHI.

The first human uretero-vesical implantation was made by the vaginal route in 1890 by DAVENPORT, to treat an ectopic opening of the ureter.

Uretero-vesical implantation became a practical surgical technique after the first successful cases in 1892 by NOVARO in Italy and by BAZY in France, who proposed the term ureteroneocystostomy.

Alternately extolled and decried after that period, ureteroneocystostomy, with simplified techniques, has now become a common operation with excellent long term results.

There are at the present time four major types of uretero-vesical anastomosis:

– Simple attachment of the ureter to the bladder, direct uretero-vesical implantation, is the true ureteroneocystostomy in the classic sense of the term.

– In other cases the anastomosis is supplemented by some device designed to prevent vesico-ureteral reflux; these are the "anti-reflux" uretero-vesical implantations.

– In other uretero-vesical anastomoses, the terminal part of the ureter or even the whole pelvic ureter is replaced: this is ureteroplasty by a tubed bladder flap.

– Lastly, side-to-side uretero-vesical anastomosis, rarely practiced nowadays, does not interrupt ureteral continuity and is in fact a form of uretero-vesical "diversion".

We shall consider here only the direct and the side-to-side anastomoses; the other two types of operation will be considered in the chapters on the surgery of vesico-ureteral reflux and on replacement ureteroplasty.

A. Direct Uretero-Vesical Implantation

Many procedures have been described and used for implantation of the ureter into the bladder (Fig. 45).

– Simple intubation, used by BAZY and by BOEMINGHAUS, is an operation in which the ureter, divided transversely or obliquely, is passed into the bladder where its tip projects and lies free. The ureter is fixed where it passes through the bladder wall.

– Ricard's procedure consists in folding back the tip of the ureter so that the ureteral mucosa is in contact with the bladder mucosa. A longitudinal slit is necessary if the ureteral wall is thick.

– In Payne's procedure, the ureter is bivalved and each half is caught up in a horizontal mattress suture which is used to pull the ureter into the bladder and then passed through the bladder wall and tied on the outside.

The object of these procedures is to reduce the opening in the bladder to the minimum needed for the passage of the ureter. All the evidence of modern surgery is that the most certain way to obtain rapid healing is to ensure edge-

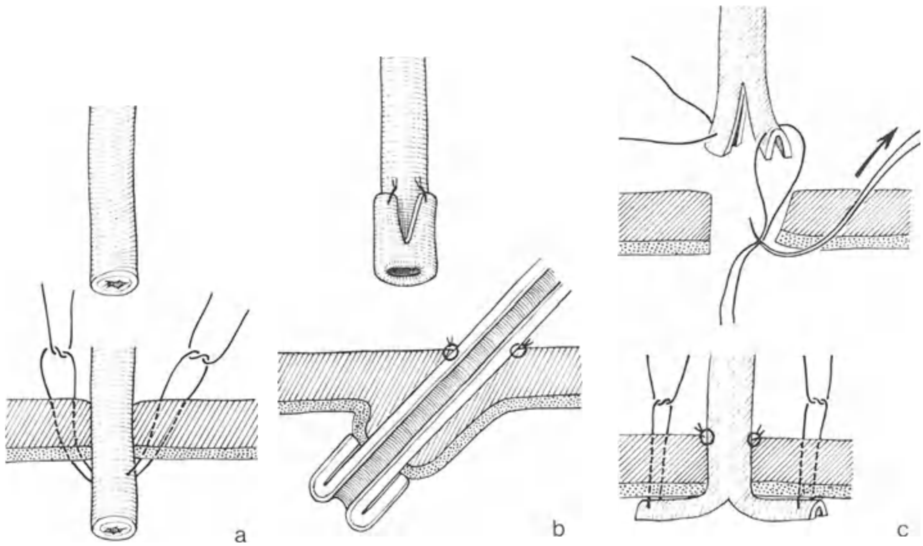


Fig. 45a—c. Uretero-neocystostomy: older techniques. (a) Simple intubation (BAZY). (b) Ricard procedure. (c) Payne procedure

to-edge apposition of the tissues. Hence, it is better to perform direct implantation with edge-to-edge, end-to-side anastomosis, producing a new orifice, and the correct performance of this operation requires a combined transvesical and extravesical approach. We shall describe the technique of this direct uretero-neocystostomy before considering the various problems.

a) Uretero-Vesical Implantation by Combined Transvesical and Extravesical Approach

The ureter is identified where it crosses the iliac vessels. It is dissected enough to permit mobilization and approximation without tension to the lateral aspect of the base of the bladder which is exposed extraperitoneally. The ureter is then divided above the lesion after placing a marker suture in its anterior wall to prevent any subsequent torsion. The bladder is opened and the edges of the bladder wound are picked up by guy sutures. A scissors is used to cut out a small patch of bladder mucosa just above the ureteral orifice (Fig. 46).

A long, curved, blunt forceps is introduced through this hole in the mucosa and passed through the bladder wall from within outwards until its tip appears on the posterior aspect of the bladder; the forceps grasps the tip of the ureter and draws it into the bladder without torsion (Fig. 47).

The ureter is fixed to the bladder by edge-to-edge anastomosis with a single layer of plain or chromic 00 catgut picking up more of the muscle than of the mucosa. It is important to ensure perfect apposition of the two mucosal edges (Fig. 48).

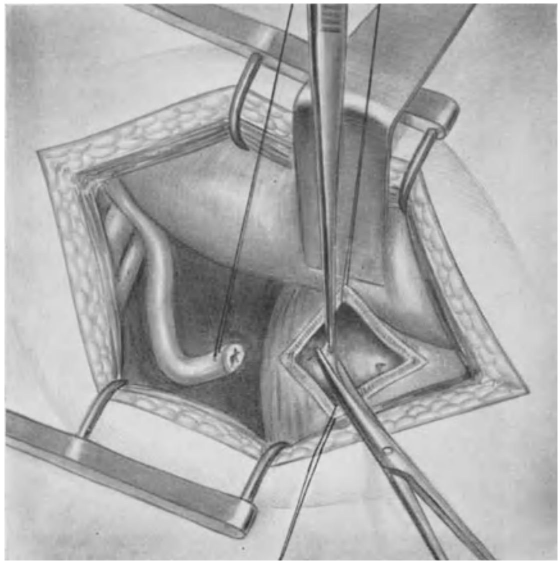


Fig. 46. Direct uretero-vesical implantation by combined intra-vesical and extra-vesical approach (Küss). Section of the ureter—Trimming the mucosa

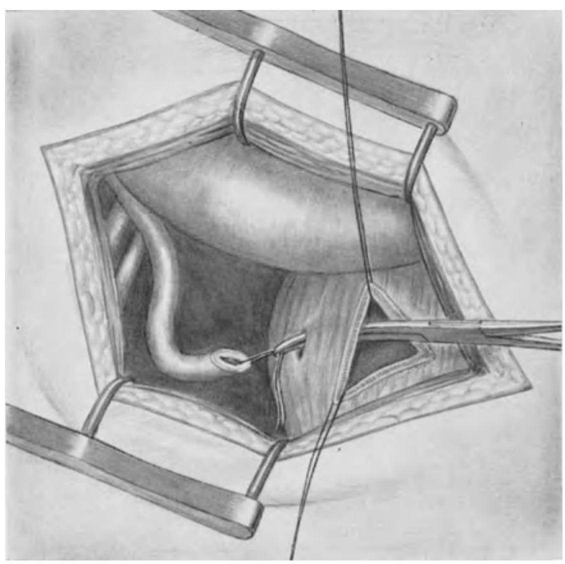


Fig. 47. Direct uretero-vesical implantation by combined approach (continued). Bringing the ureter through

A ureteral catheter may be inserted and then the bladder is closed with a single layer of 0 catgut and the bladder is drained by a urethral catheter. The retro-vesical space is drained and the catheters are removed between the tenth and the fifteenth day.

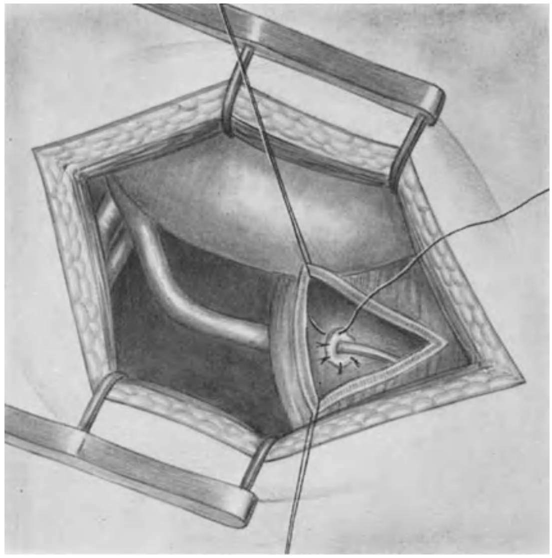


Fig. 48. Direct uretero-vesical implantation by combined approach (concluded). Suture

b) Modifications

This is the standard technique. Numerous modifications are possible, according to the position of the new meatus, the method of approach, the type of drainage and the length of the ureter.

Position of the New Meatus

It has long been thought that it was advisable to place the ureter in the trigone, the fixed part of the bladder, as close as possible to the natural meatus. In fact the ureter can just as well be implanted into the mobile part of the bladder, on the lateral wall or even the dome, with excellent results. The important point is to perform an accurate anastomosis, with no tension on the ureter and perfect mucosal apposition, away from any diseased areas in ureter or bladder. In practice, the nature and the topography of the lesions dictate the position of the new meatus.

Methods of Exposure

Where the ureter is divided or resected accidentally or deliberately as part of an intraperitoneal operation, the transperitoneal route is used for the re-implantation. It then suffices to extraperitonealize and drain the region of the anastomosis. When the uretero-vesical reimplantation is practised electively for the treatment of fistula or stricture it is better to use an extraperitoneal approach, either lateral iliac or midline supra-pubic. Sometimes a purely transvesical approach is adequate, when the anastomosis follows terminal ureterectomy by this route, for a lesion of the intramural or prevesical ureter ("pull through" or Puigvert operation); the ureter is divided in a healthy zone, pulled into the bladder where it is attached by a direct circular anastomosis at the site of the original meatus (cf. Chap. V).

Length of the Ureter

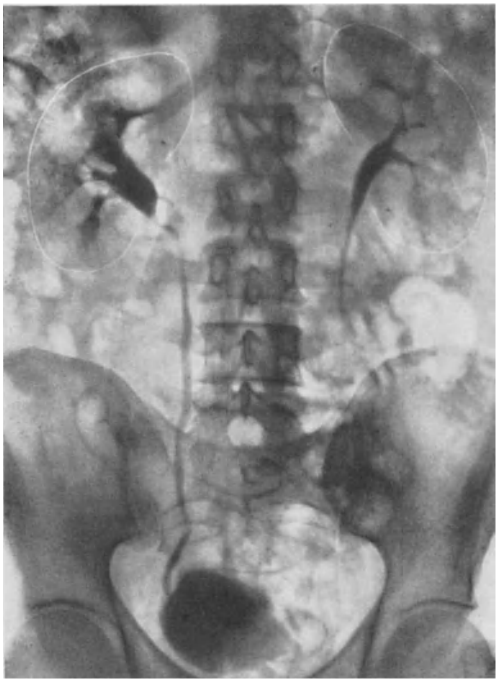
Because lack of tension on the anastomosis is an essential condition for success, it may happen that so much ureter is removed that ureteroneocystostomy cannot be performed, even with implantation of the ureter into the dome of the bladder. It may not be necessary to undertake ureteral replacement and the operator may prefer in these cases to use the device of bladder partition according to Magder's technique (cf. Chap. V), or a large bladder flap into which the ureter is reimplanted (MICHALOWSKI).

Drainage

Although it is not essential, it seems helpful to leave a ureteral catheter in place for 8 or 10 days. This catheter may emerge through the urethra, alongside a ureteral catheter, or it may be brought across the bladder and through the abdominal wall as a ureterostomy in-situ, a more secure arrangement.

c) Indications and Results

The classic direct ureteroneocystostomy is now used less often than in the past. The operation has been applied essentially to surgical lesions of the pelvic ureter in its last 5 to 6 cms, whether an accidental injury during gynaecologic surgery or deliberate division in major pelvic clearance surgery (Wertheim's operation, removal of rectum). Ureterorrhaphy on this deep terminal part of the ureter is very much more difficult and more uncertain than reimplantation into the bladder. Many cases of tuberculous stricture of the terminal ureter have been treated by Puigvert's operation and ureteroneocystostomy can also be applied to strictures in the same region occurring as a complication of stone disease. In the course of partial cystectomy or hemicystectomy for bladder tumour, the ureter is generally reimplanted directly because it seems undesirable to make a submucous tunnel in the region of a bladder tumor, especially as this type of surgery for malignant disease must be followed by cobalt radiation. Direct reimplantation by a purely transvesical route has sometimes been done for congenital megaureter due to stenosis of the uretero-vesical junction but the ureter should not be reimplanted directly in such cases because the inevitable massive reflux up the dilated and abnormal ureter must prejuduce function of the kidney. *Vesico-ureteral reflux* is in fact the major disadvantage of direct ureteroneocystostomy, although excellent long term results can be achieved as far as patency of the anastomosis is concerned (Fig. 49). This reflux is virtually always present but its pathologic significance is very variable. When a healthy ureter with normal tone is implanted into a healthy bladder, the resulting reflux is not severe, and sometimes only temporary, and well tolerated by the kidney provided that the physician has ensured complete sterilization of the urine (Fig. 50). If, on the other hand, the ureter is atonic or the bladder diseased and especially if there is any obstruction to micturition with significant urinary infection, the



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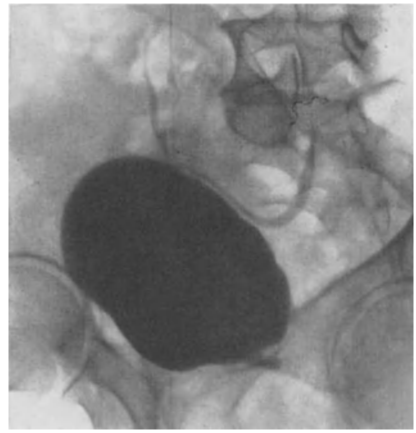

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Fig. 49a and b. Direct re-implantation of the left ureter after hemi-cystectomy for tumor. (a) I.V.P. (15 mins). Note the course of the left ureter, crossing the midline towards the right part of the bladder. (b) Cystogram

a

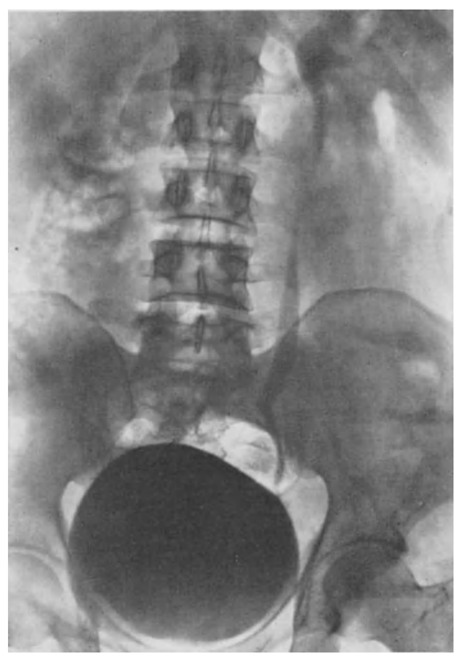

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Fig. 50a and b. Direct uretero-neocystostomy for tuberculous ureteritis. Excellent long term tolerance (13 years) of vesico-ureteral reflux. (a) I.V.P. (30 mins) 13 years after re-implantation of the left ureter. Note the tuberculous lesions in the upper pole of the left kidney. (b) Retrograde cystogram: passive reflux up the left ureter. Excellent renal function (endogenous creatinine clearance 105 ml/mn) reflux may have very serious consequences for renal function and act as a source of persisting infection. Thus it must be borne in mind that reflux will follow direct reimplantation, although such reflux is in no sense a general contraindication of the operation.

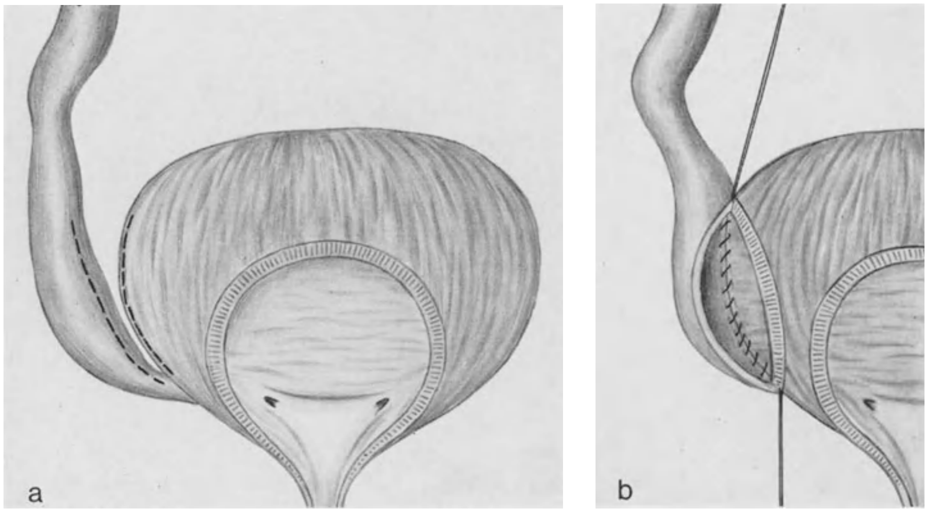
Acquired lesions of the pelvic ureter, such as tuberculous or calculous stricture, uretero-vaginal fistula and post-radiation ureteritis, are in most cases better treated by ureteroplasty with a tubed bladder flap than by simple ureteroneocystostomy and so, in view of the unsuitability of congenital megaureter for this operation, it would seem that the only indication for direct implantation at the present time are as a part of a hemicystectomy for bladder cancer, partial cystectomy for papillomatosis and the ureteral transposition required in treating certain vesico-vaginal fistulae. With surgical lesions of the terminal ureter, it is better to deal with the situation immediately by some anti-reflux procedure provided there is sufficient ureter and the bladder is healthy, protecting the kidney against any ill effects of reflux without any significant increase in the risk of stricture. If an anti-reflux procedure is technically impossible because of inadequate length of ureter, direct ureteroneocystostomy is indicated.

B. Side-to-Side Uretero-Vesical Anastomosis

This uretero-vesical diversion is now very rarely used. The ureter is anastomosed to the bladder without interrupting the continuity of the ureter. The technique was developed by KROGIUS (1924) and MICHON (1933) and was adopted by a few others, including DARGET, ABRAHAMSEN, CIBERT, BOEMINGHAUS and GREGOIR.

a) Operative Technique (Fig. 51)

The approach is extraperitoneal, through either a lateral iliac or a midline supra-pubic extraperitoneal incision. The ureter is dissected down to the point where it comes in contact with the posterior aspect of the bladder. The bladder is drawn upwards and forwards. An incision $1^1/_2$ cms long is made in the posterior aspect of the bladder and a longitudinal incision in the wall of the ureter. The ureteral opening is anastomosed to the bladder opening by a single layer of interrupted 00 catgut sutures with the knots tied on the outisde. When the posterior suture line is completed a large ureteral catheter is passed up to the renal pelvis and its lower end is attached to a bladder catheter passed in through the urethra so that the ureteral catheter can be drawn out through the urethra or alternatively the ureteral catheter may be brought through the bladder and out through the abdominal wall as a transvesical ureterostomy-in-situ. When this catheter has been fixed in place the anterior row of sutures is completed. The wound is closed with drainage of the retro-vesical space and a bladder catheter is inserted. Bladder and ureteral catheters are removed after about 12 days. This operation can also be performed by a purely transvesical route. After the bladder has been opened, the bladder wall above and lateral to the ureteral orifice is incised, the ureter displayed and a side-to-side anastomosis of ureter to bladder is performed as before.



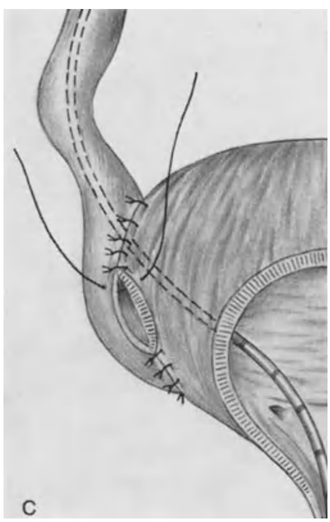


Fig. 51 a—c. Side-to-side uretero-vesical anastomosis. (a) Incisions. (b) Suture of posterior layer. (c) Anterior layer

b) Indications and Results

The indications for this operation are necessarily confined to stenosing lesions of the terminal ureter of very limited extent, such that a very dilated but otherwise healthy ureter lies in contact with normal bladder wall. The operation has been used principally in the treatment of congenital stenosis of the uretero-vesical junction with megaureter and in certain cases of tuberculous stenosis and stricture of calculous or unknown origin involving only the last cm of the ureter with no surrounding inflammation.

Good results have been obtained but there are two types of secondary complication:

– progressive narrowing of the anastomosis so that the urine flow gradually returns to the normal channel through the meatus,
– or, on the other hand, complications such as stone or persistent infection due to the blind loop below the anastomosis. Such complications may be due to performing the surgery for the wrong reason or to technical error with the anastomosis placed too high. If for some reason the anastomosis has to be placed rather high the blind loop should be excluded by ligaturing the ureter below the anastomosis (GREGOIR). There will obviously be massive reflux through this wide direct opening between the bladder and the ureter that is, by definition, very dilated. Hence, it would seem very undesirable to use the operation in any case where reflux would be harmful and in the vast majority of cases it is preferable to use an anti-reflux technique of uretero-vesical reimplantation, with or without reshaping of the ureter.

V. Ureterectomy

Resection of part or all of a ureter may be indicated for congenital lesions such as segmental atresia, stenosis, megaureter, retrocaval ureter and ectopic ureter or for acquired lesions such as accidental or surgical trauma, following radiation or diseases involving the entire urinary tract such as stone, tuberculosis, papilloma, carcinoma and bilharziasis.

In considering resection, attention must be paid to the condition of the kidney above and of the kidney on the other side and also to the possibilities of restoration of the urinary tract.

When the amount of ureter resected is not more than a few cms, continuity of the urinary tract can be restored by end-to-end anastomosis of the two cut ends of the ureter. When this is not possible because of the length of ureter resected, it is necessary to have recourse to replacement ureteroplasty.

1. Segmental Ureterectomy

Except when the resection of the ureter is part of some urologic, gynaecologic or other surgery performed transperitoneally, the elective route of approach is extraperitoneal and may be lumbar, iliac, pelvic or transvesical depending on the site of the lesion.

A. Segmental Resection of the Lumbar Ureter

The incision is the normal extraperitoneal loin approach to the kidney. End-to-end anastomosis of the ureter is possible in the lumbar segment only if the resection is limited to 3 to 4 cms at the most. If more ureter has to be removed the continuity of the urinary tract will have to be established by some form of ureteral replacement such as a tubed flap from the renal pelvis, ileal replacement or, on the right side, appendicular replacement—see Chap. VII. Alternative procedures that avoid the necessity for replacement are mobilization of the kidney and renal autotransplantation.

a) Mobilization of the Kidney

as used and suggested by Popescu, may provide a gain of several centimeters. It can be done extraperitoneally, or intraperitoneally with retraction of the colon.

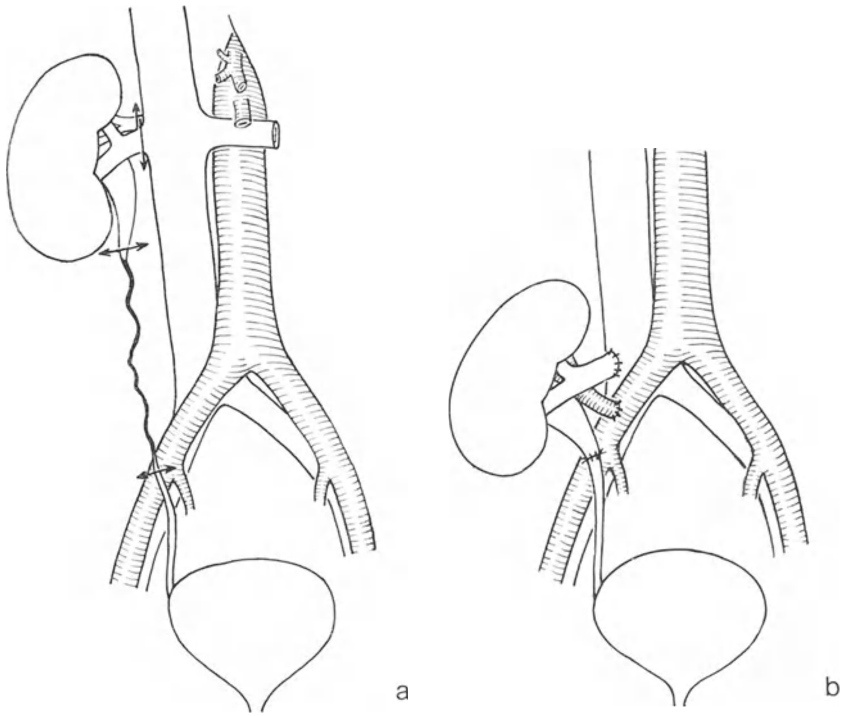


Fig. 52a and b. Auto-transplantation of kidney. (a) Level of sections. (b) Kidney transplanted to the iliac fossa on the same side

The kidney is dissected and mobilized completely with exposure and dissection of the renal pedicle, if necessary with ligature of the adrenal artery arising from the renal artery. The proximal ureter is also freed and the kidney is lowered as far as possible after mobilization. The lower pole of the kidney is fixed by stitching its capsule to the tendon of the psoas muscle as low down as possible. In some patients, usually women, the kidney is very mobile and the length of the renal pedicle and tortuosity of the lumbar ureter are such that much more extensive resection of the ureter is possible without giving rise to any problem in the restoration of continuity by end-to-end anastomosis.

b) Renal Autotransplantation

has been used occasionally and is a very much more serious affair. The renal pedicle is divided and the renal vessels are reimplanted into the iliac vessels so as to bring the kidney down into an iliac or pelvic position (Fig. 52).

Long gaps in any part of the ureter can be bridged in this way. We would regard this surgery as unnecessarily major if the opposite kidney and ureter are healthy, and too risky in dealing with a single kidney. There must be very few cases in which it is genuinely indicated. On most occasions, the problem can be solved by entero-ureteroplasty with less risk.

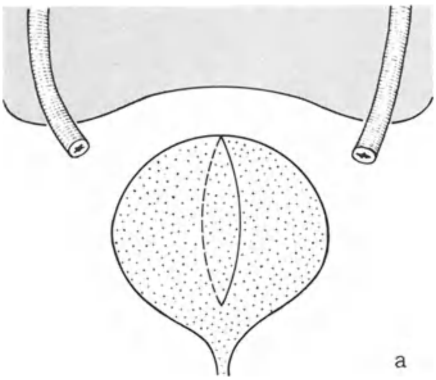
Drainage of the kidney, after segmental resection of the ureter and end-to-end anastomosis, is advisable in the great majority of cases, during the phase of atony so often seen in the excretory tract above the surgical site for the first postoperative days. In the case of resection of the lumbar ureter, the surgeon has the choice, according to the condition of the kidney between:
– simple nephrostomy;
– nephrostomy associated with intubation of the anastomosis, using a catheter of Cummings type or a silastic drain;
– ureterostomy in-situ, which is the solution that we prefer if the renal parenchyma is thick.

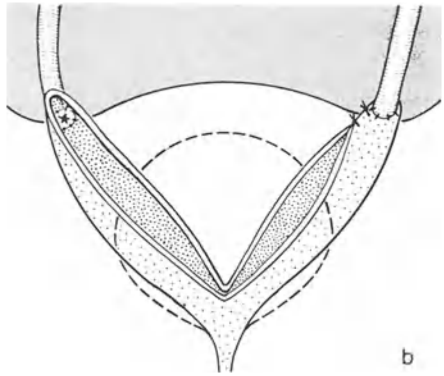
B. Segmental Resection of Iliac and Pelvic Ureter

Through an iliac, extraperitoneal incision, the ureter is identified where it crosses the iliac vessels and isolated above and below the lesions for which resection is being performed. The ureter must be divided through a healthy segment. If the amount resected is not more than 3 cms there is no difficulty in re-establishing continuity. With a slightly longer resection, it may be easy to approximate the ends of the ureter after mobilizing the lower ureter and straightening its pelvic curve. Provided that dissection is kept outside the sheath of the ureter, it may be freed down to the back of the bladder without any fear of interfering with its blood supply, even if all the vessels coming to the ureter in this region are divided and the superior vesical artery is divided also. It is essential to avoid tension in the ureteral anastomosis; the ends are joined by five or six interrupted sutures of 000 or 0000 chromic catgut, avoiding eversion of the mucosa.

In the ideal case of a limited resection with the rest of the ureter healthy, drainage with a ureteral catheter is not essential but it is advisable in most cases. The catheter can be placed in position at the time of the anastomosis and the lower end of the catheter can be retrieved from the bladder subsequently through a cystoscope or it may be brought out as a transureteral ureterostomy in-situ a few cms below the anastomosis, or as a transvesical ureterostomy in-situ, procedures that have the advantage that they do not interfere with early ambulation of the patient. The ureteral catheter is not left in for longer than 8 or 10 days.

When the extent of resection of the pelvic ureter (for radiation damage, for example) is too great for end-to-end anastomosis, many possibilities remain open to the surgeon:
– if there is sufficient length of ureter remaining to reach the upper part of the bladder, ureteroneocystostomy is the simplest solution.
– if the ureter will not reach the bladder,
– if the bladder is healthy, the gap can be bridged by a tubed pedicle flap of bladder (Boari-Küss technique),
– if, for example because the bladder wall is very thin, a bladder flap seems unwise, it may still be possible to implant the ureter into the bladder by making use of a *psoas hitch* (Popescu): the bladder is freed as completely as possible after division of the peritoneum and the dome of the bladder is fixed high to the psoas tendon with a strong catgut stitch.





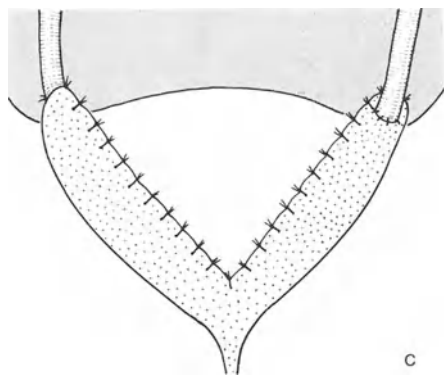


Fig. 53a–c. Splitting the bladder in two. (a) Midline section of the bladder. (b) Construction of vesical "horns". (c) The procedure concluded

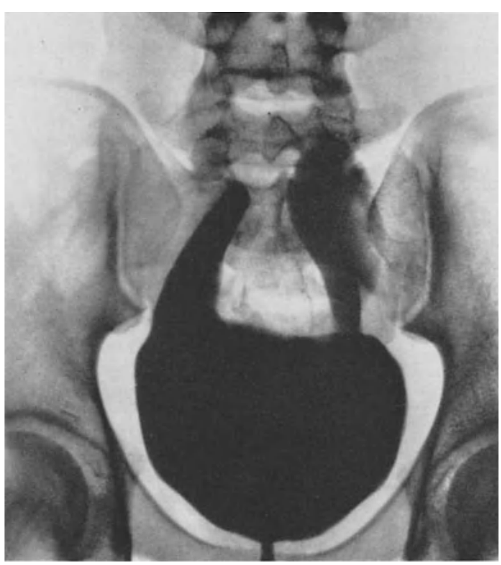


Fig. 54. Radiological appearance of a "bicornuate" bladder (bilateral uretero-vesical re-implantation for bilharzial ureteritis)

Another technical trick suggested by MAGDER in 1963 is *bisection of the bladder*. The dome of the bladder is freed from the peritoneum and then divided in the midline. By this means, each lateral half of the fundus of the bladder can be drawn upwards and laterally for a considerable distance. The bladder wall can easily be brought up as far as the iliac vessels or higher with gentle traction with a sufficiently large incision in the bladder if the bladder is healthy. Longitudinal closure of each half of the bisected fundus produces a bicornuate bladder and uretero-vesical implantation can then be carried out at the apex of each horn (Fig. 53). This simple technical device makes it possible to bridge gaps up to and even beyond the pelvic brim following complete loss of the ilio-pelvic ureter (Fig. 54).

C. Resection of the Terminal Ureter

When the last part of the ureter close to the bladder is to be resected *the approach may be transperitoneal or extraperitoneal, lateral or median*. If only one or two cms of the ureter remain below the resection, uretero-ureteral anastomosis would often be technically very difficult and under these circumstances it is better to reimplant the ureter into the bladder and complete the procedure by transvesical ureterostomy in-situ.

In most cases the resection will involve the intramural part of the ureter and then the *transvesical approach* is best, either alone or associated with a simul-

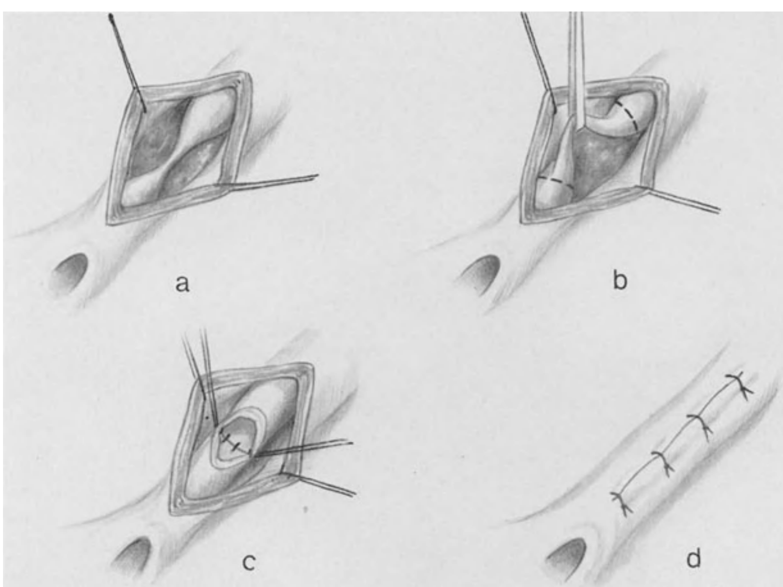


Fig. 55 a–d. Resection of terminal ureter above the orifice (trans-vesical approach). (a) Incision and exposure of the stenosed intramural ureter. (b) Freeing the ureter. (c) Ureteral suture—posterior layer. (d) Operation completed

taneous lateral vesical approach. Two techniques are then possible, depending on whether or not the ureteral meatus is involved in the lesion:
– in the rare cases where the meatus can be preserved, with a limited lesion lying immediately above, recourse may be had to resection above the ureteral orifice.
– in most cases the lesion will involve the juxta-vesical ureter, the intramural ureter and the meatus and the whole of the terminal ureter must be resected, with a pull-through procedure of the Puigvert type.

a) Resection of the Terminal Ureter Above the Ureteral Orifice [KÜSS and CHATELAIN (Fig. 55)]

Either a vertical or a transverse suprapubic incision is used for midline, extraperitoneal cystotomy.

The bladder is opened and the ureteral orifice is identified. The posterior wall of the bladder is incised obliquely upwards and outwards in the line of the ureter but the incision does not extend down into the ureteral orifice.

The intramural ureter is dissected, after identification with the help of an inlying catheter if necessary, up as far as the diseased zone. The diseased zone is resected, and the ureter repaired by end-to-end anastomosis. The incision in the posterior bladder wall is closed with careful reconstruction of the intramural course. A ureteral catheter may be left in place, to emerge as a transvesical ureterostomy in-situ. The bladder is closed and the retro-pubic space drained.

b) Transvesical Resection of Terminal Ureter (Including the Ureteral Orifice)

This type of operation was used largely by PUIGVERT in the treatment of tuberculous strictures of the terminal ureter. Many varieties of pull-through operation have been described, differing from one another in technical detail.

The technique that we use is as follows. The bladder is opened through a suprapubic, extraperitoneal incision and a self-retaining retractor of the Hryntschak type is inserted. The ureteral meatus is transfixed by an X suture which serves as a tractor; alternatively 3 guy sutures may be placed at equidistant points on the orifice, for better exposure in the subsequent dissection.

A circular incision is made around the meatus, at a distance of a few mm and deepened progressively to display the intramural ureter and then the juxta-vesical ureter with division of any pathologic adhesions and of the ureteral insertions of the muscle fibres of the trigone. Hemostasis is secured as the exposure proceeds; once the dissection goes through the bladder wall it reaches a rich plexus of peri-ureteral veins (Fig. 56). The ureter is thus drawn progressively into the bladder until the ureter above the stenosis is clearly visible. A marker stitch is placed in the anterior wall of the ureter and the ureter is divided transversely through healthy tissue below this stitch (Fig. 57). The ureter is anastomosed to the bladder at the site of the original meatus with individual sutures of 00 or 000 chromic catgut passing through the full thickness of both ureteral and bladder wall (Fig. 58). If the degree of pyelo-ureterectasis indicates the need for drainage, a ureteral catheter is placed up through the new meatus as far as

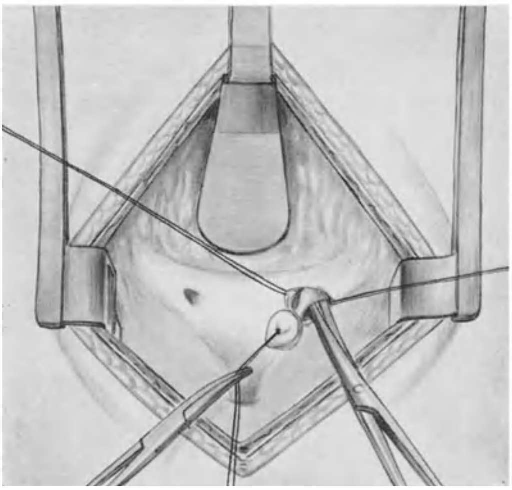


Fig. 56

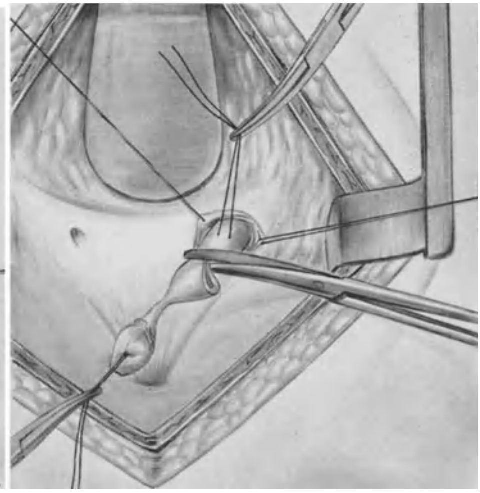


Fig. 57

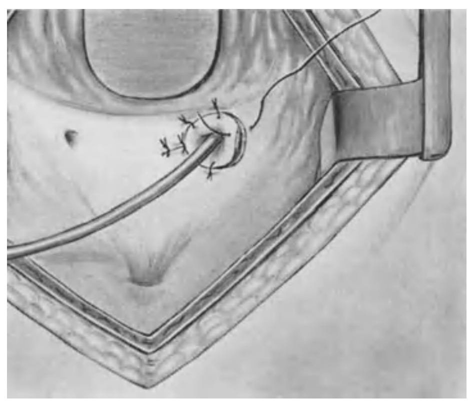


Fig. 58

Fig. 56. Resection of the terminal ureter from within the bladder ("pull through" operation). Dissection of the terminal ureter

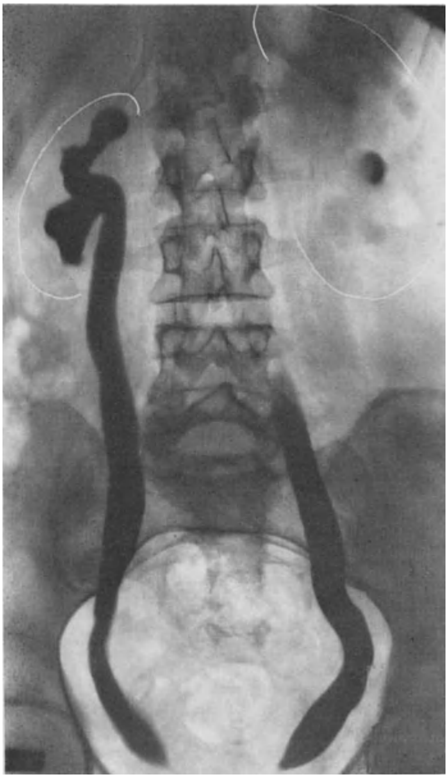
Fig. 57. Resection of the terminal ureter from within the bladder ("pull through" operation) (continued). Ureter completely freed—ureteral resection

Fig. 58. Resection of the terminal ureter from within the bladder ("pull through" operation) (concluded). Uretero-vesical suture

the renal pelvis and the lower end of this catheter can be brought out through the urethra alongside the urethral catheter draining the bladder. or it may be brought across the bladder and out through the abdominal wall as a transvesical ureterostomy in-situ. The bladder is closed and the retropubic space is drained. The ureteral catheter is removed after about 10 days.

With this technique, the last 5 to 6 cms of ureter can be resected and in cases of megaureter it is sometimes possible to pull some 10 or 12 cms of ureter into

Fig. 58′a—d. Long term results (14 years) of a bilateral "pull through" operation for tuberculous ureteritis. Woman aged 51 years. (a) Emptying film of bilateral pyelogram showing stenosis of both terminal ureters. Note that there is already atrophy of the right kidney. (b) 14 years after bilateral Puigvert operation. I.V.P. (12 mins). Atrophy of right kidney but excellent function, good parenchyma and absence of dilatation of the left kidney. (c) Retrograde cystogram shows that bilateral reflux has been present for 14 years. (d) Nephrotomogram to display the condition of the renal parenchyma. Conservative surgery on the right side was a poor decision but the reflux on the left side is perfectly tolerated



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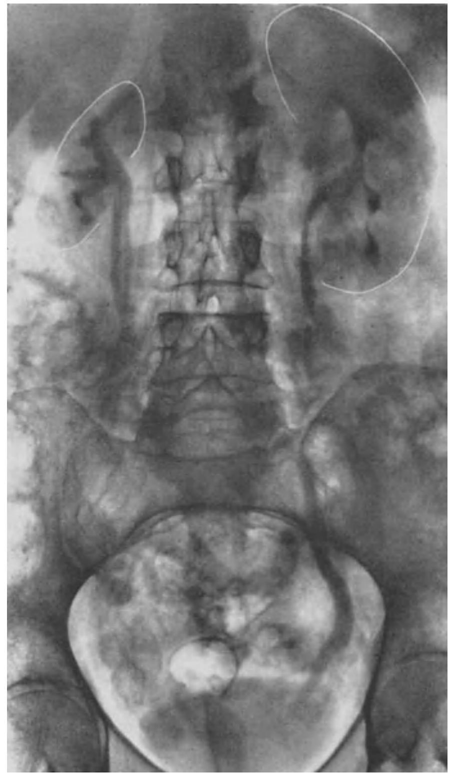

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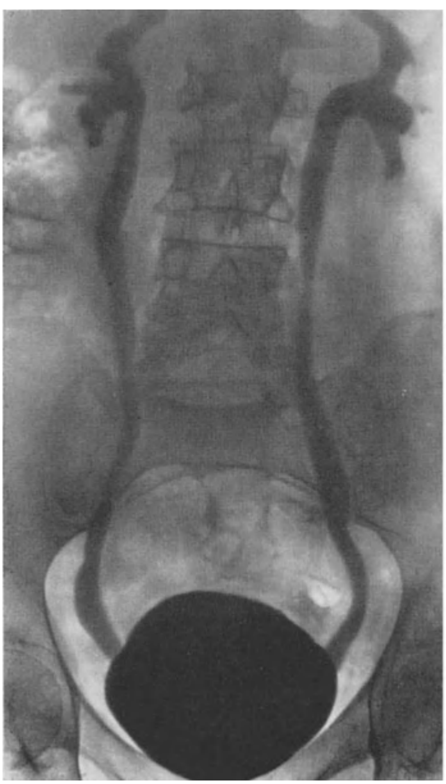
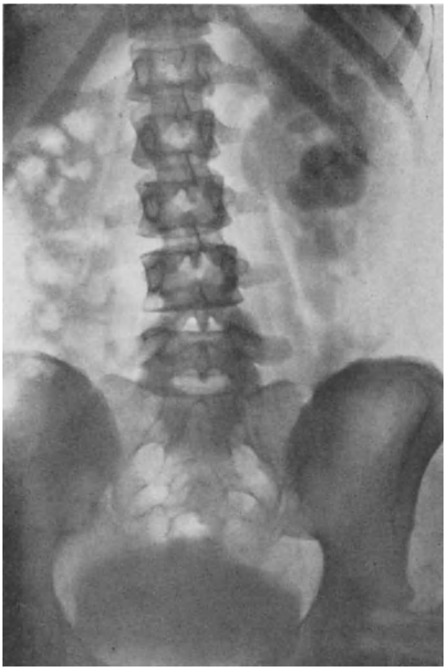


c

Fig. 58′a—d

d



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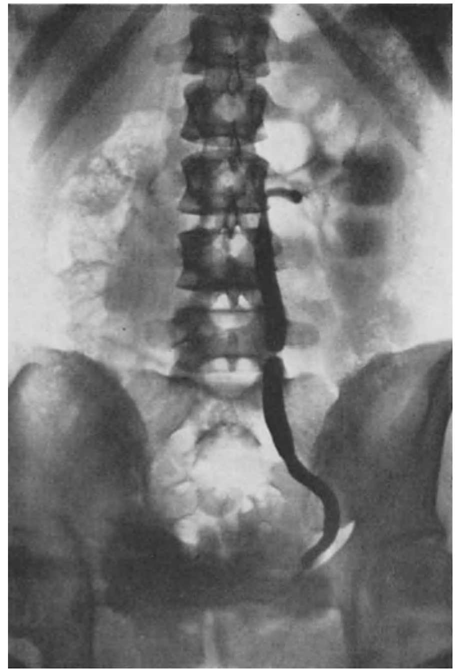

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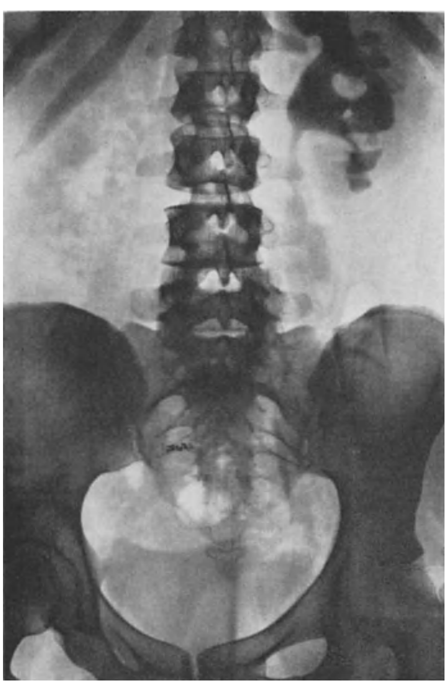


c

Fig. 58″a—c. Triple segmental resection of the ureter for tuberculous strictures (solitary kidney). Followed for 15 years. Woman aged 26 years. Right nephrectomy 1945. Seen in 1956 with dilatation of the remaining kidney (a); tubercle bacilli present in the urine. Left uretero-pyelogram (b)—bladder healthy, ureteral orifice healthy, 3 strictures: juxta-vesical, lumbar and at the pelvi-ureteral junction. Surgery was performed in stages, first resection of the pelvi ureteral junction and nephrostomy then, one month later, segmental resection of the lumbar stricture with end-to-end anastomosis of the ureter and resection of the terminal ureter with re-implantation of the ureter into the bladder. I.V.P. 6 months after surgery (c) shows satisfactory reno-ureteral dynamics. 15 years later there is no mechanical obstruction but there is progressive renal insufficiency caused by progression of pyelonephritis due to secondary infection of the tuberculous condition the bladder. The technique is possible only if there is no significant degree of periureteritis, and this is very difficult to determine before surgery. If the ureter is difficult to mobilize because of surrounding fibrosis, or if it will not come down far enough for anastomosis without tension, any attempt to "force" the situation must be avoided, otherwise there is a risk of rupture of a diseased ureter or of suture under tension. In such cases it is better to approach the juxta-vesical ureter by the lateral vesical extraperitoneal route, a procedure that can be done easily through the same incision. By this means the ureter can more easily be dissected under direct vision. This combined approach adds greatly to the ease of the operation and the ureter can be reimplanted at the site of the original meatus or, if a longer section of ureter has been resected, higher on the lateral aspect or dome of the bladder or it may even be necessary to do some replacement ureteroplasty.

The indications for terminal ureterectomy by the pure transvesical route are limited to segmental lesions of the last 6 cms of the ureter including tuberculous stricture, stricture due to stone and benign tumours. The results are generally good from the point of view of ureteral patency. The disadvantage is the creation of *vesico-ureteral reflux* but fortunately this does not appear to have serious consequences (Fig. 58′). In congenital lesions of the uretero-vesical junction, intra-vesical dissection of the terminal ureter is usually only the first stage of more complex anti-reflux surgery.

D. Multiple Resections of the Ureter

It is possible to perform several segmental resections on the same ureter. The operation is very rarely indicated but we reported two original observations of double resection and triple resection of tuberculous strictures in the same ureter from a single kidney, with excellent results.

2. Total Ureterectomy

Total ablation of a ureter may be indicated in three very different circumstances:

– There may be strictly ureteral lesions with good function of the kidney above: extensive ureteritis, ureteral tumour or malformation. The ablation of the ureter is followed by immediate replacement with intestine.

– The removal of the ureter may be associated with removal of the kidney because of some disease affecting the whole of the upper urinary tract on that side or because the kidney above the ureteral lesions has been destroyed: this is total nephroureterectomy.

– Sometimes it is necessary to remove the ureter remaining after a previous nephrectomy.

At the time of nephrectomy, functioning ureter should not be removed without a very good reason because it may be required at some time in the future as a replacement for the ureter on the other side.

a) Total Ureterectomy with Preservation of the Kidney

This may be necessary in the case of a single or principal functioning kidney, or whenever the etiology of the lesions raises doubts about the future of the kidney or ureter on the other side. The ureter may have to be removed for extensive or multiple tuberculous, or more often bilharzial lesions of the ureter, for ureteral tumours or for lesions following previous stone or surgery. The kidney may still be functioning quite well, especially if a previous temporary diversion, such as nephrostomy, has been done in good time.

The chief technical problem in these cases is the replacement of the ureter and this nearly always requires total entero-ureteroplasty apart from the extremely rare case in which ureteral transposition can be considered (cf. Chap. VI). The midline transperitoneal approach is best both for the ureterectomy and for the ureteral reconstruction. In asthenic patients the incision may run from xiphoid to pubis but in the fat patient it may be better to carry the upper part of the incision from the umbilicus obliquely upwards and laterally as described by BARRAYA and QUENU. The upper two thirds of the ureter is found easily after retraction of the colon. The dissection of the pelvic ureter is carried down to the bladder wall. When necessary, the intramural ureter, with or without a wide cuff of bladder, can be removed after lateral or median cystotomy and the cystotomy incision will serve for the subsequent entero-vesical anastomosis.

A very special case is the removal of one of the ureters in complete duplication. When the corresponding part of the kidney is still good, it may be preserved by anastomosing its pelvis to the other ureter. It is preferable in these cases to use a double extraperitoneal lateral approach (cf. following paragraph). If the upper part of the ureter to be removed is still good, the operation may be confined to removal of the pelvic and terminal segments of the ureter with uretero-ureterostomy higher up and the entire operation can then be carried out through a lateral iliac approach.

b) Total Nephro-Ureterectomy

Total nephro-ureterectomy is much more often performed by the lateral extraperitoneal approach than through a midline transperitoneal incision.

The lateral extraperitoneal approach is made through two separate incisions. The single full length incision of ALBARRAN causes too much damage to the abdominal wall. *The lumbar or renal stage* includes the removal of the kidney and lumbar ureter. The incision may vary with the position and the size of the kidney. We prefer the thoraco-abdominal incision of FEY with resection of the anterior part of the 11th rib; the incision is then carried obliquely downwards and medially through the abdominal wall so that the ureter can be freed as far as the iliac vessels.

Depending on its size and condition, the kidney may be pushed down into the bottom of the wound or it may be removed together with the upper two thirds of the ureter after marking the lower part of the ureter with a long stitch. The loin wound is closed with drainage of the renal bed.

The pelvic stage includes removal of the pelvic ureter and, if necessary, the intramural ureter and a cuff of bladder. If it is possible to place the two incisions at least 15 cms apart, to avoid loss of tone of a segment of the abdominal wall, the lower incision can be *lateral*, oblique and curving medially to the suprapubic region in the midline (the classic approach to the pelvic ureter). It is easy to remove the terminal ureter and, if necessary, a cuff of bladder through this incision but it is not a good approach for complete exploration of the bladder if this should be necessary. *In such cases a midline suprapubic, extraperitoneal approach is better.* With this incision it is easy to approach the terminal ureter lateral to the bladder and the bladder is not be opened if this is not necessary; on the other hand, a wide cystotomy and transvesical excision of the intramural ureter is possible and a combined approach can be used in difficult cases. The damage to the abdominal wall is minimal and there is no further muscle damage to add that caused by the loin incision.

In children, upper *hemi-nephrectomy with removal of the corresponding ureter* is a fairly common procedure to remove a destroyed or dysembryoplastic upper pyelon with the whole of the corresponding ureter in cases of duplex ureter with ectopic ureterocele or ectopic opening of the ureter. The midline transperitoneal approach is not indicated in these cases and two extraperitoneal incisions will usually provide a very satisfactory approach. The kidney is usually approached by BAZY'S transverse extraperitoneal incision and the lower ureter is approached by a short lateral ilio-pelvic incision. The removal of the lower end of the ureter is facilitated by the abdominal position of the bladder in young children. Alternatively the lower end of the ureter may be approached by a midline extraperitoneal incision.

c) Ureterectomy of Residual Ureter (after Previous Nephrectomy)

Removal of a ureteral remnant after previous nephrectomy may be required in various circumstances:

– if there is vesico-ureteral reflux, the ureteral remnant behaves as a long diverticulum and may be the source of chronic infection or of a persistent loin fistula;

– there may be persisting purulent infection in the ureteral remnant above an unrecognised obstruction such as stone or intrinsic or extrinsic stricture; in such cases removal of the pyoureter may be the only means to achieve rapid and definitive cure;

– the ureteral remnant may contain a tumor.

An extraperitoneal approach should be used in all these cases unless previous surgery makes it undesirable. A single incision is adequate in the great majority of cases. A lateral approach can be extended as far up as necessary. The midline supra-pubic approach is more limited above but it is easier for transvesical removal of the intramural ureter which is preferable in cases of reflux.

The approach must be tailored to the individual case, depending on the length of the ureteral remnant, previous surgery and the nature of the lesion.

VI. Replacement Ureteroplasty

Progress in replacement surgery of the ureter is such that it is no longer necessary after segmental resection of the ureter, however extensive, to sacrifice the kidney or to perform external or intestinal diversion of the urine.

When only a few centimeters of the ureter have to be removed, continuity can in general be re-established by end-to-end anastomosis, if necessary with the aid of certain devices such as lowering the kidney or raising the bladder.

But there are limits to the length of ureteral defect that can be bridged by direct anastomosis and then it is necessary to have recourse to ureteral replacement. The material to replace the ureter may be derived from the bladder below or from the renal pelvis above, or from the ureter on the other side or from a segment of intestine and in this way it is possible to replace even the entire ureter.

a) Inert Ureteral Prostheses

Every attempt to use materials other than living tissue taken from the patient himself has ended in failure. Nevertheless, the prospect of a simple and technically easy solution is so attractive that many experiments with *inert ureteral prostheses* have been made in dogs. Silver, vitallium, and tantalum were tried first and then the synthetic substances including polyethylene (HERDMANN, 1949; HARDIN, 1954; CHAUVIN, 1954), polyvinyl (ULM and LOX), dacron (KOWARA and ZAK), teflon (ULM and KRAUSS, 1960; KOWARA, 1962), ivalon (GUILLEMIN, DUFOUR and THELLIER), silicone (BLUM, 1962; LEWIS, SHERWOOD and PIERCE), a Dacron tube in a polythene splint (NOUKTAR, 1963) and silicone elastomer (AUVERT, 1968). The majority of these attempts failed completely or gave very unsatisfactory results due to obstruction of the lumen of the prosthesis or dilatation and damage to the kidney above. The least unsatisfactory results were obtained with silicone. Certain limited experimental successes have encouraged some authors to try their technique in clinical cases. LHEZ reported eight in 1968 but only one had an encouraging result 11 months post-operatively (LEWIS). AUVERT and DUFOUR (1971) made a careful study in dogs and replaced forty ureters by silicone elastomer prostheses and they had much greater success when they substituted a double intubation technique for edge-to-edge uretero-prosthetic anastomosis. They tried this technique in two clinical cases, with satisfactory short term results. DAUTRY and his colleagues, in close collaboration with a physico-chemical research laboratory, did very important experimental work in animals. A new method of treating the internal surface of ureteral prostheses has practically eliminated the problem of encrustation but the problem of the anastomoses is only partly solved. They have had some excellent short term clinical successes. It is fair to say, however, that inert ureteral prostheses have not yet been taken beyond the experimental stage and they cannot be regarded as satisfactory in clinical work, except in some cases of extended retroperitoneal carcinoma.

b) Regeneration of the Ureter

from a strip occupying only part of the circumference is a remarkable phenomenon brought to light by the work of DAVIS (1943–1951) on intubated ureterotomy. The experiments of LAPIDES, STRAUCH (1967) and BAKER have shown that this regeneration can be obtained over a considerable distance provided that there is a strip of ureter to serve as an inductor. If, however, there is a loss of substance involving the entire circumference of the ureter, no such reconstitution is possible (HERDMAN, HARDIN, HUFFMAN). For this reason, the phenomenon has a very limited clinical application.

c) Preserved Human Tissues

have proved no better than inert prostheses. Free grafts of fascia, peritoneum, veins and arteries have all failed.

HOVNANIAN and KINGLEY have, however, obtained contractile tubes with free grafts of bladder mucosa or of half thickness bladder wall (on a polyethylene splint); unfortunately, hydronephrosis ensued in half the cases. There may possibly be some place in the future for certain free grafts in the therapeutic reconstitution of the ureter.

A free graft of a segment of ureter was tried by us in two cases with one good result and one failure (Fig. 59). We are not aware of any other work on these lines.

d) Pedicled Grafts

have been tried because of the need to maintain the nutrition of the graft and avoid progressive fibrous transformation. Skin tubes and Fallopian tubes have not been successful but intestine, and especially the small intestine, has given excellent results and this is the basis of the intestinal ureteroplasties widely used today. But an isolated segment of intestine is not the only possible method of entero-ureteroplasty.

Seromuscular ureteroplasty, without interrupting intestinal continuity, has given promising results in experimental work [SHOEMAKER (1955), BRUEZIÈRE (1962), STWILL, BOYARSKY and GLENN (1966/67), HABIB and colleagues (1968), KENDALL and KARAFIN (1969)]. BRUEZIÈRE had five good results in dogs out of fourteen ureters reconstituted by sero-serous suture. But LACHAND, ROBERT and WATCHI (1970) had only one success in seventeen left colic ureteroplasties of this type, nevertheless they remain optimistic about the possibilities of the technique. NOVAK (1971) reported complete failure of eight reconstructions of part of the ureter in dogs by sero-serous suture of intestine; in his view, the mesodermal nature of the intestinal serosa, giving rise to a connective tissue that

Fig. 59. Free graft of ureter. Man aged 23 years. Bilateral atresia of the lumbar ureter. Left hydronephrosis; right kidney destroyed. February, 1959: right nephrectomy; the atretic left lumbar ureter was resected and replaced over a length of 4 cm by a free graft of the right ureter. Good result. Retrograde ureteropyelogram (October 1960) shows no obstruction; the arrows indicate the limits of the ureteral graft. He continued to do well until 1962 when he developed severe hypertension complicated by cerebral edema and progressive renal failure. Renal homotransplantation in April 1965

does not form a lining but fills the new lumen, is the reason for the failure and on these grounds he questions the validity of the principle.

The ureter is a contractile organ and it would seem that the best chance of successful replacement lies with an organ that is in itself contractile, whose activity will restore at least in part the function of urine transport. Preservation of the blood supply of the graft is an essential condition of its vitality and the maintenance of contractility. These requirements (apart from the use of another ureteral segment) limit the possibility of ureteral replacement to three tissues, the renal pelvis, the bladder wall and the intestine. Any replacement of the ureter presupposes two further conditions as well:

– Sufficient function in the relevant kidney to justify its preservation, or the absence, actual or potential, of function in the controlateral kidney.
– An intact lower urinary tract with satisfactory micturition.

1. Ureteroplasty with a Tubed Bladder Flap

Boari and Casati in 1904 experimented in dogs with a method of uretero-neocystostomy using a strip of bladder wall. After further successful experiments,

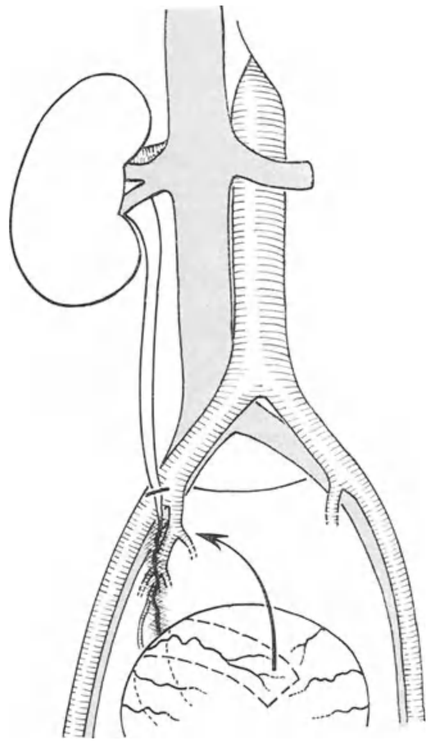


Fig. 60. Pelvic ureteroplasty with tubed bladder flap. Principle of the procedure

DEMEL (1924), BAIDIN (1926) and OCKERBLAD (1936) were the first to apply this method in man. We modified the technique in 1952 and the good results in a large series widened the therapeutic scope of the procedure.

A. The Boari-Küss Operation

The operation is based on the Boari and Casati technique of using a bladder strip but it is, in fact, a substitution ureteroplasty rather than a mere uretero-neocystostomy. If the bladder is healthy, the whole pelvic ureter can be replaced as far as the brim of the pelvis and sometimes even higher by a bladder tube of the same calibre as the ureter, anastomosed directly, end-to-end, to the ureter so that it is perfectly possible subsequently to pass catheters up the ureter (Fig. 60).

a) Surgical Approach

The operation can be done equally well by an extraperitoneal or transperitoneal route but the latter is obviously necessary in the immediate repair of accidental or deliberate resection of part of the lower ureter during some other operative procedure. In elective surgery for ureteral lesions such as polyps, fistula or stricture, we prefer the extraperitoneal approach with a lateral iliac exposure of a single ureter or a midline supra-pubic approach if the lower ureter on both sides is to be replaced at the same time.

The lower part of the lateral iliac incision opens into the rectus sheath after division of the inferior epigastric vessels. The peritoneum is retracted and the ureter identified where it crosses the iliac vessels and then dissected downwards where it will often disappear into fibrous or inflammatory tissue associated with a fistula or ureteritis and it may be closely adherent to the external iliac vessels. In such cases there is no need to carry the dissection further down because a properly designed bladder flap will always reach the pelvic brim without traction and also it is very important to divide the ureter through healthy tissue to prevent subsequent stricture at the site of anastomosis. When the ureter is divided, its distal end is tied or removed. A large catheter is passed up the ureter to drain the kidney and to keep the operative field clear of urine during the surgery.

b) Size of the Bladder Flap

If the bladder is filled through a large urethral catheter placed in position before beginning the surgery, it is much easier to extraperitonealize the lateral aspect of the bladder. The first stage of the operation is to elevate the lateral peritoneal cul de sac to display the lateral wall of the bladder from which the flap will be taken. The flap should be as long as possible, with its anterior extremity in the region of the bladder neck and its base close to the base of the bladder just above the trigone, a zone with an excellent blood supply from the vesical artery. The flap must be wider at the base than at the tip, with an average width of 20 mm. The length of the flap depends on the length of the gap to be bridged but it can be as much as 15 cms if the bladder has a good capacity. The fashioning of the flap can be begun either at the base or at its apex marked by two sutures. Subsequent closure of the bladder is easier if several guy stitches are placed along the edge of the bladder incisions (Fig. 61).

c) Tubing the Flap and End-to-End Anastomosis of the Tube to the Ureter

After making sure that the bladder flap is long enough to reach the ureter without tension, the flap is tubed by suturing its lateral margins over a large ureteral catheter which acts as a splint. Closely placed, interrupted sutures of 00 chromic catgut on fine curved needles take a good bite of muscle with great care to prevent herniation of the mucosa through the suture line (Fig. 62).

Any excess length of flap can be trimmed and the tip of the tube is adapted to the size of the ureter by the extent of the distal closure of the bladder flap. Then an end-to-end anastomosis is performed between the ureter and the bladder tube, using interrupted sutures taking mainly muscle (Figs. 63 and 64).

When local adhesion makes it inadvisable to resect the pelvic ureter, the diseased zone can be short-circuited by making an end-to-side anastomosis of the bladder tube to the ureter above the lesion (Fig. 65).

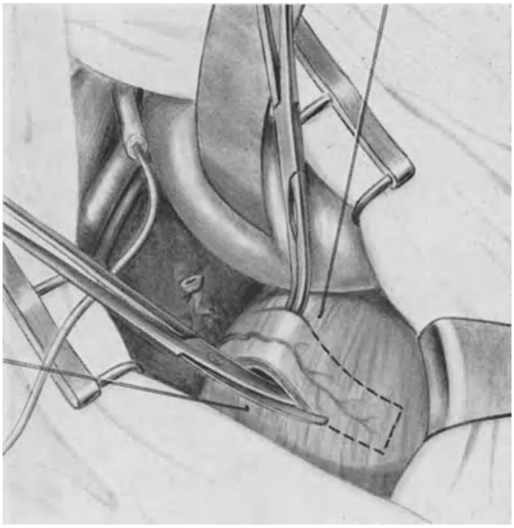


Fig. 61

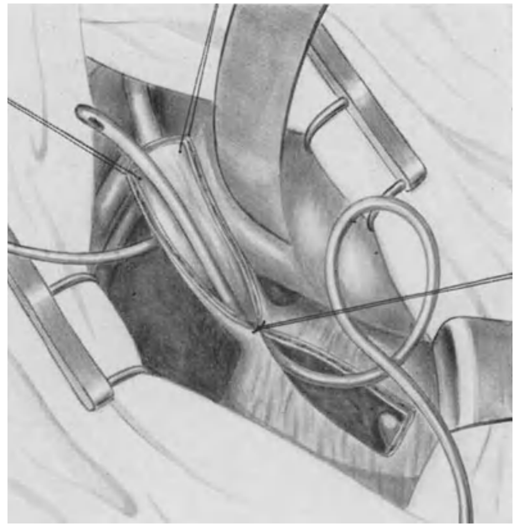


Fig. 62

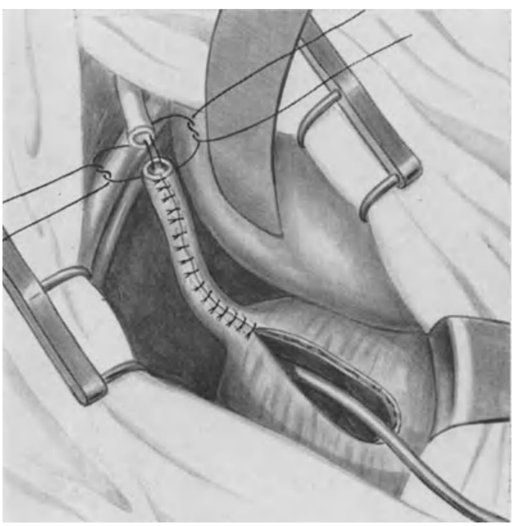


Fig. 63

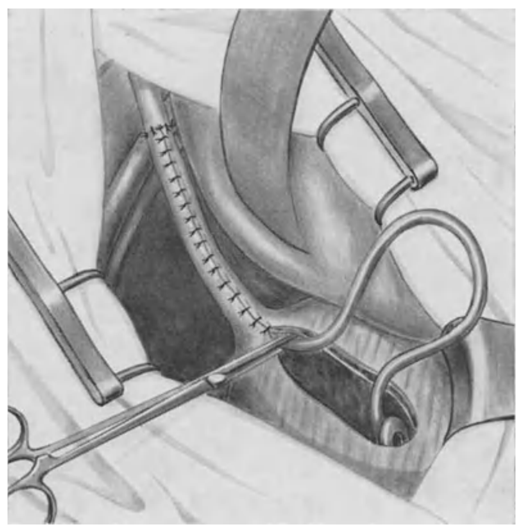


Fig. 64

Fig. 61. Ureteroplasty with tubed bladder flap (Boari-Küss technique). Fashioning the flap

Fig. 62. Ureteroplasty with tubed bladder flap (continued). Beginning the suture

Fig. 63. Ureteroplasty with tubed bladder flap (continued). Flap sutured— beginning the uretero-vesical suture

Fig. 64. Ureteroplasty with tubed bladder flap (concluded). Uretero-vesical continuity is re-established. Placement of catheter before closing the bladder

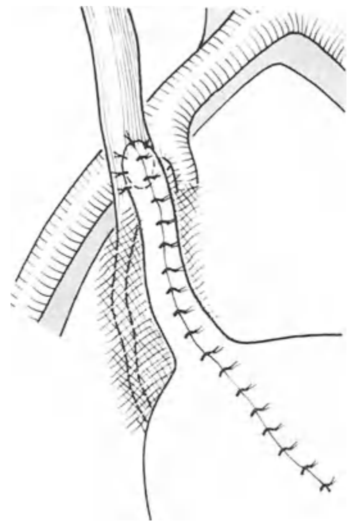


Fig. 65. Ureteral "bridging" with a tubed bladder flap (Küss). Plan of the surgery, with end-to-side anastomosis of the tubed flap to the ureter

d) Closure

Before completing the anterior layer of anastomosis, the ureteral catheter is fixed in its definitive position. Its upper end must lie in the renal pelvis and the lower end may emerge through the urethra alongside the urethral catheter but we prefer a transvesical ureterostomy in-situ with the lower end of the catheter brought across the bladder and out through the bladder wall and abdominal wall. This is a more stable arrangement and makes ambulation easier (Fig. 66).

The bladder is closed in one layer with interrupted sutures of plain or chromic 00 or 0 catgut with an indwelling urethral catheter. The lateral vesical space is drained for five to eight days and the urethral catheter is removed about the fourteenth day.

B. Alternative Techniques

a) Anastomosis by Intubation

This is the experimental operation of Boari-Casati. The bladder flap is taken from the anterior wall and the ureter is invaginated into this bladder cone. This procedure of intubating the ureter has the advantage of simplicity and it has been advocated to prevent leaks and strictures. Boeminghaus modified this technique by slitting the end of the ureter and fixing it to an area bared of mucosa (Fig. 67).

To prevent reflux, a submucous tunnel can be made at the tip of the bladder flap and the ureter can be brought through this tunnel and slit; the two flaps of ureter are then anastomosed to the bladder mucosa with interrupted catgut sutures (Gil Vernet, Fig. 68).

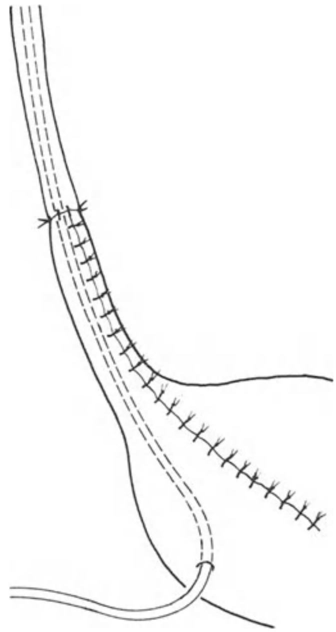


Fig. 66. Trans-vesical ureterostomy in situ

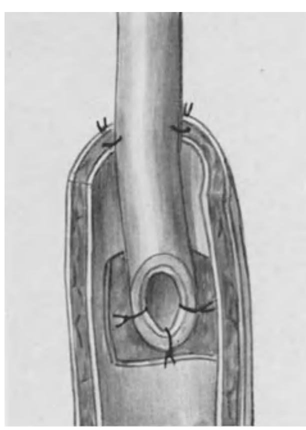


Fig. 67

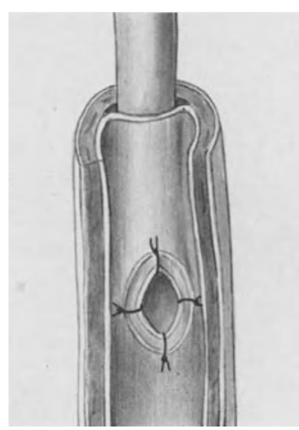
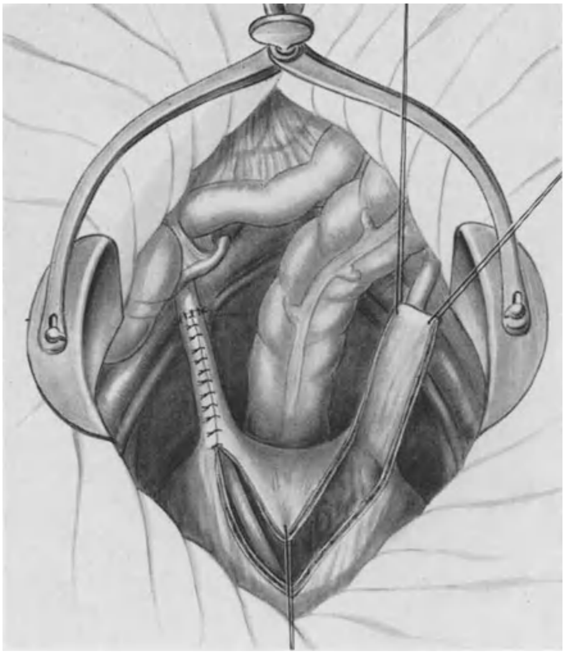


Fig. 68

Fig. 67. Alternative technique for ureteroplasty with a tubed bladder flap: intubation by Boeminghaus technique

Fig. 68. Alternative technique for ureteroplasty with tubed bladder flap: anti-reflux tunnel (GIL VERNET)

Although these modifications are ingenious, they provide less length and may make it difficult to pass a ureteric catheter after surgery if this should ever be necessary.



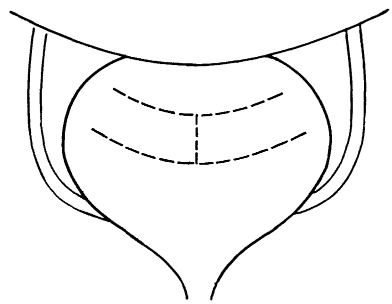


Fig. 69 Fig. 70

Fig. 69. Bilateral ureteroplasty with tubed bladder flap

Fig. 70. Fashioning the bilateral flaps by the Gregoir technique

b) Bilateral Ureterocystoplasty

This can be done in one or two stages by an extraperitoneal approach through two lateral incisions or can be done in one stage through a midline suprapubic transperitoneal approach. The two flaps may be distinct, taken from each lateral wall (Fig. 69) or they may be linked in the manner proposed by GREGOIR (Fig. 70).

C. Postoperative Course and Complications

The immediate postoperative course is generally simple. As after the removal of any ureteral catheter, there may be a flare of urinary infection after the second week; this is usually transient and easily controlled by antibiotic therapy, associated, if necessary, with a short course of steriods.

In some cases excessive or, more notably, prolonged drainage of urine is an indication of partial breakdown. In many cases the leak is from the bladder suture line and this will heal spontaneously with the simple expedient of maintaining a indwelling bladder catheter. In a few cases the leak is higher up in the flap or at the anastomosis and it is then necessary to place an indwelling urethral catheter: this is quite easy with a direct vision cystoscope if the base of the bladder flap lies sufficiently posterior and the anastomosis to the ureter is end-to-end without any submucous tunnel. A very few cases of more extensive breakdown of the anastomosis have been reported and these have required early re-operation.

Secondary complications are rare but can appear in the first few weeks or in the first year.

Infection in the extraperitoneal tissue may produce an ilio-pelvic abscess in a period of weeks or months. Such abscesses are due to a transient fistula or to an infection that has been drained inadequately and they may compress the new ureter or the anastomosis and can endanger the kidney above.

Stricture at the site of the anastomosis becomes apparent during the first year. If it is recognised early, before the kidney has been damaged irretrievably, it may be corrected by further surgery but in some cases the stricture has not been discovered until the kidney was destroyed and secondary nephrectomy has been necessary.

Massive vesico-ureteral reflux of infected urine can rapidly destroy a distended kidney that is not protected by the tone of the proximal ureter. Nephroureterectomy is indicated for the resulting pyonephrosis.

It must be emphasised that these complications are rare. In a personal series of 77 Boari-Küss operations (four bilateral), we had three immediate failures (due to fistula, pyonephrosis, ilio-pelvic abscess), and six secondary nephrectomies during the first year (two for acute pyonephrosis due to massive reflux in congenital megaureter, two for stricture and two for a nonfunctioning kidney possibly due to progressive tuberculous disease). Thus, the total incidence of immediate and late complications was 11.6 per cent. There was no surgical mortality.

D. Indications and Long Term Results

Ureteroplasty with a tubed bladder flap is currently the most satisfactory method of bridging a gap at the lower end of the ureter even when this gap includes the entire pelvic ureter. But this operation is possible only if bladder tissue is available in adequate quantity and quality. The bladder capacity must be good and many small contracted tuberculous bladders are no use for the treatment of stricture of the adjacent terminal ureter. Pelvic irradiation greatly diminishes the plastic qualities of bladder muscle; radium treatment of cancer of the uterine cervix affects mainly the base of the bladder and the dome may retain a good vitality, adequate to provide a bladder flap, but cobalt radiation of the pelvis compromises the vitality of the entire bladder wall and in such cases the surgeon should be very chary of using a bladder flap. Similarly, in bilharzia, there is calcareous infiltration of the submucosa and even of the muscle layer so that there is little possibility of using bladder tissue to treat a neighbouring bilharzial stricture of the lower end of the ureter.

The indications for ureteral repair by a tubed bladder flap include:

1. *Operative trauma*, or deliberate resection of the pelvic ureter (in Wertheim hysterectomy, for example) may be handled very satisfactorily in this way.

2. *Ureteral fistula.* Whether the fistula is uretero-vaginal (the commonest, usually a complication of gynaecologic surgery), uretero-cutaneous, uretero-

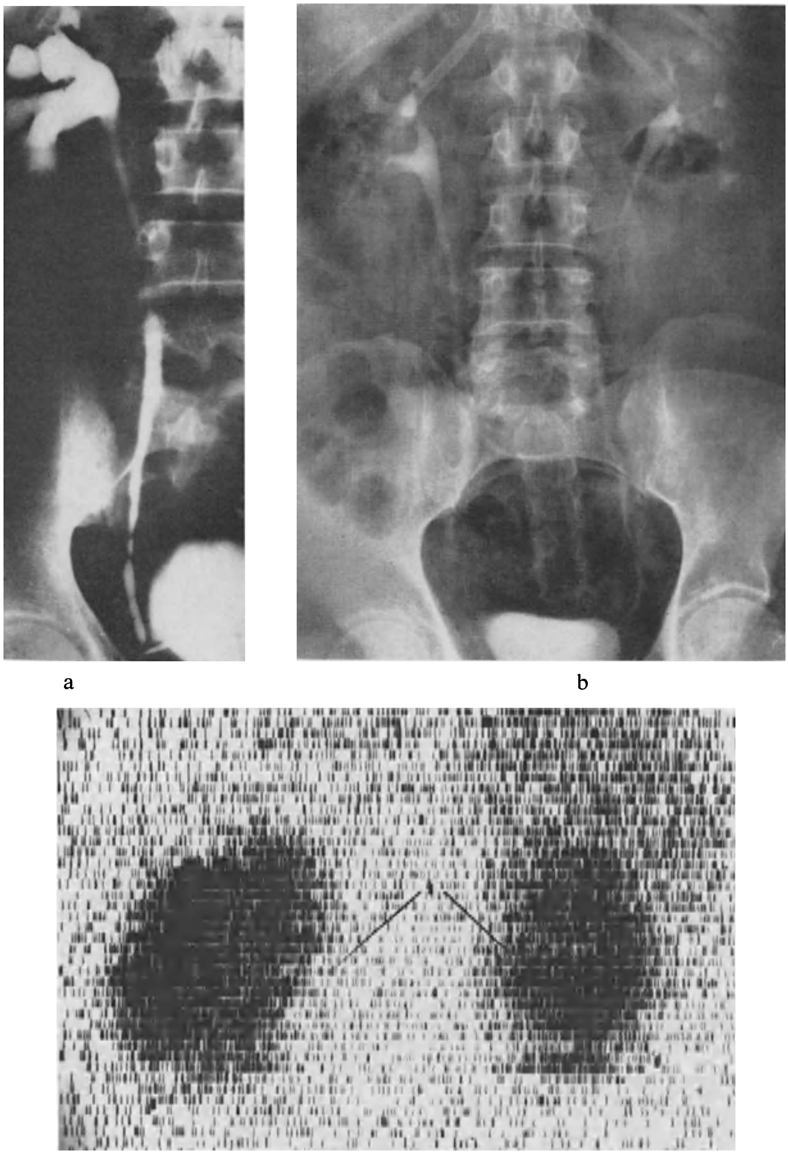


Fig. 71 a—c. Long term result (18 years) of ureteroplasty with a tubed bladder flap for tuberculous ureteritis. Man aged 44 years. (a) Right ureteropyelogram (1952): tuberculous strictures in pelvic ureter (plus calyceal lesions). (b) I.V.P. (15 mins) 18 years after ureteroplasty with a tubed bladder flap. The only persisting defect is the tuberculous lesion in the upper right calyces. (c) Renal scan confirms excellent function of the lower two thirds of the kidney (endogenous creatinine clearance 96 ml/mn)

perineal, uretero-sacral or uretero-uterine, the bladder flap will bridge the fistulous zone and thus avoid the laborious and often dangerous dissection of the terminal ureter.

3. *Organic ureteral stricture*. Stricture can occur as a complication of gynaecologic surgery. Strictures following radiation of the uterus (whether or not combined with surgery) may not be treatable by a bladder flap for the reasons given above. Tuberculous ureteritis localized to the pelvic segment of the ureter was once the commonest indication for the Boari operation. But these lesions are very much rarer nowadays because of earlier diagnosis and more effective drug therapy. Before operating on these tuberculous cases, it is desirable to obtain stabilization of the kidney disease by adequate drug therapy but progressive ureteral obstruction may be an indication for early surgery.

Other stenosing lesions of the ureter such as those due to stone or nonspecific inflammation can also be treated satisfactorily by this method. Bilharzial strictures of the ureter can rarely be treated by the Boari technique for the reasons already given.

4. *Congenital lesions*. Certain cases of congenital megaureter in adults, strictly localized to the pelvic segment, can be replaced by a tubed bladder flap, especially if surgery is indicated in any case for a complicating stone. The Boari-Küss operation should not be used for total megaureter in children.

5. *Tumours of the pelvic ureter* may require resection of a considerable length of ureter that is easily bridged by a bladder flap.

a) Long Term Results

Most of the complications occur in the first year and after this the long term results are excellent. Our 77 cases have been followed from two to eighteen years with 87 per cent good results including good recovery and function of the kidney above (Fig. 71).

Vesico-ureteral reflux is very common and indeed will be found in every case if carefully sought. It seems, however, to be perfectly harmless in most cases (Fig. 72).

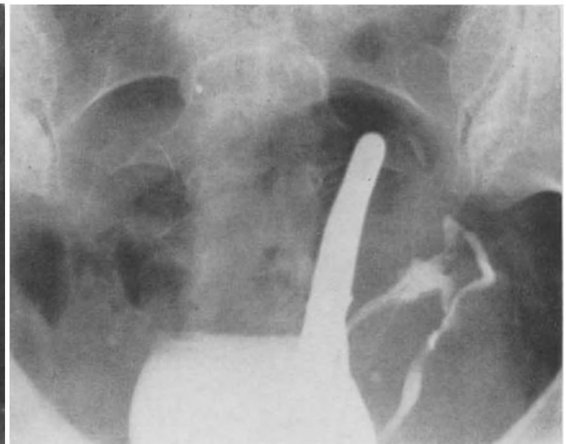
Urographic and scintiscan studies of the function of the two kidneys have been performed in these patients, some more than 15 years following surgery. The patterns have varied somewhat with the indications for operation.

Where the operation was done for traumatic ureteral lesions, the kidney function remains the same as at the time of surgery, whether or not there is reflux. The stability of the result seems to be an essential characteristic of this type of repair when the kidney was not diseased at the outset.

On the other hand, when the operation is performed for tuberculous ureteritis or an inflammatory stricture of other origin or for congenital megaureter, the kidney is pathologic initially; tuberculous lesions may progress or there may be secondary chronic pyelonephritis. In such cases there is a gradual diminution of renal function but the reason lies in the kidney parenchyma itself. In only one patient have we seen a relatively rapid deterioration of kidney function, after six years, on the occasion of an acute infectious episode. In another patient secondary functional deterioration was due to tuberculous exclusion of the upper pole, proved by the scintiscan.

It can in fact be said that the long term result of the Boari-Küss operation depends on the etiology, the function of the kidney at the time of surgery and,

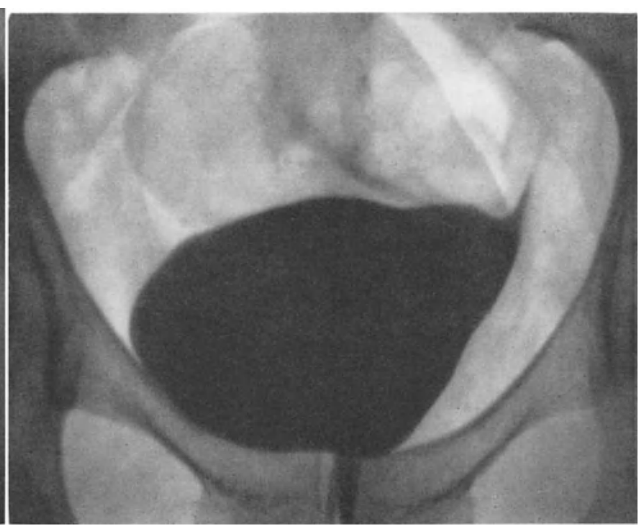
a



b

Fig. 72a—d. Long term result (20 years) of ureteroplasty with tubed bladder flap for ureterovaginal fistula. Excellent long term tolerance of vesico-ureteral reflux. Woman aged 39 years. (a) I.V.P. after radical hysterectomy for carcinoma of the cervix uteri (stage 1). Left ureterovaginal fistula (1951). (b) Left ureteropyelogram demonstrating the fistula. (c) I.V.P.: the left kidney one year after repair by ureteroplasty with a tubed bladder flap (1952). (d) Cystogram (1952): note the characteristic appearance of the bladder after the Boari-Küss operation

c



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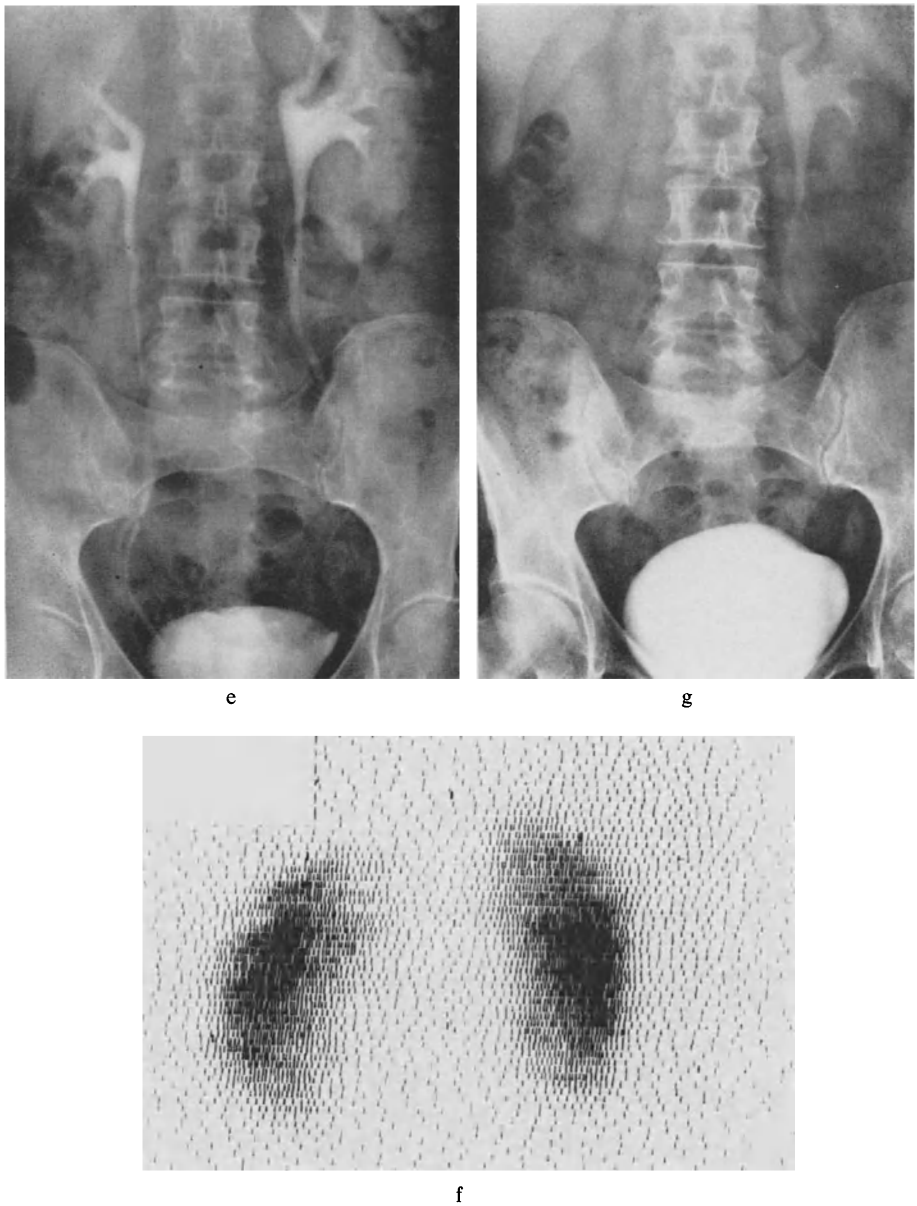


Fig. 72e—g. (e) I.V.P. (30 mins). 20 years later (1972). Clinical condition perfect. Urine sterile. (f) Renal scan demonstrates symmetrical normal function of the two kidneys: fixation of mercury 26.1% on the right, 26.4% on the left. (g) Retrograde cystogram: left vesico-uretero-renal reflux has been demonstrated on many occasions during the course of the 20 years

above all, on the strictness of the indications. If the operation is used wrongly for a diffuse lesion of the ureter such as megaureter in children or too extensive tuberculous or bilharzial ureteritis or if unhealthy bladder tissue damaged by radiation or chronic infection is used, or if there is a gross deficiency in the kidney above or a dysectasia of the lower urinary tract that might transform an inoffensive reflux into permanent renal damage, the operation will fail and subsequent nephrectomy or urinary diversion will be necessary. The necessary elements for total and definitive cure include division of the ureter through healthy tissue, normal tone in the proximal ureter, normal bladder muscle, a good kidney, an unobstructed lower urinary tract and meticulous technique.

2. Pyelo-Ureteroplasty with a Tubed Flap from Renal Pelvis

If more than three or four cms of the proximal lumbar ureter are resected, anastomosis of the ureter to the pelvis may be difficult or impossible even after extensive mobilization of the lumbar ureter and lowering the kidney. Is is then tempting to replace the missing segment of ureter by a tubed flap from the renal pelvis. Obviously, this operation is possible only if the pelvis is dilated so that the indication is in practice reduced to the treatment of those cases of hydronephrosis where the stenosis does not appear to be limited to the pyelo-ureteral junction, where the first few cms of the ureter present anomalies of structure or contraction. A pelvic flap can be used only if the atresia of the proximal lumbar ureter is not more than 6 or 7 cm. Acquired lesions are only very rarely suitable for treatment in this way.

a) Operative Technique

The kidney is exposed by the usual extraperitoneal, loin approach. The upper ureter, pyelo-ureteral junction and renal pelvis are dissected. It is particularly important to preserve the blood supply of the renal pelvis and so the dissection must not be carried too close to the wall of the pelvis, otherwise the blood supply to the flap will be compromised. The ureter is divided in a healthy zone. A pelvic flap is fashioned, about 1.5 cm wide, with an adequate length to bridge the gap (Fig. 73).

This flap can be taken on either the posterior or anterior aspect of the pelvis and may be cut vertically or obliquely in a spiral but its base is always at the lower part of the pelvis, forming the hinge about which the flap is rotated downwards. The morphology of the vessels and renal pelvis determine the limits of the upper part of the flap. Any excess pelvic tissue is removed, together with the pelvi-ureteral junction and any pathologic ureter.

When the flap has been swung down, the pelvis is closed from above downwards by interrupted sutures of 000 chromic catgut taking a wide bite of muscle but very little mucosa; the pelvis is closed first and then the flap is tubed. A silastic catheter with multiple eyes is put in position with its upper end emerging through a lower or middle calyx as a nephrostomy and the lower end of the catheter reaching down to the middle part of the ureter. Anastomosis of the tubed flap to the ureter is made obliquely.

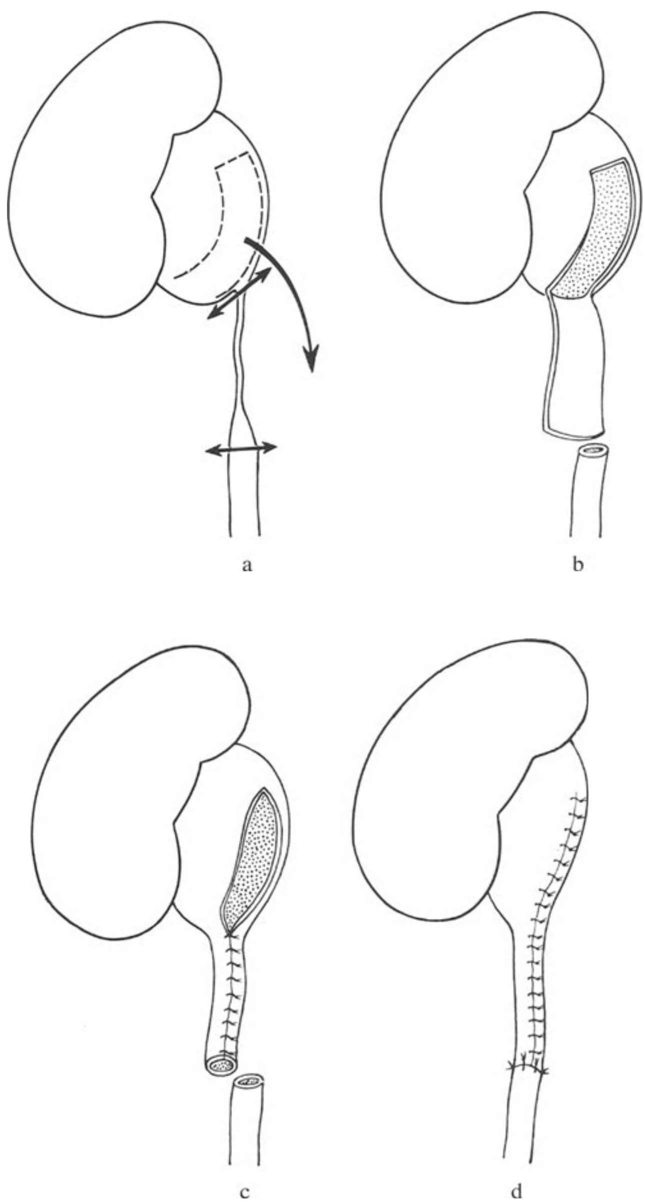
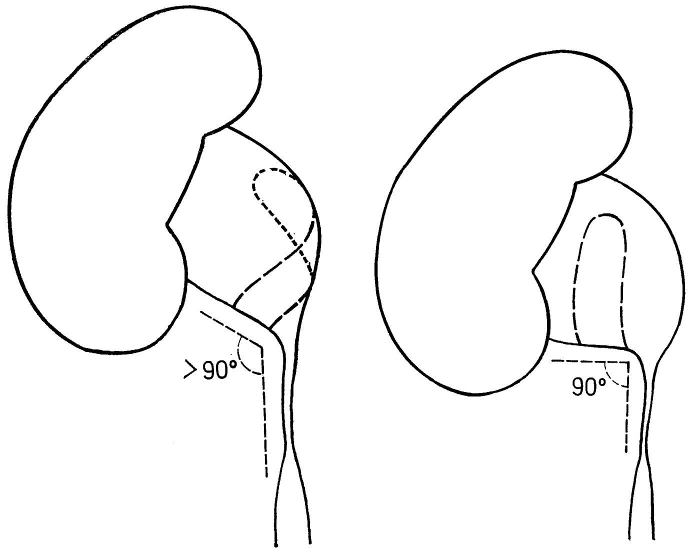


Fig. 73a—d. Tubed pelvi-ureteroplasty. (a) Outline of pelvic incision and ureteral section. (b) Fashioning the flap. (c) Tubing the flap. (d) Sutures completed

The wound is drained and the silastic splint is removed about the 15th day.

Many technical variations have been described, differing essentially in the manner of fashioning the pelvic flap, including Gregoir's arciform flap, Scardino's vertical flap and Culp's spiral flap (Fig. 74).



a b

Fig. 74a and b. Tubed pyelo-ureteroplasty: alternative techniques. (a) Spiral flap (Culp). (b) Vertical flap (Scardino)

b) Results

The operation has not been extensively employed. Gregoir had good results without late stenosis in ten cases. Truc and Grasset reported seven good results and two failures in nine cases. The method has been used also by Henriet, Küss, Quenu, Raymond and Benady with varying results. The worst results have been in cases where the operation was easiest, in other words where the hydronephrosis was greatest (even though the degree of loss of function in no way corresponded to the degree of dilatation).

In fact the real indications for this operation appear very limited. They include the combination of a lesion of several cms of the proximal ureter, a kidney with good function and a sufficiently distended renal pelvis. If the dilatation of the renal pelvis is recent the retraction of the flap may produce traction on the anastomosis or if the distension is of long standing the poor quality of the tissue in the renal pelvis may explain the uncertain results. Lowering the kidney and possibly entero-ureteroplasty are probably more certain ways of ensuring good evacuation of these chronically dilated kidneys because it is very difficult to estimate with any certainty the degree of loss of contractile power of the pelvic wall.

3. Uretero-Ureterostomy

When a gap in the lower end of the ureter cannot be bridged by a bladder flap and if for one reason or another entero-ureteroplasty seems undesirable,

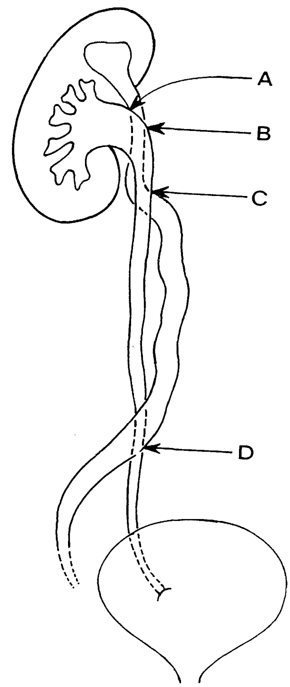


Fig. 75. Various possible levels of homo-lateral anastomosis. *A* Pyelo-pyelostomy. *B* Uretero-pyelostomy. *C* Lumbar uretero-ureterostomy. *D* Iliac uretero-ureterostomy

the problem may be met by using the other ureter, performing a uretero-ureterostomy.

The idea of anastomosing one ureter to the other was suggested by BOARI (1894). After the experimental work of MONARI (1895), WISSINGER (1896), BERNASCOGNI and COLUMBINO (1905) and SHARPE (1906), HIGGINS successfully performed the first crossed uretero-ureterostomy in 1934. The operation was used subsequently by NEUSWANGER (1935), SMITH (1940), SLUTSKY (1947), and MOORE (1948). KULL in 1954 successfully performed the first total transposition of the ureter. Other surgeons who adopted the technique included KÜSS, BOISSONAT, SWENSON, SANDEGÅRD, ANDERSON, and HODGES.

There are two possible types of operation:

– homolateral uretero-ureterostomy in cases of duplex ureter, when one of the ureters is implanted into the other ureter of the same side.

– crossed uretero-ureterostomy in which one ureter is led into the ureter on the opposite side or into the renal pelvis on the opposite side (crossed uretero-pyelostomy) and in this way the normal excretory tract of the opposite side is used to replace a gap in the lower ureter.

a) Homolateral Uretero-Ureterostomy

Where the ureter is duplex, this operation may be used to re-establish the continuity of the excretory tract of a half kidney after resection of diseased ureter

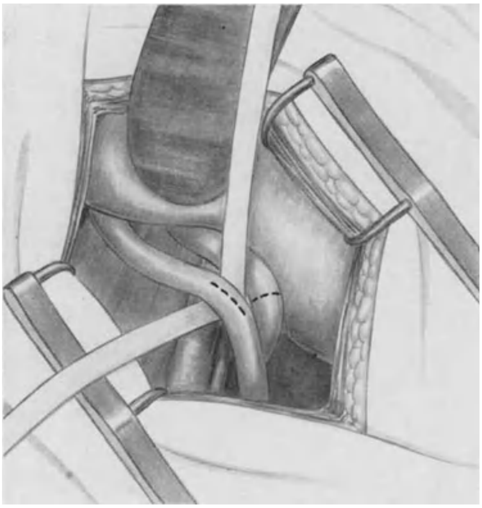


Fig. 76

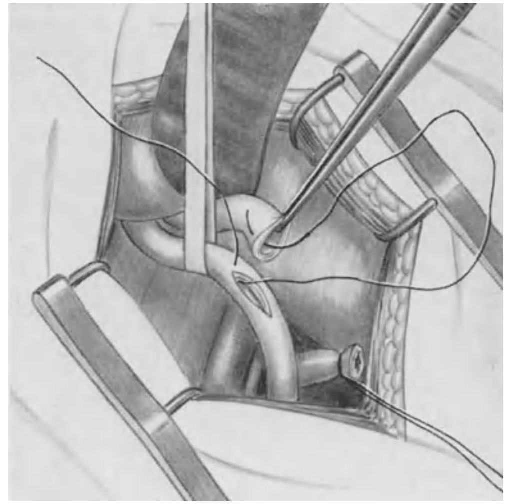


Fig. 77

Fig. 78

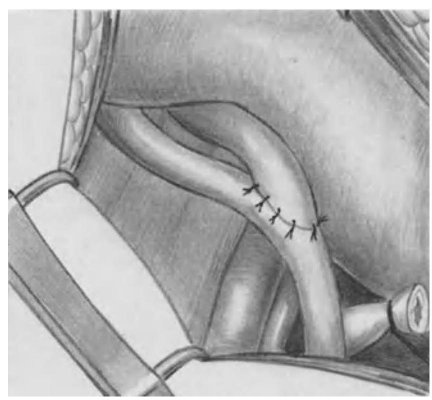


Fig. 79

Fig. 76. Homolateral uretero-ureteral anastomosis in the iliac region. Exposure of the ureters; outline of the incisions

Fig. 77. Homolateral uretero-ureteral anastomosis in the iliac region (continued). Division of the ureter to be implanted and incision of the recipient ureter

Fig. 78. Homolateral uretero-ureteral anastomosis in the iliac region (continued). Suture: posterior layer completed, beginning the anterior layer

Fig. 79. Homolateral uretero-ureteral anastomosis in the iliac ıegion (concluded). Appearance at the end of the procedure

such as a pelvic megaureter, or more often resection of the lower end of a ureter with an ectopic opening in cases where the corresponding part of the kidney still has good function and its ureter possesses adequate tone.

Depending the on amount of ureter resected, the implantation may be in the lumbar, iliac or pelvic part of the ureter (Fig. 75). In our opinion the simplicity of uretero-ureterostomy in the iliac zone makes this procedure preferable to ureteropyelostomy except in the case of megaureter which should be removed in its entireity and then the preferable procedure is pyleo-pyelostomy. Iliac uretero-ureterostomy is also preferable to reimplantation of the ureter into the bladder which requires a greater length of ureter, especially if an anti-reflux procedure is to be used and a further important point is that this uretero-vesical implantation is a more delicate procedure when performed in proximity to the healthy orifice of the other ureter.

Technique of Homolateral Uretero-Ureteral Implantation in the Iliac Segment

It is a wise precaution to begin by placing a catheter in the healthy ureter so that this recipient ureter can be recognised with greater ease and certainty during the course of the surgery.

The approach is extraperitoneal, iliac or pararectal. The two ureters are identified where they cross the iliac vessels. The ureters are dissected free and separated. A tape is placed around the recipient ureter (containing the catheter) (Fig. 76). The abnormal ureter is divided obliquely and its distal extremity is resected or tied. The cut upper end of ureter is brought alongside the recipient ureter which is then incised longitudinally (this incision is made much easier by the presence of the indwelling catheter) to a length equal to the diameter of the oblique section of the ureter to be implanted (Fig. 77). The ureteral catheter is removed and a single layer, end-to-side anastomosis is performed with interrupted 000 catgut (Figs. 78 and 79). The incision is closed with a drain down to the site of the anastomosis.

b) Crossed Uretero-Ureterostomy

Although crossed uretero-ureterostomy in the lumbar region is possible, its technical difficulty is such that we do not recommend it and anatomic considerations would seem to limit the operation to replacement of ureter at or below the point where it crosses the iliac vessels. In other words this operation is best suited to replacing the pelvic ureter and its indications derive principally from the contraindications to the obvious alternative, the Boari operation, chiefly the impossibility of using a bladder flap.

Technique

Crossed Uretero-Ureterostomy at the Level of the Pelvic Brim (Fig. 80)

Through a midline suprapubic incision the peritoneal cavity is opened and the ureters are identified where they cross the iliac vessels. The posterior peritoneum is incised over the ureters at this point. The ureter is dissected free as far down as possible so as to provide the necessary length. The ureter is divided through healthy tissue and its distal end is tied or removed. By careful blunt dissection, a tunnel is created behind the peritoneum, joining the two incisions in the posterior peritoneum. This tunnel runs behind the sigmoid mesocolon and the divided ureter is brought through this tunnel to the other side with great care to avoid angulation. The divided ureter is then anastomosed end-to-side

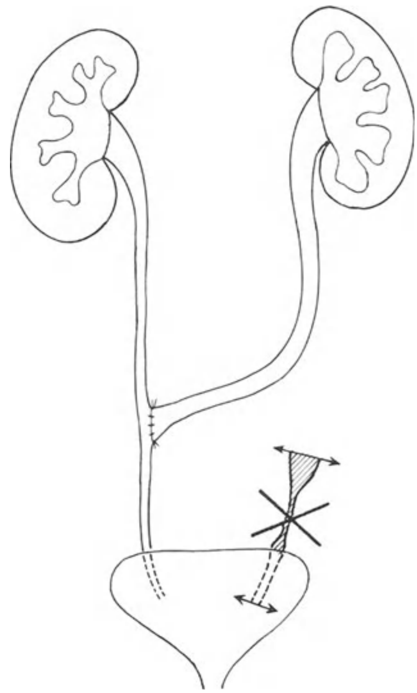


Fig. 80. Crossed uretero-ureterostomy at the pelvic brim

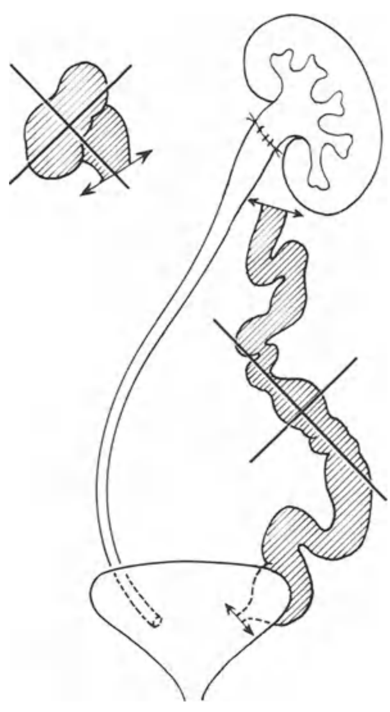
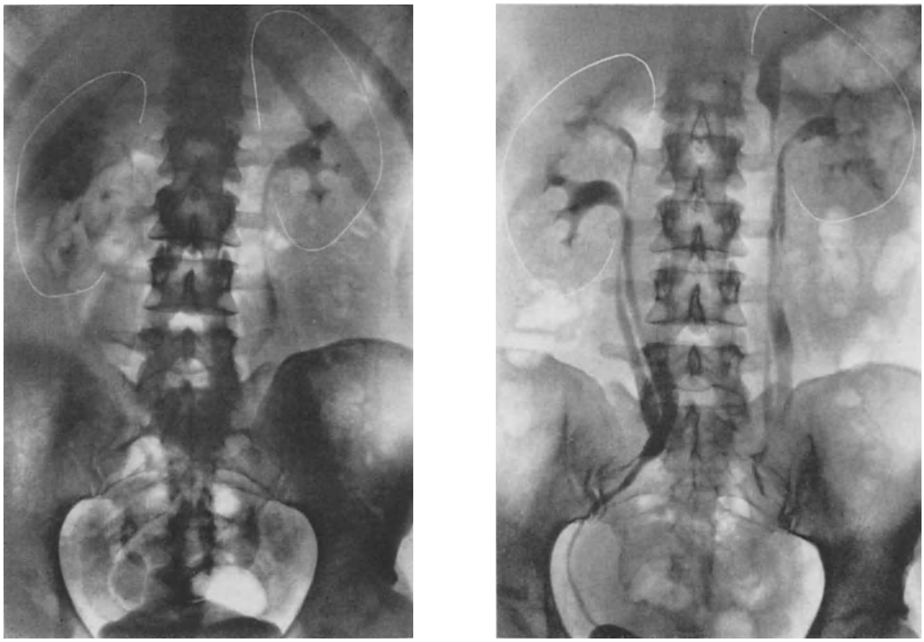


Fig. 81. Crossed uretero-pyelostomy



a b

Fig. 82a and b. Ipsilateral uretero-ureterostomy. Woman aged 23 years. Incontinence due to ectopic opening of the ureter from a superior pyelon on the left side. (a) Preoperative I.V.P.: poor secretion in the left upper region. (b) I.V.P. 13 years after left uretero-ureterostomy in the iliac region, with resection of the lower end of the ectopic ureter. Clinical condition perfect. The ureteral bifurcation on the left is the result of the surgery but on the right side it is a congenital bifid ureter

to the other ureter with interrupted sutures of plain or chromic 000 catgut. There must be no tension on the anastomosis. The retroperitoneal tissues are drained through a lateral stab wound.

Crossed Lumbar Uretero-Ureterostomy or Crossed Uretero-Pyelostomy (Fig. 81)

This is a more complex procedure. In our view, the only rational indication is utilization of a ureter remaining after nephrectomy. It is now proven that ureter remains normal and can return to normal function many years after nephrectomy. One of us has used a pelvic ureter left in place four years after earlier nephrectomy in the successful re-establishment of the continuity of the urinary tract in a case of kidney transplantation (1960). Through a midline transperitoneal incision the colon is retracted medially and the ureter is mobilized from the lumbar fossa to the pelvic brim, with great care to protect its blood supply in the pelvic region. An oblique retroperitoneal tunnel is opened by blunt dissection in front of the great vessels below the duodenum. The ureter is led from below upwards through this tunnel with care to avoid angulation. The lower pole of the kidney is defined and also its proximal ureter. Continuity is re-established either by end-to-end uretero-ureteral anastomosis (crossed uretero-

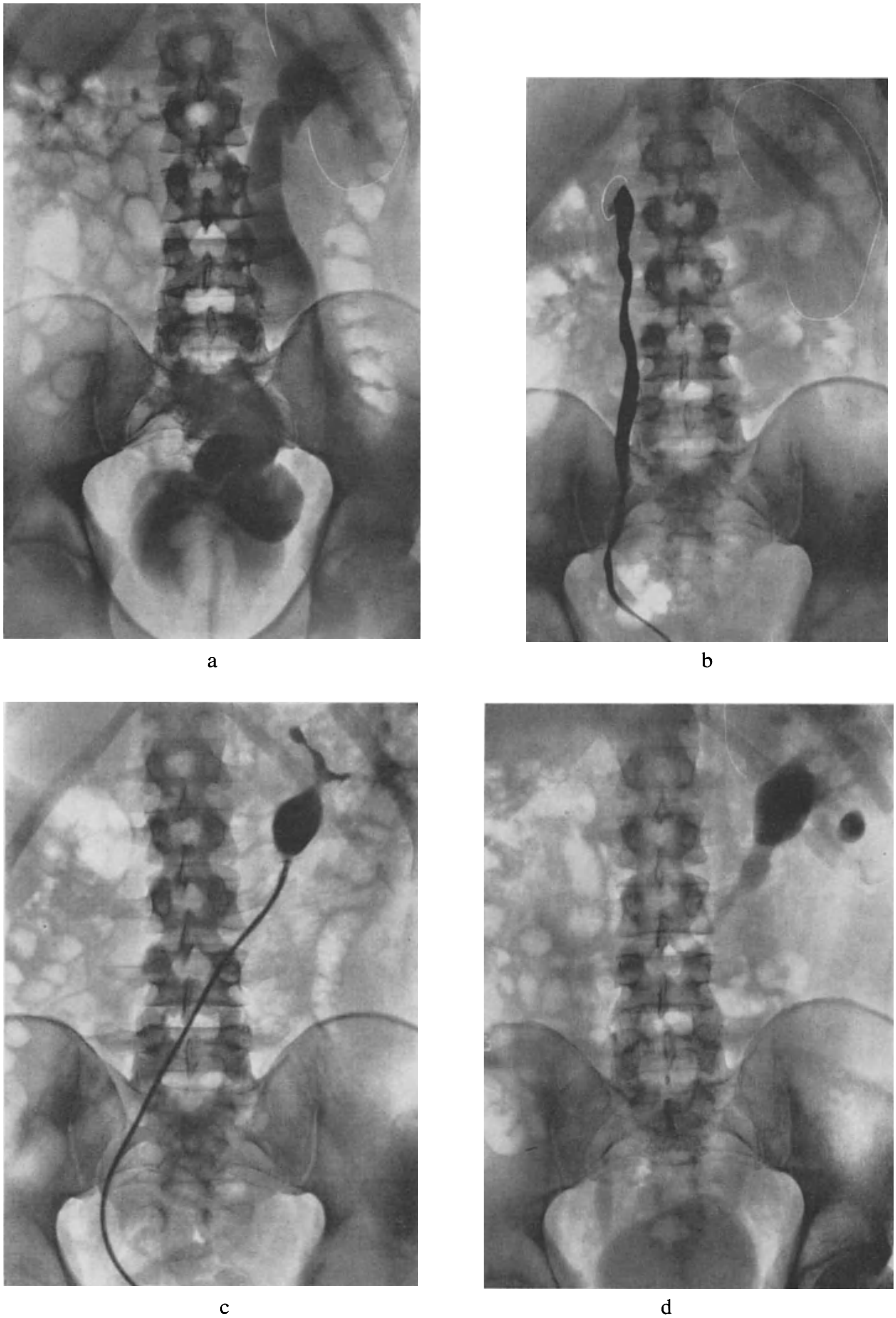


Fig. 83a—d. Total crossed transposition of the ureter. Man aged 22 years. Recurrent infection and hematuria. (a) I.V.P.: only the left kidney is functioning and it has undergone compensatory hypertrophy; congenital left megaureter. There is a stone in the right renal region. (b) Right ureteropyelogram: small atrophic dysgenetic kidney containing stone; ureter normal. (c) 1963: right nephrectomy, removal of left megaureter and anastomosis of the normal right ureter to left renal pelvis. Post operative film with catheter in position. (d) Seven years later, the patient is well and the urinary tract is normally patent. Endogenous creatinine claerance 79 ml/mn. A stone has developed in the lowest calyx

ureterostomy) or by uretero-pelvic anastomosis after resection of the pyelo-ureteral junction (crossed uretero-pyelostomy). In the latter case, the residual ureter replaces the ureter of the solitary kidney in its entirety. Both retroperitoneal spaces are drained, the colon is replaced and the abdominal wound is closed. If the solitary kidney is distended and infected it is wise to drain with an indwelling ureteral catheter, a ureterostomy in-situ or a temporary nephrostomy for 12 or 15 days.

c) Discussion and Results

Uretero-ureterostomy is not widely used. The very principle is debated. Many urologists fear that fistula or stenosis of the anastomosis may compromise the function of the healthy kidney and for this reason they will not countenence the procedure. This attitude is not in fact justified by the results.

We have had excellent long term results with five cases of homolateral uretero-ureterostomy, two followed up for 12 and 13 years (Fig. 82). We have also had uneventful recovery and good long term results from several crossed uretero-ureterostomies and with one case of total ureteral transposition followed up for seven years (Fig. 83). In 1964, THOMAS gathered 45 cases from the literature and described 15 unpublished cases by SMITH. JACOBS, POLITANO and HARPER (1967) presented nine other cases. Postoperative complications were very few and the vast majority of cases were successful. In every case the recipient ureter and kidney remained normal. In one of SMITH'S cases the kidney whose ureter had been implanted had to be removed because of gross infection but the kidney on the recipient side was normal three years later, showing that, even with such complications, the recipient excretory tract can remain intact.

From our own experience, and from the reports of authors such as SMITH, ANDERSON and HODGES, and JACOBS and POLITANO, we are satisfied that, given good surgical technique, the risk of causing trouble in the normal recipient ureter is non existent. Although the indications are limited, this technique for re-establishing continuity merits consideration.

There is one definite contraindication. If the ureters have been radiated (generally in the treatment of bladder or uterine cancer), the combination of radiation and the inevitable ureteral dissection may interfere with the blood supply of the ureter so that it is not safe to perform uretero-ureterostomy either to re-establish continuity or to produce only a single cutaneous stoma for skin diversion. In such cases, there is too great a risk of ureteral necrosis at the site of the anastomosis and consequent urinary fistula.

4. Entero-Ureteroplasty

The idea of replacing the ureter by intestine, a contractile tube with vector properties, is quite old. The experimental studies of FOGGI, of URSO and FABII and of MELINKOFF date respectively from 1888, 1900 and 1912. SHOEMAKER had the first clinical success in 1906 when he performed two stage ileo-ureteroplasty;

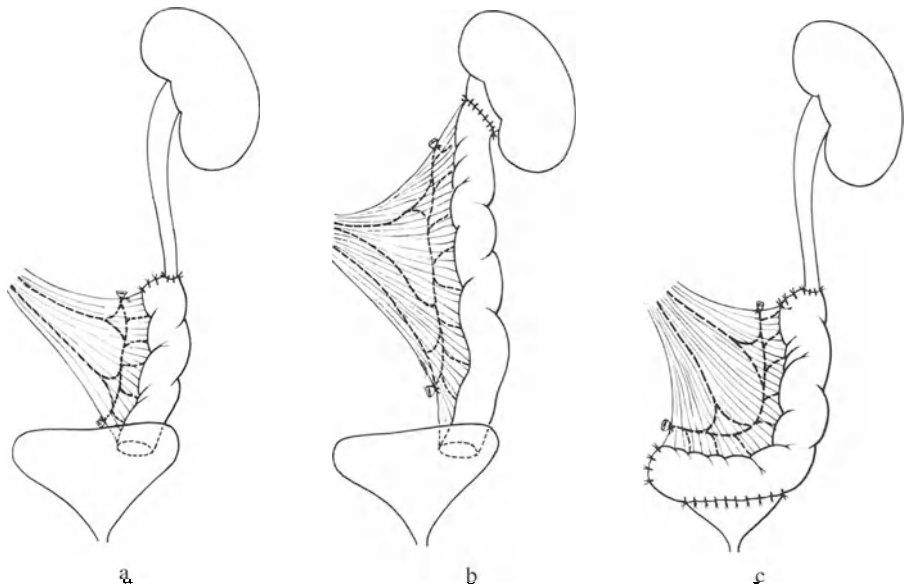


Fig. 84a—c. Unilateral entero-ureteroplasty. (a) Partial lower. (b) Total. (c) With cystoplasty

in the first stage he brought the ileal loop to the skin and transferred it to the bladder in the second stage. The next cases were reported by NISSEN (1940), MULLER (1949) and LONGUET (1949). In France, COUVELAIRE, followed by CIBERT, began bladder replacement by an intestinal segment in 1950 and they were followed by KÜSS (1951), FORET, BAUM and ORTVED. Bladder enlargement with an intestinal graft led on to replacement of the pelvic ureter and these operations were followed by the development of total entero-ureteroplasty, used for the first time in the treatment of giant hydronephrosis by KÜSS in 1957. The fear of reabsorption of urinary constituents by the intestine led to experimental attempts to reduce the surface area of intestine by longitudinal tailoring (SWENSON), by removing the mucosa or using only the reversed seromuscular layers (ROVINESCO) or by achieving epithelialization of the surface of the graft as a first stage (ATWILL, BOYARSKY and GLENN). The results were generally poor. Numerous experimental studies by MCLEAN and FAIS, ANNIS, ROVINESCO, CLARKE and MAHONY, and BRACCI and GIULIANI and clinical studies by KÜSS and LEGRAIN (1958) showed that the degree of reabsorption was not in fact significant. Hence the graft used is now an intact intestinal segment, usually the ileum, sometimes the left or right colon. In 1959, KÜSS, CAMEY and ROUCAUTE published the first case of replacement of the lumbar ureter by the appendix.

The possibilities of using intestine to replace ureter, and thus avoid otherwise inevitable urinary diversion, were so great that the method was widely adopted. BITKER reported 17 cases in 1954, BRACCI and GIULIANI described 464 cases in 1966 and LHEZ gave an account of 669 cases in 1968.

Entero-ureteroplasty is now a standard procedure. The entire ureter can be replaced or only its lower segment. Unless the appendix is used, total enteroplasty is required for intestinal replacement of the lumbar ureter; the very few cases of segmental replacement of the lumbar ureter by an intestinal graft have all failed because the normal lower ureter seems incapable of coping with the mucous secretions of the intestinal loop above. The ileum, the left colon or the ileo-colic segment may be used for the graft. One or both ureters may be replaced, in one or two stages. The bladder may be replaced at the same time, in part or entirely. There is a large number of possible technical variants (Fig. 84).

We shall review the various techniques and then consider the postoperative course, complications, long term results and, finally, the indications. The use of the appendix will be considered separately in another chapter; it is in no way comparable to other enteroplasties in possibilities or indications, in the gravity of the surgery or postoperative course or in frequency.

A. Surgical Technique

The patient must be prepared as for any major abdominal surgery by correction of anemia and of any protein deficiency and by thorough evaluation of the cardio-vascular and pulmonary status. Standard intestinal preparation with a non-residue diet and antibiotics or unabsorbable sulfonamides is advisable if the colon is to be used. Evaluation of renal function is especially important, particularly in dealing with a solitary kidney or bilateral lesions. The patient should have adequate glomerular filtration (more than 20 ml/mn and a normal blood electrolyte pattern and the urine should, if possible, be sterile. Pre-operative antibiotic therapy, to control urinary infection, is thus nearly always essential. In dealing with a distended and infected kidney, preliminary nephrostomy will improve kidney function and render disinfection of the urine easier.

a) Total Left Ileo-Ureteroplasty
(Fig. 85)

Surgical Approach

It is possible to use a long lateral extraperitoneal incision, later opening the peritoneal cavity for the preparation of the graft but this approach does too much damage to the abdominal wall and provides a poor exposure for the isolation of the loop. We always use a midline transperitoneal approach through an incision running from the xiphoid to the pubis, or in some cases the incision of Barraya or Quenu.

The left colon and mesocolon are reflected medially after incising the posterior peritoneum in the left paracolic gutter; this reflection includes the splenic flexure to reveal the kidney, renal pelvis and upper ureter. The dissection is continued downwards behind the sigmoid mesocolon, producing two peritoneal flaps destined to exclude the future ileo-vesical anastomosis. The ureter is thus exposed in its entirety and, depending on the nature of the lesions, it is removed or left in position.

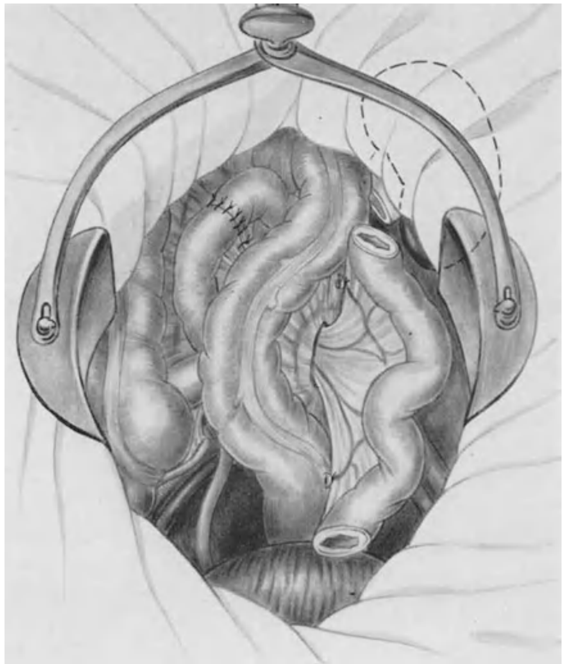
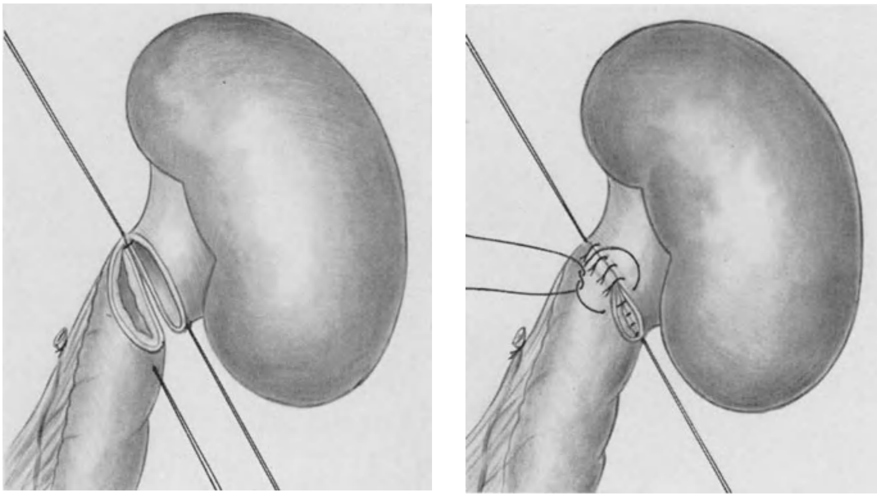


Fig. 85. Total left ileo-ureteroplasty—graft lying behind the colon

Preparation of the Intestinal Graft

This is generally taken from one of the terminal loops of ileum and the length is measured by laying the intestine in its future position. The choice of loop is in fact determined by the vascular arrangements of the mesentery, defined by transillumination or palpation. The graft should be supplied where possible by two arterial axes forming a vascular loop of sufficient length although a single vascular trunk branching out in a fan may in fact suffice. It is essential that the blood supply of the future graft is such that the ends of the isolated loop can reach the renal pelvis above and the bladder below without any traction on the vessels. Excessive length is also undesirable because it may cause urinary stasis or even volvulus; we have had to do a secondary segmental resection for volvulus on one occasion. The average length required is 35 to 40 cm. It is better to err on the side of making the loop too long; it can then be shortened as necessary before performing the bladder anastomosis. The extremities of the loop, marked by tapes, should be placed simultaneously against the renal pelvis and the bladder before the gut is divided.

The mesentery is divided in convergent fashion, with careful hemostasis, taking care that the base of the mesentery of the graft is not too narrow and that all ligatures are at some distance from the main vessels supplying the loop. The ileum is then divided at the chosen site, hemostasis is secured in the cut ends and the isolated loop is washed out. Intestinal continuity is restored by



a b

Fig. 86a and b. Total ileo-ureteroplasty—detail of ileo-pelvic anastomosis. (a) Posterior layer. (b) Anterior layer

end-to-end anastomosis in front of the mesentery of the isolated loop, using a single layer of interrupted extra-mucosal sutures of unabsorbable material.

Placing the Ileal Graft

The time taken for the intestinal anastomosis is adequate to ensure the vitality of the isolated loop which should retain its normal color throughout. The loop and its mesentery are passed through an opening in the left mesocolon to lie in its retroperitoneal bed. On the left side, it lies naturally in an isoperistaltic direction.

Upper Anastomosis of Ileum to Pelvis

In most cases the upper anastomosis is made to the renal pelvis (Fig. 86). Where is this possible, the pelvis is cut obliquely so that the opening in the pelvis corresponds to the diameter of the isolated ileal loop. The anastomosis can then be made end-to-end, ensuring the best possible evacuation. Guy sutures are placed fixing the mesenteric border of the graft to the lower part of the pelvis and, diametrically opposite, fixing the anti-mesenteric border of the graft to the upper part of the pelvis. The anastomosis is made with interrupted, 000 chromic catgut sutures taking the entire thickness of the wall of the pelvis but picking up only the seromuscular and submucous layers of the ileum. The posterior layer is done first. If the kidney is to be drained, this is done before the anterior layer of the anastomosis is completed.

Drainage of the kidney is not essential in every case but it is advisable if the kidney is very dilated and infected, and especially if it is solitary. This drainage can be achieved in one of two ways: either a small nephrostomy tube can be brought out through a lower or middle calyx or a multifenstrated silastic tube

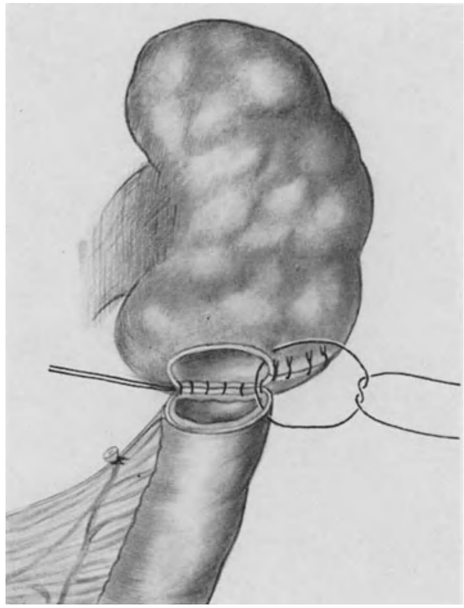


Fig. 87. Total ileo-ureteroplasty—ileum anastomosed to lower calyx

can be passed up as far as the superior calyx and the lower end can be brought out through the wall of the ileal loop (and then through the lateral abdominal wall) 8 to 10 cm below the ileo-pelvic anastomosis. This "safety valve" is useful for post-operative radiologic checks.

Modifications of the Upper Anastomosis

The ileo-pelvic anastomosis is generally easy with giant hydronephrosis but it may be much more difficult in cases with intrahilar stenosis due to infection, stone or previous surgery. It may be quite impossible to use the pelvis for this anastomosis and then recourse can be had to *implantation of the ileum into the lower calyx*, after resection of the lower pole of the kidney (Fig. 87) but if this anastomosis is to be satisfactory the calyx must be quite dilated. The ileal loop can in fact be anastomosed to any dilated calyx; it can even drain several independant kidney pockets by multiple anastomoses on the convex border of the kidney (Fig. 88a). Drainage of a very dilated kidney may be even more effective with double anastomosis of the ileum to the pelvis and to the inferior calyx (Fig. 88b). GOODWIN has extended the pelvic anastomosis into the inferior calyx (pyelo-nephro-ileal anastomosis) to ensure spontaneous elimination of recurrent kidney stones (Fig. 88c).

Lower, Ileo-Vesical Anastomosis

The left side of the bladder, previously extraperitonealized, is incised and a wide disk of bladder muscle is excised above the trigone. The ileo-vesical anasto-

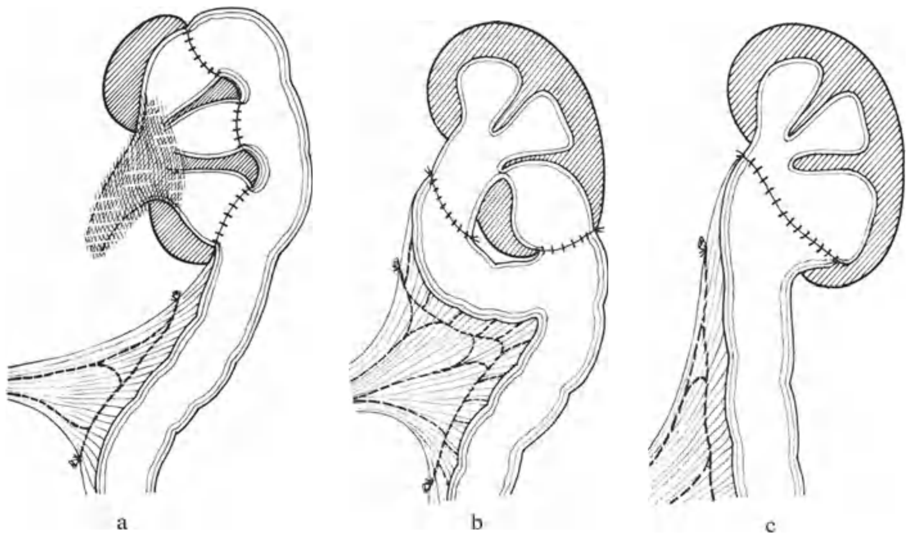


Fig. 88a—c. Total ileo-ureteroplasty—alternative ileo-calyceal anastomoses. (a) Multiple (on the convex border). (b) Pelvic and calyceal anastomosis. (c) Pyelo-nephro-ileal anastomoses (GOODWIN)

mosis may be end-to-side or side-to-side. If end-to-side (Fig. 89), the loop must first be trimmed to the correct length, avoiding any tortuosity. The end of the loop is cut obliquely and anastomosed with interrupted sutures of 00 chromic catgut to the bladder. The sutures take a wide bite of muscle but little mucosa. The posterior layer is completed first and here it may be necessary, for technical facility, to leave the knots within the lumen.

Side-to-side anastomosis (Fig. 90a) utilises a greater length of ileum and may include partial enlargement of the bladder. The anti-mesenteric border of the loop is incised to provide an anastomosis of whatever width is desired. The distal end is closed with a single layer of sutures or it may be included in the anastomosis so that the ileum is then applied to the bladder as a wide spatula (Fig. 90b). A urethral catheter is inserted; this should be of large calibre with multiple eyes for easy evacuation of the intestinal mucus which is often very abundant in the first few days.

Peritonealization and Drainage

Two drains are placed, one to the region of the upper anastomosis emerges through a high lateral stab and the other, brought out through a low lateral stab, is placed down to the region of the lower anastomosis. Both drains are extraperitoneal and one may be split in Y and one of its limbs used to drain the retrocolic space. Peritonealization should be meticulous with interrupted sutures of chromic catgut or unabsorbable material. The openings in the ileal mesentery and in the left mesocolon must be closed carefully and the retro-mesenteric hiatus (BITKER) is closed by suturing the mesentery of the graft to

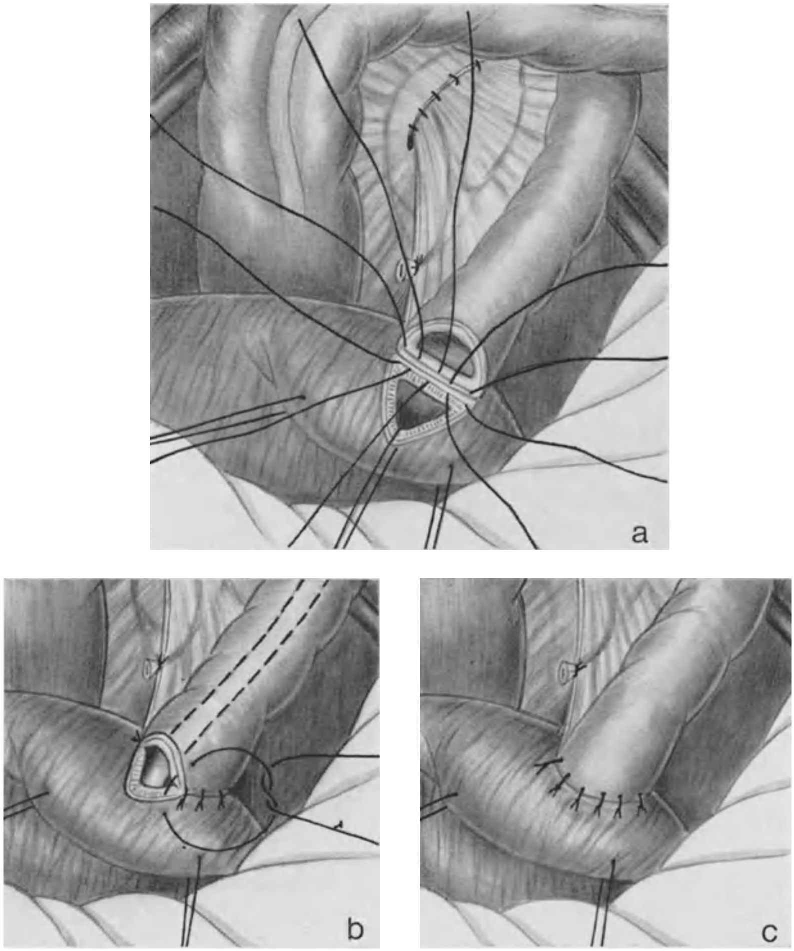


Fig. 89a—c. Ileo-ureteroplasty—end-to-side ileo-vesical anastomosis. (a) Posterior layer. (b) Anterior layer. (c) Anastomosis completed

the posterior peritoneum (Fig. 91). The extraperitonealization of the entire loop and anastomoses is achieved by suturing the paracolic gutter above and by reconstitution of the pelvic peritoneal floor below using the sigmoid colon and the peritoneal flaps prepared at an early stage.

Variant Position of Neo-Ureter: Intraperitoneal Graft (Fig. 92)

In most cases we prefer to place the graft retroperitoneally as just described so that the neo-ureter lies in a position similar to that of the normal ureter. For anatomic or pathologic reasons, it may in some cases be preferable to place the graft within the peritoneal cavity in front of the colon. In such cases, only the upper end of the graft is passed through the left mesocolon to reach the renal pelvis. The lower end of the graft may run in front of the sigmoid colon

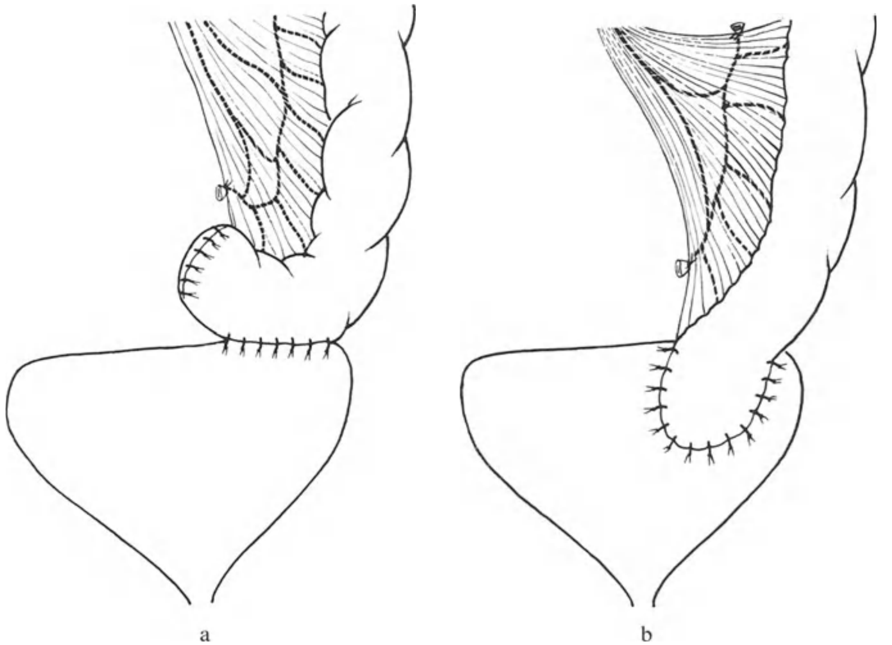


Fig. 90a and b. Ileo-ureteroplasty—alternative ileo-vesical anastomoses. (a) Side-to-side anastomosis. (b) Spatulation

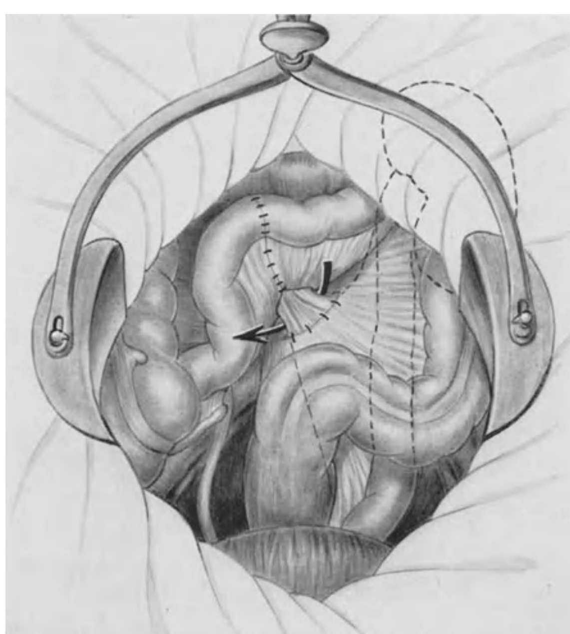


Fig. 91. Ileo-ureteroplasty—the retro-mesenteric hiatus (Bitker)

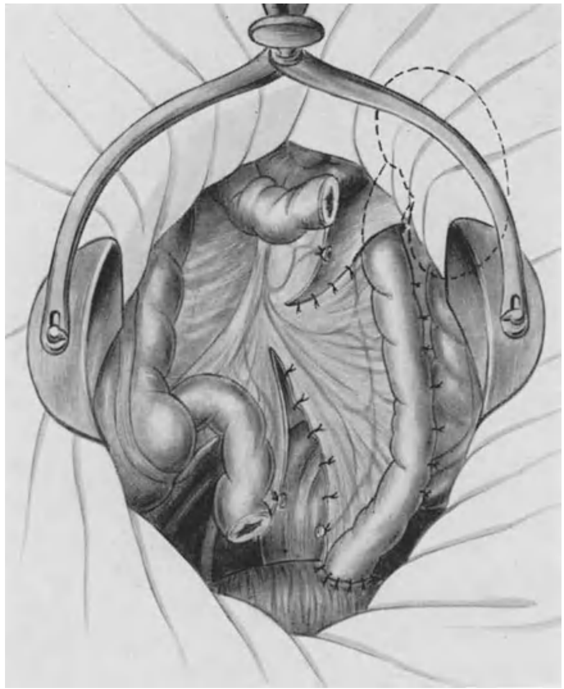


Fig. 92. Total left ileo-ureteroplasty. Ante-colic type (intra-peritoneal graft)

or through the sigmoid mesocolon. Only the two anastomoses are extraperitoneal and lateral extraperitoneal drains are passed down to each anastomosis. The graft lies free in the peritoneal cavity. The edges of the mesentery of the isolated loop are sutured to the parietal peritoneum to occlude any opening that might give rise to herniation.

Postoperative Management

Gastro-intestinal suction is seldom required. It is a factor in producing electrolyte imbalance and is dangerous in renal failure. It should certainly not be employed routinely. Careful attention to water and electrolyte balance is essential in the first few days. The drainage tubes are removed gradually from the fourth day. Frequent bladder washouts may be needed to clear the large amounts of mucus secreted by the ileal loop. The urethral catheter is removed after two weeks. If a nephrostomy or a transileo-renal catheter has been inserted, it can be used for radiographic check of kidney and neo-ureteral drainage before it is removed after the fifteenth day.

b) Total Right Ileo-Ureteroplasty

There are a few points of difference from the operation on the left side. The reflection of the hepatic flexure, ascending colon and caecum is continued down-

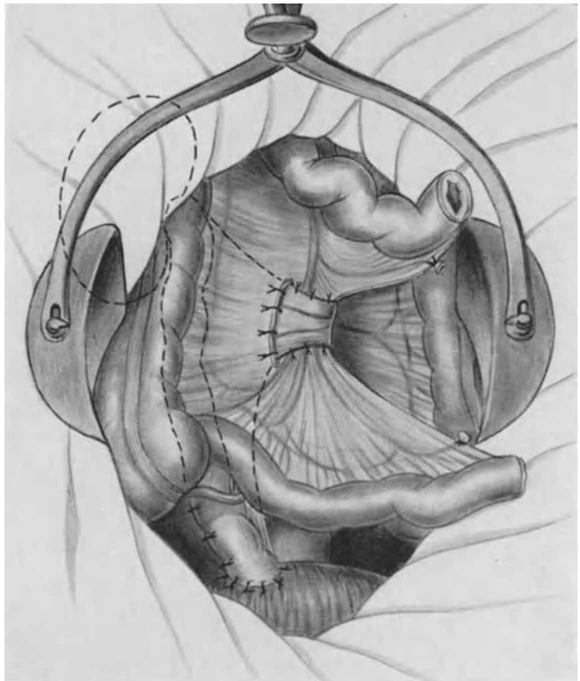


Fig. 93. Total right ileo-ureteroplasty. Retro-colic graft

wards by incising the posterior peritoneum over the ureter as far as the bladder, before extra-peritonealizing the right side of the bladder.

The real difficulty is placing the graft in position. On the right side, simply swinging the mesentery to the right would place the graft naturally in an antiperistaltic position. A second rotation around a transverse axis is necessary to achieve the isoperistaltic position that is so very desirable in total ureteroplasty. Some urologists fear that this double folding of the mesentery may interfere with the blood supply of the loop. Although we always place the graft in an isoperistaltic fashion, we have never encountered vascular problems but we are careful to ensure that the mesentery of the loop lies in a wide, smooth spiral, avoiding any kink or torsion in a limited segment (Fig. 93).

If the graft is placed within the peritoneal cavity it may cross in front of the terminal ileum or pass behind the terminal ileum through an opening in the mesentery.

c) Partial Ileo-Ureteroplasty

The technique is very similar to that of total ureteroplasty (Fig. 94). There is much variation in the length of ureteral segment to be replaced, from replacement of the terminal ureter (justified only if the Boari operation is impossible) to subtotal ureteroplasty in which only 3 to 4 cm of proximal ureter remain.

A midline transperitoneal incision is used, its length depending on the length of ureter to be replaced. We nearly always place the graft retroperitoneally.

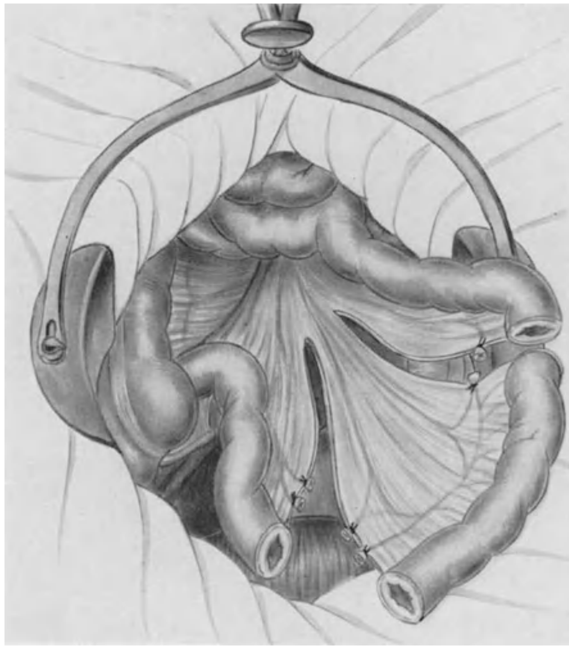


Fig. 94. Partial ileo-ureteroplasty. Isolation of the graft

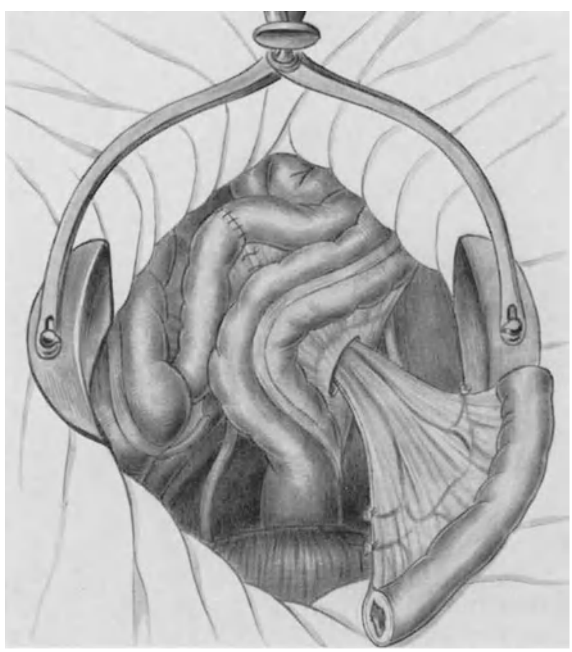


Fig. 95. Partial left ileo-ureteroplasty in the retro-peritoneal position. Passage through the mesosigmoid

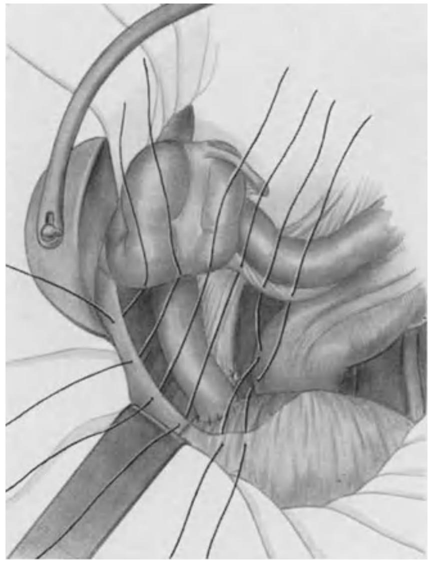


Fig. 96. Partial right ileo-ureteroplasty in the retro-peritoneal position. Peritonealization

For replacement of the pelvic ureter, the graft is passed through the sigmoid mesocolon on the left side (Fig. 95); on the right side the mesentery of the neo-ureter descends behind the terminal ileum and reaches the pelvis by the right lateral rectal gutter; the graft is later excluded from the peritoneal cavity by reperitonealization of the pelvic floor utilising the flap of parietal peritoneum, the posterior parietal peritoneum of the para-rectal and pre-ureteral gutter, and the right side of the rectum (Fig. 96). The graft can also be placed in the peritoneal cavity. On the right side it is always easy to arrange the partial graft iso-peristaltically.

The chief difference from total replacement is the *upper uretero-ileal anastomosis*. The healthy extremity of ureter is dissected as little as possible so as to preserve its blood supply and the end is cut obliquely. The more dilated the ureter, the easier is the anastomosis which is made end-to-end between the bevelled end of the ureter and the partially closed upper end of the ileal loop (Fig. 97a). It is wise to start by making the "racket handle", partially closing the end of the loop from its mesenteric border, tailoring the orifice to the size of the ureter. The uretero-ileal anastomosis is then made with a single layer of interrupted 000 chromic catgut taking the full thickness of the ureter but an extramucosal bite of the intestine. When the ureter is sufficiently wide there is no need to drain the kidney above except possibly by a nephrostomy performed previously or at the same time. If the ureter is not dilated it is preferable to use a ureteral catheter, emerging through the urethra alongside the bladder catheter and it is even better to use a transvesical ureterostomy in-situ.

The uretero-ileal anastomosis is excluded from the peritoneal cavity at the same time as the entire graft. Below the pelvic brim, the site of anastomosis

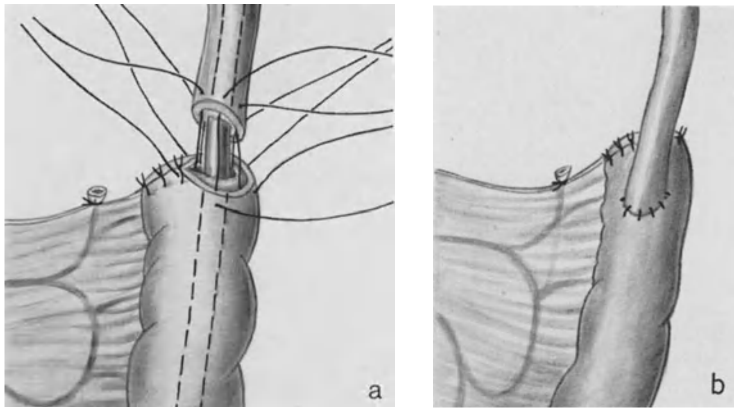


Fig. 97a and b. Partial ileo-ureteroplasty. The upper uretero-ileal anastomosis. (a) End-to-end anastomosis. (b) Alternative end-to-side anastomosis

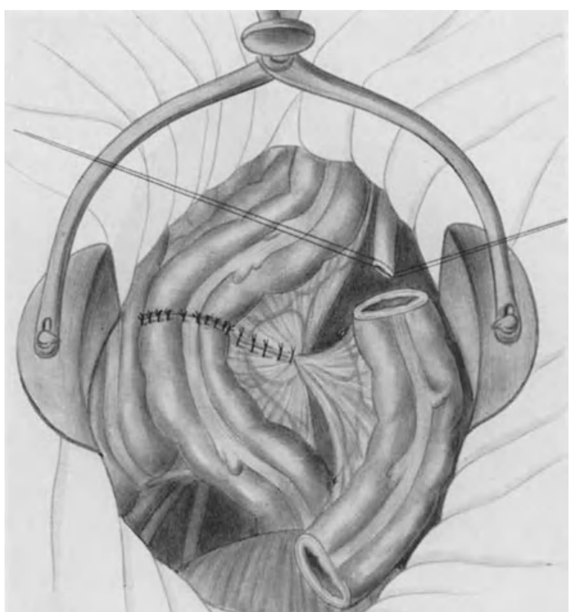


Fig. 98. Left colo-ureteroplasty. Isolation of the graft and preparation of the ureter

can be drained by the pelvic drain but if the anastomosis is very high it is better to place an additional lateral drain as in total ureteroplasty.

Especially when the ureter has a normal calibre, some urologists prefer to make the uretero-ileal anastomosis end-to-side (Fig. 97b) with or without spatula-

Fig. 99. Left colo-ureteroplasty. Graft in place—uretero-colic and colo-vesical anastomoses

tion of the ureter by the Nesbit technique. The sutures can be placed from the outside or from the lumen of the temporarily everted graft. The thin wall of the ileum is not very suitable for anti-reflux submucous tunnels and such a procedure has little chance of success unless the ureter is very small.

d) Left Colo-Ureteroplasty

The ileum is not the only material used for ureteroplasty. It may be very difficult or impossible to use the ileum because of multiple adhesions from previous surgery. The ureter, especially on the left, can be replaced also by a segment of colon. *The left pelvic ureter* is easily replaced by a *sigmoid graft* (Fig. 98); the only condition is that the sigmoid loop must be sufficiently long and free from disease. Intestinal continuity is restored in front of the isolated segment which then lies naturally in a good position – retroperitoneal, pelvic and iso-peristaltic. Peritonealization is easy. The risk of postoperative intestinal obstruction is much less than with ileal grafts (Fig. 99).

More extensive ureteral replacement, even *total left colo-ureteroplasty* (Fig. 100) is perfectly possible. It requires neither dissection nor mobilization of the left colon, which is left in place. The upper section is made at the level of the renal pelvis so that the upper end of the graft is separated from the pelvis only by the perirenal fascia. Intestinal continuity is restored by mobilization of the splenic flexure and anastomosis to the divided sigmoid colon where it lies. There is no

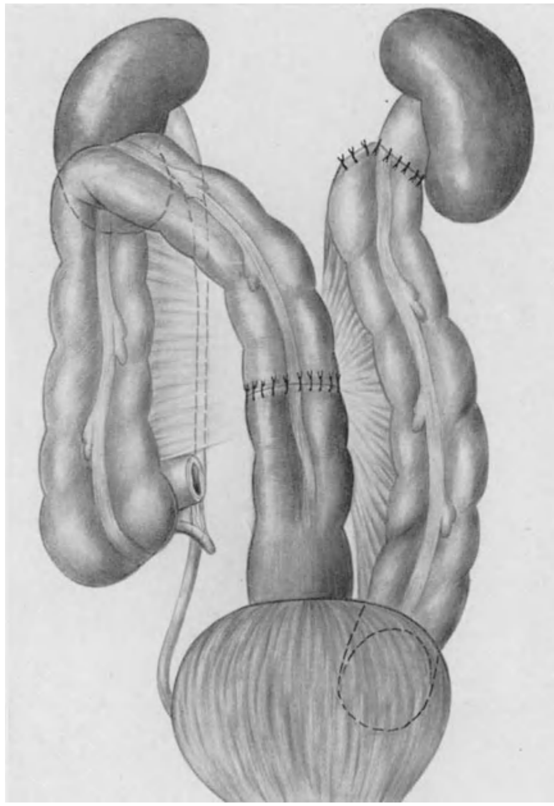


Fig. 100. Total left colo-ureteroplasty

difficulty in approximating the divided lower end of the graft to the bladder and peritonealization is also very simple.

e) Bilateral Entero-Ureteroplasty

Bilateral partial ureteroplasty offers no additional technical difficulty. The ileal or sigmoid graft can be arranged in a U or a J depending on the length of ureter to be replaced (Fig. 101). The ureters are anastomosed to each extremity of the graft and the side-to-side entero-vesical anastomosis is made at the dependant part of the isolated loop, incised widely along its antimesenteric border; the anastomosis should be very big, with a diameter of at least 8 cm, and it is preferable to excise a disk of bladder wall so as to prevent any subsequent narrowing the anastomosis by secondary retraction of the detrusor. The "limbs" of the intestinal graft may lie intraperitoneally or extraperitoneally; in the latter case, the graft lies in a horseshoe in front of the rectum. This arrangement means that one of the neo-ureters is antiperistaltic but this does not matter if the segment replaced is relatively short. Above the pelvic brim, it is better to use a different

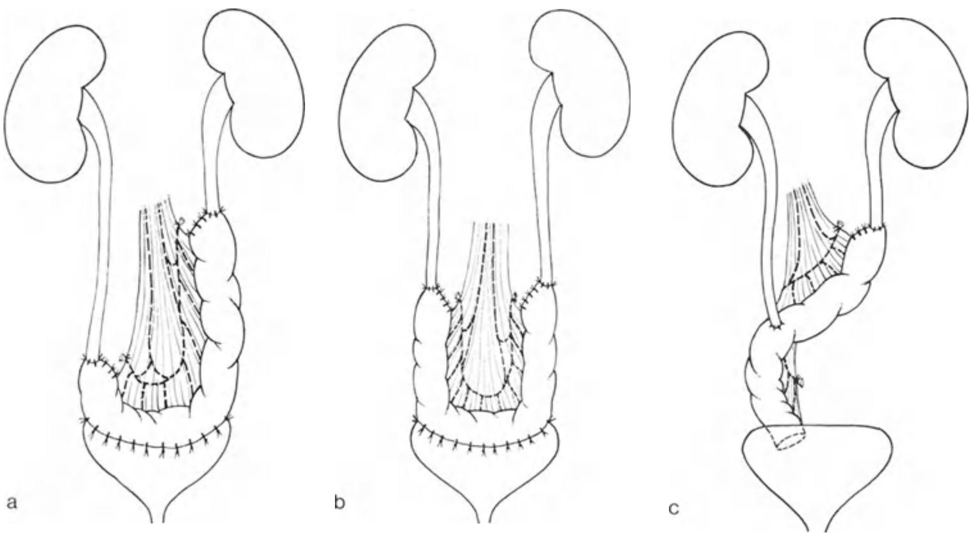


Fig. 101 a—c. Bilateral partial entero-ureteroplasty. (a) J-form. (b) U-form. (c) Totally isoperistaltic arrangements

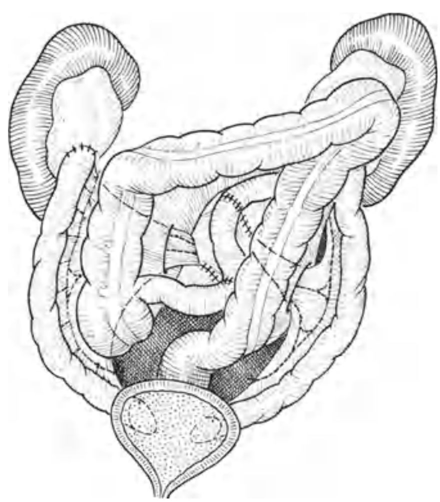


Fig. 102. Bilateral total entero-ureteroplasty with two separate grafts

arrangement, entirely isoperistaltic, using an ileal loop arranged in a long S (Fig. 101c). At least part of such a graft has to lie within the peritoneal cavity.

Total bilateral ureteroplasty poses greater problems.

Two separate grafts can be used (Fig. 102); the operation can then be performed in one or two stages. When renal insufficiency is already advanced, it seems reasonable to perform the procedure in two stages, beginning on the side of the better kidney.

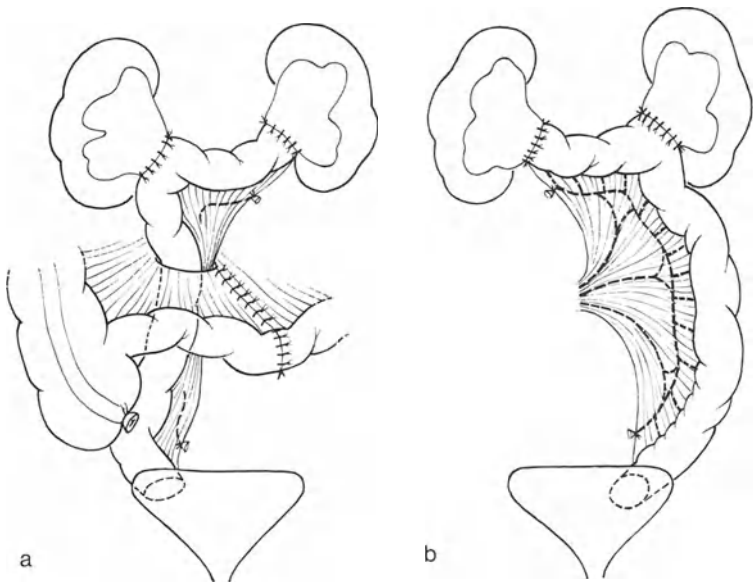


Fig. 103a and b. Bilateral total enteroplasty with a single graft. (a) Right. (b) Left

It may also be possible to use a single graft. A long ileal loop arranged as a U may be technically possible for total double ureteroplasty despite the difficulties associated with the arrangement of the mesenteric blood vessels but we think that this procedure is not advisable; the degree of traction on the mesentery endangers the blood supply to a degree that is difficult to assess at the time of surgery and the antiperistaltic arrangement of one of the limbs is undesirable in total replacement. It is better to arrange the graft as a 7: the upper end of the graft is anastomosed to one renal pelvis then brought laterally to the other renal pelvis before passing down to the bladder (Cockett technique, Fig. 103). The vertical part of this graft can lie within the peritoneal cavity; the transverse part may be intraperitoneal in front of the mesentery, or retroperitoneal, passing behind or above the superior mesenteric artery.

An ileo-caeco-colic graft also offers various possibilities for bilateral ureteroplasty.

f) Ureteroplasty Utilising the Ileo-Caeco-Colic Segment

This segment offers multiple possibilities for substitution of the urinary tract. It has been used by relatively few urologists, including Gil-Vernet and Chatelain, mainly when enlargement or replacement of the bladder is required. In such cases the caecum constitutes the new bladder and the right colon, the terminal ileum or even the appendix (provided that the ureter has normal tone and is not dilated) are used for the ureteral replacement. A competent ileo-caecal valve may prevent reflux. Many technical arrangements are possible depending on the length of ureter or ureters to be replaced, including partial or total right

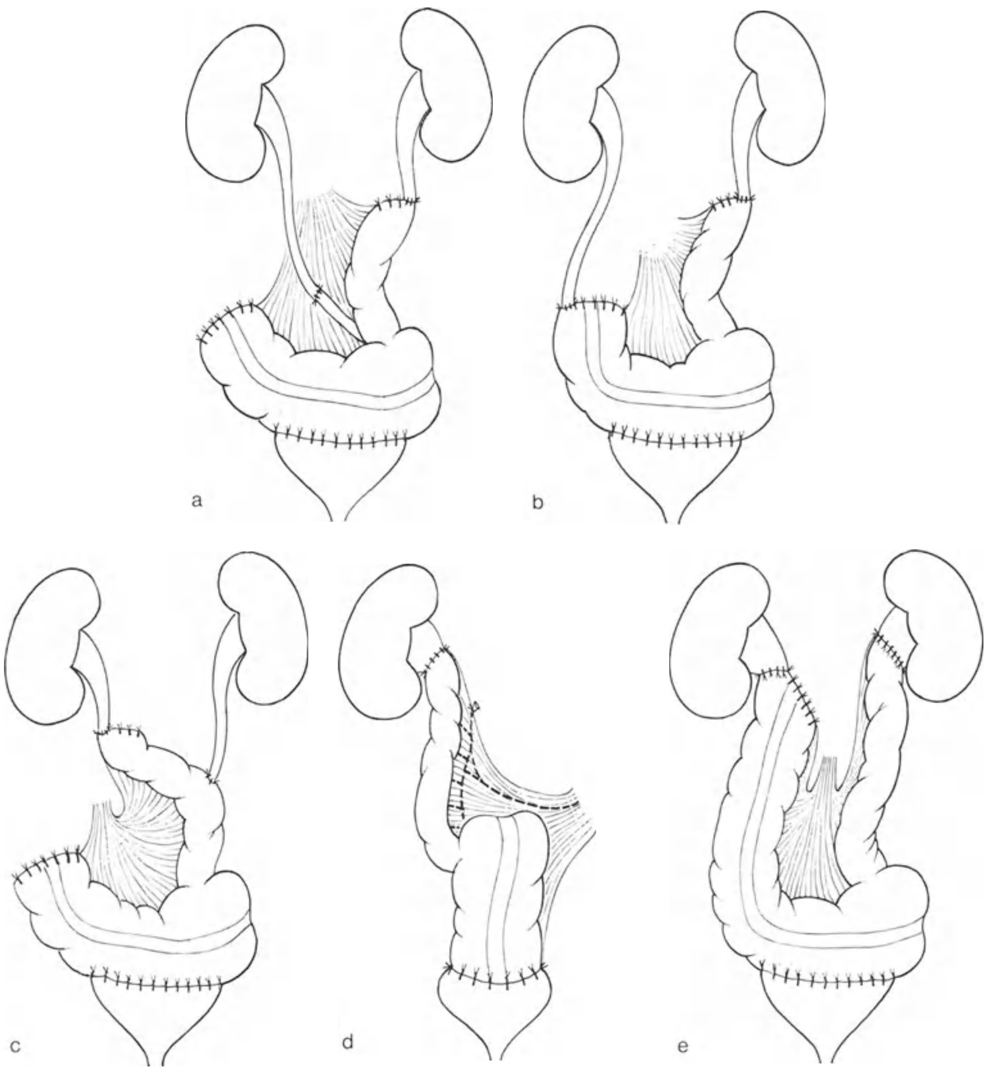


Fig. 104a—e. Entero-ureteroplasty using the ileo-caeco-colic segment. (a) Using the terminal ileum and appendix. (b) Direct implantation of the right ureter. (c) Both ureters attached to the terminal ileum. (d) Total right unilateral. (e) Total bilateral

colo-ureteroplasty, partial or total right or left ileo-ureteroplasty or replacement of terminal ureter by the appendix (Fig. 104). The possibilities of an ileo-caeco-colic graft go as far as subtotal replacement of the excretory tract.

g) Entero-Ureterocystoplasty

These operations replace not only one or both ureters (usually the pelvic ureters) but also all or part of the bladder with the one intestinal graft. The graft may be ileal, left colic or ileo-caeco-colic. The operative technique differs little from that of bilateral partial ureteroplasty. The only additional feature is the partial or subtotal removal of the bladder. The lower anastomosis may be to the trigone or to the bladder neck, deeper and more difficult, bringing the graft lower down in the pelvic cavity.

B. Postoperative Course – Complications – Results

The postoperative course of entero-ureteroplasty is often simple. But this is major surgery, compounding the risks of intestinal and urinary surgery in patients who are often weak, with a single kidney, tuberculosis and renal insufficiency. There is thus a wide spectrum of possible complications.

a) Early Complications

1. *Intestinal obstruction* may occur as after any major abdominal surgery. It may be a simple paralytic ileus that will respond to duodenal aspiration and careful maintenance of water and electrolyte balance but it may also be a mechanical obstruction due to volvulus or strangulation, requiring rapid intervention. Mechanical obstruction cannot always be avoided even with the most meticulous care in peritonealization.

2. *Volvulus of the graft* is rare but if it does occur it will be necessary to perform segmental resection of the twisted segment. This complication is associated with excessive length of the intestinal loop and it may occur early or late because every such graft has a tendency to subsequent elongation.

3. *Ischemic necrosis of the graft* has been observed in some cases due to kinking or torsion of the mesentery of the neo-ureter.

4. *Urinary fistula* rarely occurs from the upper anastomosis but is more common from the entero-vesical anastomosis, especially if the bladder has been irradiated after radical hysterectomy. Such a fistula may close spontaneously if bladder drainage is maintained for several weeks but it may be necessary to perform a secondary surgical closure.

5. *Uro-intestinal fistula.* We have noted this on two occasions, revealed about the tenth day by the appearance of faecal matter in the urine, but both resolved spontaneously. A third appeared at a very much later stage (Fig. 105).

6. *Infection* is the most common complication. It may be of any degree, from the usual initial infection of the urinary tract, controlled by antibiotics, with a tendency to recur after removal of the catheters, to very severe pyelonephritis with organisms often resistent to antibiotics. There may even be Gram-negative septicaemia in which the prognosis is always doubtful even though treatment is early and vigorous.

Extraperitoneal infection and closed pelvic abscesses are less serious but may present local problems of drainage and may compromise the subsequent good function of the neo-ureter.

7. *Wound complications* such as infection and partial or complete disruption are always possible.

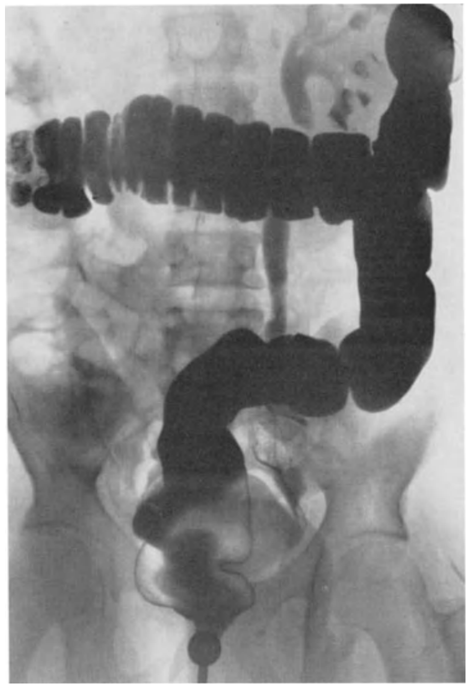


Fig. 105. Uro-intestinal fistula as a late complication 2 years after colo-uretero-cystoplasty for schistosomiasis

8. *Thrombo-embolic complications* are relatively uncommon but are always to be feared after major surgery on the abdomen and pelvis.

9. *Water and electrolyte disorders* in the immediate postoperative period should not occur with careful management. Aggravation (often transient) of pre-existing *renal insufficiency* is often due to some other complication, especially infection.

Although the list of possible complications is long, their incidence is not very great. In a personal series of 43 partial entero-ureteroplasties, the postoperative course was uneventful in 32, and 13 out of 18 total entero-ureteroplasties made an uneventful recovery. Because of the diverse etiology of the underlying disease and because of the relatively few cases in many reported series, it is not yet possible to obtain an exact notion of the true incidence of these complications.

b) Operative Mortality

is relatively low. In 61 enteroplasties we had two deaths (3.2 per cent): one due to acute cardio-respiratory failure and the other on the twelfth day following acute dilatation of the stomach with renal failure. Thrombo-embolic complications and infection are the chief causes of death recorded in other series (WELLS 7 per cent, BRACCI 25 per cent, MORALES 16.6 per cent). Another source of mortality is aggravation of pre-existing renal failure which may develop very rapidly in the presence of any abdominal complication.

Dialysis should overcome the problem of this acute, functional and transient renal failure in some cases. Renal and pelvic lesions present before surgery are the basic sources of problems in the post-operative period.

c) The Long Term Results

are in general very good. Hydronephrosis improves in most cases with stabilization of renal function. This is true for both total and partial ureteroplasties.

In 43 partial ureteroplasties, we have had 29 good late results, some after more than fifteen years; CIBERT reports 15 good late results in 26 cases and BRACCI 11 out of 13 cases. With total ureteroplasty, we have had 14 good results in 18 cases (the longest follow up being more than thirteen years; BRACCI had 3 satisfactory results out of 7 and MOONEN 4 good results out of 6. GOODWIN had 13 good results in 18 cases; WELLS reported satisfactory late results in 52 cases and CIBERT reported 24 good results in 41 cases.

There would seem to be several distinct stages in the progress of a patient after entero-ureteroplasty, once the postoperative period is passed. There are a certain number of deaths in the first two or three years due to serious infection or to progression of severe renal insufficiency pre-dating the operation or to complications related to the original etiology such as progression of tuberculous lesions and recurrence of malignant disease. In such patients, the ureteroplasty has been only palliative but it has at least had the advantage of avoiding external urinary diversion.

The majority of cases run a more favourable course with efficient evacuation of the urine from the kidney and stabilization of renal function: subsequent very slow progression of renal insufficiency is similar to that seen in mildly progressive chronic pyelonephritis.

A certain number of problems remain.

1. *Urinary infection* is very common. Often the organisms are multiple, Gram-negative (especially *proteus*) and resistant to most antibiotics. The result is a chronic pyuria but fortunately this is well tolerated in most cases. Disorders of the lower urinary tract present before surgery, incomplete emptying of the graft and the presence of intestinal mucus are probably the principal factors hindering sterilization of the urine. The fear always remains that this chronic lower urinary tract infection can at any moment lead to acute pyelonephritis, encouraged by the vesico-ileo-renal reflux.

2. *Electrolyte disorders* seem to be of no more than minor clinical importance. Although there is a loss of bicarbonate and a tendency to hyperchloremic acidosis, this seldom becomes significant unless renal function is seriously depressed. The healthy kidney finds no difficulty in compensating the potential acid-base imbalance. Treatment is necessary only if there is renal insufficiency. The electrolyte disorders do not in themselves appear to have any ill effect on the progress of the chronic pyelonephritis.

3. *The vesico-entero-renal reflux* has been held to be responsible for transmitting lower urinary tract infection to the kidney and so causing recurrent pyelonephritis which, in the long term, would produce deterioration of renal function. Reflux from the bladder into the graft can always be found if it is

Fig. 106. Reflux in entero-uteroplasty. Bilateral pelvic ileo-ureteroplasty for bilharzial ureteritis. J-type graft. Low pressure reflux on the left and no reflux on the right although no anti-reflux measures were taken and there was no stricture

carefully sought but it has little significance. The important problem is to know if this reflux involves the kidney, in which case it is truly harmful (Fig. 106).

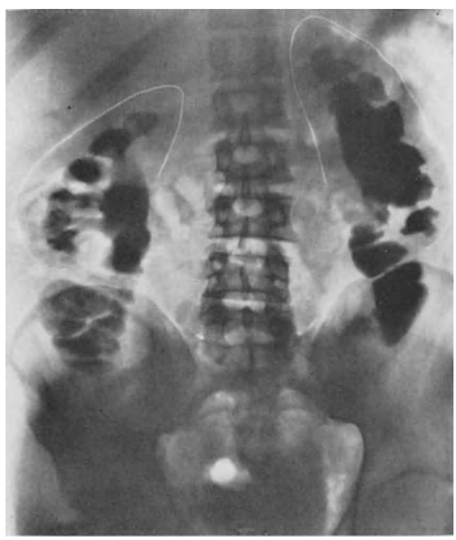
In the total entero-ureteroplasties, it is our experience that in about half of the cases the reflux does not extend more than half way up the neo-ureter; the isoperistaltic loop seems to protect the kidney above. In the other cases the reflux does reach the kidney but it seems to have little pressure at kidney level. This reflux does not appear to do much harm as shown by the excellent progress of 13 of our 18 total entero-ureteroplasties. In only one case did total reflux appear to be responsible for recurrent attacks of acute pyelonephritis in the first post-operative months.

Although very common, reflux appears even less harmful in partial entero-ureteroplasties because the tonic segment of remaining ureter seems to protect the kidney above. This has been so evident in practice that we always perform a direct uretero-intestinal anastomosis without any anti-reflux technique, on the grounds that the dangers of reflux are much less than those of any possible stenosis. It is clearly important to be sure that there is no bladder neck obstruction or to treat it before entero-ureteroplasty.

4. *Late complications* can appear after many years. These include stone and mechanical obstruction of the excretory tract.

a

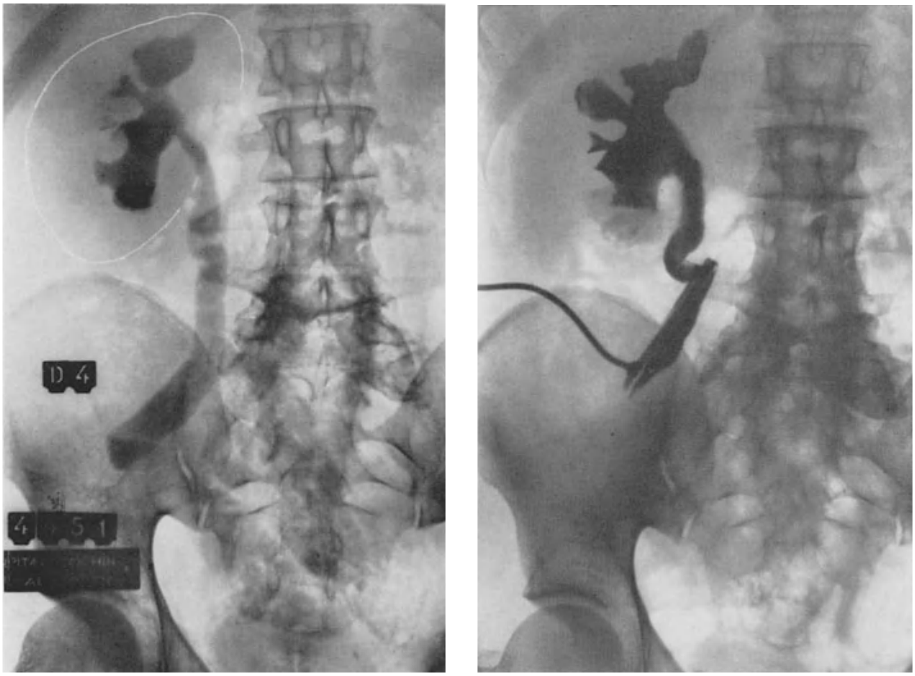
b



c

Fig. 107a—c. Staghorn calculus complicating total entero-ureteroplasty. Man aged 29 years. Bilateral total ileo-ureteroplasty (in two stages) for giant hydronephrosis (1956). Remained perfectly well for nine years. Staghorn calculus developed in the right kidney and was removed by ileo-pyelo-nephrolithotomy in 1967. Subsequent progress excellent. Renal function normal 16 years after the original surgery. (a) I.V.P. one year after bilateral total ileo-ureteroplasty. (b) The right staghorn calculus 10 years later. (c) I.V.P. one year after removal of the stone

a) *Stone* is not a common complication. We have seen one staghorn calculus in one of our total ileo-ureteroplasties (1/18) and the stone was removed ten years after the original surgery (Fig. 107); we had also a case of renal stone



a b

Fig. 108a and b. Late stenosis of the uretero-intestinal anastomosis. In 1956, at the age of 23 years, this patient underwent right ileo-uretero-cystoplasty for the treatment of a small contracted tuberculous bladder, re-establishing continuity with the remaining right kidney that had been drained by cutaneous ureterostomy. Pyelolithotomy in 1958. In 1963, 7 years after the plastic procedure, stricture of the uretero-intestinal anastomosis produced anuria. The anastomosis was refashioned. Follow up examination in 1972 showed excellent progress. (a) I.V.P. (50 mins) one year after enteroplasty. Stone is already present. (b) Ureterography through T tube placed in ureter 7 years later for emergency relief of anuria; no contrast medium enters the bladder

in one partial ureteroplasty (1/43). It must be admitted that a number of conditions favourable for stone production seem to be combined, including alkaline urine, chronic infection, the presence of mucus that could form an organic matrix for stone, and relative stasis. Eight of our 185 entero-cytosplasties have developed staghorn calculi, evidence of a real risk. Calculus is always a serious complication because of the increased danger of infection, the deterioration of renal function and the necessary further surgery.

b) *Mechanical obstruction of the excretory tract.*

Secondary stenosis of the entero-vesical anastomosis is rare. It is seen chiefly with small tuberculous bladders and is due to failure to resect enough detrusor before making the anastomosis. Such stenosis can be complete. Re-operation is necessary to resect the contracted detrusor and fashion a new anastomosis.

Adynamic distension of the graft, without any mechanical obstruction, has also been reported.

Late stenosis of the uretero-intestinal anastomosis is a serious complication because it frequently leads to destruction of the kidney above without any warning

Fig. 109 a

Fig. 109 b

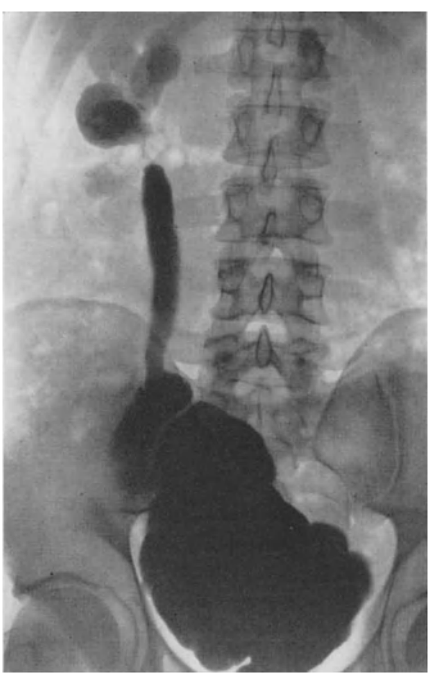


Fig. 109 c

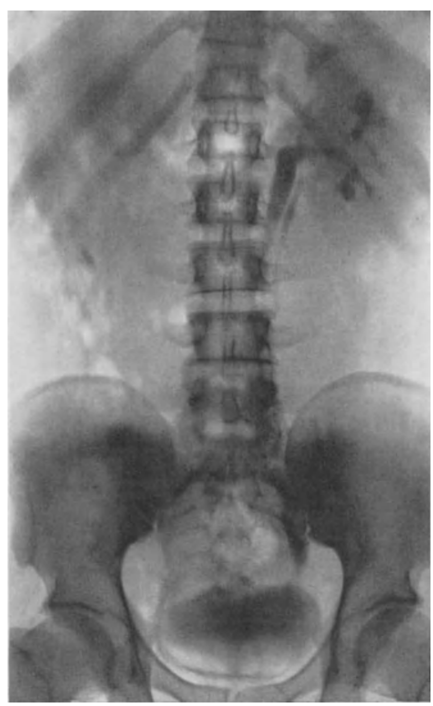


Fig. 110 a

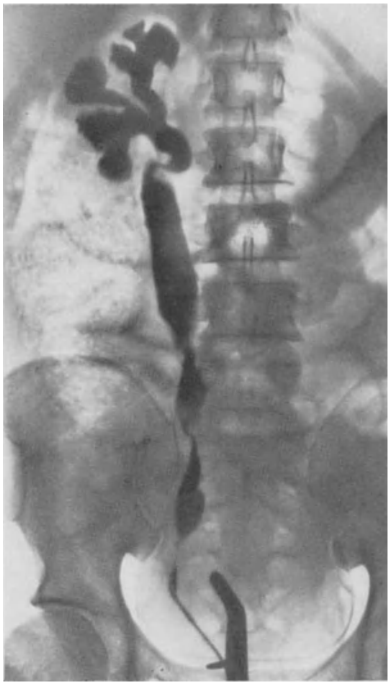


Fig. 110b

Fig. 110c

Fig. 109a—c. Caeco-colo-uretero-cystoplasty for tuberculosis. Man aged 29 years. (a) I.V.P. (30 mins). Small tuberculous bladder with bilateral reflux, diminished function and dilatation more marked on the right (glomerular filtration 18 ml/mn on the right and 58 ml/mn on the left). Uretero-cystoplasty utilising the caecum and ascending colon; the left ureter is anastomosed to the terminal ileum and the right to the divided end of the colon (February 1970). (b) I.V.P. 9 months after surgery; excellent recovery of the left kidney; the uretero-ileal anastomosis can be seen. (c) Retrograde cystogram demonstrating the graft and right ureteral reflux; there is no reflux on the left side which is protected by the ileo-caecal valve. Good progress three years after surgery. Considerable improvement in function of the left kidney although there is deterioration on the right side. Endogenous creatinine clearance: 105 ml/mn. Fixation of mercury (calibrated scintiscan)

	October 1969	January 1970	February 1970	May 1972
Right	12.2%	9.7%	Surgery	6.8%
Left	20.5%	17.7%		30.4%

Fig. 110a—c. Total right ileo-ureteroplasty for urogenital schistosomiasis. Native of Mali aged 36 years. Emergency removal of stone impacted in the navicular fossa. Hematuria; right loin pain; schistosomiasis treated. (a) I.V.P. (30 mins), September, 1968; vesical calcification; very low bifurcation of the left ureter; little function in the right kidney. (b) Right uretero-pyelogram: entire ureter affected by schistosomiasis, with varying degrees of stricture. (c) Total right ileo-ureteroplasty (November 1968) (scanning showed significant function in the right kidney) I.V.P. (30 mins) one month after surgery: good recovery of function on the right side and satisfactory dynamics

clinical signs (Fig. 108). We have seen this complication in 3 out of 43 partial ureteroplasties, two of them seven years after surgery. Despite further corrective surgery, the considerable aggravation of renal failure in one of these patients ended in death two years later. These stenoses must be discovered and treated surgically as soon as possible, The incidence of such strictures, to judge by the analogy of the much more extensive statistics of ileo-cutaneous ureterostomy, is far from negligable (6.7 per cent according to Bowles, Cordonnier and Parsons; 12.5 per cent according to Burnham and Farrer).

Bladder neck obstruction, whether due to prostatitis, to stricture of the urethra, to secondary sclerosis of the bladder or to prostatic hypertrophy in older patients, must not go unrecognised. The obstruction may be present before the replacement surgery, (and then must be treated in the first instance) but may also develop slowly and silently in subsequent years. In addition to the usual complications of such obstruction, there is a risk of transforming low pressure reflux into permanent renal damage. The condition must be diagnosed and treated at an early stage.

In summary, a follow up of more than fifteen years reveals that entero-ureteroplasty is an excellent operation with good long term results but there is no doubt that the results can be compromised by late complications. Patients with an entero-ureteroplasty must undergo regular urologic checks for the rest of their life and the minimum necessary is intravenous urography with renal function studies once a year.

Apart from neoplastic conditions and the major complications, results depend in essence on the state of renal function before surgery. A glomerular filtration rate of 15 ml/mn is probably the lowest reasonable limit compatible with a good result.

C. Indications

The indication for an enteroplasty of the ureter stems from the necessity of replacing a stenosed or destroyed ureter and the impossibility of using other simpler procedures with tissue taken from bladder, renal pelvis or ureter.

1. *Stenosing ureteritis* is one of the commonest indications for entero-ureteroplasty. The extent of the stenosis determines whether the replacement has to be partial or total. The principle conditions that cause stricture of the ureter are *tuberculosis* and *bilharzia* (Figs. 109 and 110). Both can produce ureteral lesions that may be limited or extensive and both can affect the bladder so that bladder flap replacement is impossible. Furthermore, both diseases may affect the lower urinary tract and compromise the result of surgery if unrecognised. In most cases entero-ureteroplasty for tuberculous or bilharzial lesions gives excellent results, both in terms of urinary dynamics and preservation of renal function. If necessary, the intestinal graft can serve at the same time for enlargement of the bladder. Tuberculous patients may have specific renal lesions that are already advanced or that may relapse, lesions that have often required the sacrifice of one kidney and that menace the function of the remaining kidney, whereas bilharzia affects the kidney only secondarily by mechanical obstruction and

a

b

Fig. 111 a—c. Re-establishment of continuity by entero-ureteroplasty after cutaneous ureterostomy for small tuberculous bladder. Man born in 1931. May 1949: Left nephrectomy (tuberculous pyonephrosis). July 1949: Right nephrostomy. January 1950: Right cutaneous ureterostomy (a). November 1953: Right ileo-ureteroplasty re-establishing continuity (b). May 1973: 20 years later: patient leading a normal life and working full time. Micturition normal. No urinary infection. Blood urea 50 mg per 100 ml; serum creatinine 1.8 mg per 100 ml; blood pressure 120/80. I.V.P. (c): satisfactory ureteral dynamics. Attacks of pain due to intermittent reflux

c

secondary infection. The long term prognosis is linked to the degree of renal insufficiency that precedes the surgery.

2. *Destructive lesions of the pelvic ureter*, accompanied by bladder disease, were formerly treated by definitive urinary diversion but should now be managed by entero-ureteroplasty.

Such conditions include:
– cutaneous ureterostomy for a small contracted tuberculous bladder, often with a single remaining kidney (Fig. 111).
– uretero-vaginal fistula associated with bladder lesions (vesico-uretero-vaginal fistula following a combination of radiation and surgery or a bladder subjected to cobalt radiation) that themselves may benefit from enteroplasty.
– ureteral lesions after radical hysterectomy or irradiation for pelvic cancer, or both combined, which, although not producing a fistula, are associated with irreversible destruction of the ureteral wall.

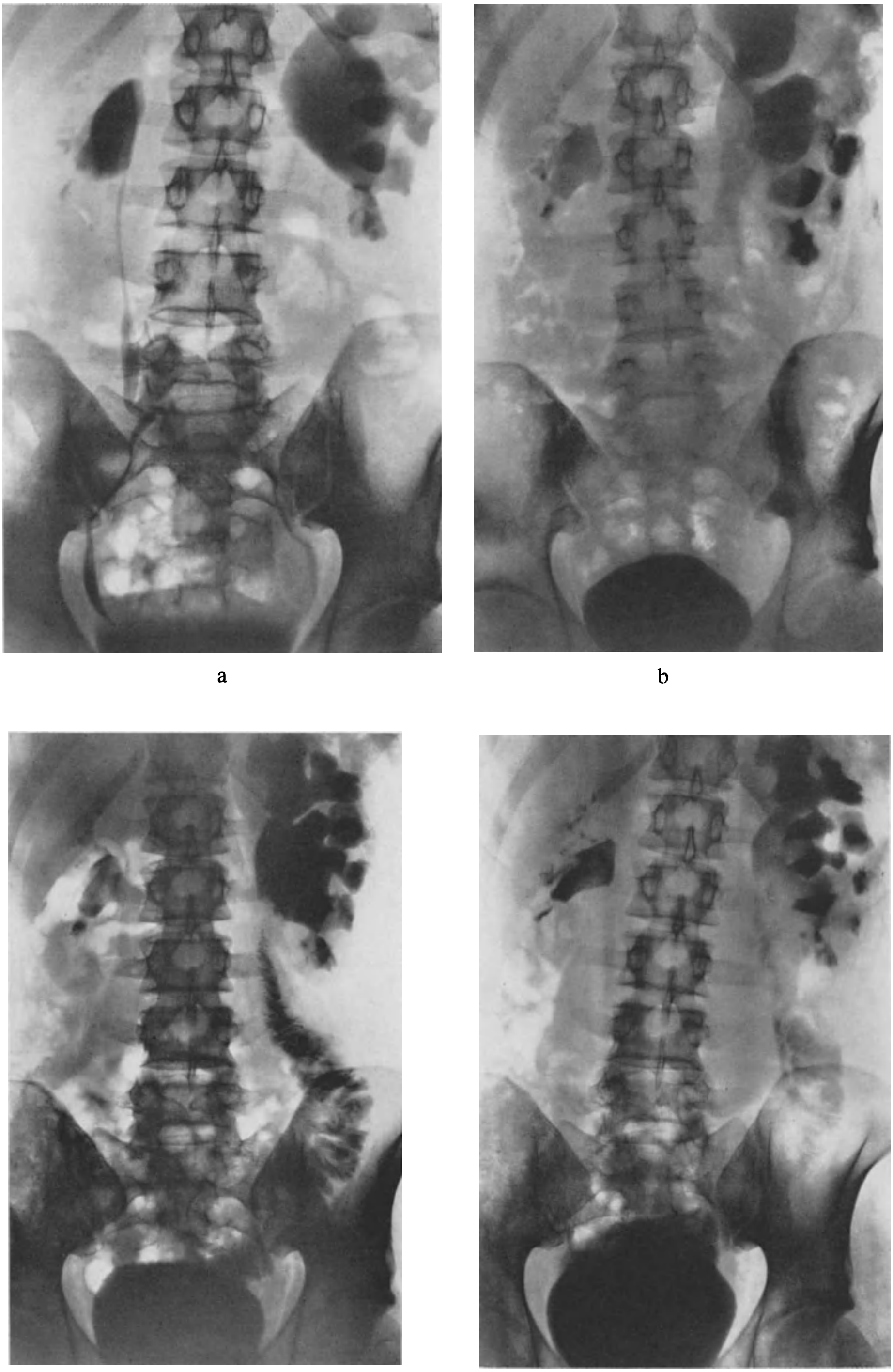
3. *Giant hydronephrosis* is one of the most precise current indications for total entero-ureteroplasty (Fig. 112). We suggested this procedure in 1957 because of the poor results of more limited surgery (such as pyeloplasty) in this particular type of hydronephrosis. We have used the operation in 15 cases with very satisfactory results. It would seem that the normal ureter has difficulty in evacuating the huge cavities of a kidney whose function may not be far from normal whereas the intestinal graft will ensure emptying at much lower pressures and has the additional advantage of permitting the passage of any stones that may form.

4. *Extensive peri-ureteritis* due to retroperitoneal fibrosis, or to the inclusion of the ureter in the fibrous tissue of a tuberculous abscess or even certain cases of secondary neoplastic peri-ureteritis, may require total entero-ureteroplasty. When the liberation of the ureter involves too much danger to its blood supply, it is better to use total replacement with an intestinal graft that can be placed within the peritoneal cavity as far as desired from the diseased zone.

5. *Tumors of the ureter*. When a benign papillary tumor of the ureter is too extensive to be treated by segmental resection or when wider removal is indicated because of the possible malignant nature of the lesion, when the kidney above is healthy, total replacement of the ureter by an intestinal graft is a simple and elegant solution, especially if there is reason to suspect that all is not well with the upper urinary tract on the other side.

6. *Congenital mega-ureter* is rarely an indication for total or partial replacement by an intestinal graft. In children, reconstruction of the uretero-vesical junction, sometimes associated with tailoring of the ureter, gives generally satisfactory results in moderate degrees of the disease. In the more advanced types, urinary diversion to the skin is indicated rather than reconstructive surgery because of the degree of renal damage. Adults present only segmental or minor

Fig. 112a–d. Total ileo-ureteroplasty for giant hydronephrosis. Man aged 19 years. (a) Giant left hydronephrosis; minimal obstruction at right pelvi-ureteral junction. (b) Admitted with ureteral fistula after resection of the left pelvi-ureteral junction. (c) Total left ileo-ureteroplasty. I.V.P. one month afteı surgery: good function of the graft. (d) I.V.P. one year later: less dilatation and improved evacuation of the left kidney



a b c d

Fig. 112 a—d

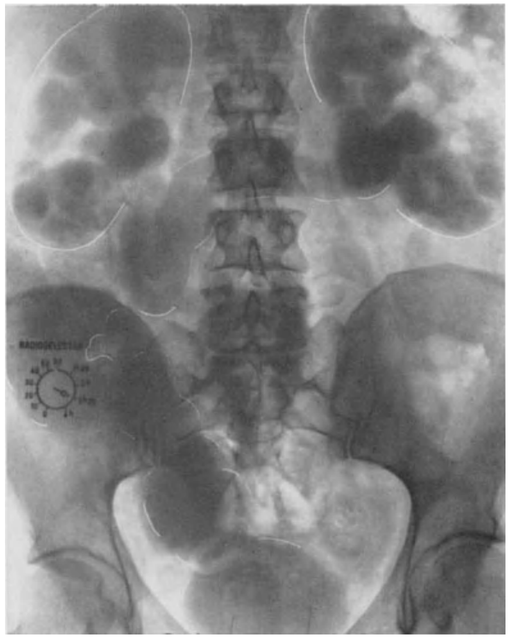


Fig. 113. Bilateral total ileo-ureteroplasty with a single loop arranged as a reversed 7. Woman aged 47 years. Bilateral reflux with enormous uretero-renal dilatation due to neglected bladder neck disease

varieties of the condition and ureteral replacement is rarely indicated for serious complications (infection or stone).

7. *Severe vesico-uretero-renal reflux* that has caused total failure of ureteral function may sometimes be an indication for total ureteral replacement, often bilateral, in an attempt to stabilize kidney function which is often seriously compromised (Fig. 113).

8. *The need to achieve renal drainage* may be another indication in cases of extensive sclerosis of the pelvis and upper ureter, whether following trauma, previous surgery, stone or infection. Local reconstruction may be completely impossible in such cases and it may then be necessary to drain the dilated kidney by some other means, especially if the kidney is solitary or functionally predominant; the ileal graft is then attached, via the convex border of the kidney, to one of the dilated calyces, or to all the calyces if intercalyceal communication is poor.

In certain cases of recurrent renal stone, GOODWIN has suggested draining the kidney by an ileal graft widely attached to the renal pelvis and lower calyx in the hope that any further calculi will be passed down to the bladder. This suggestion has been taken up by other urologists and we feel that the plan is well conceived.

D. Replacement of the Ureter by the Appendix

When a gap in the upper, lumbar ureter is too extensive to be bridged by mobilization of the kidney above and ureter below, the possible solutions to the problem are few:

- a tubed flap pyelo-ureteroplasty;
- renal autotransplantation;
- subtotal or total ileo-ureteroplasty.

The first solution requires a big dilated renal pelvis of good quality, rarely found in practice. The two other solutions imply surgery whose extent is out of proportion to the lesion to be treated. On the left side there is no alternative if the kidney must be preserved but on the right side there is an elegant and much simpler solution, replacement of the missing segment of ureter by the appendix. Obviously, this is possible only if the appendix is healthy and long enough and so the decision to use the appendix cannot be taken until the actual time of surgery, after resection of the ureter.

a) Operative Technique

The approach may be through a midline transperitoneal incision or by an extraperitoneal lumbo-iliac incision with subsequent opening of the lateral peritoneum below the caecum. The choice of approach depends in practice on the nature of the primary operation on the ureter. The base of the caecum and appendix are brought up to lie in contact with both divided ends of the ureter. If the appendix is found to be long enough, it is divided close to the caecum distal to a ligature of the stump, taking care to preserve the meso-appendix and appendicular aretry. The appendix is brought through the opening in the lateral peritoneum, to lie in the retroperitoneal space, and it is arranged with its tip pointing to the renal pelvis and the base downwards, so that it will lie isoperistaltically.

The tip of the appendix is then excised, adjusting the level of section to provide a length of appendix corresponding to the gap to be bridged; as much as possible of the tip should be removed because satisfactory anastomosis is much more difficult at the distal end of the appendix than at the base. Each end of the appendicular graft is anastomosed end-to-end to the divided ends of the ureter, using a single layer of interrupted sutures with fine chromic catgut (Fig. 114). A ureteral catheter, passed up through the ureter and the appendix to the renal pelvis, can emerge below, either as an iliac ureterostomy in-situ or through the bladder and urethra.

The opening in the lateral peritoneum is closed around the base of the caecum and the meso-appendix.

The incision in the abdominal wall is closed with drainage of the retroperitoneal space.

The ureteral catheter is removed between the 12th and 15th day.

Fig. 114. Replacement of the ureter by the appendix

a b

Fig. 115a and b. Bilateral ureteral replacement by appendix and ileum for stenosing peri-ureteritis caused by tuberculous spinal abscess. (a) Replacement on the left by total ileo-ureteroplasty (post-operative descending pyelogram). (b) Segmental replacement on the right by the appendix (I.V.P.); the arrows indicate the extent of ureteral replacement; there is some stenosis at the tip of the appendix but this allows easy passage of a catheter

b) Indications and Results

The indications for replacing the ureter by the appendix are few. We have used this procedure in treating surgical damage of the upper ureter, after ureterolysis in certain cases of retroperitoneal fibrosis when a long segment of upper ureter had to be resected because of defective blood supply, after resection of an atretic retro-caval segment of ureter and for nonspecific regional ureteritis or stricture following stone. The results in general have been good; the appendix has a calibre similar to that of the ureter and it seems to function adequately in maintaining urinary flow. The lymphoid tissue in the appendix has not posed any subsequent problems (Fig. 115).

The results are not always good and certain conditions would appear to be essential:

– the proximal anastomosis should be as far as possible from the tip of the appendix to avoid subsequent stenosis.

– the appendicular neo-ureter must lie in a healthy bed so that it is not subsequently compressed by fibrous peri-ureteritis.

– the appendix must not be used if the excretory tract above the graft is too atonic and dilated because the "resistance" of the appendicular neo-ureter seems to be too high in these cases and good tone of the excretory tract above appears to be an essential condition of success.

If appendicular replacement fails, all is not lost because the situation can be retrieved by ileoplasty.

VII. Urinary Diversion Utilising the Ureter

1. Cutaneous Ureterostomy

Diversion of the urine by bringing the ureter to the skin surface is always an operation of necessity, dictated by obstruction or destruction of the lower urinary tract or by disappearance or absence of sphincteric function.

In 1869, SIMON brought the ureter to the skin after accidental damage to the ureter during gynecologic surgery. HAYES AGNEW (1881) was the first to describe a technique of elective cutaneous ureterostomy. LE DENTU (1889) used the procedure in a case of anuria due to obstruction by neoplasm.

In the early version of the operation the ureter was brought to the surface in the loin and those who preferred external diversion to intestinal implantation of the ureter were divided between nephrostomy and lumbar ureterostomy. LEGUEU and PAPIN in 1920, after extensive animal and cadaver experiments, advocated iliac ureterostomy. With the iliac position of the opening, the ureterostomy and its collecting apparatus proved much easier to manage and the improvement in patient comfort (compared to lumbar ureterostomy) was such that the method was widely adopted.

There are three main types of cutaneous ureterostomy:

a) *Terminal cutaneous ureterostomy* necessitates complete division of the ureter. Although it is usually permanent, it is possible, if desired, to re-establish normal continuity by plastic replacement of the pelvic ureter with a tubed bladder flap or an intestinoplasty.

b) *Lateral cutaneous ureterostomy* does not interrupt the continuity of the ureter. If subsequent closure is indicated, it can be achieved with simple segmental ureterectomy and end-to-end anastomosis. Unfortunately, it can be applied only to wide, tortuous ureters.

c) *Ureterostomy in-situ* is a method of temporary diversion. When used as part of plastic and reparative surgery of the ureter it has a double role as a drain and as a splint.

A. Operative Technique

a) Terminal Iliac Cutaneous Ureterostomy

(Fig. 116) may be unilateral or bilateral.

If *unilateral*, the operation is performed through the usual lateral extraperitoneal approach to the ilio-pelvic ureter; the ureter is identified where it crosses the iliac vessels, dissected free as far as necessary and divided. In an upward direction it must be dissected sufficiently far so that the ureter can be brought to the skin at the site of election *in a gradual curve and without any tension.*

Bilateral operation can be performed through two separate lateral incisions or by a single midline suprapubic extraperitoneal approach. In the latter case, the peritoneum is widely reflected and retracted, giving excellent exposure of the para-vesical and iliac region on both sides and the ureters can easily be freed and divided. When the ureterostomy is performed at the end of some intra-peritoneal surgery (total cystectomy, for example) two lateral extraperitoneal tunnels must be made in which the ureters can run to the skin.

The correct performance of cutaneous ureterostomy is not as simple as it might seem and certain important technical principles must be observed scrupulously:

– The dissection must be made at a little distance from the ureter because if the ureter is stripped clean its blood supply will be imperilled and the result will be fistula due to necrosis or fibrous stenosis. The risk is even greater if the ureter has been radiated or strangled in inflammatory tissue. The ureter must be divided through a healthy segment.

– The extraperitoneal course of the ureter to its skin opening must follow a slow, gradual curve; if there is any sudden change in direction, especially between the normal line of the ureter and the beginning of the dissected zone, catheterization may be impossible and, again, stenosis or fistula may ensue. The ureter must run a smooth course without any kink.

– It is absolutely essential that the ureter reaches the skin easily, *without any traction.*

– *The skin opening* is a possible course of numerous complications and requires special attention.

The type of collecting apparatus must be considered before choosing the site of the cutaneous orifice. The position of the stoma should be marked carefully before surgery by careful trial fitting of the proposed apparatus to the patient, standing up as well as lying down, but obviously the site of the stoma may have to be adjusted according to the length of ureter available. In general the stoma should be at least 4 or 5 cms from the bony prominence of the anterior superior iliac spine. If there is to be a bilateral stoma, the skin openings must lie as symmetrically as possible.

A subject still under debate is the actual technique of the uretero-cutaneous anastomosis. The technique should be designed to prevent the most common complication, progressive stenosis.

Some surgeons bring the ureter out through the main incision, leaving 2 or 3 cm projecting, either free and splinted by a catheter or fixed to the skin with a few interrupted sutures. It is better to bring the ureter out through a separate opening somewhat medial to the main incision (Fig. 116). For this, a simple linear incision will not do; a disk must be excised taking the full thickness of the skin, leaving clean edges. The ureter can then be anastomosed edge-to-edge to the skin with unabsorbable suture material but if too many sutures are used there is a risk of necrosis of the ureteral edges. Alternatively, the ureter can be allowed to project, simply tacked by a stitch to the skin edge; subsequent partial

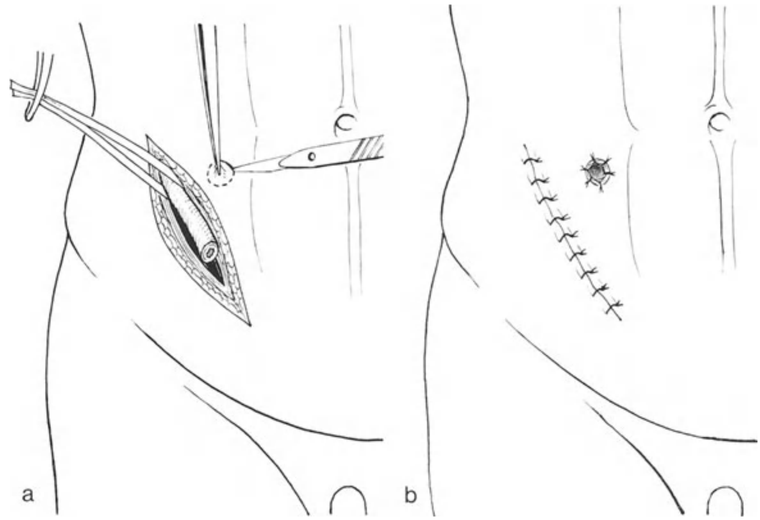


Fig. 116a and b. Terminal iliac cutaneous ureterostomy (lateral extraperitoneal approach). (a) Freeing the ureter and excision of disk of skin. (b) Operation completed

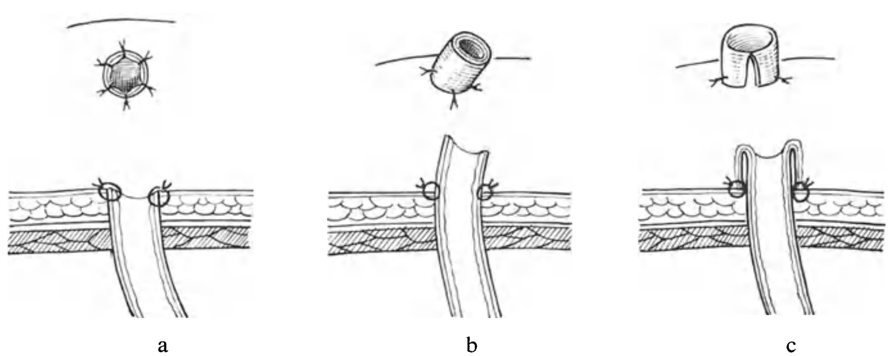


Fig. 117a—c. The various methods of suturing the ureter to the skin. (a) Direct. (b) With free stump. (c) Turned back as a cuff

necrosis and retraction form a small mucous bud. Yet another possibility is to turn back the tip of the ureter in a cuff but in this case it should be slit laterally to prevent obstruction by edema in the first few days (Fig. 117).

The need for a catheter depends on the calibre and the texture of the ureter and also the particular type of apparatus. If the ureteral calibre is normal, a catheter is necessary during the postoperative period, and sometimes permanently. No catheter is needed if the ureter is thickened and dilated.

Some authors have tried to improve the ureteral opening by fashioning a *skin spout*. The various techniques suggested make use of one or two skin flaps that surround the projecting part of the ureter like a sleeve. These flaps may be taken from the main incision (techniques of ABESHOUSE, SCHINAGEL and SEWELL,

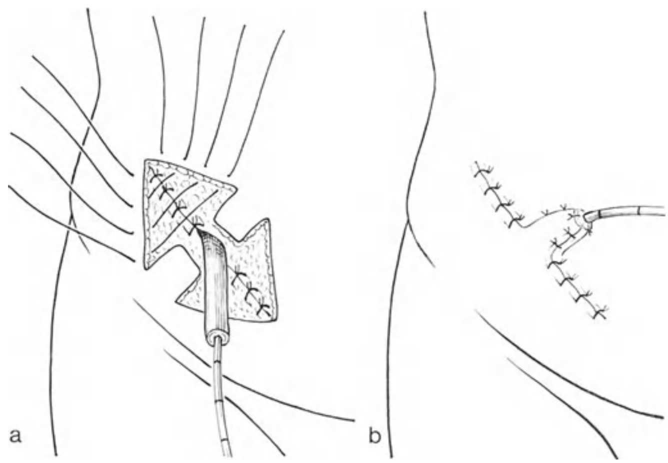


Fig. 118a and b. The skin opening—two lateral flaps (SHINAGEL). (a) Cutting the flaps. (b) Sutures

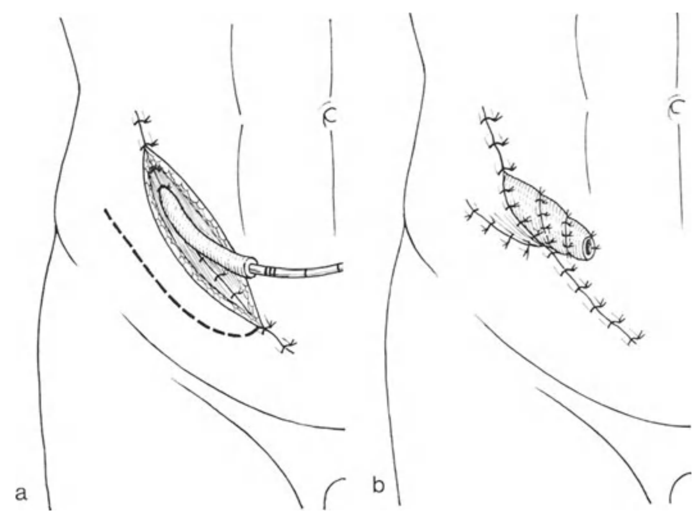


Fig. 119a and b. The skin opening—rolled flap (SHINAGEL and SEWELL). (a) Cutting the flap. (b) Suture

Figs. 118 and 119) or from a separate incision at the site of election (techniques of HUDSON, WOLAN and MAEDEN, and of FERGUSON; Fig. 120). FISH and STEVENSON construct the spout at a preliminary stage and place the ureter in it at a second stage (Fig. 121).

These techniques are more complex and add to the operative time and so may not be desirable in the relatively urgent circumstances in which this type of ureterostomy is performed. They require a length of ureter that is not always available. The long term results of this type of cutaneous ureterostomy are

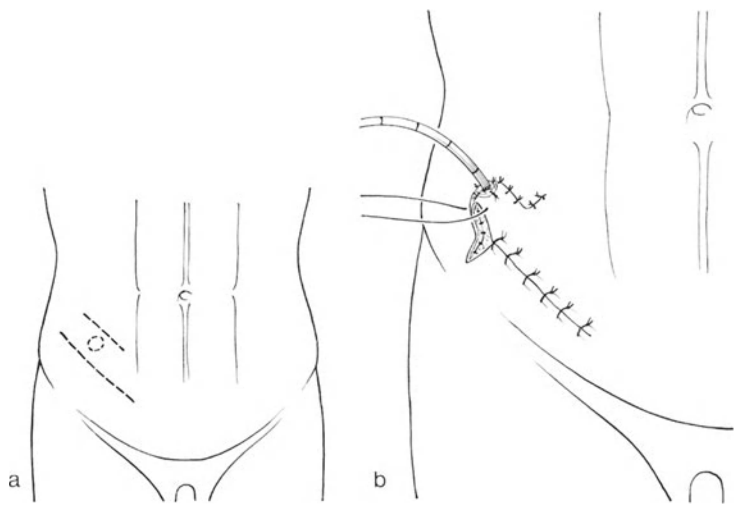


Fig. 120a and b. Cutaneous opening—folding the skin (FERGUSON). (a) The incisions. (b) Forming the opening

certainly better than with simple anastomosis of the ureter to the skin but the indications for this procedure have become quite rare and they overlap in part the indications for uretero-ileo-cutaneous diversion, although the length of ureter required is entirely different in the two procedures.

b) Lateral, or Loop Cutaneous Ureterostomy

This is an excellent method of temporary diversion. It is used principally in children because it is possible only with a dilated ureter (Fig. 122).

– The ureter is approached in the usual manner by a lateral extraperitoneal iliac incision. The mid part of the skin incision is bowed medially producing a skin flap, based laterally, which is dissected up with its subcutaneous fat in order to preserve its blood supply.

– The rest of the incision through the abdominal wall follows the usual pattern. The peritoneum is reflected and the ureter identified. The dilated ureter is dissected for a considerable distance up and down so that a ureteral loop can be exteriorized without any traction. Any kinks in the ureter are dissected free, preserving vascular attachments as far as possible; the track from the renal pelvis to the skin opening should be as direct as possible. But all traction must be avoided, the ureter must lie in a lax fashion so that its movements are not impeded.

– The main incision is partially closed, leaving an opening through which the exteriorized ureter passes easily. The skin flap is placed under the ureteral loop and sutured in two layers (subcutaneous and cutaneous) and then the rest of the incision is closed, leaving wide openings for the passage of the two limbs of the ureter.

Fig. 121a—c. Cutaneous opening—preformed tubed flap (FISH and STEVENSON). (a) The tubed flap. (b) Freeing the flap. (c) Attachment of the ureter

– Finally, the exteriorized ureter is opened by a transverse incision, after protecting the main wound with vaseline gauze.
– No catheter is necessary. The opening of this type of cutaneous ureterostomy is wide and has little tendency to stenosis.

The great advantage of this technique is that *re-establishment of normal continuity* is simple when obstruction has been relieved and the kidney has recovered its function. All that is necessary is, using the same approach, to resect the few cms of ureter close to the skin and to retract the peritoneum sufficiently to reconstitute the normal path by end-to-end ureteral anastomosis.

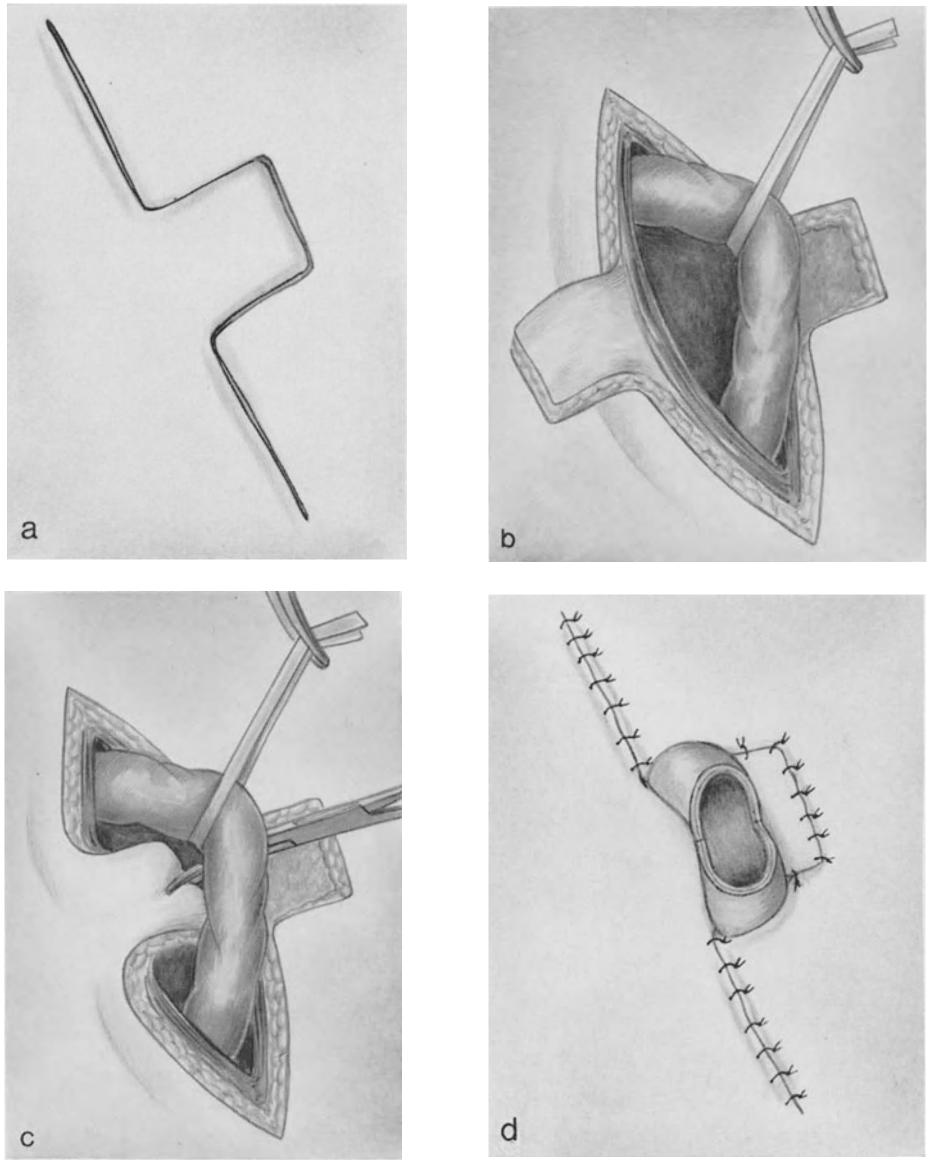


Fig. 122a—d. Lateral loop ureterostomy with a skin bridge. (a) Making the flap. (b) Exteriorization of the ureteral loop. (c) Drawing the skin bridge under the ureter. (d) Sutures completed—opening the ureter

The loop ureterostomy can remain as a permanent diversion if continued poor function in the kidney makes restorative surgery inadvisable. It is easy to fit a suitable collecting appliance and the stoma usually remains satisfactory. If it is thought desirable, this diversion can be transformed into a uretero-ileo-cutaneous ureterostomy.

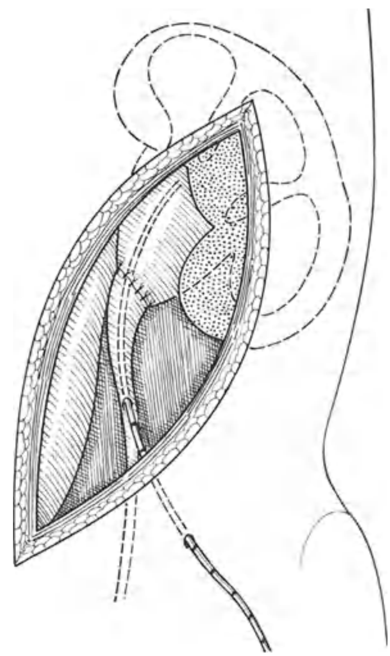


Fig. 123
Temporary lumbar ureterostomy in situ

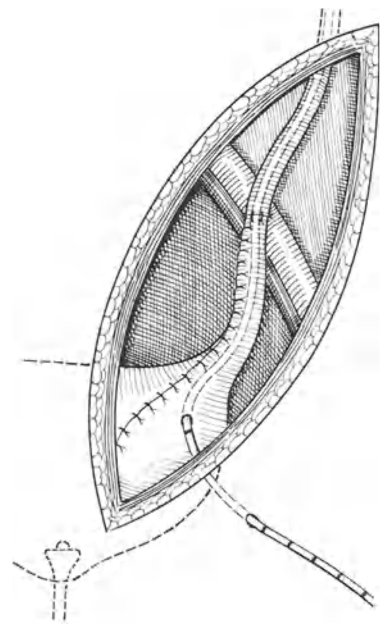


Fig. 124
Temporary transvesical ureterostomy in situ

c) Ureterostomy "in situ"

For some 12 years we have used this method of temporary urinary diversion, especially as part of plastic and reparative surgery of the urinary tract.

– *In surgery of the pyeloureteral junction or of the lumbo-iliac ureter*, the ureteral catheter can be placed through the surgical opening in the pelvis or ureter and its lower end can be brought out a few cms lower down through a small incision in the ureter; alternatively the ureter can be entered directly by the catheter on a mandrin. The lower end of the catheter is mounted on a Redon introducer and brought through the abdominal wall, taking care to avoid entering the peritoneal cavity and to *avoid any displacement of the ureter which must rest "in situ"*. When operating in the lumbar position it is well to verify the position of the catheter after straightening the table. The catheter is immediately fixed to the skin and its patency verified (Fig. 123).

– *In operations on the pelvic ureter*, the catheter is brought out above the surgical zone and it may or may not be associated with a second, splinting, ureteral catheter passed down into the bladder whose upper end emerges through a second small stab wound in the ureter close to the first catheter. This double ureterotomy can be avoided by using *trans-vesical ureterostomy in situ*. The upper end of the catheter is passed to the renal pelvis and the lower end passes down through the ureter into the bladder and is brought out through a small stab wound in the bladder wall and then passed through the abdominal wall. With this second technique, the bladder is drained by a urethral catheter (Fig. 124).

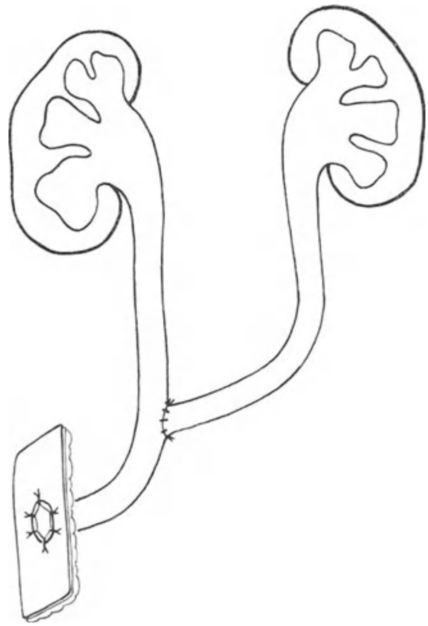


Fig. 125. Cutaneous transuretero-ureterostomy

This ureterostomy in situ provides good drainage of the kidney and can be effected through the incision made for the surgery on the urinary tract, without damage to the kidney (a disadvantage of nephrostomy) and without the need for prolonged rest in bed (a disadvantage of an indwelling ureteral catheter). This method should be used for temporary drainage, not more than two weeks, if ureteritis and peri-ureteritis are to be avoided. There may be a slight urinary leak for the first 24 hours after the catheter is removed. If more prolonged drainage is necessary it may be wise to replace the ureterostomy in situ by a ureteral catheter inserted endoscopically[1]. Complications are very rare if the position of the ureter is not disturbed. Stenosis and fistula have been seen only in a few cases in which the ureter was severely kinked.

d) Technical Modifications of Bilateral Cutaneous Ureterostomy

The disadvantages of a double stoma and the difficulties in fitting the two stomata with a suitable collecting appliance have led many surgeons to seek methods of producing a single opening for the two ureters, an undeniable advantage to the patient in terms of comfort. Apart from cases in which one kidney

[1] Translator's note: If a catheter of inert material is used, ureterostomy in situ can be maintained satisfactorily for many months or even longer and, provided that the ureterostomy catheter is brought out in a gradual curve, it is a very simple matter to change the catheter every few weeks (WALSH, A., 1967: Ureterostomy in situ. Brit. J. Urol., Vol. XXXIX, No. 6).

is removed and a cutaneous ureterostomy is performed on the other side, in one or two stages, there are three possible solutions:

1. The two ureters can be brought to the midline to emerge as a double-barrelled utererostomy (GOUVERNEUR and ROBERT, STEVENSON and SMITH, CENDRON).

2. It is also possible to anastomose one of the ureters to the other which is then brought out on the skin surface. This is uretero-ureterostomy or *cutaneous trans-uretero-ureterostomy* (Fig. 125). HODGES was one of the first to use this technique and it was then advocated by OBRANT as a method of upper urinary tract diversion and it has been used also by YOUNG and POWDER and by LATTIMER.

According to LATTIMER, this operation gives results very comparable to those of the Bricker operation, provided that it is used only when the ureters are dilated with thickened walls. It has the additional advantage over the Bricker procedure that the surgery is much simpler and less time consuming, with less operative shock, more in tune with the needs and indications for upper urinary tract diversion.

The end-to-side uretero-ureteral anastomosis (described in another chapter of this work) is generally very simple, at least in the ilio-pelvic region; the difficulties are somewhat greater if the anastomosis is made in the lumbo-iliac region. Complications are rare. In our experience, the fear of renal damage on the side of the recipient ureter, if complications such as stricture or fistula arise at the site of the anastomosis, is not justified unless the vitality of the ureteral wall has been affected by previous pelvic radiation. We regard this as a good operation if the anastomosis can be made in the ilio-pelvic region and if the ureteral wall is healthy. The operation should be avoided if so little ureter is available that the anastomosis would be high or if there has been previous radiation of the pelvic region (in the treatment of bladder cancer, for example).

3. Lastly, a segment of intestine can be used as the "intermediate vector". Either trans-ileal (Bricker operation) or trans-colic cutaneous ureterostomy is possible (see Section VII.3).

B. Critical Analysis of Cutaneous Utererostomy

a) Advantages

Cutaneous ureterostomy is the simplest method of external diversion. It has the reputation of being an easy, quick operation, producing little shock but in practice it is not always so straightforward. Obesity, peri-ureteritis, involvement of the ureter in masses of enlarged lymph nodes and adhesion to the iliac vessels can all make the operation very difficult or even impossible so that it has to be abandoned in favour of nephrostomy. In many cases, cutaneous ureterostomy is a salvage procedure; often the poor general condition of the patient (uremic, hyperkalemic, acidotic and infected), means that even as an isolated procedure the mortality is far from negligable.

Electrolyte disorders following relief of obstruction were formerly feared but should not present any problem if water and electrolyte balance is closely moni-

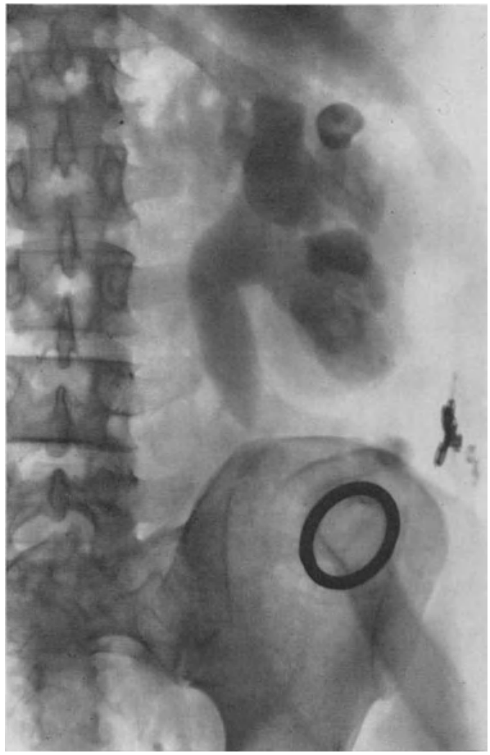


Fig. 126. Stenosis of the orifice of a cutaneous ureterostomy. 24 years after the diversion. (Man aged 57 years. Solitary kidney. Endogenous creatinine clearance: 30 ml/mn)

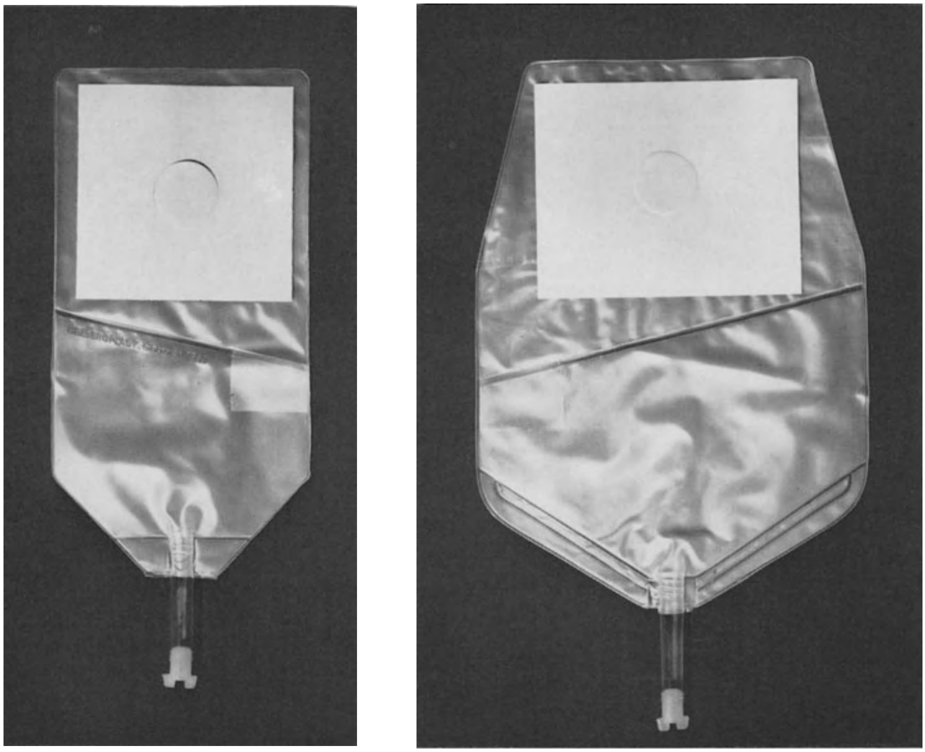
tored. Postoperative diuresis is, in fact, proof that the decision to operate was well founded.

b) Complications

Serious complications, that may rapidly prove fatal, can arise if there is any deficiency in technique, or defect in the vitality of the ureter: ischemic necrosis of a considerable length of ureter can follow if the ureter is dissected too cleanly, if there is an inadequate implantation of a ureter sutured under tension, if the track through the abdominal wall is too tight or if there is acute angulation. The inevitable result will be an *abscess or fistula* (depending on the efficiency of the drainage), loss of the ureter, or, at the very least, fibrous stricture of varying extent (Fig. 126). It is possible to re-operate, but under difficult circumstances, in an attempt to make a new opening higher up; this is not always possible and then the last resort is nephrostomy.

The later complications of cutaneous ureterostomy depend in part on the type of appliance that is used. There are two main types, with or without a ureteral catheter (Fig. 127).

A catheter passed up to the renal pelvis ensures total evacuation of the urine and, in theory, eliminates the possibility of retention; it also prevents the common



a b

Fig. 127a and b. Adhesive collecting devices for cutaneous ureterostomy. Two different models, right side (a) and left side (b). Note the anti-reflux arrangement and the system of evacuation

major complication, progressive stenosis of the skin orifice. A catheter is often used in adults for terminal ureterostomy but, to be efficient and free from complications, it requires considerable care.

The size of the catheter must be adapted to the calibre of the ureter. If the catheter is too small there may be an unpleasant leak. If the catheter is too large it may cause progressive ureteritis, a complication that is less common nowadays with the use of modern plastic materials (silastic). Catheters have a tendancy to get displaced; they must be fixed in the right position (verified, if necessary, by uretero-pyelography) and they must be changed frequently. The presence of a catheter creates a considerable risk of infection and close bacteriologic monitoring is essential. The state of renal function can be monitored by urography and by measurement of urea and creatinine clearances. In this way, a watch can be kept on the tolerance of the kidney for this particular mode of diversion: progressive dilatation, frequent infection and diminishing renal function are all indications for improving the drainage. Chronic or sub-acute pyelonephritis is often present before the diversion but, if the patient is carefully managed, one may hope to prevent further deterioration but there is always a risk that it may prove difficult to pass the catheter or false passages, peri-ureteral abscesses and fistulae may be produced.

c) Collecting Apparatus

For these reasons, wherever possible, we prefer to use a *collecting device without an indwelling catheter*. But here also there are problems, for example, in ensuring that the device is watertight and in the allergic skin reactions that may be produced by the adhesive materials. The skin opening must be watched with particular care and any stenosis treated by dilatation or preferably, if possible, by plastic surgery. A spout ureterostomy may be a good solution to the problems.

The advantages of this second type of device (without a catheter) are considerable. Ureteral peristalsis is preserved because there is no inlying foreign body; although difficult, total sterilization of the urine is possible. The exclusive use of adherent collecting devices for loop cutaneous ureterostomies in children gives excellent results and is an undeniable improvement in this mode of diversion although it is true to say that with megaureter stenosis of the skin opening is very rare.

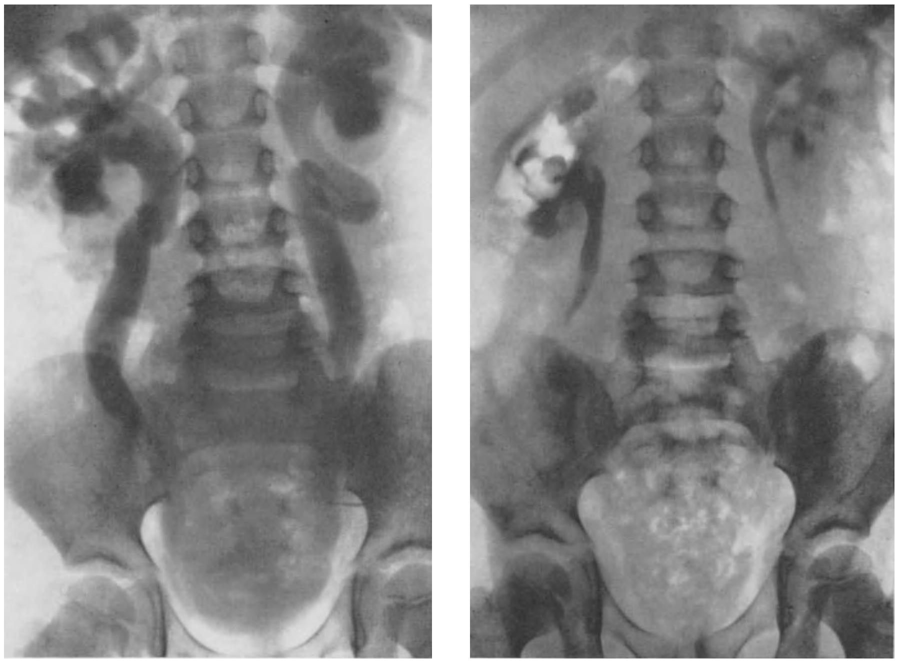
Experience has shown that the best cutaneous ureterostomies are produced with dilated and thickened ureters that remain well vascularized with good contractility; the archetype is the megaureter in children. The majority of complications occur with normal, healthy, thin-walled undilated ureters.

A further cause of secondary complications is the pre-operative radiation of pelvic tumors. There is no doubt that the radiation has a deleterious effect on the blood supply of the ureter and predisposes to ischemic necrosis after dissection of the ureter. In such cases there is a greatly increased risk of fistula, of stricture and of retraction of the skin opening.

d) Long Term Results

The long term results of definitive cutaneous ureterostomy are difficult to assess. The prognosis is closely linked with the condition that precipitated the diversion. There is a high mortality in the first few months after palliative ureterostomy to relieve upper urinary tract obstruction in advanced pelvic cancer and also in cases where the kidneys have been almost destroyed by a combination of infection and obstruction, in neglected tuberculous ureteritis, for example. Recurrent neoplasm is the common cause of death in the first years.

The important question is whether, after cure of the "causal" condition, a patient with a cutaneous ureterostomy has a normal expectation of life. An affirmative answer cannot be given although some of our patients with a cutaneous ureterostomy are surviving for 15 and 20 years without complications. The quality of the supervision and, above all, the collaboration of the patient are the essential factors in a good result. In a large number of cases, however, it seems impossible to avoid chronic pyelonephritis and in fact this disease is often present before surgery; there is a consequential risk of slow, progressive but irreversible destruction of kidney function. All depends on the rate of progression



a b

Fig. 128a and b. Bilateral cutaneous ureterostomy for congenital megaureters. Girl aged 7 years. Recurrent pyelonephritis; renal insufficiency (blood urea 90 mg per 100 ml; serum creatinine 1.6 mg per 100 ml; glomerular filtration 18 ml/mn). (a) I.V.P. (1 hour): bilateral congenital stenosis of uretero-vesical junction with atonic mega-ureters and thinned renal parenchyma. (b) I.V.P. (20 mins), six months after bilateral cutaneous ureterostomy: regression of the dilatation and improvement in function (serum creatinine 1.2 mg per 100 ml.) The pyelonephritic scars are more evident. Four months later it was possible to reimplant both ureters into the bladder with closure of the lateral loop ureterostomies

of the pyelonephritis. Deterioration may be accelerated by any acute infection such as may follow obstruction or displacement of an indwelling catheter, lavage with inadequate asepsis, stricture of the ureter or stone. There seems little doubt that renal destruction occurs more rapidly with an indwelling catheter. The increasing use of adhesive devices allows for better asepsis and more effective disinfection of the urine provided that these devices are used only when the ureter retains adequate propulsive function. Progress in anti-bacterial chemotherapy, the use of catheters made from non-reactive materials and a better organisation of the supervision of these patients should improve the long term results, but when there is a likelihood of prolonged survival the trans-intestinal ureterostomies should be considered.

In children, temporary lateral cutaneous loop ureterostomies, in cases of megaureter, often give excellent results: in a large number of cases the urine can be sterilized and there is a marked improvement in kidney function and even in the contractility and tonicity of the ureters (Fig. 128), opening new possibilities for reconstructive surgery.

C. Indications

Fortunately the progress in reconstructive and plastic surgery of the ureter and bladder in recent years has considerably reduced the indications for cutaneous ureterostomy.

Nevertheless, this is still an excellent salvage operation where renal failure is present; it can ensure survival for many years and may still be indicated at the present time in many cases.

1. *It may be used as a means of temporary diversion of the urine* where subsequent reconstruction of a properly functioning lower urinary tract is possible, for example as a first stage in the reconstructive surgery of bladder exstrophy or stenosis of the uretero-vesical junction, of the bladder neck or of the urethra (congenital or acquired), or before restoration of a vesical reservoir by enterocystoplasty. In such cases the skin diversion is often designed to protect the kidneys from the effects of obstruction or massive reflux, often with secondary infection. The diversion prevents further deterioration of kidney function and often makes it possible to sterilize the urine; this provides better conditions for the reconstructive surgery of the urinary tract below.

In children, the temporary loop ureterostomy performed on a dilated ureter, in cases of congenital stenosis of the uretero-vesical junction or congenital reflux or obstruction of the lower urinary tract, has two purposes: to protect or improve kidney function and also, hopefully, to allow recuperation of ureteral function, an essential factor in the success of any subsequent reconstructive surgery.

2. *Ureterostomy may also be definitive*; an operation of necessity, it saves the patient's life at the cost of a certain disability. In such cases the indication is the irremediable destruction of the lower urinary tract with no possibility of reconstructive surgery; it may also be indicated when the obstructive lesion is incurable (advanced malignant disease, for example). In the latter case cutaneous ureterostomy is no more than a salvage procedure performed in emergency to treat anuria due to mechanical obstruction of the pelvic ureters.

We regard this as the logical method of diversion when the nature, extent and advanced stage of the malignant pelvic lesion are such that the expectancy of life is short. Ureterostomy is the simplest method of urinary diversion and in such cases seems preferable to nephrostomy.

On the other hand, when survival for more than 18 months seems likely, and especially if the underlying lesion is not neoplastic, it may be preferable to use some other method of upper tract diversion, such as uretero-sigmoidostomy or trans-intestinal cutaneous ureterostomy.

The question as to whether the skin diversion should be unilateral or bilateral arises particularly when one of the kidneys is destroyed or when there is a considerable difference in function between the two kidneys. Apart from special indications dictated by the etiology, it seems to us that in these cases it is preferable to perform unilateral cutaneous ureterostomy on the side of the good or better kidney and to remove the other kidney, thus reducing the disability[2].

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[2] Translator's note: An even simpler procedure is ligature of the ureter on the "bad" side, a procedure that surprisingly seldom gives rise to any complications.

2. Ureterosigmoidostomy

(Intestinal Ureterostomy, Implantation of Ureters into Intact Colon)

The main object of diverting the urine to the intact intestine is to spare the patient the disability of an external cutaneous diversion. Uretero-sigmoidostomy in effect replaces the bladder sphincter with the anal sphincter which is capable of ensuring both fecal and urinary continence.

The operation was first performed in 1851 by SIMON for bladder exstrophy but the first clinical success is credited to CHAPUT in 1892 for the treatment of a uretero-vaginal fistula.

Initially, the operation had an appalling mortality [55 per cent in PAPIN'S (1925) report] but subsequently became standard surgical practice thanks to the work of COFFEY.

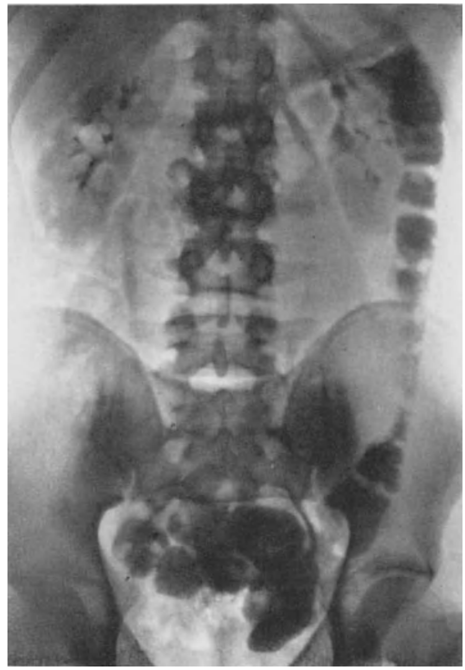
The earliest long term results showed, however, that the prognosis after COFFEY'S operation was not good, with a mortality varying from 25 to 75 per cent in the five years following uretero-colic implantation. This mortality was due to deterioration of renal function caused by ascending infection, either due to reflux or to stenosis of the anastomoses, further aggravated by water and electrolyte disorders with hyperchloremic acidosis, potassium loss and also disorders of phosphorus and calcium metabolism. This severe morbidity gradually brought the operation of ureterosigmoidostomy into disrepute, especially as other procedures such as entero-cystoplasty, trans-intestinal cutaneous ureterostomy and the formation of a rectal bladder presented more attractive therapeutic possibilities.

This disenchantment with ureterosigmoidostomy is not entirely justified at the present time. Quite apart from the technical improvements designed to prevent stenosis at the site of anastomosis, or reflux of feces or gas up the ureters, considerable advances have been made in the past 20 years. The development of antibiotics and synthetic antibacterial agents has provided an effective means of treating acute attacks of pyelonephritis. Low grade chronic pyelonephritis with slowly progressive deterioration of renal function is more difficult to control but a certain degree of prevention is possible with intermittent but regular courses of urinary and intestinal antiseptics, too often neglected by the physician or by the patient.

Starting with the work of FERRIS and ODEL in 1950, the mechanism of complications due to reabsorption of certain constituents of the urine from the intestine has been fully elucidated, including the dangers of hyperchloremic acidosis and potassium depletion, complications that can develop very suddenly. It is possible to detect these disorders at an early stage by routine biochemical studies and the complications can be prevented or managed by continuous treatment with alkali. The biochemical disturbances do not present a serious problem as long as renal function is good.

The patient should be closely supervised with intravenous urography (and, if necessary, with the renal scintiscan). In this way, any problems due to early or late stenosis of the anastomosis (due to inflammatory granuloma or fibrosis) or to reflux should be detected at a very early stage so that these purely mechanical disorders can be corrected before there is any serious renal damage.

a



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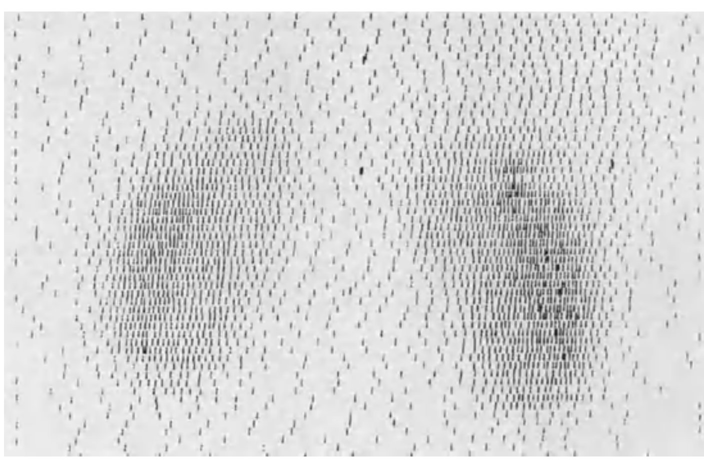


c

Fig. 129a—c. Uretero-sigmoidostomy for incontinent epispadias. 1962: Bilateral implantation of ureters into the colon at the age of 9 years. 1964: Stenosis of the right uretero-colic anastomosis (I.V.P., 50 mins) (a). Surgical reconstruction of the anastomosis. 1970: Renal scintiscan (c). 1973: Patient very well. Perfect continence. No attacks of pyelonephritis. I.V.P. (60 mins) (b): kidneys excellent, no upper tract dilatation. Serum creatinine: 1.0 mg per 100 ml; HCO_3: 25 mEq; K: 4 mEq; Cl: 105 mEq

Split renal function studies are now possible by measuring the renal fixation of radio-active mercury (RAYNAUD).

All these advances provide good reason for optimistic reappraisal of uretero-sigmoidostomy in certain conditions (Fig. 129) although it should not be considered nowadays as an absolutely definitive mode of diversion.

Although no technique can provide absolute assurance for the future of the kidney after uretero-intestinal diversion, some important principles must be stated: to propose this operation for an elderly patient whose anal sphincter is inadequate to ensure perfect continence is to go against the very principle of the procedure and exposes the patient to a far greater disability than that of external diversion.

Where the pelves and ureters are dilated, ureterosigmoidostomy runs the risk of reflux and attacks of acute pyelonephritis; pyonephrosis may develop very rapidly, or even Gram-negative septicemia.

If kidney function is poor, implantation of the ureters into the colon runs the risk of serious electrolyte disorders and will almost certainly precipitate progressive renal failure.

Normal ureters capable of withstanding reflux of intestinal contents, an anal sphincter capable of perfect control (often better assessed by the test of induced diarrhoea than by electromyography) and good kidney function are the indispensable conditions for successful ureterosigmoidostomy and, given these conditions, the operation is a perfectly justifiable method of urinary diversion.

A. The Various Techniques of Uretero-Colic Anastomosis

The various techniques suggested have three aims:

– to diminish, if possible, intestinal reabsorption of urine constituents.

– to prevent stenosis of the uretero-intestinal anastomosis.

– to prevent reflux, an aim somewhat opposed to the previous one, but nonetheless a very desirable aim when it is remembered that intracolic pressure may reach 180 cm of water during efforts at defecation whereas the pressure in the lower ureter during contraction is only 50 to 70 cm of water and the resting ureteral pressure is not more than 10 cm.

Miminizing intestinal reabsorption and the consequent humoral complications depends on the choice of *the part of the intestine into which the ureters are implanted.* Ureters have been implanted into every part of the colon, even into the caecum, but whenever the implantation is above the sigmoid colon the results are bad. It is now well known that the pelvic colon is the location of choice, tolerating contact with urine and technically the easiest and surest site for unilateral or bilateral ureteral implantation. Implantation into the anterior wall of the upper rectum below the peritoneal reflection is technically more difficult but under certain circumstances it can also give good results.

Low implantation does not, in fact, limit the contact of urine to the sigmoid colon and rectum. Colic activity is such that the urine always occupies the whole of the left colon and frequently flows back as far as the caecum and hence it is essential that the urine be evacuated every three or four hours.

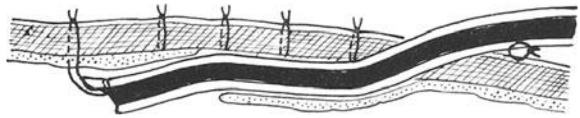


Fig. 130. Plan of the Coffey 1 operation (section)

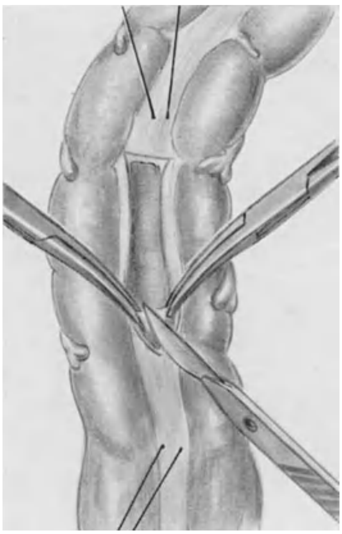


Fig. 131

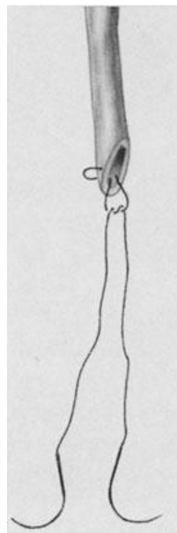


Fig. 132

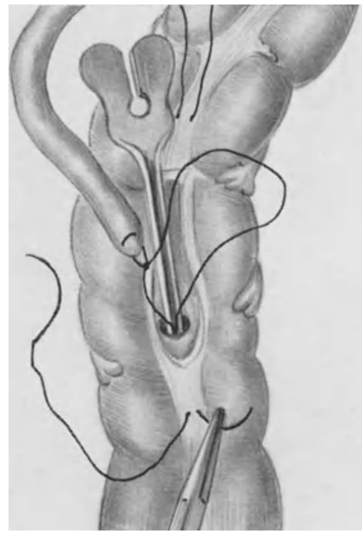


Fig. 133

Fig. 131. Coffey 1 operation. Incision of the muscle of the colon, then of the mucosa in the lower part

Fig. 132. Coffey 1 operation (continued). Needles passed through the tip of the ureter

Fig. 133. Coffey 1 operation (continued). Passage of ureteral fixation sutures with the aid of a grooved sound

The method of attaching the ureter to the colon has been the most debated technical point since the operation was first developed. Even before the time of COFFEY, there was disagreement between the advocates of direct uretero-colic implantation (CHAPUT), whether or not completed by "burying" the ureter in the wall of the colon, and the advocates of invagination of the end of the ureter into the colon (FRANKLIN and MARTIN).

The need to avoid stenosis, and reflux if possible, explains the number of techniques devised for the uretero-colic anastomosis.

At the present time there are three principal methods that are widely employed, each with numerous modifications by individual surgeons:

a) Tubular Implantation with Submucosal Tunnel: the Coffey Procedure

has been and still is the technique most widely used (Fig. 130).

The sero-muscular layer of the colon is incised through one of the longitudinal bands for about 3 cm; the intact mucosa is separated from the edges of the

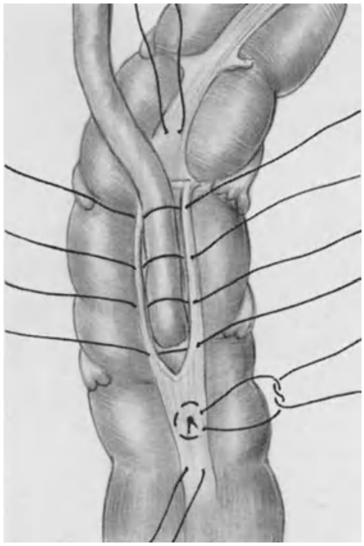


Fig. 134

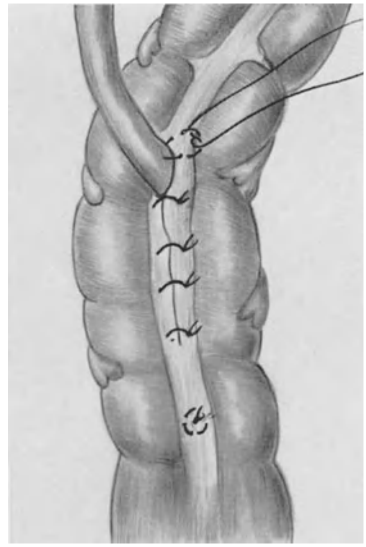


Fig. 135

Fig. 134. Coffey 1 operation (continued). Starting to bury the ureter—the anchoring stitch is tied

Fig. 135. Coffey 1 operation (concluded). The suture of the muscle layer is completed—the anchoring stitch is buried

incision by gentle blunt dissection. At the lower end of this incision, an opening is made in the mucosa, as small as possible, for the insertion of the ureter (Fig. 131). The end of the ureter is cut obliquely and then a loosely tied catgut suture, with a curved needle mounted at each end, is placed through the tip of the ureter (Fig. 132). A grooved sound introduced into the lumen of the colon through the mucosal opening guides the passage of the two needles into the lumen and out again through the wall of the colon, 1.5 to 2 cm lower down, a few mms apart (Fig. 133). The ureter is drawn into the intestinal lumen by traction on the two ends of the suture which are then tied together, fixing the tip of the ureter to the wall of the colon. This suture should be buried by a purse-string stitch of unabsorbable material, or fine chromic catgut, to prevent fistula along the course of the transfixing suture (Fig. 134). The muscle layer is then sutured edge-to-edge with an unabsorbable material, burying the ureter in a submucosal tunnel. It is essential that the ureter lies easily in its tunnel, without traction or compression, so that there is not the slightest obstruction (Fig. 135).

Transverse section of the longitudinal band at the upper part of the incision (Millin) prevents compression at the point of entry to the tunnel. Lastly, it is important to ensure that there is no angulation of the ureter in its course to the colon.

The modifications of this (Coffey I) procedure are many.

– Hinman left the ureter hanging free in the lumen of the colon with no anchorage of its tip. He ligatured the tip of the ureter and made a lateral opening above (Fig. 136).

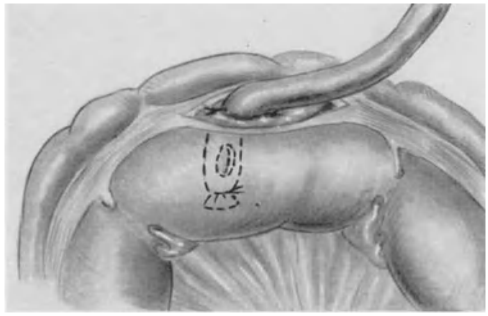


Fig. 136. Hinman modification

Fig. 137 Fig. 138

Fig. 137. Stiles technique

Fig. 138. Chaput technique (direct implantation)

– Anastomosis over a ureteral catheter (Coffey II) brought out through the anus is now little used, although still favoured by some urologists. This procedure is especially valuable in cases of renal insufficiency because the catheters ensure immediate drainage of the kidneys and prevent serious electrolyte disorders in the first postoperative days; the catheters are removed about the eight day. In fact, it is very doubtful that ureterosigmoidostomy should be used in these cases of severe renal insufficiency; it is better to adopt some other mode of diversion.

– The procedure known as Coffey III, in which the ureter is tied before being passed into the lumen of the intestine, depends on necrosis of the end of the ureter to restore continuity. This procedure has been abandoned even by its author.

– *Direct tubular implantation without a tunnel* (the old technique of Stiles, with modifications by Brunschwig and Godard) has all the disadvantages and none of the advantages of the Coffey technique and is no longer used (Figs. 137 and 138).

b) Uretero-Colic Implantation by Direct End-to-Side Anastomosis

The principal risk in Coffey's technique is stenosis of the ureteral opening due to inflammatory granuloma at the point of contact with septic intestinal

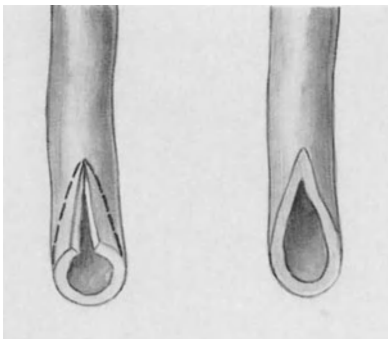


Fig. 139

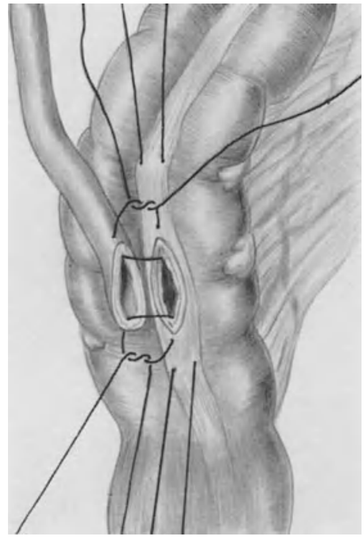


Fig. 140

Fig. 139. Nesbit technique. Preparation of the ureter

Fig. 140. Nesbit technique (continued). Coaption sutures

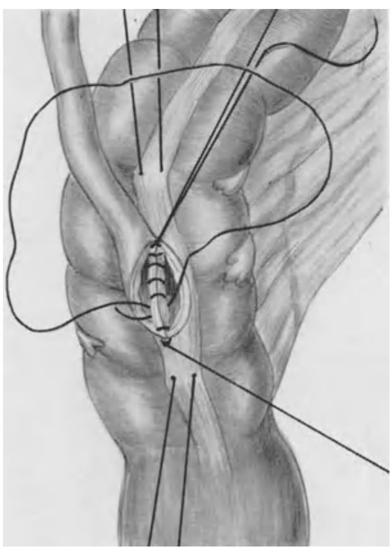


Fig. 141

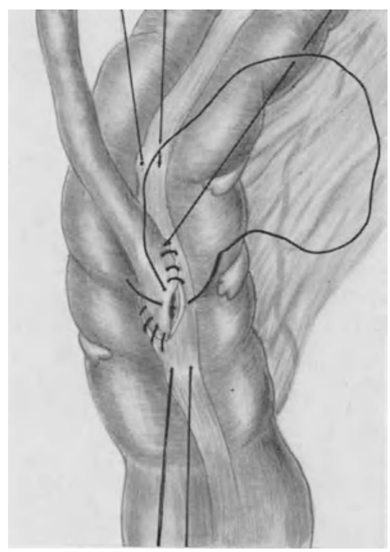


Fig. 142

Fig. 141. Nesbit technique (continued). Suture of posterior layer

Fig. 142. Nesbit technique (concluded). Suture of anterior layer

contents, to subacute ureteritis or to progressive sclerosis in the submucous tunnel. On the grounds that reflux is less harmful to the kidney than stenosis, a certain number of authors have suggested, following CHAPUT, direct, end-to-side uretero-colic anastomosis.

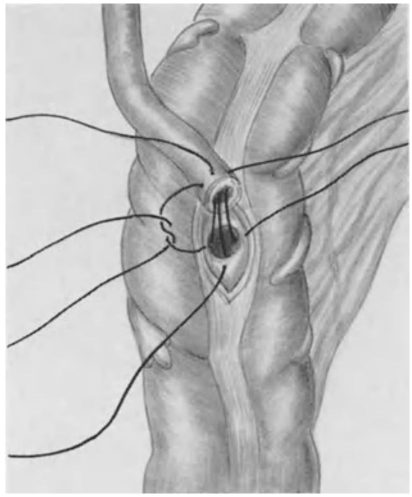


Fig. 143. Cordonnier technique. First stage

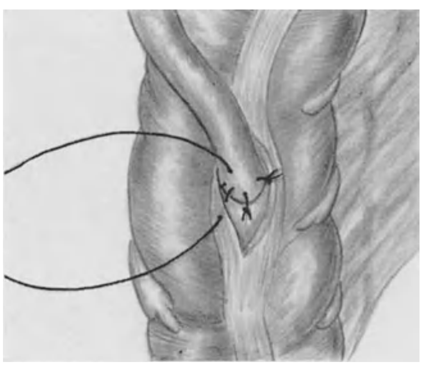


Fig. 144

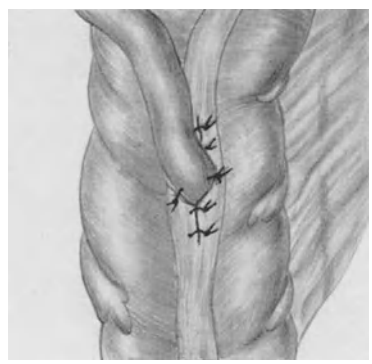


Fig. 145

Fig. 144. Cordonnier technique (continued). Second stage

Fig. 145. Cordonnier technique (concluded). Anastomosis completed

– NESBIT spatulated the end of the ureter with two lateral slits which were then anastomosed in a single layer to the edges of the incision in the colon (Figs. 139 to 142).

– CORDONNIER made a circular anastomosis in two layers, using interrupted sutures. The first layer was muco-ureteral and the second sero-adventitial (Figs. 143 to 145).

– HINMAN used two layers, the first with two continuous muco-mucous sutures and the second sero-adventitial with interrupted sutures.

– GOODWIN preferred direct edge-to-edge anastomosis from within the lumen of the colon, exposed by a longitudinal incision in the wall of the colon. He placed a few interrupted sero-adventitial sutures on the outside of the colon (Fig. 146).

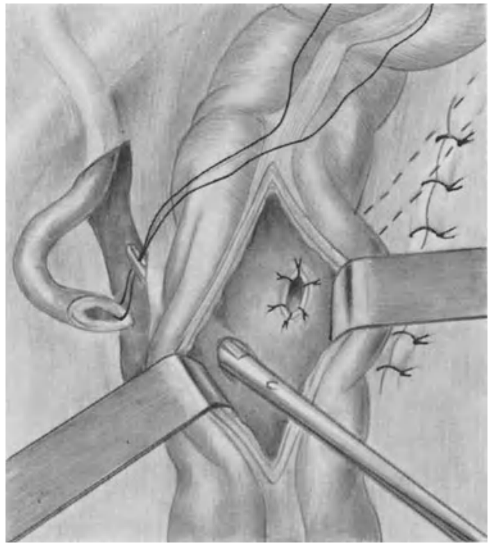


Fig. 146. Goodwin technique (trans-colic approach with direct anastomosis of ureters)

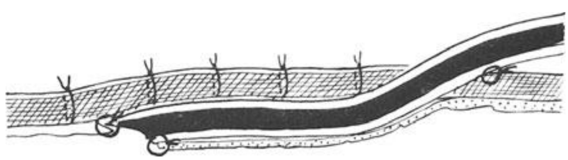


Fig. 147. Petit-Leadbetter technique (plan in section)

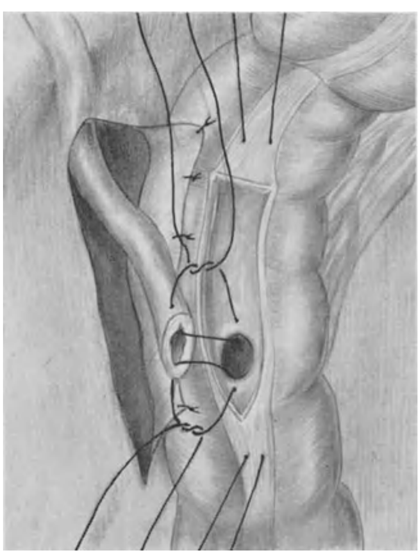


Fig. 148

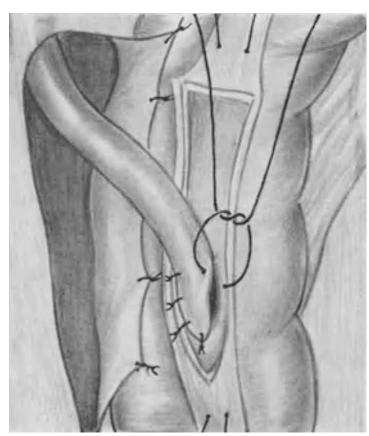


Fig. 149

Fig. 148. Petit-Leadbetter technique (continued). The first muco-ureteral sutures

Fig. 149. Petit-Leadbetter technique (continued). Lateral muco-ureteral suture

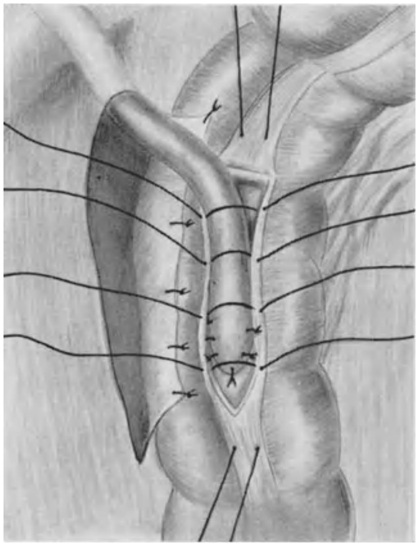


Fig. 150

Fig. 151

Fig. 150. Petit-Leadbetter technique (continued). Ureteral suture completed—suture of colonic muscle in progress

Fig. 151. Petit-Leadbetter technique (concluded). Final appearance of the sub-mucous tunnel. Peritonealization is in progress

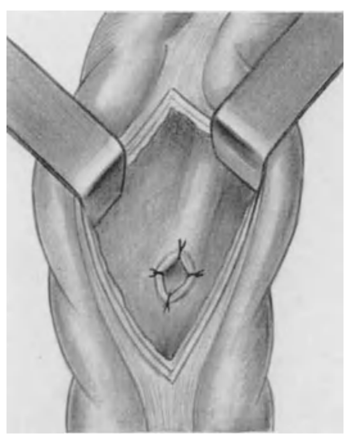


Fig. 152. Modification of Goodwin technique with anti-reflux tunnel (BITKER)

c) Direct End-to-Side Implantation with a Tunnel

In the hope of preventing both stenosis and reflux, PETIT and also LEADBETTER combined direct end-to-side anastomosis with a submucous tunnel (Fig. 147).

As in Coffey's technique, this procedure begins with incision of the sero-muscular layer of the colon, separation of the mucosa and a small opening in the mucosa at the lower end of the incision. The end of the ureter is cut obliquely

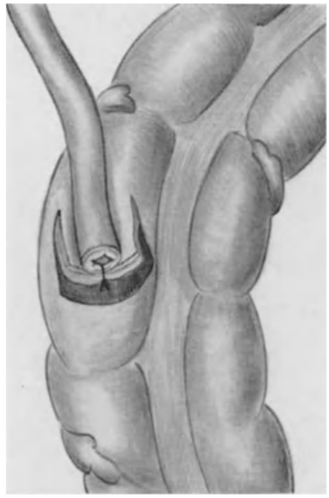


Fig. 153. Mathisen technique. The flap—initial suture

Fig. 154

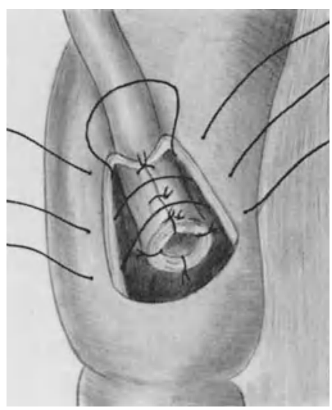


Fig. 155

Fig. 156

Fig. 154. Mathisen technique (continued). Suturing the ureteral cuff

Fig. 155. Mathisen technique (concluded). Closing the opening in the colon

Fig. 156. Mathisen technique. Seen in section

and then anastomosed edge-to-edge to the mucosal opening with interrupted sutures of fine chromic catgut (Figs. 148 and 149). The sero-muscular layer is then sutured over the ureter with interrupted unabsorbable sutures (Fig. 150). Here again it is essential that there is no traction, compression or stricture of the conduit. The ureter must lie loosely in its submucous bed (Fig. 151). If these conditions are fulfilled, the use of a ureteral catheter (WEYRAUCH) seems unnecessary.

BITKER makes a true submucous tunnel by dissection and draws the ureter through this before performing the anastomosis. A similar submucous tunnel can be created in Goodwin's trans-colic approach (Fig. 152).

d) Mathisen Technique

In Mathisen's technique a flap of muscle is fashioned from the wall of the colon and this surrounds the end of the ureter which projects into the intestinal lumen (Figs. 153 to 156).

The purpose of this projection is to prevent colo-ureteral reflux without increasing the risk of stenosis.

B. Critical Analysis of Uretero-Colic Implantation Techniques

All of these techniques just described have their advocates and their detractors.

– The *Coffey procedure*, and, in general, every procedure that leaves a segment of ureter free in the intestinal lumen, is frequently accused of producing a significant number of stenoses. It has been shown repeatedly at re-operation and verified histologically that an inflammatory granuloma develops on the tip of the ureter; secondary scarring produces stricture. In fact, we do not think that this complication is very common and one of us has had such satisfactory results with the Coffey I technique over a period of more than 20 years that we are happy to continue using it.

– The direct anastomosis is certainly more anatomic but it is more likely to allow reflux. However, Goodwin's technique has many advocates, especially among urologists who utilize uretero-colic implantation after total cystectomy for cancer (DUCASSOU, LANGE, STEG, HOHENFELLNER). These workers regard the technique as very safe and productive of excellent results, at least in the short term.

– *Direct anastomosis with an anti-reflux submucous tunnel* (PETIT-LEADBETTER) is in our opinion a better technique when the nature of the disease is such that long survival may be expected. We have had excellent long term results with this technique of urinary diversion for bladder exstrophy in a series of 18 children (CHATELAIN, BOUREAU and KÜSS).

When the ureter is healthy, contractile and uninfected to begin with, the upper urinary tract seem to remain intact for very many years. In a series of 29 children operated for bladder exstrophy (54 ureters), PETIT and CENDRON had 12 bad and only 14 good results out of 26 ureters reimplanted according to the technique of HINMAN; of the 28 remaining ureters, reimplanted according to the Petit technique, 24 were still normal 10 years after surgery.

The Mathisen technique, of which we have no personal experience, seems capable of giving similarly excellent results. to judge by a series of 19 implantations in children by COOLSAET and BAKKER. These authors have confirmed the constant absence of reflux by ascending "rectography" under micturition pressure and they have no had case of stenosis.

In fact, none of these techniques is an absolute guarantee that there will not be some degree of pyelonephritis but each can give good long term results provided that the surgery is very meticulous. Perfect technique is the essential factor in the success of uretero-colic anastomosis. If the anastomosis is performed properly, in good conditions, there should be no immediate complications such as atony, fistula, local infection or obstruction, and there is every hope of prolonged, excellent function of the kidney above.

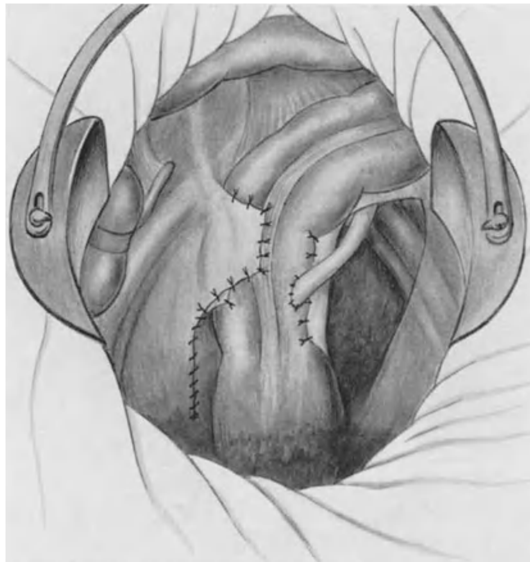


Fig. 157. Peritonealization of uretero-sigmoidostomies. Posterior (left) layer and anterior layer (right)

Collected mass statistics of ureterosigmoidostomy have little value and the only figures that count are those from a single surgeon able to judge the perfection of his technique.

C. Surgical Tactics

The intestine must be fully prepared for some days before any ureterocolostomy so that the anastomosis can be made with the colon empty and as nearly sterile as possible.

The lateral extraperitoneal approach is still preferred by some urologists as being less shocking to an ill patient and because it does not run the risk of intraperitoneal complications. Although this technique is easy on the left side, bilateral ureterocolic implantation may be difficult or impossible if the pelvic colon is short.

The transperitoneal route is the approach of choice, both for the actual anastomosis and because it allows proper exploration of the pelvis and abdomen. As with all such anastomoses, there must be no pull on the ureter and the ureter must reach the colon without any angulation or torsion. This part of the colon must be fixed and the anastomosis should be covered with peritoneum; both these objectives can be achieved by suturing to the colon the two edges of the incision in the posterior peritoneum used to display the ureter, one edge behind the anastomosis and one in front (Fig. 157).

A drain in contact with the anastomosis and drainage of the peritoneal cavity are undesirable. A rectal cather will show whether or not the anastomosis is patent and will prevent early stagnation of urine. It may happen that no urine appears for 24 to 36 hours because of transient obstruction of the anastomosis by edema, but this transient obstruction does not prejudice the outcome.

Bilateral ureterosigmoidostomy is usual and both sides should be done at the same time. The two ureters can be brought together and double-barrelled so that there is only a single implantation but we prefer to implant them separately.

Should the anastomosis be "safeguarded" by an indwelling ureteral catheter, as once proposed by COFFEY, or by ureterostomy in situ or nephrostomy above the anastomosis? Without exception, the use of a ureteral catheter has been abandoned, and rightly so.

Nephrostomy seems pointless if the anastomosis is made with a ureter of good quality, a condition that, as we have seen, is a necessary prerequisite of this type of diversion. It may be useful in some cases as a first stage in an attempt to judge the reversibility of any dilatation. Nephrostomy may also be indicated in the postoperative period if edema or early stenosis occludes the anastomosis. This gives time for regression of the edema and persistence of the obstruction can be studied with an antegrade pyelogram. In such cases it may be necessary to reoperate to make a new anastomosis.

D. Postoperative Course – Complications

In most cases the postoperative course is very simple but complications are not uncommon. In a survey that we made in 1970, including 1 385 patients, the nature and incidence of immediate complications were as follows:

Urinary and fecal fistula	13 per cent
Immediate acute pyelonephritis	9 per cent
Gram-negative septicemia	7 per cent
Wound complications	5 per cent
Intestinal obstruction	3.6 per cent
Anuria	3.3 per cent
Thrombo-embolic complications	2.9 per cent
Acute renal failure	1.4 per cent
Cellulitis and peritonitis	1.2 per cent

The list is long but it must be remembered that these complications often occur one after another in a single patient and that the overall incidence of postoperative problems is probably not more than 20 per cent.

The dangers of the ureterocolic implantation itself are difficult to assess because the operation is often associated with other major surgery (usually total cystectomy) which has its own mortality and also because the operation is often performed in unfavourable circumstances on patients that are malnourished, infected or previously radiated (Fig. 157′). This is why the postoperative mortality recorded in our survey varied, according to the centre, from 38.9 to 1.8 per cent! Only those ureterosigmoidostomies associated with cystectomy for benign lesions, or performed for vesico-cervico-vaginal fistula or for

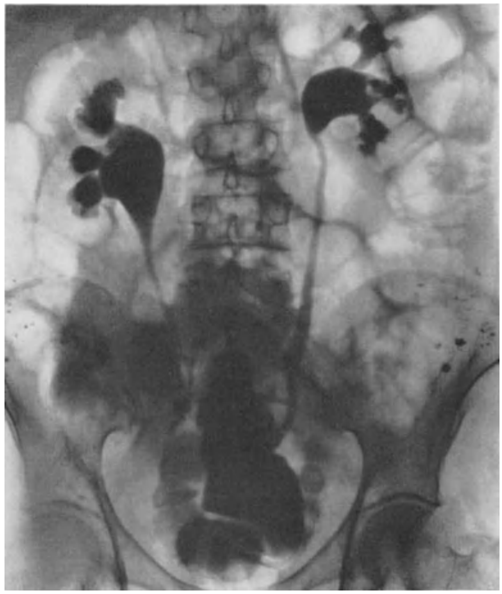


Fig. 157′. Uretero-cutaneous fistula after uretero-sigmoidostomy. Woman aged 60 years. Radical cystectomy for infiltrating cancer of the bladder with bilateral implantation of the ureters into the colon. The right ureteral fistula developed on the tenth day

tuberculosis or exstrophy give any true idea of the gravity of this ureterocolic diversion.

In a personal series of 62 patients, including 36 cases where the operation was associated with total cystectomy for cancer, we had only one postoperative death, due to septicemia.

E. Technical Modifications

The many disadvantages of ureterosigmoidostomy, that cannot always be avoided by the techniques just described, have led to the introduction of numerous more or less complicated modifications but these have found little general acceptance.

1. It is possible, for example, to preserve the ureteral meatus with the adjacent bladder wall in an attempt to utilize the anti-reflux properties of the intramural ureter.

In *Maydl's operation*, the entire trigone is transplanted into the colon or rectum (Figs. 158 to 160). In practice, these more complex operations have very limited indications because the trigone must be healthy. Vesical exstrophy is the principal if not the only indication for Maydl's operation but here the prevention of reflux may be illusory because the uretero-vesical junction is often abnormal with the ureter entering the bladder in a perpendicular fashion and the valve action may be absent as has been shown in attempts at bladder recon-

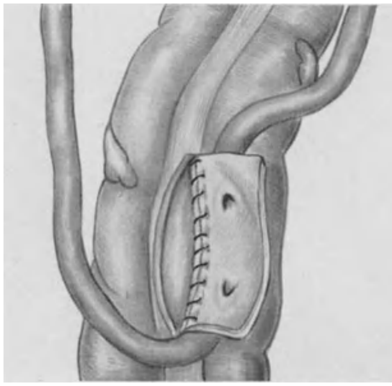


Fig. 158

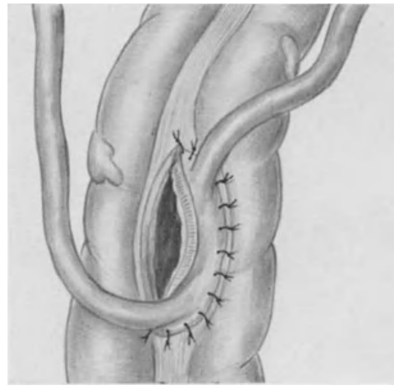


Fig .159

Fig. 158. Maydl operation. Beginning the trigono-colic suture

Fig. 159. Maydl operation (continued). Secondary mucosal opening

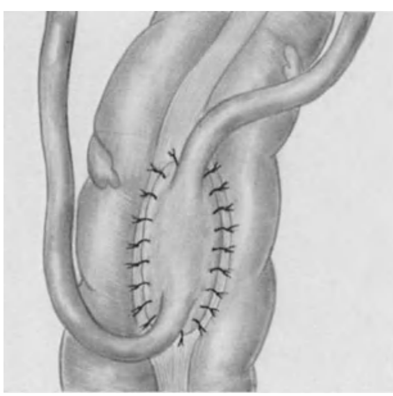


Fig. 160

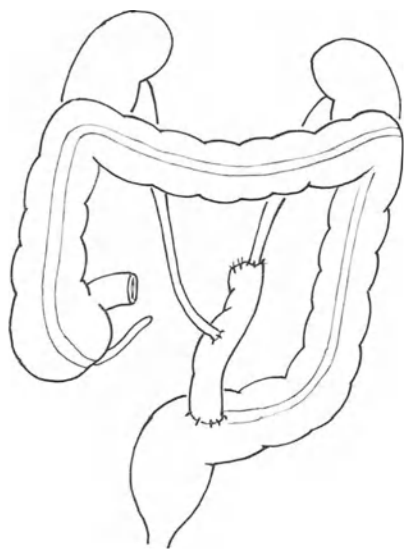


Fig. 161

Fig. 160. Maydl operation (concluded). Seen from outside—sutures completed

Fig. 161. Uretero-ileo-sigmoidostomy (BERG)

struction. Some authors (GREGOIR) believe that the reflux in these cases is secondary and they continue to use trigono-rectal implantations. Malignant tumors of the transplanted trigone have been reported 10 or 20 years or more after this operation.

2. In order to prevent or at least diminish the contact between urine and intestinal content and so to diminish infection if reflux develops, some authors have advocated *relative isolation of the recipient segment of intestine* by anasto-

moses of the limbs of the sigmoid loop (Borelius-Berglund, Mysch) or end-to-side sigmoido-rectal anastomosis (Muller, Descomps). It has also been suggested that *an ileal loop should be interposed* between the ureters and the sigmoid or rectum (Berg procedure) in the hope that the peristalsis of the interposed loop will prevent colo-ureteral reflux or at least diminish the pressure (Fig. 161). There is little evidence that the increased operative risk in these complicated procedures is balanced by the advantages that are more theoretical than real. The interposed ileal segment does not always prevent fecal reflux and it may behave rather as a diverticulum retaining urine and fecal matter. The current tendency among opponents of ureterosigmoidostomy is towards complete isolation of the urinary recepticle from the intestinal tract.

3. Lastly, mention must be made of the "wet colostomy" used by Brunschwig after pelvic exenteration. The two ureters are implanted into the sigmoid colon which is then brought out as a terminal colostomy. There is no stagnation of urine in the colon and reflux is probably avoided because of the low pressures due to the colostomy but the resultant disability is so great that, in our opinion, any other mode of diversion is preferable.

F. Indications

In our 1970 survey, the indications for ureterosigmoidostomy in 930 patients were divided as follows:

Bladder tumors	762
Ectopia vesicae	54
Vesico-vaginal fistula	21
Contracted tuberculous bladder	78
Traumatic lesions of the lower urinary tract	4
Bladder fibrosis	5
Genital tumors	6

In fact the indication for uretero-colic implantation is that of any upper urinary diversion, in other words the destruction of the lower urinary tract. But, compared with other methods of diversion, additional requirements include a healthy sigmoid colon, a competent anal sphincter, little or no dilatation of the ureters, satisfactory renal function and the agreement of the patient duly informed about the particular character of subsequent micturition.

Thus total cystectomy for bladder cancer represents by far the commonest circumstance in which the operation is performed, although ureterosigmoidostomy is in fact used much less often in these cases than cutaneous ureterostomy, simple or transintestinal. In women, however, we regard ureterosigmoidostomy as the diversion of choice.

In the treatment of ectopia vesicae, ureterosigmoidostomy is certainly used less than formerly but it still retains a place alongside the more modern techniques of uretero-vesical reconstruction (whose results are very disappointing) and transintestinal cutaneous diversion.

The contracted tuberculous bladder is now rare because of advances in treatment and prevention but, in any case, it is no longer an indication for urinary diversion. The excellent results of bladder enlargement by entero-cystoplasty, with or without ureteral reimplantation, have limited the indications for diversion to the rare cases in which lesions of the urethra, prostate and bladder neck are so advanced that one could not hope for satisfactory function of a reconstructed bladder.

The diminished emphasis on ureterosigmoidostomy is shared to some extent by all methods of urinary diversion owing to the continuing progress and development of reconstructive surgery.

G. Results

Although the indications for ureterosigmoidostomy are certainly diminished, we still regard it as an excellent operation if used with discernment. The majority of complications are due to faulty indications (dilatation of the upper urinary tract, predisposing to serious infection; poor renal function precipitating hyperchloremic acidosis and hypokalemia) or to technical failure (early stenosis) or to failure of proper supervision (including urinary and intestinal antisepsis, administration of alkali and especially regular urography). With proper care, ureterosigmoidostomy is perfectly capable of fulfilling its objectives: internal diversion of the urine with good control without endangering life by interfering with kidney function, even in the long term.

It has been shown by all the investigational techniques currently available, including separate measurement of mercury fixation in each kidney, that uretero-colic diversion, with a low mortality, can give excellent functional results (perfect continence day and night), allows a normal social life (including marriage and pregnancy) and maintains the integrity of kidney function with follow up as long as 38, 22 and 19 years in our personal series (Fig. 162).

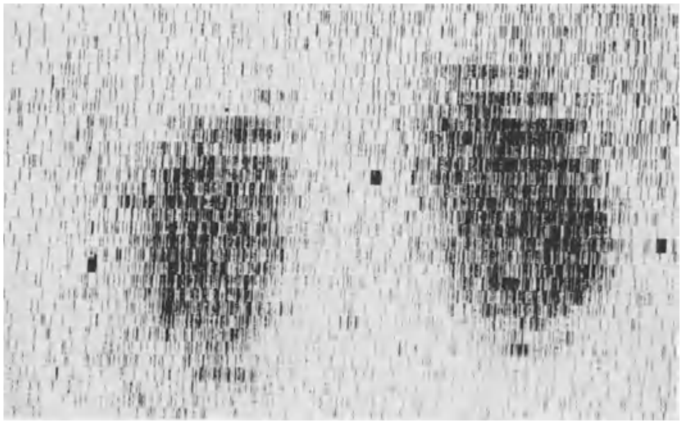
Of course this ideal result is not achieved in every case. In our survey, we have tried to assess the three factors that dominate the prognosis and possibly the justification of ureterosigmoidostomy: continence, electrolyte disorders and disturbance of renal function.

a) Continence

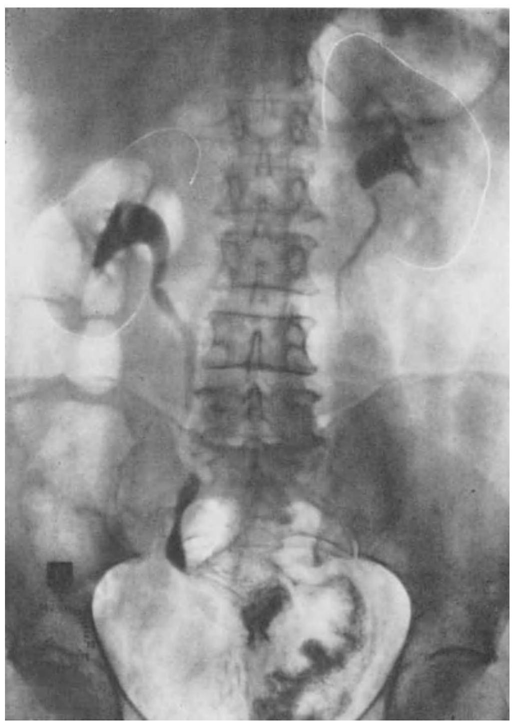
In two individual series where accurate information is available (NEDELEC: 115 cases; KÜSS: 63 cases), the figures are very similar:

Excellent control	80 per cent
Poor nocturnal control	10 per cent
Poor control day and night	5 per cent

In another series where the information is less precise but concerns 349 cases, the control is described by the author (NICOLICH) as "nearly" always perfect. Thus excellent continence can be expected in 75 to 80 per cent of cases and this percentage can be improved further if the operation is limited to patients who are demonstrated to have good sphincter control. It is obvious that incontinence



a



b

Fig. 162a and b. Long term result (22 years) of uretero-sigmoidostomy. 1951: Woman aged 36 years with diffuse papillomatosis of the bladder. Total cystectomy and bilateral uretero-sigmoidostomy (Coffey 1). 1968: Renal scan 17 years later (a). 1971: I.V.P. 20 years later (70 mins) (b). 1973: Very well. Perfect control. Despite several attacks of pyelonephritis, renal function is very good (serum creatinine 0.9 mg/100 ml). No electrolyte disorder: HCO_3 26 mEq

is incompatible with the comfort demanded of ureterosigmoidostomy but if control is imperfect there is nothing to prevent a change to another method of diversion.

b) Electrolyte Disorders

Three series (NEDELEC, DUCASSOU, NICOLICH) have shown a disturbance of blood chemistry in 40 to 66 per cent of cases, a percentage confirmed in our personal series: 29 cases out of 61 patients. These disorders occur essentially in patients with renal insufficiency, whether the poor function is primary or secondary.

It is important, however, to distinguish between mild cases, with no clinical manifestations (40 per cent), and more serious forms (20 per cent) that need re-equilibration and a special diet. In our practice, we have seen 2 cases of acidotic coma that recovered rapidly with administration of alkali and an indwelling catheter. Although it is true that these electrolyte disorders represent a disadvantage of ureterosigmoidostomy, it is now easy to detect and correct the disorder by monitoring the blood chemistry. Correction is easy with a suitable diet, administration of alkali and frequent rectal micturition.

c) Long Term Effects on the Kidney

This can be studied only in patients where the original lesion was benign because survival after total cystectomy for bladder cancer is unfortunately seldom sufficiently long to judge the tolerance of the diversion itself. We have studied renal function in those of our patients who have had ureterosigmoidostomy for more than five years (follow up of 15 years and more in many cases) by urography, by measuring plasma creatinine levels and, where possible, by a renal scintiscan (Fig. 163).

In 50 cases followed for more than five years, urography revealed:

56 per cent	normal kidneys.
16 per cent	with moderate dilatation of the upper urinary tract.
22 per cent	progressive dilatation.
6 per cent	destroyed kidneys.

The plasma creatinine (regarded as grossly normal (below 1.2 mg per 100 ml) was estimated in 27 of our patients followed up for periods between 5 and 20 years:

60 per cent	have normal function (creatinine below 1.2 mg per 100 ml).
25 per cent	have slight renal insufficiency (1.2 to 1.8 mg per 100 ml).
15 per cent	have significant deterioration of renal function.

The renal scintiscan does no more than confirm the functional deterioration in these cases, with in general a predominance on one side.

These morphologic and functional disorders are due to two factors sometimes associated:

– infection: these are the cases of recurrent acute pyelonephritis whose incidence is variously assessed (BRISSET 25 per cent, KÜSS 20 per cent, NEDELEC 50 per cent in ureters not dilated before surgery, 80 per cent in dilated ureters) that go on to definitive lesions that may progress in either subacute or chronic fashion.

– mechanical: stenosis or reflux.

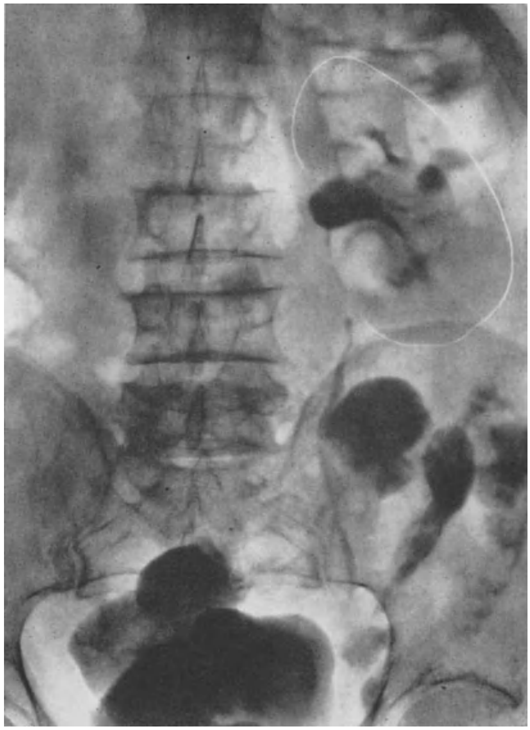


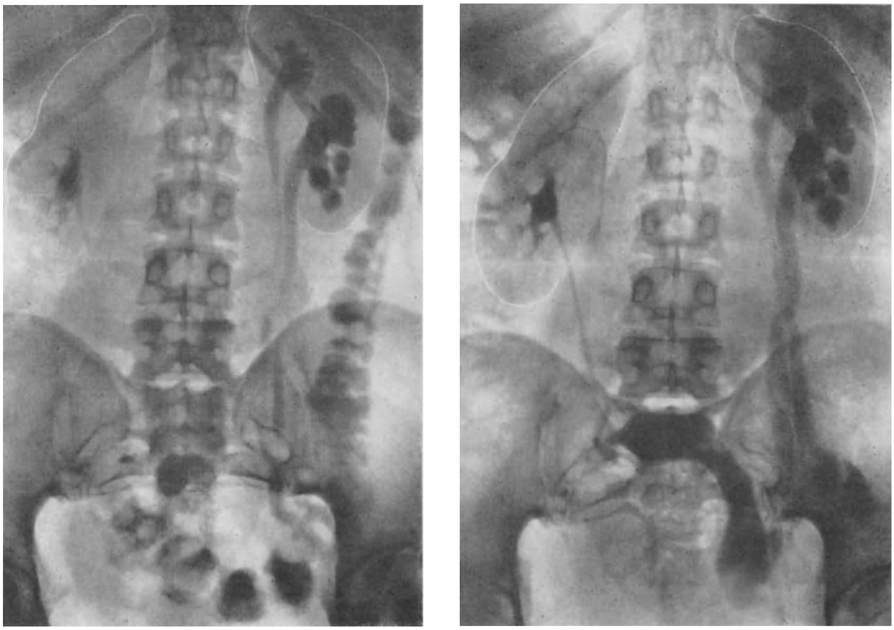
Fig. 163. 24 year follow up after uretero-sigmoidostomy. Coffey operation in 1948 after total cystectomy for diffuse papillomatosis. In 1972, 24 years later, this man aged 67 years is very well and leads a normal life. Despite loss of the right kidney (nephrectomy for pyonephrosis in 1955) renal function is satisfactory (serum creatinine 1.7 mg per 100 ml; blood urea: 60 mg per 100 ml; HCO_3: 21 mEq/l)

These disorders can be corrected by appropriate treatment, anti-infectious or surgical, provided that they are detected in time, before the establishment of irreversible renal lesions. In a group of 476 patients, the incidence of *late urologic reintervention was as* follows:

Reimplantations of ureter into colon for stenosis			17
Correction of stenosis by ureterectomy and ureterorrhaphy			1
Ureterolysis			1
External diversion	Nephrostomy	1	13
	Cutaneous ureterostomy	9	
	Sigmoid bladder	1	
	Caecal bladder	2	
Secondary nephrectomy			9
Total			41 (8.6 per cent)

A defective anastomosis should be detected very early by regular radiologic review and further corrective surgery should be instituted without delay.

Uretero-colic implantation is in no sense a definitive type of diversion. If control is imperfect, if there are frequent attacks of pyelonephritis or if there



a b

Fig. 164a and b. Transformation of bilateral uretero-sigmoidostomy to transsigmoid cutaneous ureterostomy. (a) I.V.P. (45 mins) 16 years after bilateral implantation of ureters into colon (with bilateral re-duplication) for bladder exstrophy, in a girl aged 19 years. Despite dilatation of the left upper tract, renal function is good and general health excellent but the girl is seriously disabled by almost total incontinence. For this reason the diversion was changed to a trans-sigmoid cutaneous ureterostomy: the segment of colon containing the attached ureters was resected and brought to the skin, without interfering with the uretero-colic anastomoses (1966). (b) I.V.P. (15 mins). 6 years later (1972) she is very well and married. Faecal continence is completely restored. But staghorn calculus has developed in both left pelves

is deterioration in the upper urinary tract or in kidney function, it may be necessary to change to external diversion. If the uretero-colic anastomoses appear satisfactory, the segment of colon carrying the ureters can be excluded from the intestinal tract and brought out on the skin, producing a colonic bladder (Fig. 164). If there is doubt about the ureteral implantations it is better to reimplant the ureters into an isolated ileal loop (Bricker), into a caecal bladder, or, more simply, direct to the skin if the general condition of the patient is poor.

3. Implanting the Ureters into an Excluded Intestinal Segment

Among these modes of diversion:

– some utilize the intestinal segment only as a simple vector interposed between the ureter and the skin; these are the transileal cutaneous ureterostomy (Bricker operation) and the trans-sigmoid cutaneous ureterostomy.

– others attempt to create a reservoir capable of a certain continence, but without sphincteric function: such is the caecal bladder.
– others implant the ureters into a new reservoir endowed with sphincters: these are the various rectal bladders.

A. Trans-Ileal Cutaneous Ureterostomy ("Ileal Conduit", "Bricker Operation")

After the first operation of MARION in 1909, it was principally the work of BRICKER (1950) and of CORDONNIER (1954) that demonstrated the possibilities and the value of this method of urinary diversion. The operation consists in interposing an isolated ileal segment between the ureter and the skin opening. It derives from the desire to improve the long term results of cutaneous ureterostomy, whose infectious and mechanical complications (stenosis of the skin opening) appeared frequent and formidable, or to replace ureterosigmoidostomy whose infectious, mechanical (stenosis or reflux) and humoral complications appeared at one time to be prohibitive.

Great hopes were placed in this new procedure:

1. Protection of the kidney from ascending infection, by the interposition of the intestinal "buffer", keeping the kidney more remote from the external environment ("improvement" on cutaneous ureterostomy). This intestinal segment, opening widely on the skin surface, in theory gives a rapid and continuous flow of urine and ensures low pressure and the absence of reflux (an undeniable improvement on ureterosigmoidostomy because it can be used safely with very dilated ureters).

2. The diminished risk of infection and the protection against excessive intracavitary pressure from stenosis or reflux raise expectations of better long term protection of kidney function.

3. The single skin opening is easier to manage than a double orifice. Furthermore, the wide opening is in theory free from the tendency to stricture of direct uretero-cutaneous anastomosis. The absence of any catheter is a further considerable advantage.

4. The isolation of the intestinal loop should prevent or diminish electrolyte disorders due to reabsorption of urinary constituents by the intestinal mucosa.

These are the reasons for the widespread adoption of transileal cutaneous ureterostomy in the past 15 years. The hopes have been largely – but not entirely – fulfilled.

a) Operative Technique

The operation is performed through a midline, suprapubic, transperitoneal incision, carried up beyond the umbilicus as far as necessary.

The first stage is the identification of the two ureters, on the left by reflection of the sigmoid mesocolon, on the right by vertical incision of the posterior parietal peritoneum where the ureter crosses the iliac vessels, medial to the caecum, or after medial reflection of the right colon (if the chosen skin opening is on the right side). The ureters are dissected as little as possible and the level of

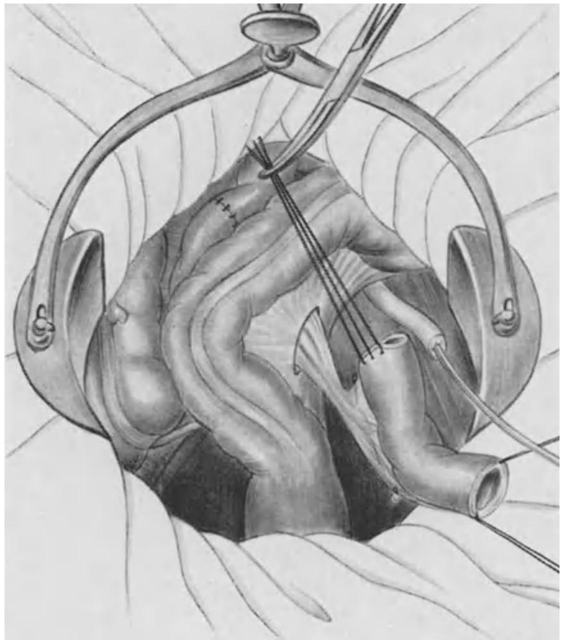


Fig. 165. Trans-ileal cutaneous ureterostomy. Skin opening on the left—the graft is placed retroperitoneally (behind the sigmoid)

section, depending on the disease, marked; this indicates the length of ureter available.

The ileal segment is then chosen, depending on the anatomy of its mesentery, so that it can be brought down and exteriorized easily and so that the ureteral anastomosis can be made without any tension.

In many cases the second last ileal loop is most suitable. A segment 15 to 20 cm long is chosen with due regard to the length of its mesentery and its vascular supply.

A longer graft, or a graft taken from higher up the intestine, may be necessary if the pelvis has been radiated, if the ureters have to be divided very high or if the mesentery is short and fat. Intestinal continuity is restored immediately using interrupted extramucosal sutures of unabsorbable material.

The ileal graft may be left within the peritoneal cavity but we prefer to place it retroperitoneally so as to achieve complete peritonealization and to reduce the danger of postoperative mechanical obstruction.

The graft should be arranged in an isoperistaltic direction but this is not an absolute necessity, provided that it is short.

The rest of the procedure differs according to whether the skin opening is to be on the left or the right and this may depend on the anatomic arrangements, on the nature and extent of the disease and on the condition of the abdominal wall.

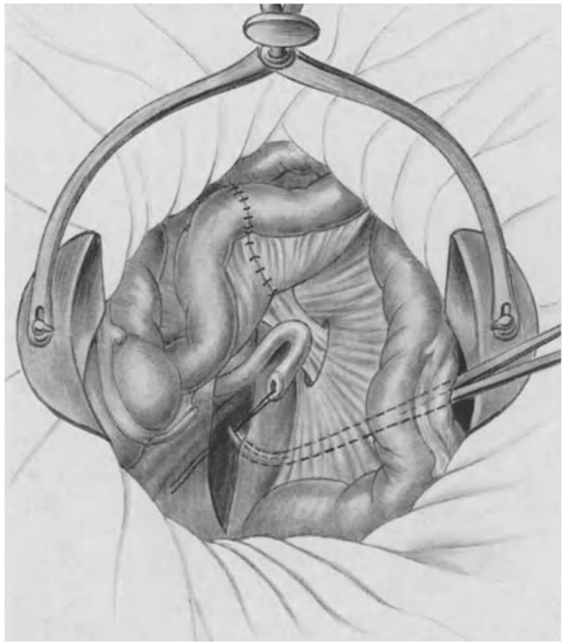


Fig. 166. Trans-ileal cutaneous ureterostomy (continued). Identification and passage of the right ureter

a) *If the skin opening is on the left*, the graft is drawn into the retro-sigmoid space through an incision in an avascular zone at the base of the sigmoid mesocolon (Fig. 165). At this point the graft meets the left ureter. The right ureter (or the proximal end of the graft, depending on the respective length of the two conduits) is brought through a retroperitoneal tunnel between the large vessels behind and the superior hemorrhoidal pedicle in front (Figs. 166 and 167). This tunnel should be sufficiently wide and the dissection of the right ureter continued sufficiently high to allow the ureter to run in a gradual curve without compression or angulation.

At this stage the ureters are anastomosed to the ileum.

We usually make a direct anastomosis with a single layer of interrupted, fine chromic catgut sutures picking up the full thickness of the ureter but only the sero-muscular layer of the ileum. The right ureter is anastomosed end-to-end to the proximal end of the ileal graft; preliminary partial closure of this end of the ileum is required in most cases but on occasion we have been able to make a full width direct anastomosis because of the enormous dilatation of the ureter. The left ureter is anastomosed end-to-side to the posterior aspect of the graft, much more distal in the retro-sigmoid region so that the opening is direct and there is no kinking (Fig. 168).

Other methods of anastomosis are possible. The uretero-ileal anastomosis can be made from within the intestinal lumen, after limited longitudinal incision

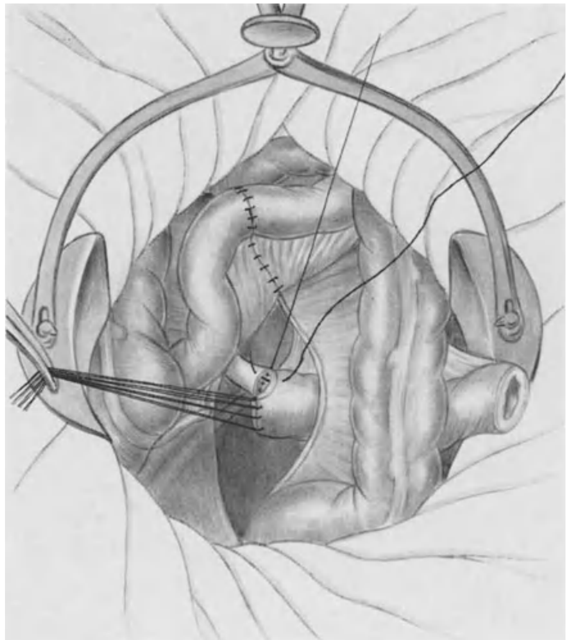


Fig. 167. Trans-ileal cutaneous ureterostomy (continued). Modification: Retro-hemorrhoidal passage of the proximal end of the graft—right ureteral suture in progress

Fig. 168. Trans-ileal cutaneous ureterostomy (continued). The ureteral anastomoses

of the graft along its anti-mesenteric border. A cuff can be made by turning the tip of the ureter back on itself or a submucous tunnel can be used in the hope of preventing reflux but this seems to us a vain hope with the thin wall of the normal ileum. Ureteral catheters for splinting or drainage are not indicated in most cases.

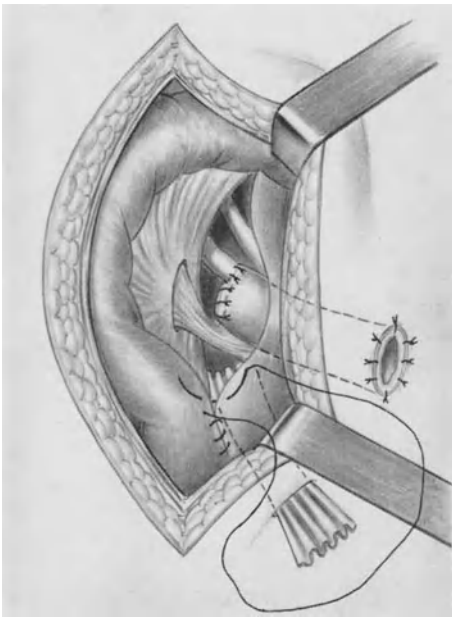


Fig. 169

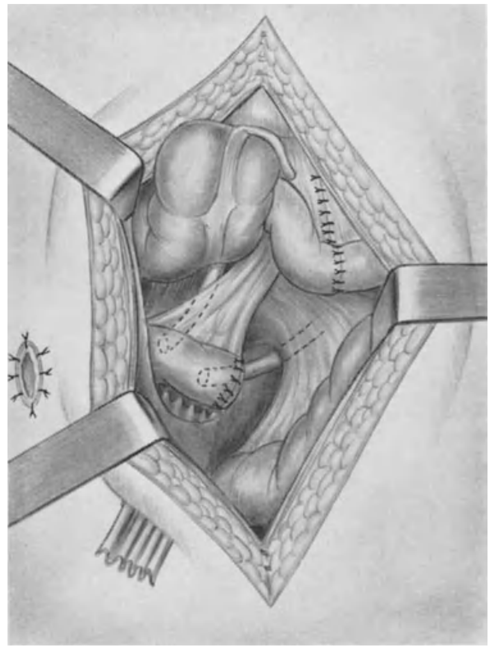


Fig. 170

Fig. 169. Trans-ileal cutaneous ureterostomy (concluded). The skin opening

Fig. 170. Trans-ileal cutaneous ureterostomy. Skin opening on the right. (Graft retro-peritoneal)

Lastly, the skin opening is made. A tunnel is made by blunt dissection outside the lateral parietal peritoneum to the site of election; at this point a circular disk is excised from the full thickness of the abdominal wall and the distal end of the ileal graft is brought through the tunnel and fixed to the skin with interrupted, unabsorbable sutures (Fig. 169).

It is rarely necessary to splint the graft with a large drainage catheter.

Complete peritonealization is then achieved by closing the openings in the mesentery and sigmoid mesocolon, closing the right posterior peritoneal incision and suturing the left colon to the parietal peritoneum. A soft retroperitoneal drain is placed through a lateral stab wound.

b) *If the skin opening is to be on the right side*, the right colon has been reflected before identifying the ureter. The ileal graft is brought into the retrocaecal region where it is easy to make the parietal tunnel. The right ureter lies naturally for a vertical anastomosis on the posterior aspect of the graft. The left ureter (or the left end of the graft, depending on the respective length of each conduit available) is brought through a retroperitoneal tunnel behind the superior hemorrhoidal vessels and anastomosed end-to-end to the left end of the ileal graft (Fig. 170). Peritonealization is somewhat more difficult than when the skin opening is on the left; the lateral para-caecal gutter must be closed carefully. It is wise to drain the left retroperitoneal space as well as the right.

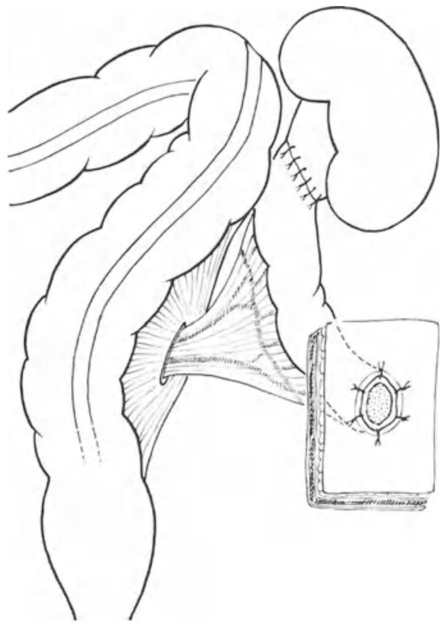


Fig. 171. Unilateral trans-ileal cutaneous pyelostomy (left)

b) Modifications

1. When the Bricker operation is used to replace a bilateral cutaneous ureterostomy, the operation is somewhat more laborious. The ureters must be dissected and excised completely from the abdominal wall. Because the ureteral wall is often fibrotic and infected and so may have a poor blood supply after dissection, it is often necessary to divide the ureters relatively high so that the ileal graft has to lie higher, in the abdomen rather than in the pelvis, and also the ileal loop has to be longer and it is more difficult to extraperitonealize. It is preferable to make the opening of the cutaneous ileostomy in a new, healthy part of the abdominal wall and to utilize the original ureterostomy tracks for drainage.

2. When the cutaneous ureterostomy to be replaced is very high, close to the kidneys, or when the ureters are destroyed or doubtfully viable (infected, tortuous and adynamic megaureters, radiated ureters) the ileal conduit may be anastomosed directly to the pelvis after resection of the ureter: this is in fact a *transileal cutaneous pyelostomy*. This procedure has been used by KING and SCOTT, by HOLLAND and colleagues, by SAUSHING and CORDONNIER and by CAMPBELL.

If unilateral (generally in cases with a single or single remaining kidney), there are few technical difficulties: The intestinal graft, some 20 to 25 cm long, is taken from the middle ileum and is passed with its mesentery through an opening in the mesocolon so that it lies quite naturally in the retromesocolic space (Fig. 171).

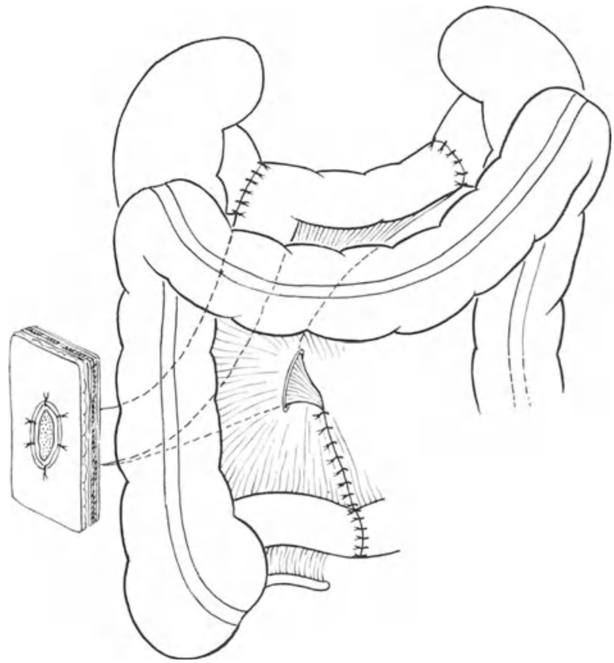


Fig. 172. Bilateral trans-ileal cutaneous pyelostomy. (Skin opening on the right)

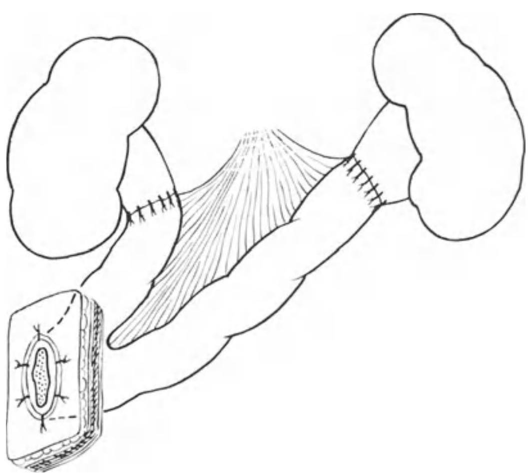


Fig. 173. Trans-ileal cutaneous pyelostomy with lateral stoma

Bilateral cases pose certain technical problems. Of necessity the intestinal segment is longer because it crosses the full width of the abdomen at the level of L 3. The skin opening is usually on the right side; the two ends of the graft, whose mesentery is turned upwards in a fan, enter the retroperitoneal spaces through openings in the right and left mesocolons. The mid-section of the graft remains within the peritoneal cavity, in front of the superior mesenteric pedicle (Fig. 172). Reperitonealization must be meticulous. The difficulties arise mainly from the vascular arrangements in the mesentery of the graft, which tend to pull the ends of the graft downwards. In one case the arrangement of the arteries was such that we had to anastomose the two ends of the graft to the renal pelves, making a lateral cutaneous stoma (on the right) over a rod with the shorter ileal segment antiperistaltic; the result was satisfactory (Fig. 173).

When the vascular arrangements in the mesentery permit, a single opening below the root of the right mesocolon may suffice to pass the graft into the retroperitoneal space; the left end of the graft then reaches the left renal pelvis by a retroperitoneal tunnel passing in front of the large vessels and behind the superior mesenteric vessels: but because of the possibility of mechanical obstruction of the loop by this vascular "pincer" we usually prefer to leave the graft within the peritoneal cavity at this level. HOLLAND and his colleagues arrange the transverse segment of the graft in a similar retroperitoneal tunnel and then bring the remainder of the graft across the peritoneal cavity in front of the colon to the para-umbilical region where they make the skin opening.

Lastly, when the renal pelvis is destroyed or cannot be exposed, it may be possible to anastomose the ileal loop to a dilated calyx.

c) Complications

Transileal cutaneous ureterostomy must not be regarded as a simple and harmless procedure. The transperitoneal approach, the intestinal resection, the intestinal and urinary anastomoses and the poor condition of many of these patients before surgery (renal insufficiency, infection, neoplasia) are all factors with a significant potential for complications.

It is not surprising that *the operative mortality* is considerable: WELLS, 25 per cent in 212 cases (1956); BURNHAM and FARRER, 21.8 per cent in 96 cases (1960); PARKHURST, a little over 10 per cent in 562 cases (1968); CORDONNIER, 3.7 per cent in 215 cases (1960); GRASSET, 21 per cent in 61 cases (1967); CUKIER, 23.8 per cent in 42 cases in adults and 15.2 per cent in 16 cases in children (1971); HOLLAND *et al.*, 5 per cent in 37 transileal pyelostomies (1968). As in all major abdominal surgery of this type, the principal casues of death were infectious complications (acute pyelonephritis, pelvic abscess, peritonitis, septicemia), fistula, intestinal obstruction, wound complications (evisceration), pulmonary infections and cardiac and vascular complications (embolus). It must be remembered that many of the cases of transileal diversion in these statistics followed major surgery for pelvic cancer and so the diversion cannot take all the blame for the mortality. BOWLES and TALL reported 53 transileal diversions in children (1967) and their earliest death was due to progressive renal failure six months after operation.

The list of *postoperative complications* is long: wound infection (5.2 per cent of 191 cases according to CORDONNIER), evisceration (6.3 per cent); intestinal obstruction (6.2 per cent) which may be a pure paralytic ileus or a mixed obstruction due to inflammatory adhesion of intestinal loops, usually responding to simple duodenal aspiration, or a mechanical obstruction that may be due to defective peritonealization and requiring urgent reintervention; early stenosis of the uretero-ileal anastomoses (1.5 per cent), a rare cause of anuria; urinary fistula (2.1 per cent) due to leak from a uretero-ileal anastomosis, that in general heals spontaneously (but with the fear of subsequent stenosis) and does not require higher diversion unless there is severe infection; fecal fistula (0.5 per cent); intestinal hernia (0.5 per cent), which presupposes incomplete peritonealization; and acute urinary infection (1.5 per cent). Although the possible complications are many and sometimes serious, a considerable number of cases have a perfectly simple postoperative course.

Secondary and late complications are essentially associated with the skin opening (stenosis) and the uretero-ileal anastomoses (stenosis or reflux) and also with infection and stone formation.

1. *Complications Associated with the Skin Opening*

These include:

– hernia alongside the stomal orifice (1.5 per cent according to CORDONNIER) always due to a technical error (defective peritonealization).
– prolapse of the ileal opening (0.5 per cent), rare and sometimes due to an incorrect collecting device (exercising suction on the orifice).
– progressive stenosis of the skin opening, the principal complication.

This is one of the major complications of transileal cutaneous ureterostomy. CORDONNIER had to reoperate on 15 occasions for this complication (7.8 per cent), sometimes repeatedly in the same patient; BURNHAM and FARRER had to reoperate in five out of 96 patients and these figures include only the most serious cases. The complication seems to be particularly common in children: BOWLES and TALL, 8 cases out of 41 (20 per cent); LEADBETTER 24 cases out of 92; GLENN 15 per cent; RICKHAM 28 stenoses in 70 cases; and SHIRLEY 12 stenoses in 44 cases. This is a serious complication that compromises the very principle of the procedure which is the free continuous flow of urine at low pressure. Stenosis of the ileocutaneous stoma leads to stagnation and increased pressure in the graft and infection, first in the loop and then by reflux to the kidneys with consequent deterioration of renal function. This removes all the hoped-for advantages of this type of diversion. Regular supervision of the stoma is essential; irritative skin lesions, sometimes actual dermatoses, can develop if the collecting apparatus is imperfect, if the opening of an adhesive bag is too wide, allowing prolonged contact with urine of an areola of skin around the ileum, especially if the collecting bag does not empty properly. These lesions may cause skin retraction and stenosis of the orifice; in the early stages, gentle dilatation can be tried; plastic revision of the opening is needed when there is a true, fibrous stenosis.

2. *Complications Associated with the Uretero-Ileal Anastomosis*

Ileo-ureteral reflux is almost constant in patients with a transileal ureterostomy, at least when investigated by retrograde "ileography" (and thus in unphysiologic conditions with pressures much higher than the usual pressure within the lumen of the graft) (Fig. 174). WOODHEAD and PORCH (1964) found reflux in 97 per cent of cases, STALEY (1960) in 90 per cent, and MINTON *et al.* (1960)

Fig. 174. Trans-ileal cutaneous ureterostomy (for bladder exstrophy in a girl aged 2 years). Ileo-ureteral reflux obtained artificially by retrograde ileo-cystography. (The principal value of this examination is to confirm the patency of the uretero-ileal anastomoses)

found bilateral reflux in every case. This reflux matters little in the normal functional state of the diversion: the very low intra-cavitary pressures, the empty ileal loop and the unobstructed flow of urine render the reflux harmless to the kidney above. This is not so when there is stenosis of the skin opening.

Stenosis of the uretero-intestinal anastomosis is a serious complication. It is far from rare. BOWLES, CORDONNIER and FARSONS had to re-operate on 19 out of 278 patients; BURNHAM and FARRER had to re-operate on 12 out of 96 and GRASSET found five cases of ureteral stenosis in 61 patients. The stenosis may be brought to light by severe clinical symptoms, including fever, pain and anuria. Much more often the stenosis occurs quietly and is detected only, for example, by a rising serum creatinine or by progressive uretero-pelvic dilatation revealed radiobiologically. Periodic intravenous urography (twice in the first year, then every year) would thus seem essential in every patient with a transileal ureterostomy. Early surgical reintervention is indicated as the only means of preventing destruction of the kidney. Many reparative techniques are possible; where possible, it is better to use a lateral, extraperitoneal approach. Possible procedures include:

– a new anastomosis after division of the ureter above the obstruction.
– longitudinal incision and transverse closure of the anastomosis.
– a new side-to-side uretero-ileal anastomosis above the stenosis, without interfering with the original anastomosis.

The results depend on how soon the diagnosis is made.

3. *Poor Function of the Ileal Graft* ("Adynamic Segment")

In some cases the ileal segment does not empty properly despite the absence of any ostial stenosis. Residual urine in the ileal loop predisposes to infectious complications. CORDONNIER reports that this complication is more common in children. BOWLES and TALL noted it in 5 out of 41 cases (12 per cent). In many of these cases the ileal loop is too long and evacuation can be improved by segmental resection.

4. *Lithiasis*

is also common. It was reported by CORDONNIER in 4.7 per cent of 215 cases and in 8 out of 54 children; by BURNHAM and FARRER in 6 out of 96 cases and by BOWLES and TALL in 10 out of 41 cases in children (24 per cent). The calculi may be renal or ureteral, often recurrent. Persistent infection with proteolytic organisms rendering the urine alkaline, intestinal mucus and residual urine are certainly predisposing or aggravating factors but the primary reason for the formation of these stones remains unknown. Lithiasis constitutes a real risk to kidney function and requires surgery on one or more occasions in most cases.

5. *Acute Infectious Complications*

of the excretory tract are not very common. CORDONNIER reported 16 cases of acute pyelonephritis "at some stage" in 16 out of 215 patients (8.4 per cent); GLENN found similar complications in children in 13 per cent of cases and BOWLES in 7 out of 41 cases (17 per cent). These acute infections usually respond well to antibiotics associated with steroid therapy; if they persist or recur, a search must be made for any mechanical obstruction.

6. *Late Intestinal Obstruction*

is possible, as after any major abdominal surgery.

7. *Electrolyte Disorders*

are rarely sufficiently severe to cause clinical symptoms, except in cases with a considerable degree of renal failure before surgery. Acodisis is quite common (BOWLES, 15 per cent). A salt-losing syndrome is constant, as shown by MATHIEU, and may be so severe as to lead to collapse.

d) Results

Apart from the complications, whose overall incidence is far from prohibitive, *what are the results of transileal cutaneous ureterostomy*? What is the effect of the operation on the dynamics of the upper urinary tract and on renal function?

Many urologists regard the long term results as excellent. CORDONNIER and NICOLAI in 1960 reported their results in 191 cases: of these, 90 had *no* complications; the long term results, judged by intravenous urography, were satisfactory in 123 (normal upper urinary tract or regression of dilatation present before the surgery), mediocre in 37 (16 of these patients had marked pre-operative dilatation); 31 patients had an inadequate follow up. BOWLES and TALL in 1967,

Fig. 175. Trans-ileal cutaneous ureterostomy (same patient as preceding figure). I.V.P. (15 mins): no upper tract dilatation. Morphology and function of both kidneys excellent

after 41 BRICKER operations on children followed for 12 years, considered that the operation was no panacea but that it was the best method of upper urinary diversion currently available. PARKHURST in 1968 reviewed 562 transileal cutaneous ureterostomies performed at the Massachusetts General Hospital in Boston over a period of 12 years and he came to the same conclusions. Many authors, such as GRASSET and CUKIER, have greater reservations and feel that the risks of post-operative intestinal obstruction and of uretero-intestinal stenosis are such that they hesitate to recommend this operation in many cases.

We can summarize our views as follows:

Transileal cutaneous ureterostomy is an excellent method of urinary diversion in the long term; it has proved its value in the preservation of renal function, in the lower risk of infection, and in the better tolerance and greater facility of fitting a collecting device (adhesive bags, no catheter necessary) and in the greater comfort of a single skin opening (Fig. 175). It has the further technical merit of being applicable to all ureters whatever their state of dilatation and whatever length is available; it can even drain the renal pelvis directly. Lastly, the intestinal graft itself preserves the possibility of subsequent re-establishment of urinary tract continuity.

But the coin has another side: this is major abdominal surgery with inevitable risks and mortality. The danger of late complications is real: stenosis of the cutaneous stoma or of the uretero-ileal anastomoses may annul all the advantages of this mode of diversion; careful supervision is essential for the rest of the patient's life. Electrolyte disorders are not so conspicuously absent as has

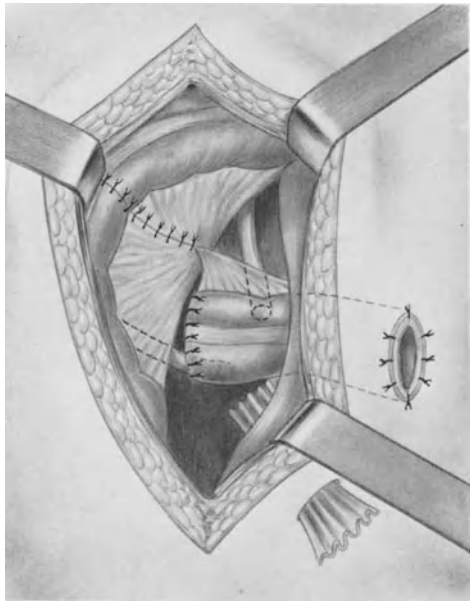


Fig. 176. Trans-sigmoid cutaneous ureterostomy

been reported and it is better to avoid transintestinal diversion in any patient with severe renal insufficiency. Lastly, it is by no means certain that the ileum is the segment of intestine best adapted to this surgery of urinary diversion.

All these pitfalls must be kept in mind when this mode of diversion is preferred to other solutions.

B. Trans-Sigmoid Cutaneous Ureterostomy ("Colonic Conduit")

By 1957, the advantages of transileal cutaneous diversion had been demonstrated by Bricker and colleagues in quite large series but the complications and long term disadvantages began to come to light and, at that time, Mogg drew attention to the use of an isolated segment of sigmoid colon instead of the ileal conduit. The anatomic (size, situation, thickness of wall) and physiologic (reabsorption, peristalsis) differences raised the hope that a sigmoid graft might solve some of the problems presented by ileal grafts. Since 1952, Mogg has used this type of diversion in more than 70 cases. The procedure has been taken up by many urologists, mainly pediatric, including Cendron, Melin, Bruezière, and Cukier.

a) Operative Technique

This does not differ greatly from that of transileal cutaneous ureterostomy (Fig. 176).

The peritoneal cavity is opened through a midline suprapubic incision. The sigmoid mesocolon is isolated and the left colon is reflected to an extent depending on the available length of the sigmoid loop. A sigmoid segment about 15 cm long (as short as possible) is isolated and intestinal continuity is restored.

The ureters are identified and divided. The right ureter is brought over to the left through a retroperitoneal tunnel passing below the superior hemorrhoidal vessels, making sure that it runs in a smooth curve. The ureters are implanted into the isolated colic segment:

– direct implantation may be used.

– MOGG makes a small incision in the seromuscular layer of the colonic segment and pulls out a cone of colonic mucosa which he opens and anastomoses directly to the ureter; then, with the aid of a ureteral catheter, this anastomosis is pushed into the lumen of the colonic conduit where it forms a small bud.

– a submucous tunnel may be used to prevent reflux.

– CENDRON performs the uretero-colic anastomosis with a technique similar to that of PETIT and LEADBETTER for ureterosigmoidostomy, placing the ureter in a tunnel in the wall of the colon to prevent reflux.

The skin opening is in the left iliac fossa. The isoperistaltic arrangement of the graft requires only slight rotation of its mesocolon that does not interfere with the blood supply.

Complete peritonealization is ensured easily by suturing the sigmoid colon (even though shortened), to the parietal peritoneum reflected above the tunnel in the abdominal wall.

b) Complications – Results

MOGG and SYME (1969) published the results of 40 transcolic cutaneous diversions with a follow up from six months to 10 years. Most of the operations were performed for neuropathic bladder in children (spina bifida).

These results should be compared with those of transileal ureterostomy.

It seems that with the colonic bladder the intra-cavitary pressure remains much lower than with an ileal loop; this may be due to differences in peristalsis and tone of the intestinal wall. Even with stenosis of a skin opening, the pressure remains lower and there was none of the progressive dilatation of the upper tract seen with a certain number of ileal conduits. Because of the low pressures, even when no special measures have been taken to prevent reflux, there is reflux in only 50 per cent of cases (compared with almost 100 per cent with ileal bladders). Furthermore, the thicker wall of the colon makes it possible to use effective anti-reflux procedures (CENDRON). All these factors contribute to better protection of the kidneys.

Stenosis of the skin opening can occur with the colonic bladder but the larger size of the intestinal opening seems to make stenosis less common and easier to treat.

The evacuation of the colonic graft also seems to be better than that of an ileal conduit, even when the montage is anti-peristaltic (MOGG). In 40 cases, MOGG found a residual urine greater than 40 ml in only 11 cases (six of these had stenosis of the skin opening), although the mean capacity of the colonic conduit is 165 ml and may be as much as 350 ml in adults.

There should in consequence be a lower incidence of infection in patients with trans-sigmoid ureterostomy.

Mogg describes this method of diversion as "good, safe and useful, with a very low mortality and morbidity" and certainly it seems to have a certain number of advantages over trans-ileal cutaneous ureterostomy, although the latter technique is much more widely used.

C. The Substitute Caecal Bladder

This mode of urinary diversion represents a further step in the search for patient comfort, the acquisition of continence.

The idea of a caecal bladder began with Verhoogen whose technique, described in 1908, was taken up by Maccas in 1910 and then by Langemann in 1912. The caecum is isolated as a recepticle and the ureters are anastomosed to it; the urine is led to the skin surface by the appendix. This unsatisfactory procedure was improved in principle by Bricker in 1948 and by Merricks and Gilchrist in 1949; with their modification, the terminal ileum, a much wider conduit, more accessible to catheterization, is brought to the skin surface; furthermore, the ileo-caecal valve may provide continence. Further developed by Van Wien and Gregoir in Belgium and by Van Eyden and Lefebre, the technique of making a caecal bladder was modified by one of us in 1958, in the hope of improving continence, in collaboration with Brisset who wrote his thesis on this subject.

The caecal bladder makes use of the isolated caeco-colic segment of the intestine to form a urinary reservoir to which both ureters are anastomosed and the urine is led to the skin surface by the terminal ileum. Continence, hopefully total, is achieved by the ileo-caecal valve re-inforced by certain technical devices. The urinary reservoir must be emptied regularly and artificially by a catheter passed through the stoma, down the ileal stump and through the ileo-caecal valve into the caecum. This is not a true bladder replacement because there is no sphincteric function and no micturition, but rather an upper urinary diversion.

a) Operative Technique
(Fig. 177)

1. *Preparation*

The gut must be prepared with great care, ensuring an empty and sterile colon, particularly difficult to achieve on the right side.

2. *Approach*

The peritoneal cavity is opened by a midline suprapubic incision extending well above the umbilicus. This incision should be adequate to expose the hepatic

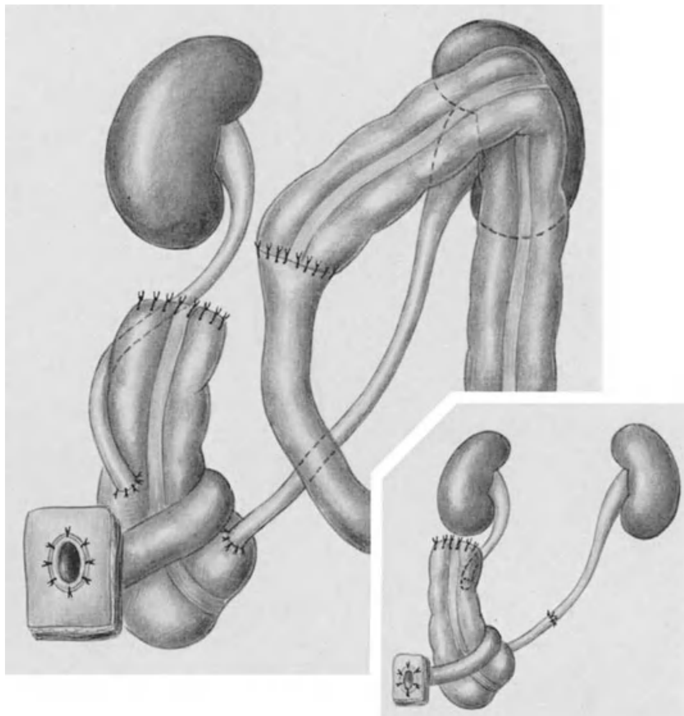


Fig. 177. Caecal bladder substitution. Inset is the plan for "short ureters" and use of the appendix

flexure and right half of the transverse colon. In a fat patient, the incision may be extended obliquely upwards and to the right (BARRAYA) to give a wider exposure.

3. "*Intestinal*" *Stage*

In order to achieve good continence, the new caecal bladder should have a very large capacity. This is effected by isolating a segment as in right hemicolectomy. The right side of the transverse colon is divided after detachment of the right side of the great omentum. There is no need to make a deep division of the transverse mesocolon because the upper part of the ascending colon is left in place and need not be dissected. The terminal ileum is divided 20 to 30 cm above the ileo-caecal junction, the exact site depending on the vascular pattern which is quite variable in this region and on the length required which depends on the build and obesity of the patient.

The ileum is anastomosed to the transverse colon, either end-to-end or end-to-side with a single layer of unabsorbable extramucosal sutures.

4. "*Urinary*" *Stage*

This is the construction of the new caecal reservoir and includes:

a) Closure of the divided end of the isolated transverse colon, with a single layer of 00 or 000 chromic catgut extramucosal sutures.

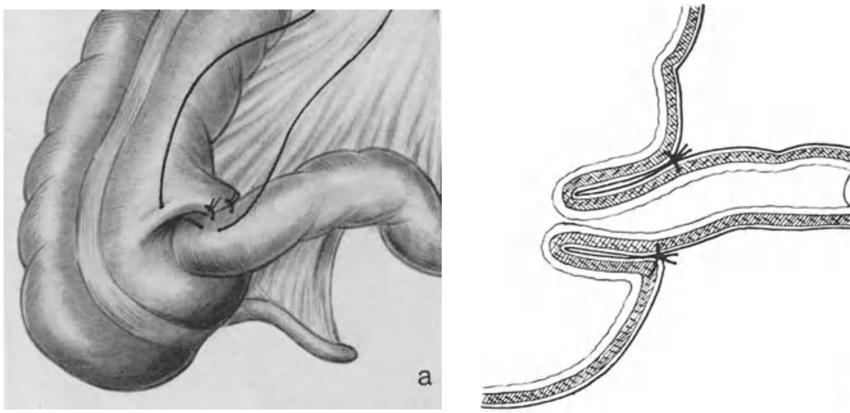


Fig. 178a and b. Caecal bladder substitution—detail of the ileo-caecal invagination. (a) The suture. (b) The plan in section

b) Reflection of the caecum and first part of the ascending colon, leaving the upper part of the ascending colon and the hepatic flexure in position. This reflection brings the caecum into a dependant position, improving continence, and facilitating the anastomosis of the left ureter and also re-peritonealization. Obviously this reflection will vary greatly in extent, depending to a large extent on the initial position of the caecum. The caecum is swung downwards and medially so that its original lateral border becomes the inferior border and the ileo-caecal valve becomes the highest point of the caecal apparatus.

c) Ileo-caecal invagination (Fig. 178). This is designed to reinforce the competence of the ileo-caecal valve. The invagination is achieved by a series of interrupted, unabsorbable sutures taking a wide bite of the seromuscular layer of the ileum and caecum at a distance of 1 to 1.5 cm from the junction of the two segments, with care to avoid the brances of the ileo-caecal artery which are numerous in this region. The invagination should be completed before the ureters are anastomosed because a certain amount of traction on the caecum and ileum may be required during the procedure.

d) Implantation of the ureters. The right ureter is found easily after incision of the posterior peritoneum. The site of implantation varies with the length of ureter available. We perform a direct anastomosis, with no anti-reflux device (which would in any case be ineffective because of the thinness of the caecal muscle) by interrupted sutures of fine chromic catgut taking the entire thickness of the ureter and the seromuscular layer of the caecum.

The left ureter is sought by incising the posterior peritoneum lateral to the sigmoid mesocolon and the ureter is divided as low as possible. It is brought over to the right side either by an opening in the sigmoid mesocolon or by a retroperitoneal tunnel burrowed behind the superior hemorrhoidal vessels to reach the right posterior peritoneal incision. This track is significantly shortened by the fact that the caecum has previously been swung to the left. The anastomosis is made, end-to-end, to the base of the appendix after ligature of the meso-appendix at the same level as the section of the appendix, with fine chromic

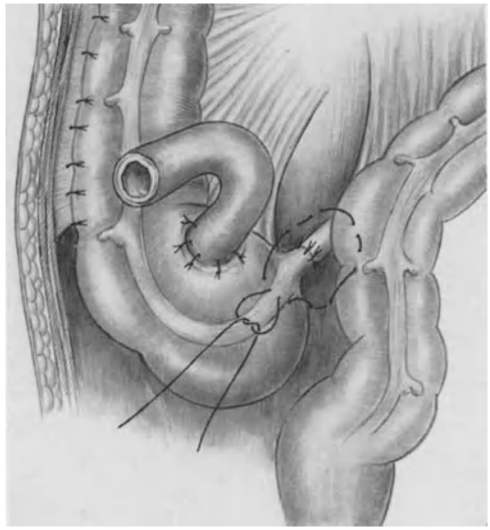


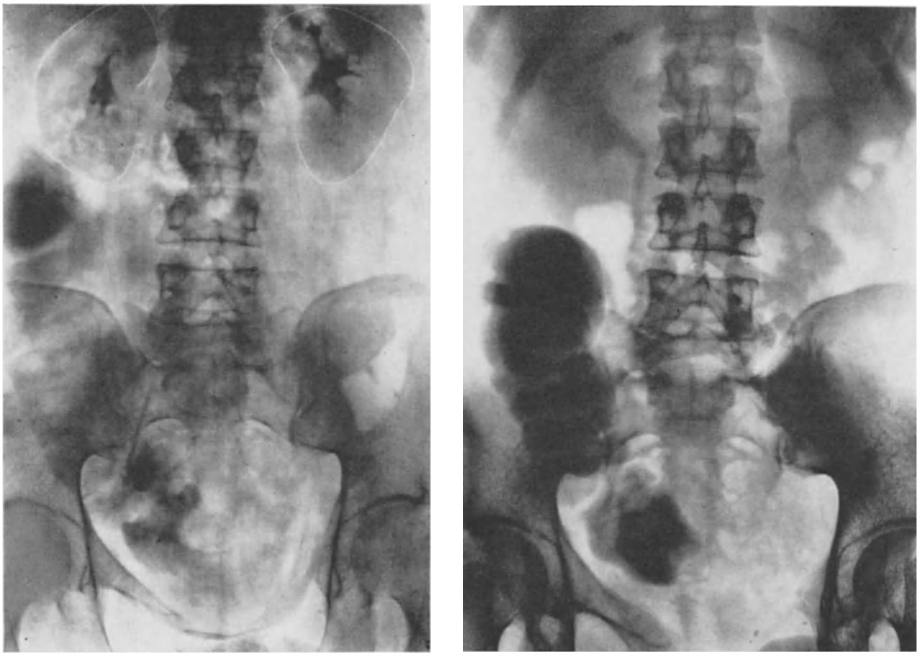
Fig. 179. Caecal bladder substitution—detail of the peritonealization in the region of the left ureter

catgut with the knots on the outside. This anastomosis is perfectly congruent and much easier than anastomosis to the caecum. An additional advantage is that the appendix can to some extent compensate for lack of length in the left ureter. If the appendix has previously been removed the left ureter will have to be implanted into the base of the caecum. A ureteral catheter is not necessary in these anastomoses.

e) Attachment of the ileum to the skin. A site in the right iliac fossa is chosen, depending on the length of the ileal segment and its mesentery, the thickness of the abdominal wall and the position of the caecum after removing all retractors. It is important to avoid any kink so that subsequent catheterization will be easy. A disk is excised from the full thickness of the abdominal wall and the cut edge of the ileal segment is anastomosed to the skin edge with interrupted, everting sutures of unabsorbable material. A large catheter with multiple eyes is immediately passed through the ileo-caecal valve into the caecum.

5. *Peritonealization*

This is by no means the easiest part of the operation. The opening in the mesentery must be closed and the upper end of the caecal bladder must be placed extraperitoneally. The extraperitonealization of the right ureter is achieved at the same time but the left ureter poses more difficult problems; if the new track of the left ureter is retroperitoneal, behind the hemorrhoidal vessels, it is easily covered on the right side but if the ureter has been brought through the sigmoid mesocolon it is necessary to use a purse string joining the caecum, sigmoid colon and posterior parietal peritoneum and possibly the beginning of the last ileal loop (Fig. 179). It now remains to fix the lower part of the right colon to the



a b

Fig. 180a and b. Caecal bladder substitution. Continent trans-caecal diversion to the skin surface established in 1958 after traumatic destruction of the lower urinary tract in a man aged 26 years. 14 years later, he is very well. He catheterizes the caecal bladder every 5 or 6 hours and is leading a normal professional life. (a) I.V.P. (25 mins): normal upper urinary tract (serum creatinine 0.9 mg per 100 ml). (b) I.V. cystogram: the new caecal bladder

edge of the parietal peritoneum, to partition off the pelvis and to close the gap between the ileal neourethra and the lateral abdominal wall.

The extraperitoneal spaces are drained, either through lateral stab wounds or through the lower part of the main incision.

6. *Postoperative Care*

The caecal catheter is left in place for 10 to 15 days with gentle daily lavage to remove mucus and any remaining fecal debris. After removal of the catheter, regular catheterization is begun; continence is always very imperfect to begin with but then improves. The drains are shortened about the fifth or sixth day and removed between the eight and tenth day.

b) Complications — Results

The indications for this procedure are not very common and so our comments are based on a limited series of 10 caecal bladders but the longest follow up is more than 12 years (Fig. 180).

The establishment of a caecal bladder involves major surgery on both intestinal and urinary tract and in theory is open to the same *postoperative complications* as the Bricker procedure, including urinary fistula, intestinal obstruction, infection and thrombo-embolic complications. We have met with no intestinal complications: there is no doubt that these can be reduced to a minimum by careful preparation of the colon and meticulous re-peritonealization. Neither have we had any lasting urinary leak: the anastomosis of ureter to caecum or ureter to appendix with catgut seems to be quite safe. The postoperative course has been quite straightforward in every case.

Although postoperative mortality or morbidity is obviously possible, we regard the caecal bladder as an operation relatively free from risk.

Secondary or late complications are also possible.

The creation of a urinary reservoir emptied artificially by catheterization naturally raises the fear of chronic retention and consequent infection. This does not occur in practice; "cystograms" taken after filling the caecum with opaque fluid show that there is little or no residual urine after catheterization, although it is sometimes necessary to perform double catheterization because of the somewhat delayed evacuation of the upper part of the caecal bladder.

Electrolyte disorders due to reabsorption have been absent or minimal; there is a slight tendency to hyperchloremic acidosis and loss of bicarbonate but this has never proved significant. This may be additional evidence of the good emptying of the new bladder. One patient who had kidney stones before the operation and who was careless about attending for follow up studies developed a huge "bladder" stone that had to be removed surgically. In another patient a pre-existing calyceal stone progressed to a staghorn calculus. In one further patient, a calyceal stone remained unchanged.

Vesico-ureteral reflux can be demonstrated by retrograde "cystography" on the right side in all cases and sometimes on the left. It does not appear to have any ill effect on the renal parenchyma provided that the new bladder is regularly and aseptically emptied (which, unfortunately, does not obtain in every case).

Late stenosis of the uretero-intestinal anastomosis is always possible but we have seen no case in this very limited series (but with a long follow up).

The long term results of the caecal bladder must be assessed in terms of two essential criteria:

- The comfort of the patient.
- Preservation of kidney function.

1. The comfort of the patient.

This can be very satisfactory; some of our patients catheterize themselves regularly and easily every three to five hours, evacuating some 300 ml of urine, and are perfectly continent in the interval so that no apparatus is necessary; they require only a pad or a small cup over the stoma; the latter gives an extra sense of security while travelling or taking exercise, when there is some risk of a slight urinary leak. A sensation of fullness in the right iliac fossa and tingling in the region of the stoma warns the patient that the new bladder is full and should be catheterized. However, even in "good" cases, the necessity for regular catheterization represents a constraint that may be tolerated poorly in the long term. The sterility of the catheters, which must be carried about the person, may leave something to be desired.

All these contingencies require that a patient with a caecal bladder should have a suitable personality. One of our patients, for whom we changed the caecal bladder to a trans-ileal ureterostomy after 10 years, expressed his satisfaction with the peace of mind that he had acquired with the continuous, involuntary flow of urine.

The function results are not always good as in some patients (especially those who have not had an ileo-caecal invagination) continence is imperfect so that both a collecting device and catheterization are necessary, raising practical problems that are difficult to resolve. Complete retention of urine due to difficulty in catheterization occurred in only one patient one occasion.

2. Kidney function is preserved in a manner very similar to that found with transileal ureterostomy. In most of our patients, glomerular filtration has not changed in periods of 3 to 12 years. In most cases, intravenous urography has demonstrated stabilization of any dilatation of the upper urinary tract present before the diversion. Only one patient presented clinical signs of uretero-renal reflux with attacks of acute pyelonephritis and, after 10 years, we had to change the caecal bladder to a transileal ureterostomy, using for this purpose the segment of ileum that was already attached to the skin.

In conclusion, the caecal bladder seems to us to be a method of urinary diversion that is valuable in terms of function and of kidney preservation. Compared with the Bricker operation, it has the advantage of continence, although at the cost of regular catheterization. This operation should be performed only on patients who are obviously capable of looking after themselves, after the whole situation has been explained fully.

D. Rectal Bladders

The idea of using the ampulla of the rectum as a urinary reservoir controlled by the anal sphincter and of passing the colon down through the same sphincter to preserve fecal continence, was carried into practice by GERSUNY in 1898 (pre-rectal route) and by HEITZ HOYER and HOVELACQUE in 1910 (retro-rectal route). Operations of this type have been perfected and utilized at the present time by TRUC and HENRIET, DUHAMEL and especially NEDELEC in France and by BRACCI in Italy.

These are true urinary diversions but also authentic bladder replacements because the new urinary reservoir is endowed with both continence and the possibility of voluntary micturition.

Rectal bladders are considered in another part of this work under the heading of bladder replacement surgery.

E. General Indications for Urinary Diversion into an Excluded Intestinal Segment, Ileal, Left Colic or Ileo-Caecal

Implanting the ureters into an isolated intestinal loop brought to the skin surface presupposes the desire to divert the urine in definitive fashion or at least for a very long time. Absence, destruction or irreparable loss of the function of the lower urinary tract constitute the circumstances in which transintestinal cutaneous ureterostomy may be envisaged and in which this mode of diversion has been adopted universally; it has rendered immense services.

In our opinion, however, transintestinal cutaneous ureterostomy has been used somewhat to excess. We believe that the nature of the primary lesion is the most important factor in the indications.

1. *In non-neoplastic conditions.* Transintestinal cutaneous diversion has been employed widely:

– In children with ectopia vesicae, incontinent epispadias, certain serious types of neurogenic bladder (spina bifida, sacral agenesis), the megaureter-megacystis syndrome and in certain cases of megaureter with advanced renal insufficiency.

– In adults with inoperable damage to the lower urinary tract, large vesico-vaginal fistulae in radiated tissues with sphincteric destruction and certain cases of neurologic incontinence (including tuberculous meningitis and spinal cord damage).

– In both children and adults to replace some other mode of diversion poorly tolerated by the patient, the ureters or the kidneys – such as cutaneous uretero-stomy or especially uretero-sigmoidostomy.

The permanent, though not necessarily definitive, character of this diversion, the relative comfort of the patient and, above all, the long term preservation of kidney function are a perfect justification in all these cases for the additional risk of combined urinary and intestinal surgery. The only argument is about the segment of intestine to be used, ileal, sigmoid or ileo-caecal and this is a matter of personal experience and of preference; we have discussed the advantages and disadvantages of each of these grafts.

2. *In neoplastic disease*, on the other hand, for which transintestinal cutaneous ureterostomy has been employed routinely by many urologists in a large number of patients (after total cystectomy for infiltrating carcinoma of the bladder, anterior exenteration for radiated bladder or genital cancer or botryoid sarcoma in children), the indication for this type of diversion seems to us to be at least open to question. Few such patients will survive sufficiently long to appreciate the long term advantages (from a renal viewpoint) of these bladder substitutes. In our view, it is not in the immediate interest of these patients to deprive them of the much simpler postoperative course following a simple cutaneous uretero-stomy, the least "serious" of all diversions and a procedure that still leaves open the possibility of subsequent construction of an intestinal "intermediary" if there is no recurrence or metastasis of the neoplastic disease. In our own practice, whenever diversion is indicated for a cancer with a poor prognosis, we prefer "interim" cutaneous ureterostomy (or sometimes ureterosigmoidostomy in women) to diversion by means of an isolated segment of intestine.

VIII. Surgery of Vesico-Uretero-Renal Reflux

The knowledge and treatment of vesico-uretero-renal reflux form a part of recent advances in urology.

The subject was mentioned by LEPOUTRE at the French and Italian Congresses of Urology in 1926 but the pathologic significance of reflux and the possibilities of treatment were not considered properly until more recently, following the work of HUTCH on neuropathic bladder. Many authors, mostly pediatric urologists, such as INNES WILLIAMS, LEADBETTER, PAQUIN, LATTIMER, STEPHENS, STEWARD, MARSHALL and GREGOIR contributed to the subsequent clarification of the many facets of this complex pathologic picture. Differences, sometimes fundamental, in the interpretation of the mechanism, of the pathogenesis and of the physio-pathologic consequences of reflux explain the diversity of surgical techniques proposed for its correction.

The variety of lesions encountered is a partial explanation of the multitude of procedures; it would hardly be logical to use the same technique for an normal ureter and for a megaureter, for atonic ureter and for a distended and aperistaltic conduit, for a thin bladder wall or a hypertrophied detrusor, for a rigid, gaping orifice or a normal supple orifice.

This is not the place for an exhaustive study of all the problems created by vesico-uretero-renal reflux. Our intention is to give a critical account of the principal technical procedures and the lesions for which they are used, their advantages and disadvantages and their limitations. Brief consideration will then be given to the general therapeutic indications and the results.

1. Techniques

These vary greatly, even in their underlying conception, attempting to utilize or to recreate one or more of the normal mechanisms that prevent reflux: the mechanical effect of the mucosal valve, the length of the intramural ureter, the contraction of the bladder muscle during micturition and the restoration of effective ureteral peristalsis.

They may be classified into two main groups according to whether or not the ureteral meatus is preserved.

A. Techniques Preserving the Ureteral Meatus

These techniques presuppose that the meatus is normal.

a) Hutch I Technique

The principle is to restore a solid muscular support to the intramural ureter, without interfering with the meatus.

HUTCH frees the terminal ureter by an extravesical approach and then,operating across the bladder, incises the detrusor onto a ureteral catheter, above the intact meatus. The intramural ureter is then brought into the bladder and the bladder wall, including the mucosa, is sutured behind it; there is a loop of ureter free in the bladder lumen (Fig. 181).

The physio-pathologic basis for this operation, first described for neuropathic bladders, is the pathogenic interpretation of reflux, attributed to "extra-vesicalization" of the terminal ureter due to disappearance or inadequacy of the muscle wall at the site of the intramural ureter, creating a juxta-meatal diverticulum. This operation generally gives excellent immediate results but it is not uncommon to find reflux reappearing subsequently, after several months, and cystoscopy reveals the disappearance of the intravesical ureteral loop. The "good results" of this operation must therefore be considered in terms of length of follow up. Another disadvantage is that the ureter may be obstructed where it passes through the bladder wall if the suture of the bladder incision is too "complete". It is important to avoid constricting the ureter.

This operation has the enormous advantage of technical simplicity (it is also performed easily by a purely transvesical approach) and it is possible whatever the state of the mucosa. Three conditions are, however, essential to a good result: a normal meatus, a normal, tonic ureter and a bladder wall that is not significantly thickened. A dilated ureter and a very hypertrophied detrusor are the conditions that will predispose to organic stenosis.

b) Gregoir Technique

This is an "extravesical burial" of the terminal ureter, which again has the effect of reconstituting a solid posterior muscle support for the ureter.

By a lateral, extraperitoneal, extravesical approach, the detrusor is incised vertically above the uretero-vesical junction; this incision goes right through the muscle but does not include the mucosa. The ureter is buried in contact with the mucosa and the muscle sutured over it. This produces a submucosal track of whatever length is desired, without touching the meatus or opening the bladder cavity (Fig. 182).

The obvious danger is stenosis if the ureter is dilated, the detrusor thick and the muscle is closed too tightly over the ureter.

Similar to the Gregoir technique is the *procedure employed by* ALEXANDRE for uretero-vesical reimplantation, principally in kidney transplantation. In the same way, by a purely extravesical approach, the bladder muscle is incised; at the lower end of this incision a hole is made in the mucosa for direct end-to-side

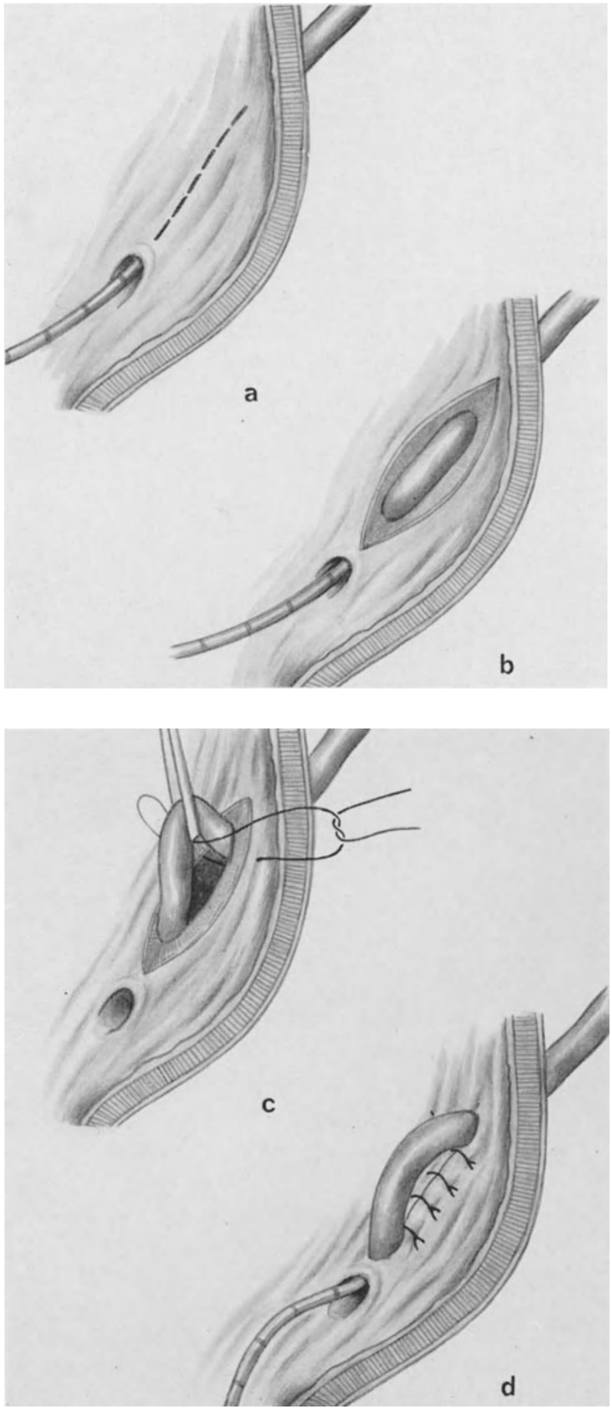


Fig. 181 a–d. Hutch 1 technique. (a) Incision. (b) Retro-vesical approach to the ureter. (c) Drawing the ureteral "loop" into the bladder. (d) Suturing the bladder wall behind the ureter

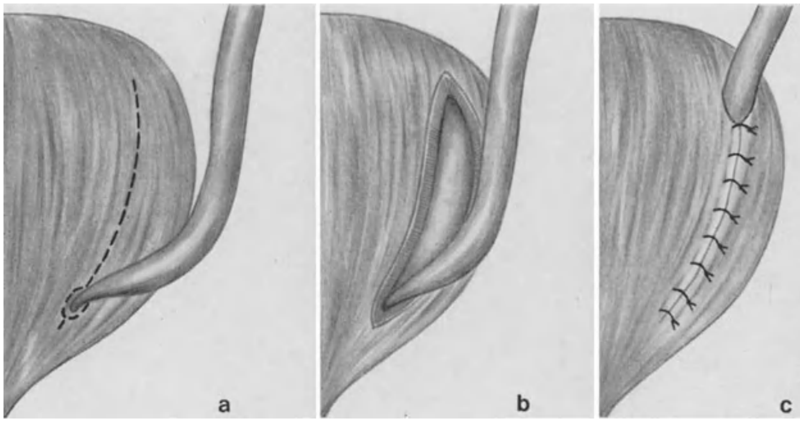


Fig. 182a—c. Gregoir technique. (a) Extra-mucosal incision of the bladder (posterior aspect). (b) Detachment of the mucosa and preparation of the ureter. (c) Suture of the bladder muscle behind the ureter

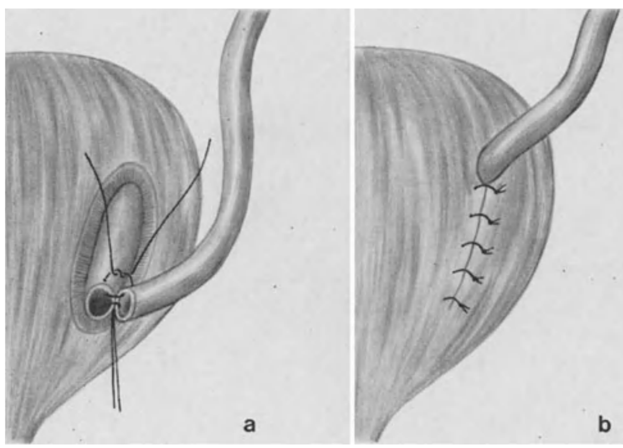


Fig. 183a and b. Alexandre procedure. (a) Incision of the bladder wall—uretero-vesical implantation: muco-ureteral suture. (b) Suture of the muscle behind the reimplanted ureter

anastomosis of the ureter to the mucosa and then the ureter is laid in the submucosal track and the muscle sutured over it (Fig. 183).

c) Mucosal Plasties

These techniques utilize the trigonal mucosa to create a long valve over the ureteral meatus.

The operation advised by BISCHOFF has some similarities with the Denis Browne technique for correcting hypospadias. The operation is purely transvesical. After inserting a ureteral catheter, traction sutures are placed in the mucosa and the bladder wall is incised in an elongated U prolonging the meatus. The lateral mucosal flaps are then sutured by 4 or 5 fine chromic catgut sutures

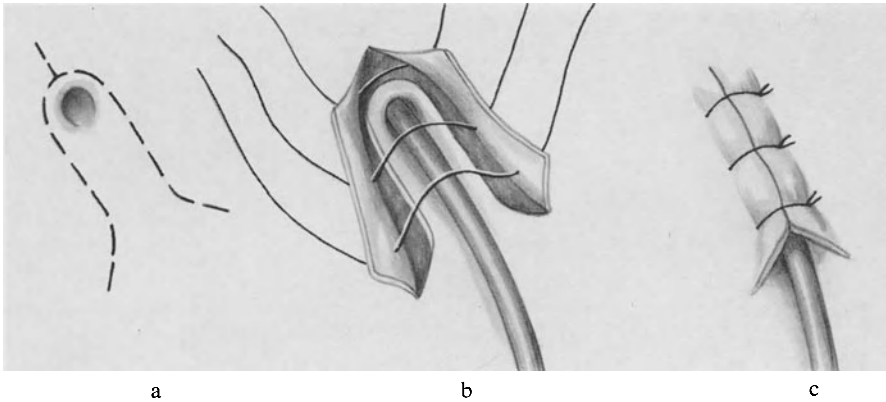


Fig. 184a—c. Bischoff technique. (a) Mucosal incision. (b) Dissection of the mucosal flap and passage of sutures. (c) Suture

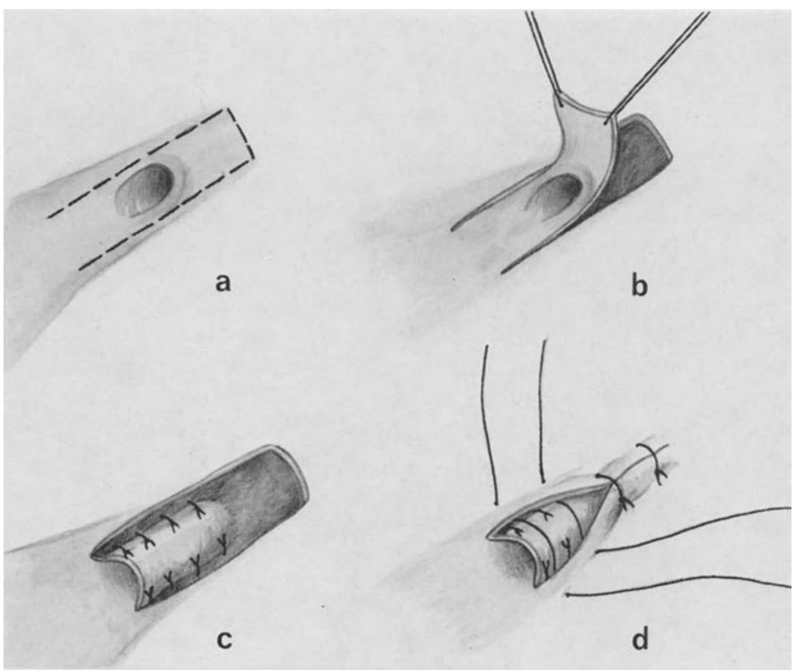


Fig. 185a—d. Whitherington modification. (a) Incision. (b) Dissection of the mucosal flaps. (c) Fixation and suture of the flaps. (d) Suture of the covering mucosa

over the median strip and the splinting catheter which should be removed after 2 to 3 days (Fig. 184). BISCHOFF seems very satisfied with this technique which has given him "numerous successes". According to this author, the operation can be performed on both sides and combined with a Y—V plasty of the anterior lip or resection of the posterior lip of the bladder neck, or combined with resection

Fig. 186a—c. Schulman and Brisset modification. (a) Incision. (b) Suture of the mucosal tube. (c) Covering mucosal layer

and re-modelling of a megaureter. The procedure can also be used to cure secondary reflux after ureteroplasty with a tubed bladder flap of the Boari-Küss type or even as an adjunct at the time of this operation. There are, however, some objections to this technique. In practice, it requires a healthy mucosa and any inaccuracy in the suturing will nullify the result; pressure necrosis due to the ureteral catheter may disrupt the fragile mucosal tent and this is why BISCHOFF himself recommends early removal of the catheter. The operation is possible only when the meatus is at some distance from the bladder neck and bilateral operation requires two orifices that are at some distance from one another; these conditions are difficult to fulfil in children and especially in infants. According to BISCHOFF, in these cases of congenital reflux with megaureter, the orifice is "dystopic, very often in the bladder dome" but in our experience the ureteral orifice is often normally placed or may even be ectopic, at or near the bladder neck. Lastly, the technique presupposes a normal intramural path and functioning ostia, free from any dysectasia, sclerosis or stenosis, whether organic or dynamic; this is certainly not the rule, especially in congenital megaureter with reflux.

WHITHERINGTON has suggested a technical modification designed to reduce the number of suture defects: his "ureteral osteoplasty" resembles the Mathieu technique for hypospadias (Fig. 185). BRISSET and SCHULMAN have used another technical modification inspired by the Duplay operation (Fig. 186).

B. Techniques that Do not Preserve the Ureteral Meatus

Some authors make use of the meatus: they detach it and bring it lower down to elongate the submucosal and intramural path. These are the ureteric advancement operations (Innes Williams, Hutch mark II).

Other urologists remove the meatus, resect the terminal ureter and reimplant it into some part of the bladder (LEADBETTER, POLITANO, PAQUIN, MATHISEN).

a) Techniques of Detachment and Advancement of the Ureteral Meatus

Innes Williams Technique

This is a transvesical operation. The meatus is detached and the floor of the terminal ureter dissected, leaving the covering bladder mucosa attached to

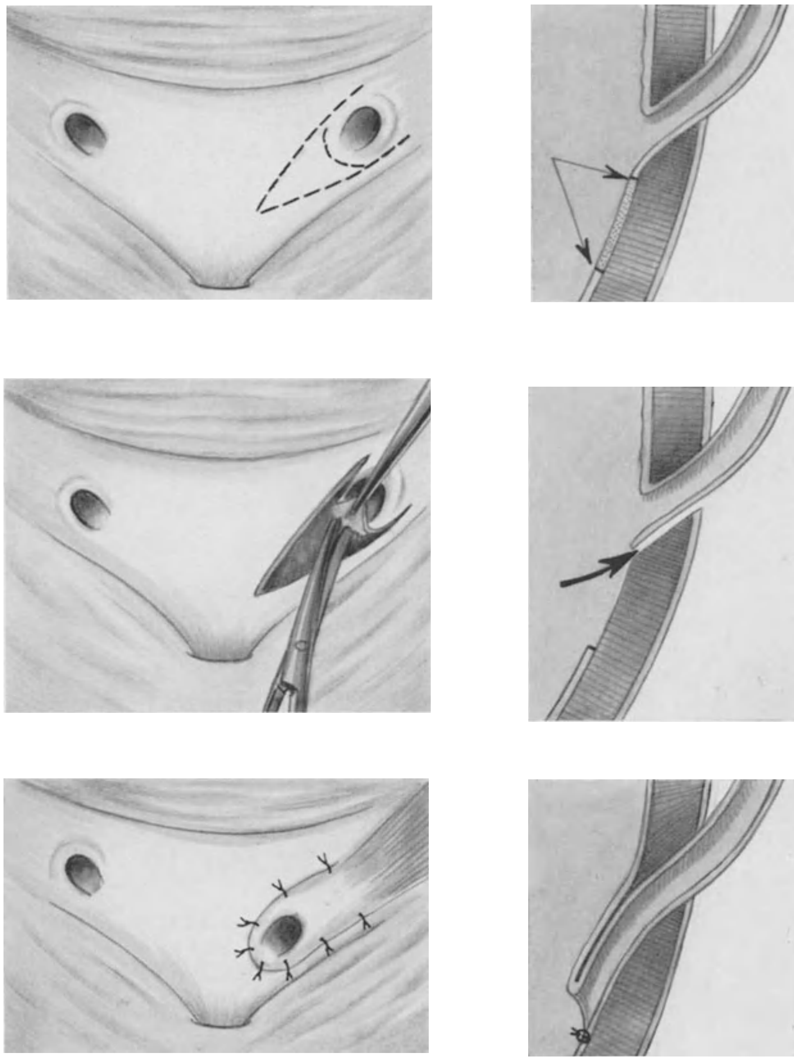


Fig. 187a–c. Innes-Williams technique (ureteric advancement). (a) Incision–Excision of the triangle; (a′) section. (b) Posterior ureteral dissection; (b′) section. (c) Drawing in and suture of the ureter; (c′) section

the terminal ureter. A triangle is excised from the trigonal mucosa and the ureter with its meatus intact is advanced downwards and medially. It is fixed by suturing the mucosal edge to the edges of the trigonal defect (Fig. 187).

Hutch Technique (Mark II)

This operation is based on the fact that the intramural ureter and the lateral part of the trigone form a whole which is not attached to the subjacent bladder

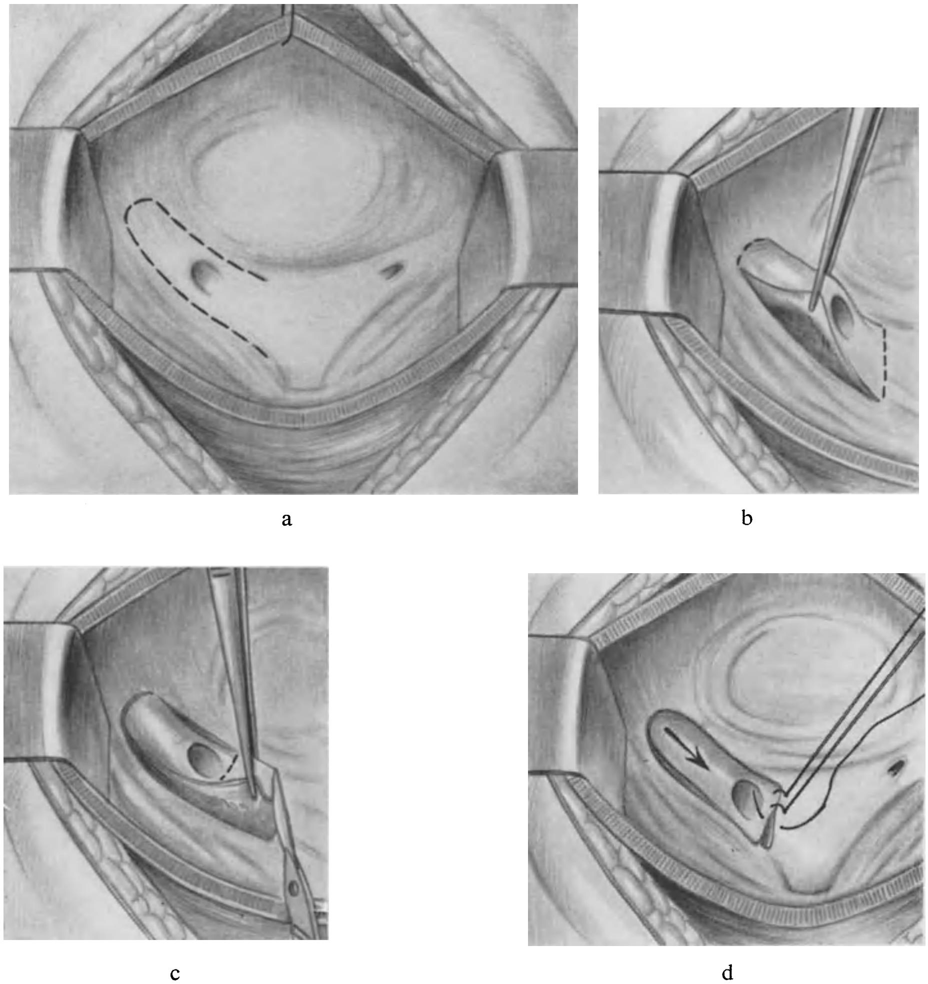


Fig. 188a—d. Hutch II technique. (a) Incision. (b) Dissection of the terminal ureter. (c) Section of the strip. (d) Suture after drawing the ureter through

muscle. The bladder mucosa is incised and the intramural ureter and lateral part of the trigone are dissected free. The tongue of trigone prolonging the ureter is divided as close as possible to the midline and above the meatus which is left intact, after drawing the terminal ureter into the bladder. The ureter is fixed by the stump of the strip to the opposite hemi-trigone, close to the midline (Fig.188)

These two operations, although very different in conception from the pure mucosal plasties, present the same problems or even impossibilities, especially in small children, including inadequate depth of trigone and too short a distance between the two ureteral orifices for bilateral surgery. Nevertheless, a modified ureteric advancement can be performed through a submucosal tunnel running horizontally or even upwards.

b) Techniques Including Removal of the Meatus and Terminal Ureter

1. Leadbetter-Politano Operation

The original technique of these authors is performed transvesically. The meatus is detached but subsequently restored to its original site after it has been brought through a new submucosal tunnel. At the same time, if necessary, the terminal ureter can be resected. The operation begins with a circular incision of the mucosa around the ureteral meatus, followed by dissection and liberation of the intramural and juxtavesical ureter. A submucosal tunnel is then developed from the site of the meatus in the normal direction of the ureter. At the upper end of this tunnel the bladder wall is incised and through this opening the end of the ureter is seized in a clamp and drawn into the bladder. The normal muscle opening is closed, the ureter is passed through the submucosal tunnel and the meatus is reattached by muco-mucosal suture at its original site (Fig. 189).

This is an excellent operation. In its original form, the entire ureter is preserved and there is merely a change of course providing a solid muscle base for the terminal ureter. In our opinion, the cure of reflux in many cases requires resection of the abnormal uretero-vesical junction which may be atretic (congenital stenosis) or at least dysectatic (in primary reflux) or frankly abnormal in secondary reflux (cicatricial or inflammatory sclerosis, gaping or associated stenosis). This *resection of the terminal ureter*, designed to reimplant healthy and normally contractile ureter, is a standard feature of *a technique of reimplantation by a combined intravesical and extravesical approach* inspired by the Leadbetter-Politano operation and developed by one of us (CHATELAIN). This technique is particularly applicable to congenital lesions of the uretero-vesical junction. The principal stages are as follows:

– transverse, skin-crease, suprapubic incision with upward retraction of the upper skin flap.

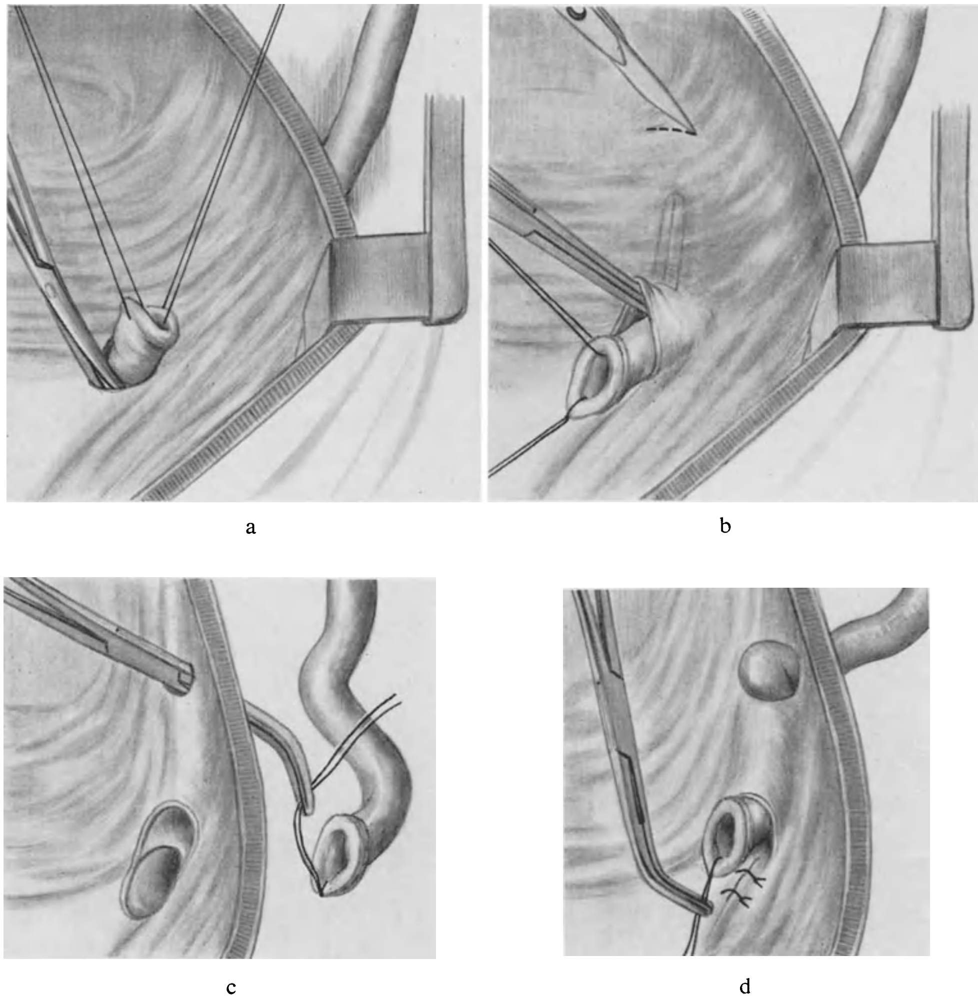
– vertical midline incision of the aponeurosis (Fig. 190).

– extraperitoneal cystotomy.

– operating transvesically, the intramural ureter is dissected as in the preceding operation (Fig. 191).

– then, working outside the bladder, the juxtavesical and pelvic ureter are dissected as far as necessary to provide enough length for reimplantation after resection of the lower end and also to make sure that the ureter will run in a gradual curve through the bladder wall, avoiding any sharp entry or angulation. In the course of this dissection, it may be necessary to divide several vessels going to the bladder or other pelvic organs but care must be taken to avoid compromising the blood supply of the ureter and the dissection must be kept at a little distance from the wall of the ureter. In girls the uterine vessels should be preserved (Fig. 192). The temporary placement of a ureteral catheter is a great help in finding the ureter in this lateral vesical region.

– the site for reimplantation of the ureter into the bladder is chosen according to the desired length of the intramural pathway and the available length of ureter. The intramural track should be about 4 times the diameter of the ureter.



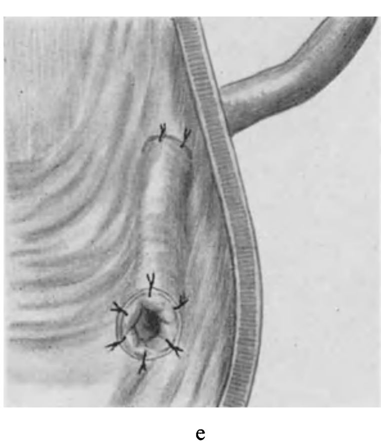


Fig. 189a—e. Leadbetter-Politano operation. (a) Mucosal incision and beginning of ureteral dissection. (b) Construction of sub-mucous tunnel and incision of the mucosa at its upper end. (c) Drawing the ureter through. (d) Passage of the ureter through the sub-mucous tunnel—suture of the bladder incision. (e) Final appearance

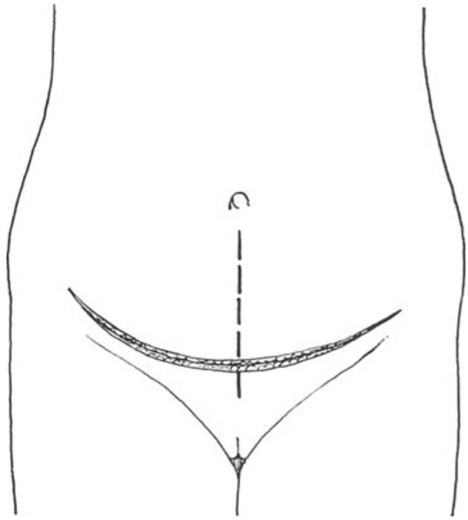
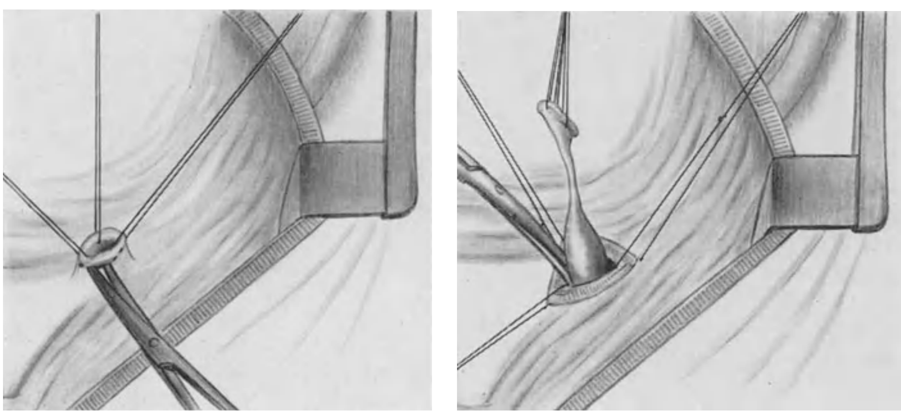


Fig. 190. Anti-reflux reimplantation by combined approach with resection of the terminal ureter (CHATELAIN). Approach: horizontal supra-pubic skin incision and midline incision of the abdominal wall



a b

Fig. 191 a and b. Anti-reflux reimplantation by combined approach with resection of the terminal ureter (continued). First intra-vesical stage. (a) Making the mucosal cone and placement of three traction sutures at 120°. (b) Dissection of intramural and juxta-vesical ureter

– the ureter is then pulled into the bladder through an opening made by splitting the muscle fibres (Fig. 193).
– this muscular opening is closed by a few interrupted chromic catgut sutures and the ends of these sutures are kept long to act as tractors.
– the submucosal tunnel is burrowed between the two mucosal openings and the ureter is drawn through.
– the ureter is then divided obliquely through healthy tissue at the site of election (the distal end of the ureter has served for traction up to this point).

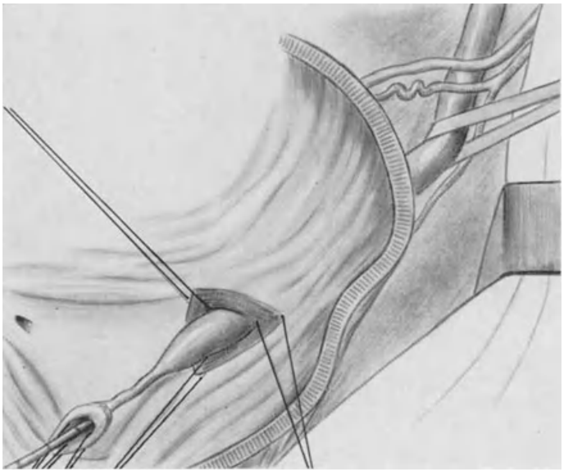


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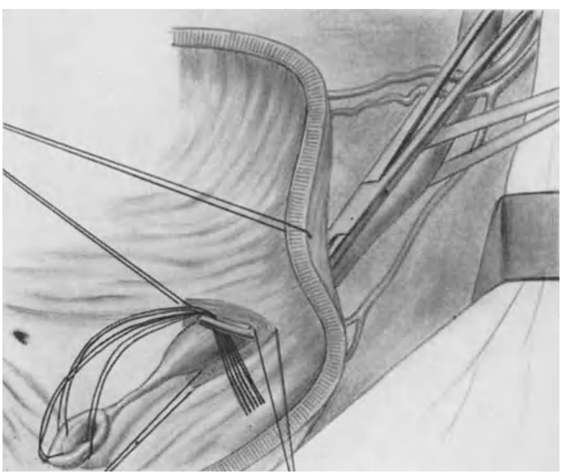
Fig. 192a—c. Anti-reflux reimplantation by combined approach with resection of the terminal ureter (continued). Extra-vesical stage. (a) Identification of the extra-vesical ureter (catheter in place). (b) Passage of ureter towards the lateral vesical region. (c) Crossing of the genital vessels



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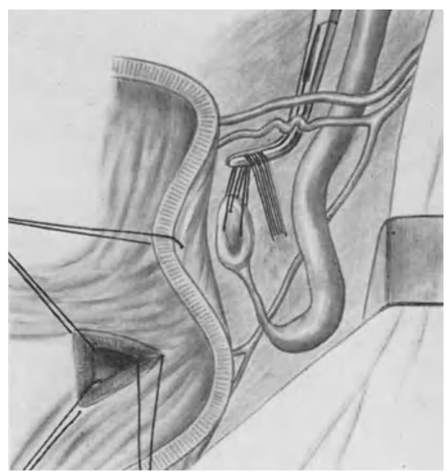


c

– the tip of the divided ureter is fixed by a firm anchoring stitch to the trigonal muscle and then a muco-mucosal anastomosis completes the formation of the new orifice (Fig. 194).

– the upper mucosal opening is then closed. No fixation sutures are used in the track through the bladder wall so as not to interfere with ureteral function.

Fig. 194a—e. Anti-reflux reimplantation by combined approach with resection of the terminal ureter (concluded). (a) Suture of the initial bladder incision. (b) Construction of the submucous tunnel. (c) Passage of the ureter. (d) Beginning the resection at the terminal ureter. (d′) Anchoring stitch. (e) Uretero-mucosal suture

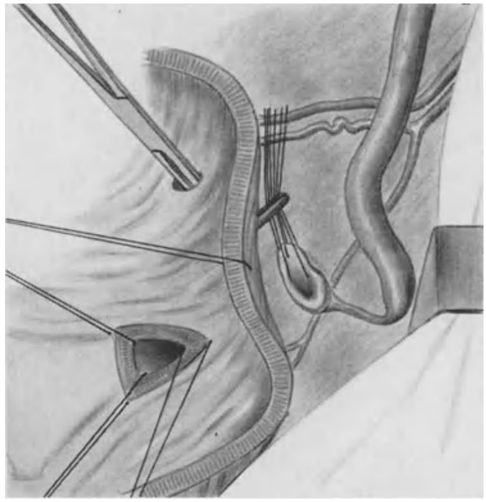
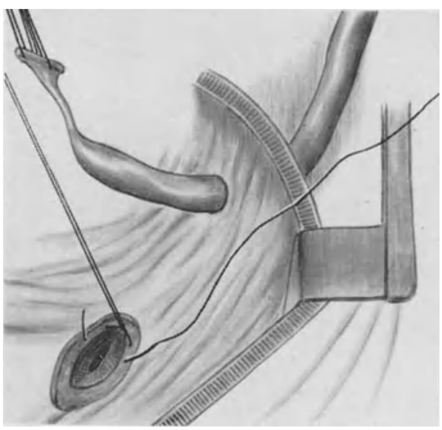


Fig. 193. Anti-reflux reimplantation by combined approach with resection of the terminal ureter (continued). Combined stage: passage of the ureter through the bladder wall



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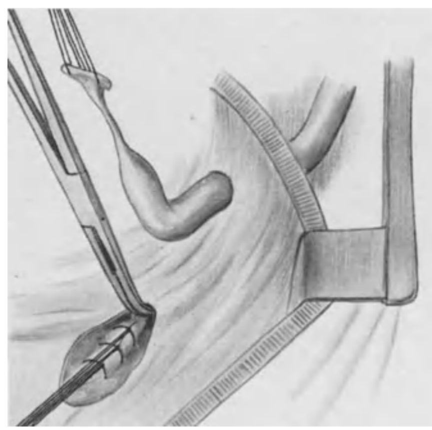

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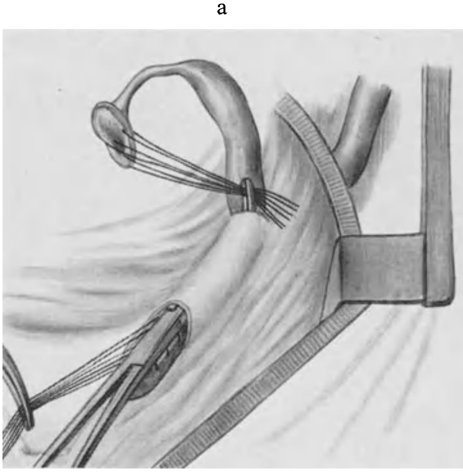

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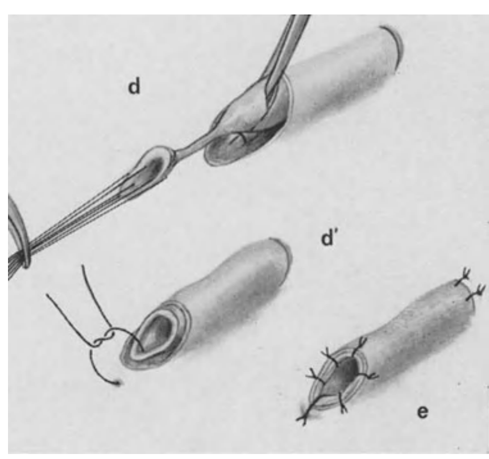
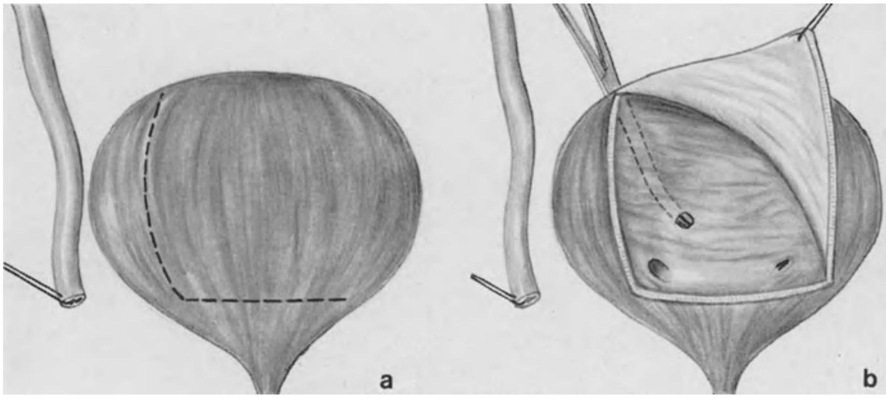


Fig. 194 a—e



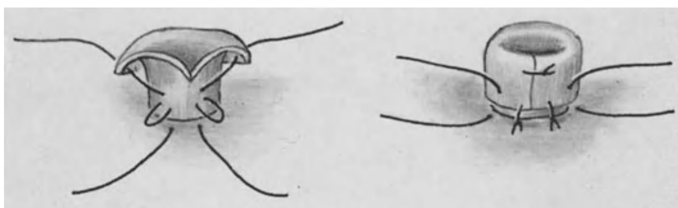


Fig. 195a—c. Paquin technique. (a) Bladder incision and division of the ureter. (b) Ureteral reimplantation (dissecting the tunnel). (c) Details of the suture of the end of the ureter

– the bladder is closed in a single layer with a small cystostomy catheter and drainage of the lateral vesical space.
– we do not normally leave any catheter in the ureter or in the urethra so as to avoid contact of any foreign body with the suture lines. The cystostomy catheter is removed about the tenth day and it may be advisable to leave the ureteral catheter in place for a few days after this.
– both ureters can be reimplanted in the same session: in such cases it is helpful to carry out all the intravesical manoeuvres first.

This operation has a very wide application. It can be used to treat stenosis of the ureteral orifice or more extensive strictures of the intramural or terminal ureter, as well as for the treatment of reflux. It is feasible whatever the state of the bladder wall (except with small fibrous bladders) and, more important, whatever the size of the trigone. The calibre of the ureter is not in itself a limiting factor so long as the intramural pathway is at least four times the diameter of the ureter; if the ureter is extremely dilated it is quite simple to do a re-fashioning resection.

2.Paquin's Technique

differs in details but produces the same anatomic arrangement.

The ureter is divided flush with the bladder, leaving the original intramural ureter, and then reimplanted in another area after passing through a submucosal

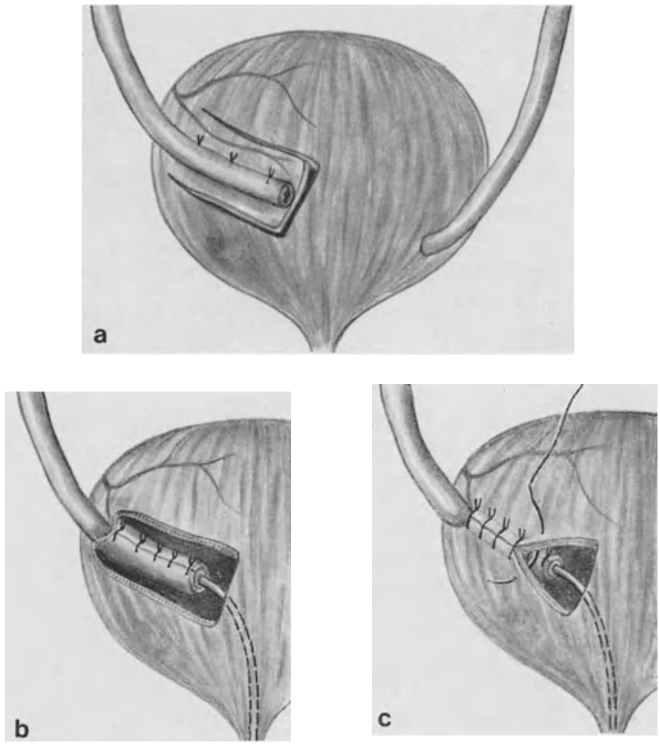


Fig. 196a—c. Mathisen procedure. (a) Construction of the bladder flap—section and placement of the ureter. (b) Construction of the intra-vesical opening. (c) Beginning the bladder suture

tunnel formed from a new orifice placed further up and back. At the anastomosis of the ureter with the new mucosal orifice, a small nipple is formed by cuffing the end of the ureter (this is easier to do if a longitudinal slit is made on the avascular side of the ureter) (Fig. 195).

3. Mathisen's Technique

The ureter is divided flush with the outside of the bladder. Then a muscle flap is cut in the lateral wall of the bladder with its base posterior and above. This flap is sutured in a sleeve around the end of the ureter, like a sort of reversed Boari (Fig. 196). The bladder wall is closed over the sleeve so that the end of the ureter forms a spout projecting into the lumen of the bladder.

The last two techniques are less commonly used but they enable the surgeon to resect lesions of the terminal part of the ureter and the reported results are satisfactory.

2. General Therapeutic Indications

In vesico-uretero-renal reflux, the therapeutic indications are very complex for two main reasons; firstly, there is a great variation in the urinary tract lesions (megaureters or normal ureters, ureteral meatus normal or diseased, reflux may be primary or secondary to a lesion of the bladder neck or urethra); the conditions vary in children and in adults, the state of the bladder wall is very variable and in some cases there are neurologic disorders—all these variations account to a great extent for the great variety of techniques suggested; the second reason is the frequent uncertainty about the exact effects of reflux on the function of the kidney above although this is the fundamental problem that must determine the line of treatment.

A decision about the need for surgical treatment of reflux requires an attempt to answer many questions. Might the reflux disappear spontaneously or with simple medical treatment? Is reflux always harmful to the kidney? Should all cases of reflux be treated surgically, and, if not, which should be so treated? If surgery is indicated, what influences the choice of one particular technique rather than another? What are the results of surgery in the treatment of reflux?

A. When is Surgery Indicated?

The problem is somewhat different in children and in adults.

a) In Children

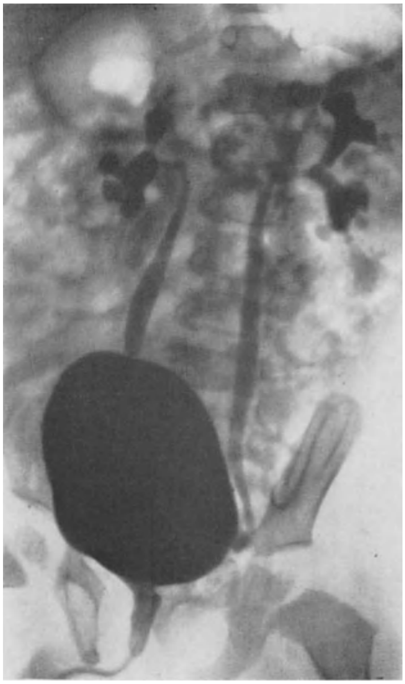
Reflux in children can be classified into four main groups that pose different therapeutic problems.

1. "Pure" or "Simple" or "Isolated" Vesico-Ureteral Reflux

This is reflux into an apparently healthy ureter with no obvious abnormality of the upper urinary tract. It may be due to a congenital or to an acquired lesion of the uretero-vesical junction.

The congenital lesion is essentially a lack of length in the intramural ureter. According to MIDDLETON, the mean ratio of the length of the intramural ureter to the diameter of ureter is 6.7/1 in normal ureters but only 0.75/1 in refluxing ureters. In some cases there is no intramural part, the orifice is wide and the ureter joins the bladder wall at a right angle. Similarly, any defect or congenital absence of trigonal musculature and consequent inadequate contraction during micturition leaves the ureter wide open and unsupported when the intravesical pressure rises. *Acquired lesions* can also cause reflux. Any urinary infection can cause trigonal inflammation that produces edema and a certain rigidity of the tissues with consequent incompressibility and patency permitting reflux.

The special feature of this type of reflux is that it may resolve spontaneously or with medical treatment. While infection may be secondary to reflux, it may also be the cause and then cure of the infection makes the reflux disappear. Even when the causal lesion is congenital, it may disappear with time. According to HUTCH, the intramural ureter grows from 5 mm in the neonate to 13 mm in adults.



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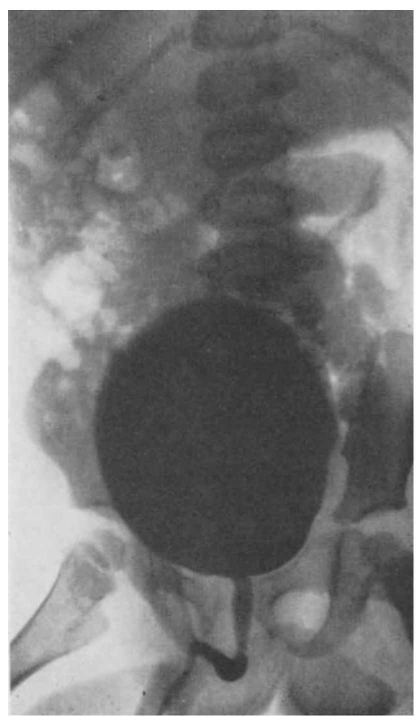
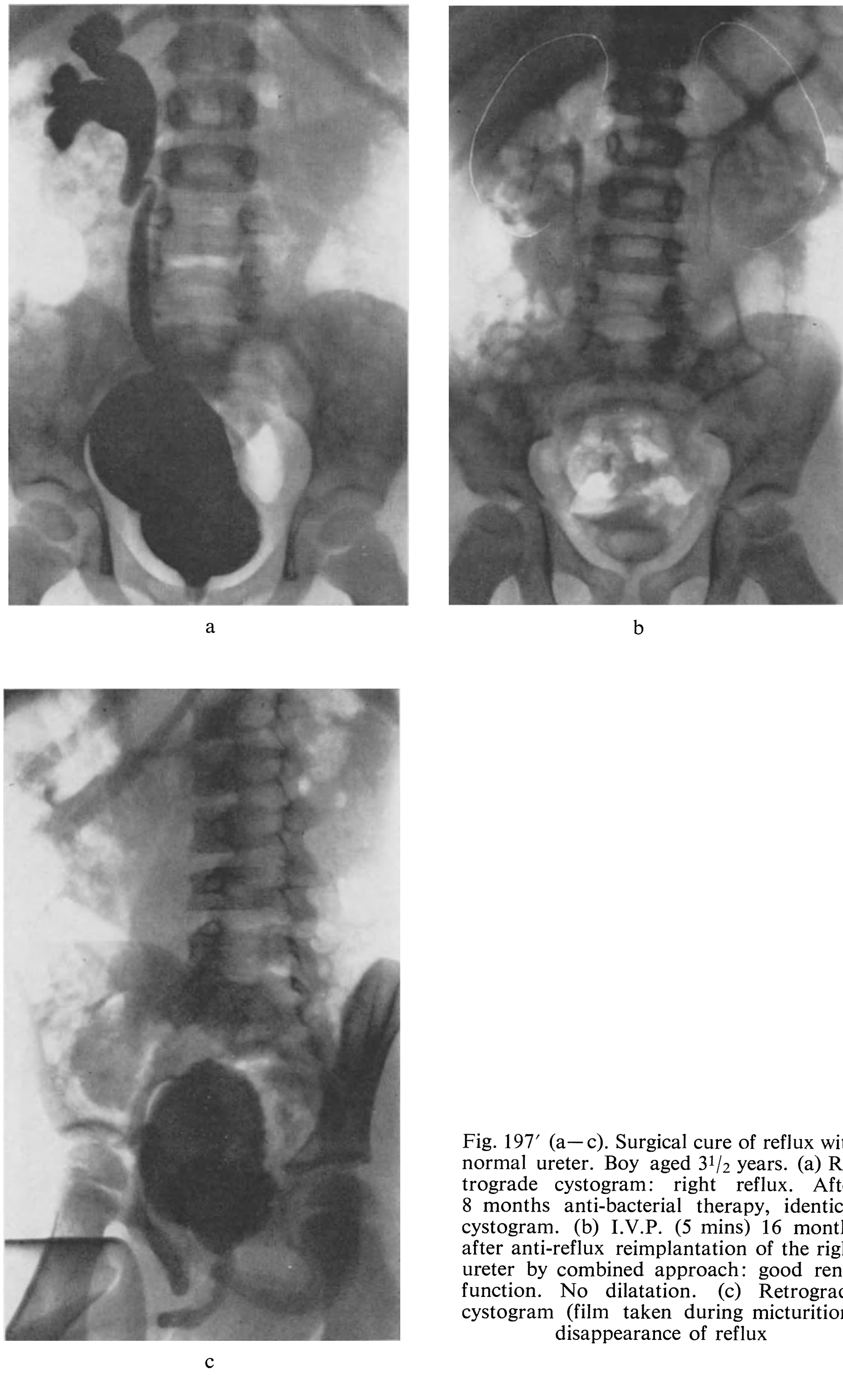


c

Fig. 197a—c. "Medical" cure of bilateral reflux with normal ureters. Boy aged 13 months. (a) Retrograde cystogram after an attack of infection: bilateral reflux. (b) Three months after sterilization of the urine: disappearance of reflux on the right. (c) 11 months after sterilization of the urine: there is no longer any reflux. Followed for four years without any recurrence of infection or reappearance of reflux



a b c

Fig. 197′ (a—c). Surgical cure of reflux with normal ureter. Boy aged $3^1/_2$ years. (a) Retrograde cystogram: right reflux. After 8 months anti-bacterial therapy, identical cystogram. (b) I.V.P. (5 mins) 16 months after anti-reflux reimplantation of the right ureter by combined approach: good renal function. No dilatation. (c) Retrograde cystogram (film taken during micturition) disappearance of reflux

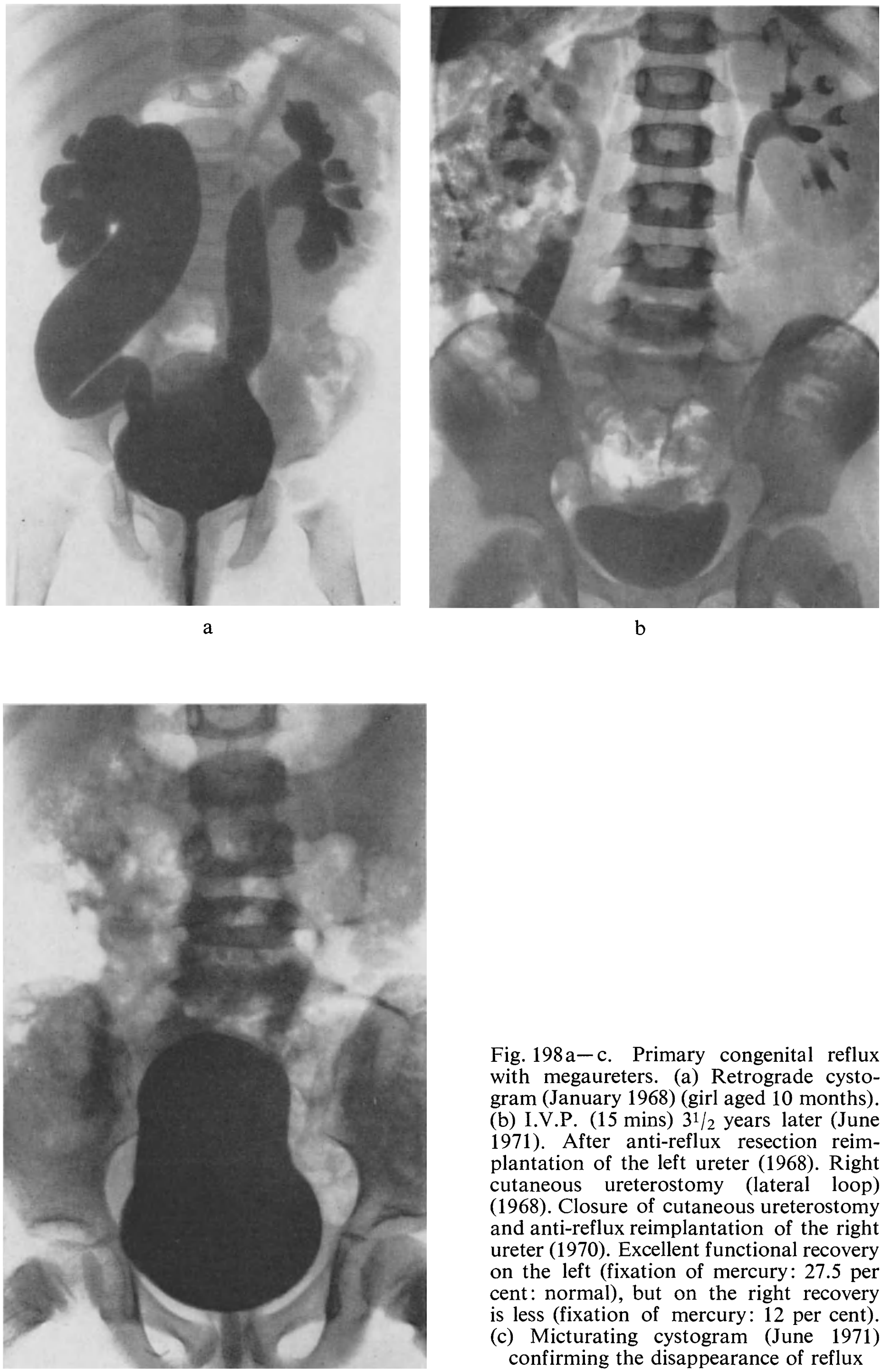
The shortness of this segment in very small children probably explains why infection very easily provokes reflux at this stage (and also explains the large number of cases found with enthusiastic retrograde cystography). It may be expected that with growth of the trigone the competence of the uretero-vesical junction will increase so that the same infection will no longer produce the same effect and the reflux disappears. It is obvious that the approach to this type of reflux should be very conservative with emphasis on the treatment of infection and careful medical supervision (Fig. 197).

There are certainly cases in which the lesions in the ureters, calyces and renal parenchyma leave no room for doubt about the harmful effects of the reflux (although judgement may be difficult if there are associated parenchymatous disorders such as dysplasia and segmental hypoplasia), or where wide, rigid ureteral orifices and the absence of any intramural segment leave little room for hope of "medical" cure of the reflux; in these cases corrective surgery is clearly indicated but, even here, an initial period of treatment of urinary infection is well worth while. In most cases, there is no evidence of any immediate threat to the upper urinary tract and no obviously irreversible lesion of the ureteral orifices. In such cases, surgery is not indicated; in the first instance, the urinary infection must be treated – at this stage it is not known whether the infection is the cause or the consequence of the reflux; it must be remembered that the normal growth of the trigone will tend to cure the reflux. After an interval of some months, the urologic investigation is repeated to discover whether the reflux has disappeared or still persists, to detect improvement or deterioration in ureteral dynamics and in kidney function. Peristent reflux, recurrent infection, ureteral deterioration and any loss of renal function, however slight, are then indications for surgery (Fig. 197′).

2. *"Primary" Congenital Reflux with Megaureter*

"Primary" congenital reflux, in which congenital abnormality of the uretero-trigonal musculature is apparently the primary and fundamental part of the malformation, which always includes megaureter, is a much more serious lesion. Although there are still many gaps in our understanding of this complex abnormality and although the exact relationships between the reflux, the megaureter and the kidney lesions are not clearly established, it seems that there is no possibility of spontaneous regression or amelioration and that surgical revision of the uretero-vesical junction is essential if progressive destruction of the renal parenchyma is to be prevented. Hence, surgery (unfortunately, not always "reconstructive") is nearly always indicated (Fig. 198). It should be said, however, that in practice it may be very difficult to be sure that the ureteral dilatation is in fact a congenital megaureter and not a loss of tone with fibrosis induced by infection. For this reason, it may be wise to treat infection and observe progress in many cases, but for only a short period.

The megaureter – megacystis syndrome is a special case. There is bilateral megaureter with massive reflux and a large atonic bladder that empties very poorly although there is no anatomic obstruction. The results of every type of reparative surgery are very poor in these cases.



a b

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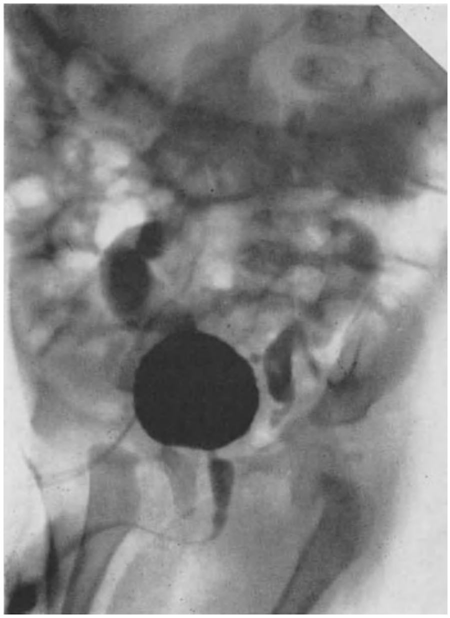
Fig. 198a—c. Primary congenital reflux with megaureters. (a) Retrograde cystogram (January 1968) (girl aged 10 months). (b) I.V.P. (15 mins) $3^1/_2$ years later (June 1971). After anti-reflux resection reimplantation of the left ureter (1968). Right cutaneous ureterostomy (lateral loop) (1968). Closure of cutaneous ureterostomy and anti-reflux reimplantation of the right ureter (1970). Excellent functional recovery on the left (fixation of mercury: 27.5 per cent: normal), but on the right recovery is less (fixation of mercury: 12 per cent). (c) Micturating cystogram (June 1971) confirming the disappearance of reflux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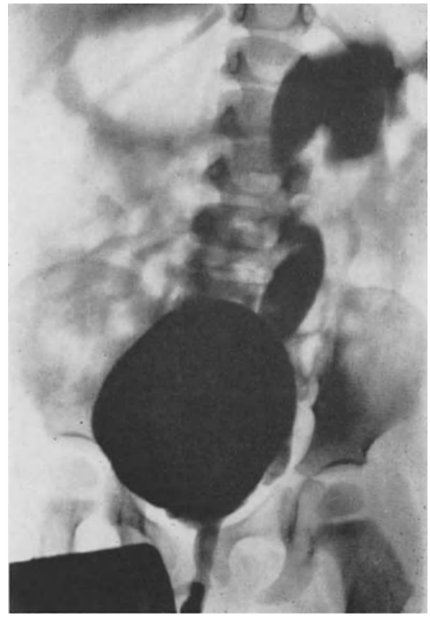
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Fig. 199a—c. Secondary congenital reflux (bladder neck obstruction). (a) Micturating urethrogram (February 1970) (boy aged $4^1/_2$ months): congenital bladder neck obstruction; bilateral reflux with megaureters. Considerable disturbance of renal function. (b) Micturating urethrogram 22 months after Y-V plasty of the anterior bladder neck (December 1971): on the right there has been no reflux for one year, on the left the reflux persists but with no pathologic consequences; complete and lasting sterilization of urine, progressive improvement in maximum specific gravity of urine (from 1011 to 1021), creatinine clearance: 98 ml/mn. (c) I.V.P. (10 mins) (December 1971)

3. Secondary Congenital Reflux

This is the result of congenital obstruction in the lower urinary tract, such as bladder neck obstruction, valves in the posterior urethra and segmental atresia and diverticula of the urethra. The muscular decompensation above the obstruction involves the trigone and terminal ureter, producing as a secondary effect the conditions necessary for reflux. In very many cases, there is no need for any direct surgical attack on the reflux because this may disappear after removal of the obstruction. The obstruction must be treated in the first instance provided that the condition of the upper urinary tract is adequate. Anti-reflux surgery should not be considered for many months after correction of the obstruction by YV-plasty of the bladder neck or resection of ureteral valves (Fig. 199).

4. Neurogenic Bladders with Reflux

In children, neurogenic bladder is due to meningo-myelocele or to malformations of the sacrum. Although theoretically belonging to the previous category, the reflux in these cases presents special problems.

Excluding cases in which permanent diversion is indicated because of the severity of upper urinary tract lesions, the treatment of choice depends essentially on the possibility of recovery of bladder and sphincteric function. Anti-reflux surgery is often very disappointing in these cases because of the morphologic and functional changes in the bladder wall and it is never justified unless there is a very definite hope of functional recovery by re-education, replacement or stimulation.

b) In Adults

While there is no doubt that reflux can be very harmful in children, it is far from certain that the same is always true in adults. Prolonged reflux is perfectly compatible with preservation of normal renal function. A very striking example from our own experience is the case followed for 19 years summarized in Table 1. Even a diseased kidney does not necessarily deteriorate in the presence of reflux. We have monitored renal function for periods of 10 to 25 years in 15 patients with spontaneous or postoperative reflux and a diseased kidney (usually tuberculous). In only four was there any deterioration of renal function

Table 1. Reflux followed for 19 years. After Boari operation for uretero-vaginal fistula

I.V.P.		Retrograde cystogram	Scintiscan figures		Overall renal function		Separate renal function creatinine clearance	
			right	left	urea	plasma creatinine	right	left
1951	Dilatation of ureter, pelvis and calyces				27 mg per 100 ml			
1967	Normal	Left reflux			35 mg per 100 ml	0.8 mg per 100 ml	31.5 ml/mn	35.5 ml/m
							urine sterile	
1970	Normal	Left reflux	26.1% (N 27 ± 3.5)	26.4% (N 26 ± 3.5)	38 mg per 100 ml	0.7 mg per 100 ml		
							urine sterile	

Table 2. Evolution of renal function in 15 patients with acquired reflux and a solitary remaining kidney

Patient	Follow up (years)	Etiology	Eventual surgery	Initial blood urea mg per 100 ml	Latest blood urea mg per 100 ml	Latest plasma creatinine mg per 100 ml	Urinary infection
Bon	25	T.B. bladder neck				1.6	+
Pui	20	T.B.	Uretero-ileo-cystoplasty	37	45	1.9	+
Cha	18	T.B.		30	40	0.85	+
Faj	17	T.B.		37	70	5.2	+
Vig	14	T.B.	Ureterostomy followed by uretero-ileocystoplasty	50	65	1.8	+
Gra	14	T.B.	Ileocystoplasty	30	35	1.4	+
Caz	13	T.B.		35	25	1.8	+
Mar	13	T.B.	Cystoplasty	40	45	1.7	0
Mor	13	T.B.	Colocystoplasty	50	30	1.1	+
Gru	13	T.B.	Cystostomy then ileocystoplasty	40	60	3.2	+
Lev	12	T.B.	Uretero-ileo-cystoplasty	34	80	2.75	+
Lam	12	T.B.	Bladder neck resection		34	1.2	+
Caz	12	T.B.	Colocystoplasty	75	80	4.4	+
Col	11	T.B.	Colocystoplasty	40	35	1.7	+
Rey	10	T.B.	Colocystoplasty	30	45	1.5 (1.2 in 1957)	+

(Table 2). In fact, the various types of reflux found in adults have very different degrees of potential for kidney destruction (Fig. 200).

"Spontaneous" reflux associated with tuberculous or bilharzial lesions of the uretero-vesical junction may, as we have seen, be tolerated very well. In contrast, the reflux, often bilateral, associated with small contracted bladders, (whether due to tuberculosis, bilharzia, chemical or physical damage or to interstitial cystitis) is nearly always infected and produced under high pressure and in most cases causes considerable damage to the kidney above and may even lead to the rapid development of pyonephrosis.

Reflux associated with neurogenic bladder is also very harmful.

"Acquired" reflux may follow many surgical procedures such as direct uretero-neo-cystostomy, operations of the "pull through" type, Boari-Küss vesico-ureteroplasty, entero-cystoplasty with direct reimplantation of the ureters and total entero-ureteroplasty. In such cases the reflux is often tolerated perfectly but this is not always so.

Two principal factors determine whether or not such reflux is harmful:

a) Infection

This is probably the most important factor: the attacks of acute pyelonephritis and chronic pyelonephritis lead to renal failure although the rate of deterioration

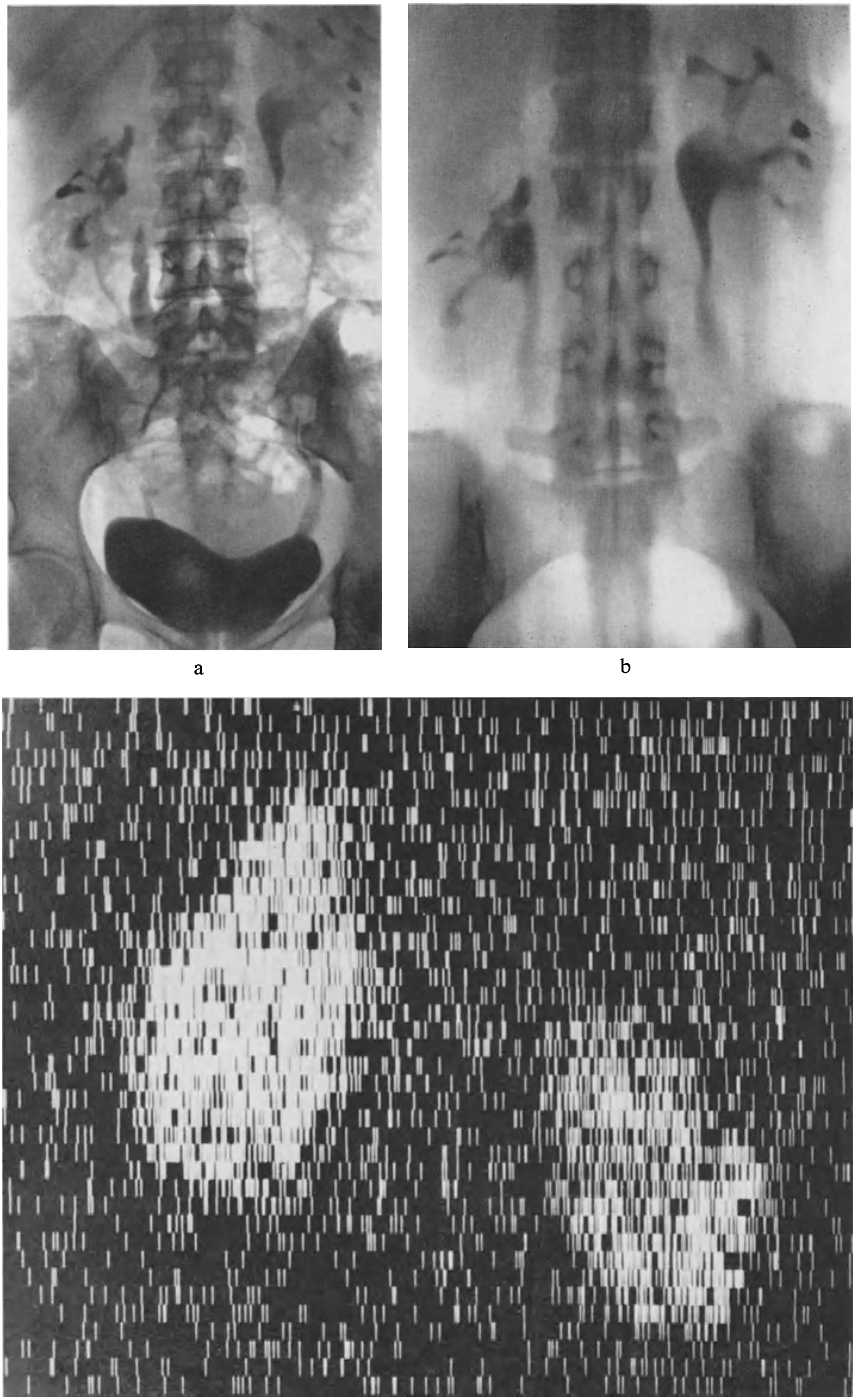


Fig. 200 a—c

of renal function varies greatly. The ureter is affected also: inflammatory lesions start in the submucosa and go onto affect the muscle layer; these go onto fibrosis and interfere with ureteral dynamics, thus aggravating the effects of the reflux.

b) Excessive Intrarenal Pressure

This may be continuous or may occur during micturition, depending on whether the reflux is passive or active. The severity, and consequently the harmful effects of this pressure, depend on many conditions:

The capacity of the bladder reservoir and the flexibility of its wall.

Small fibrotic bladders produce high pressure reflux with pressure peaks whose frequency increases as the capacity diminishes. In contrast, the intestinal graft of a large flexible entero-cystoplasty constitutes an expansion chamber that "absorbs" variations in micturition pressure: in such cases, the reflux has little pressure and is usually well tolerated. In hypertonic neuropathic bladders, on the other hand, reflux is much more dangerous.

The state of the ureteral wall.

A healthy ureter affords excellent protection to the kidney above; its peristalsis can counter pressure from below (as can the peristalsis of the ileal loop in total ureteroplasty). Progressive sclerosis of the ureteral wall, due to infection, and ureteral dilatation increase the risk that reflux will damage the renal parenchyma.

The patency of the lower urinary tract.

If micturition is easy and complete, reflux is much less harmful. But where there is any obstruction, whether due to bladder beck fibrosis, to excessive sphincter tone (neuropathic bladder) to ureteral stricture or to prostatic disease, the increased pressure, the stasis and consequent infection render the reflux much more serious. Thus "well tolerated" reflux, as in entero-cystoplasty, for example, must be kept under careful review as advancing age increases the possibility of lower urinary tract obstruction.

In summary, the discovery of vesico-renal reflux in an adult is not an indication for surgery, provided that there is no dysectasia or obstruction in the lower urinary tract. Surgery is indicated only if the reflux is causing damage to the kidneys. Attacks of acute pyelonephritis, loin pain with significant pyuria, dilatation of the ureter and calyces and deterioration of renal function are the indications for anti-reflux surgery. In the absence of such complications, treatment should be purely conservative but regular supervision of the patient is essential.

Fig. 200a—c. A case of vesico-ureteral reflux in an adult. Woman aged 31 years. Recurrent pyelonephritis. Bilateral reflux. The I.V.P. (a) shows that there is already parenchymal damage: on the right there is renal atrophy with almost complete disappearance of the upper pole, on the left there is a mixed collection of pyelonephritic lesions, again most marked in the upper pole. These lesions are even more evident on the nephrotomogram (b) and the renal scintiscan (c). Renal function is still adequate (blood urea: 47 mg per 100 ml; serum creatinine: 1.2 mg per 100 ml; endogenous creatinine clearance: 78 ml/mn). Anti-reflux uretero-vesical reimplantation eliminated the mechanical factor and the infection was subsequently cured but there is some danger that the pyelonephritic lesions may continue to evolve

B. If Surgery is Necessary, which Technique Should be Chosen?

Unfortunately, anti-reflux surgery is not applicable to all patients but must be reserved for cases where there is no more than moderate damage to the urinary tract and to renal function, where there is a good chance of recovery or at least stabilization.

When there is considerable uretero-renal dilatation, when ureteral peristalsis has been lost because of long standing infection and when there is serious disturbance of kidney function, the only possible treatment in the first instance is urinary diversion. If the lesions of the upper urinary tract are so far advanced that little recovery can be expected and if at the same time there is a serious disorder of the lower urinary tract, as in neuropathic bladder due to spina bifida, the best solution is permanent diversion by *transileal cutaneous ureterostomy*. But in most cases, direct *cutaneous ureterostomy* is the first step. This may be temporary or permanent depending on the degree of recovery of function. With megaureter in children in particular, lateral loop cutaneous ureterostomy, unilateral or bilateral, is indicated, protects kidney function and provides an opportunity to judge the possibility of recovery of ureteral and renal function and also makes possible sterilization of the urine; in favourable cases it may then be possible to perform anti-reflux surgery and re-establish continuity by simple ureterorrhaphy or segmental ureteral resection.

If one kidney is destroyed the only solution in *total nephro-ureterectomy*. Leaving a stump of ureter predisposes to infection like a neglected bladder diverticulum.

In favourable cases, when renal function is good, infection is controlled and the ureter is peristaltic and only moderately dilated, recourse can be had to one of the anti-reflux operations already described. The particular choice of technique will depend on the experience and preferences of the individual surgeon. We have attempted to define, in the preceding chapter, the advantages and disadvantages, the necessary conditions and technical limitations of each technique. Although we sometimes use the Hutch technique (mark 1) for pure reflux in tonic ureters, we generally prefer to resect the terminal ureter and reimplant it through a submucosal tunnel by a combined intravesical and extravesical approach, using our own modification of the Leadbetter-Politano technique.

Transuretero-ureterostomy may be an elegant solution in some cases.

Should anti-reflux surgery be supplemented by other surgery? It has been suggested that anti-reflux surgery in children should always be supplemented by resection of the posterior lip of the bladder neck or by YV-plasty of the anterior lip of the bladder neck in order to reduce outflow resistance. This is an unnecessary practice that may endanger continence and fertility; we have never performed supplemental surgery of this type.

Reflux secondary to or associated with lower urinary tract obstruction is an entirely different matter. The obstruction must be treated first by resection of posterior urethral valves, YV-plasty of the bladder neck or whatever is indicated in the particular case. Some urologists routinely perform anti-reflux surgery at the same time but in fact the reflux will disappear in a large number of cases after cure of the causal lesion. It seems more logical to wait and see what happens;

in a small number of patients, secondary anti-reflux surgery may be indicated for persistent, harmful reflux. Such problems are common in children but even more common in adults, especially with advancing age where bladder neck obstruction may produce reflux or aggravate a reflux that was previously well tolerated. Any such obstruction must be treated surgically at an early stage.

Ureteral duplication presents a special technical problem. There is often reflux in only one pyelon. If the corresponding renal parenchyma has little function, the best treatment is hemi-nephro-ureterectomy. If the relevant kidney parenchyma is functioning well there is a choice between uretero-pyelostomy or homolateral uretero-ureterostomy on the one hand and anti-reflux surgery on the other hand but the former would seem to be the simpler and more desirable procedure. If anti-reflux surgery is performed, the special technical difficulties are easily resolved if care is taken to dissect and reimplant the two ureters within their common sheath, in double-barrel fashion.

3. Results

It is easy to find statistics giving the success of the various techniques in preventing reflux. The figures vary considerably. In the United States, HUTCH collected figures from 232 urologists and in total there were 74 per cent good results, 16 per cent with persistent reflux and 10 per cent had developed stenosis. POLITANO reported 9 failures in a series of 100 patients followed for more than five years after surgery. INNES WILLIAMS, in 1964, reported 276 operations, with:

83 per cent success with the Hutch operation	(48 operations)
86 per cent success with the Williams operation	(14 operations)
21 per cent success with the Bischoff operation	(21 operations)
96 per cent success with the Leadbetter-Politano operation	(57 operations)
80 per cent success with the Paquin operation	(136 operations)

In the same year, CHAUVIN collected figures from French urologists and he reported that the failure rate of the principal techniques was:

BISCHOFF	32 per cent
HUTCH	20 per cent
GREGOIR	50 per cent
POLITANO	17 per cent

In 1970, we reviewed a personal series of 140 children with reflux. We had used the Hutch I operation only in limited cases but every one had been successful. 62 ureters had been reimplanted by our own technique: the reflux was cured in 87 per cent and there was only one stenosis.

Postoperative stenosis is not common but when it occurs it does more harm to the kidney than the original reflux. It must be detected at an early stage and treated by a second ureteral implantation, unless diversion or nephrectomy is indicated because of further deterioration of an already damaged upper urinary tract.

Unfortunately, anti-reflux surgery is not the whole of the treatment and disappearance of the reflux does not in itself ensure success. The actual benefit to the patient must be judged by several criteria:
- disappearance of infection.
- improvement of ureteral dynamics.
- improvement or at least stabilization of renal function.

This last point is fundamental but does not seem to have been studied in detail in any long series. We are in the process of such a study but the overall follow up is not yet sufficient for a truly objective conclusion. It is in fact very difficult to assess the results of anti-reflux surgery in terms of kidney function, especially in cases of unilateral reflux. The presence or absence of major abnormalities such as megaureter and the possibility of associated parenchymatous malformations such as renal dysplasia and segmental aplasia interfere with the measurement of renal function and the assessment of the significance of the reflux in any renal insufficiency. It is difficult to judge the effect of anti-reflux surgery on the evolution of the chronic pyelonephritis that is always present if, as so often happens, there are lengthy gaps in the postoperative supervision without proper kidney function studies. In children, the clinical cure of recurrent acute attacks, sterilization of the urine and return to normal growth give the urologist the comforting assurance that surgery has been beneficial in a large number of cases but in adults there is far more doubt about the indications for surgery and the benefit derived.

In conclusion, it may be said that while the indications for surgical intervention in a case of vesico-ureteral reflux are based essentially on the condition of the ureter (and failure to recognise altered ureteral dynamics is probably the cause of most failures after surgery), the result must be judged in terms of kidney function. More accurate investigation of ureteral dynamics is probably one of the most important factors in considering treatment.

IX. Surgery of Megaureter

1. Classification

Megaureter is not a clearly defined and limited pathologic concept. The term is used for all forms of congenital dilatation (PERRIN) and in fact it covers a large number of diverse anatomic lesions although it is true that the physio-pathologic consequences are very similar.

Is megaureter an intrinsic abnormality of the ureter itself or is it the particular response of the ureter in early life (including intra-uterine life) to obstruction lower down, whether mechanical or functional? This is the controversial question of "primary" and "secondary" megaureter.

Although there is an element of subjectivity in every attempt at classification, the concept of megaureter should, in our opinion, be broken down, distinguishing:

a) Malformation of the Uretero-Vesical Junction

where the megaureter appears to be secondary to a dynamic disorder localized to the lower extremity of the conduit. There are essentially four lesions that may be responsible:

– congenital stenosis of the uretero-vesical junction.
– congenital reflux.
– ureterocele.
– certain types of ureteral ectopia.

Ureterocele in children is relatively easy to recognise: it develops much more often at the opening of a duplex ureter than in a single ureter and, like *certain ectopic ureteral openings*, it produces mechanical stenosis with a megaureter above.

Congenital reflux, in which a defect of the uretero-trigonal muscle is the primary, essential phenomenon, is also associated with reflux that can be regarded as secondary.

Congenital stenosis of the uretero-vesical junction is a more complex problem. The ureteral orifice is normal and the terminal ureter is easily catheterized; the disorder is apparently purely functional, similar to congenital obstruction of the pelvi-ureteral junction. The megaureter revealed by urography looks primary at first sight because the dynamic obstruction is difficult to demonstrate. Even from a nosologic viewpoint the question is not clear. The absence of obstruction of the ureteral lumen does not in fact signify the absence of some disorder of the ureteral wall. GREGOIR and DEBLED made more than 3000 serial sections of 30 "primary" megaureters and they found that this "functional" abnormality was in fact associated with gross histologic changes in the texture of the terminal ureter; they classify these changes into four distinct groups—collagen hypertrophy, muscle hypertrophy, fibro-epithelial dysembryoplasia and complete dysembryoplasia. Thus the functional defect, acting like an obstruction, corresponds to anatomic lesions of the ureteral walls.

b) Megaureter Secondary to Lower Tract Obstruction

Congenital obstruction of the lower urinary tract affects the upper tract by way of acquired, secondary lesions of the uretero-vesical junction, either reflux produced by changes in the trigonal musculature aggravated by stasis in the bladder, or stenosis of the intramural ureter, gradually strangled by the muscle hypertrophy or fibrosis of the bladder wall caused by the obstruction below.

c) Primary Megaureter

is due to a congenital defect in the wall of the ureter without any obstruction below. It has been suggested that the genesis of this type of megaureter is a purely neurogenic mechanism, defective parasympathetic innervation of the terminal ureter (Swenson). It is possible that the neuromuscular lesions of the wall are more diffuse but their exact nature has not been determined. The clinical archetype is the megaureter-megacystis syndrome (Innes Williams).

Pelvic megaureter in adults should perhaps be included in this category. This segmental abnormality of the ureteral wall is not associated with any obstruction and may be completely harmless; it is often discovered late in life during the investigation of some other condition.

This suggested classification makes no pretence to be all embracing.

In practice, it is often impossible to make a clear distinction between the various possible lesions. The evidence for functional obstruction of the uretero-vesical junction is often doubtful. On the other hand, a true anatomic obstruction may be associated with congenital abnormality of the ureteral wall itself or even with disorders of the pelvis and calyces or renal parenchyma. It is often very difficult to establish the exact part played by each of these various factors.

This explains the multiplicity of suggested techniques and indications for surgery.

2. Surgical Technique

a) Total Nephroureterectomy

A radical solution, applicable to unilateral cases with renal destruction is *total nephroureterectomy* (cf. Chap. V). Simple nephrectomy, leaving the ureter behind, runs the risk of pyo-ureter in cases of uretero-vesical junction obstruction, of urinary fistula in cases of reflux and, at the very least, produces a cul de sac equivalent to a bladder diverticulum with the consequent risk of infection and stone. The entire ureter must be removed with the kidney in every case.

b) Cutaneous Ureterostomy

The palliative solution of cutaneous ureterostomy may be indicated because of renal insufficiency or gross changes in the excretory tract. This external diversion may be temporary, and lateral loop cutaneous ureterostomy (cf. Chap. VII) is a technique particularly well adapted to the megaureter of young children. If renal function and, more important, ureteral dynamics recover to a satisfactory degree, continuity can be re-established by simple segmental ureterectomy and end-to-end ureterorrhaphy. In very small children, it is often desirable to make the ureterostomy very high, using the upper lumbar ureter, in order to obtain more direct drainage and to keep the opening as far away as possible from fecal soiling and to avoid interference with subsequent surgery of the uretero-vesical junction. The urine is best collected in adhesive bags with an evacuation system and an anti-reflux valve, provided that care is taken to keep the surrounding skin in good condition. Where there is little or inadequate improvement in renal and ureteral function, this cutaneous ureterostomy may remain as a permanent diversion or it may be changed to a trans-intestinal cutaneous ureterostomy (cf. Sec. VII.3).

3. Conservative and Corrective Operations

constitute in fact the true surgical treatment of megaureter.

A. Operations Correcting the Malformation of the Uretero-Vesical Junction

are in our opinion the most important part of the treatment of megaureter.

a) Endoscopic Dilatation

of the intramural ureter, associated with steroid therapy, has been tried by some authors. This is an illogical procedure with a serious risk of introducing infection and of producing fibrosis. It should not be attempted.

b) Ureteral Meatotomy

consists in opening the bladder and incising the roof of the intramural segment with careful apposition of the cut ureteral and bladder mucosa. Used in the treatment of stenosing lesions, this operation is possible only if the terminal atretic segment is short. It opens the way to massive reflux in a dilated ureter and for this reason it is scarcely to be recommended. STEPHENS, however, has transformed congenital stenosis of the uretero-vesical junction into reflux with the aim of treating the reflux subsequently by a strict micturition discipline (double or triple micturition). The treatment of reflux in a megaureter can also be considered in isolation without interfering with the terminal ureter although this may be abnormal. The operations most frequently employed in these cases have been the *anti-reflux procedures* of the Bischof for Gregoir type, alone or combined with tailoring the pelvic ureter (cf. Chap. VIII).

In our opinion it is essential to resect the terminal ureter not only in the stenosing lesions, where the atretic zone is often several cms long, but also in cases of reflux because this zone is always abnormal. The operation that we emply most often is the *anti-reflux resection-reimplantation by a combined approach* (cf. Chap. VIII) *which may be combined with tailoring the pelvic ureter* (Figs. 201 to 204). When the atretic segment is short, GREGOIR performs *side-to-side uretero-vesical anastomosis* instead of reimplantation. This procedure has been criticised but the objections can be overcome if it is combined with Gregoir's anti-reflux procedure and care is taken to leave no cul de sac below the anastomosis.

B. Resection and Tailoring

It may not be sufficient to correct the disorder of the uretero-vesical junction. It is sometimes necessary in addition to correct the dynamic defect caused by anatomic changes in the ureter itself by *tailoring the ureter*, or *"reconstructive" ureteroplasty*.

In megaureter, all dimensions of the conduit are increased: in addition to dilatation of the lumen and thickening of the walls there is elongation that may be considerable. The elongated ureter develops kinks that may be very acute and become fixed by secondary fibrosis, often accentuated by segmental stasis of a considerable volume of fluid. For this reason, it is sometimes necessary to reconstruct the ureter to eliminate these relative stenoses and to diminish the capacity of the conduit.

a) Tailoring the Pelvic Ureter

The ureter is approached by a midline or lateral extraperitoneal incision and it is identified where it crosses the iliac cessels. With care to avoid damage to its blood supply, the ureter is dissected downwards as far as the bladder. In this pelvic region, a voluminous ureteral "pocket" is found more often than the numerous convolutions that are seen higher up. The ureter is opened and a silastic tube is inserted; this tube is usually brought out as a transvesical uretero-stomy in situ. A longitudinal strip of ureter is resected along the outer border and the cut ureter is sutured over the tube with closely placed, interrupted sutures of fine chromic catgut. The retroperitoneal space is drained. In children this operation is nearly always combined with treatment of the lesion of the uretero-vesical junction (congenital stenosis or reflux). The longitudinal tailoring is then only a supplementary procedure in the course of resection-reimplantation or whatever anti-reflux procedure is performed (Figs. 201 to 204).

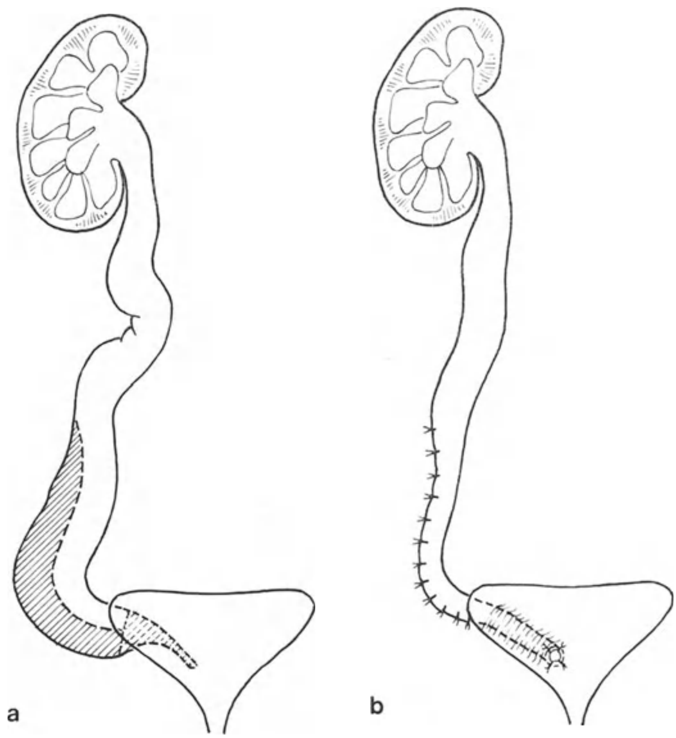


Fig. 201 a and b. Plan of resection and tailoring of the ileo-pelvic ureter with terminal resection and anti-reflux reimplantation. (a) Levels of section. (b) Result

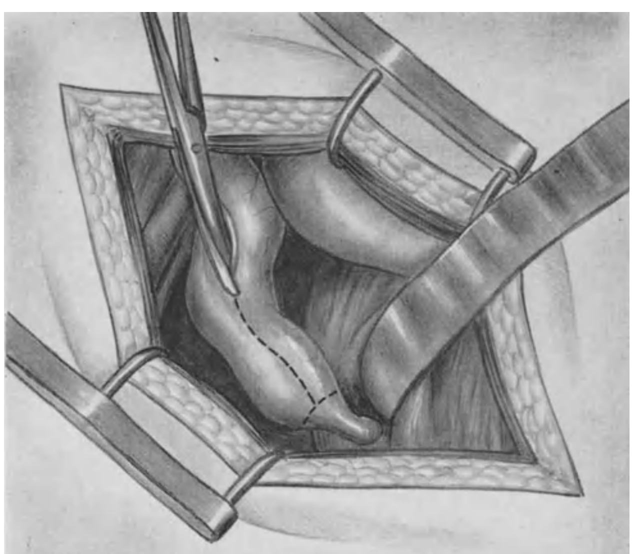


Fig. 202. Resection and tailoring of the pelvic ureter. The section

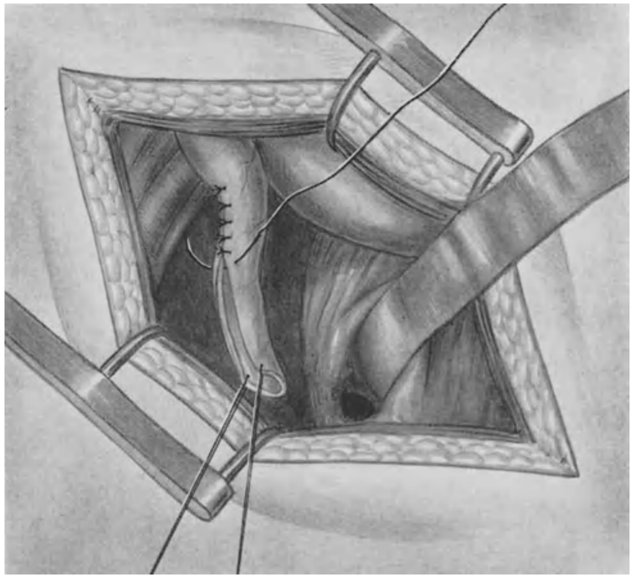


Fig. 203. Resection and tailoring of the pelvic ureter (continued). Beginning the suture

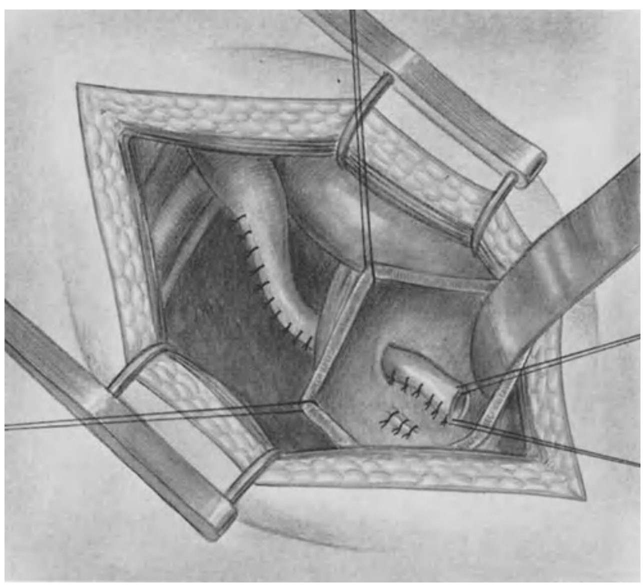


Fig. 204. Resection tand tailoring of the pelvic ureter (concluded). Reimplantation into the bladder in progress

HENDREN has given a very detailed account of his own technique for this operation, using specially designed instruments (Fig. 205). BISCHOFF has described a technique for tailoring the pelvic ureter in which the uretero-vesical junction is left intact (Fig. 206).

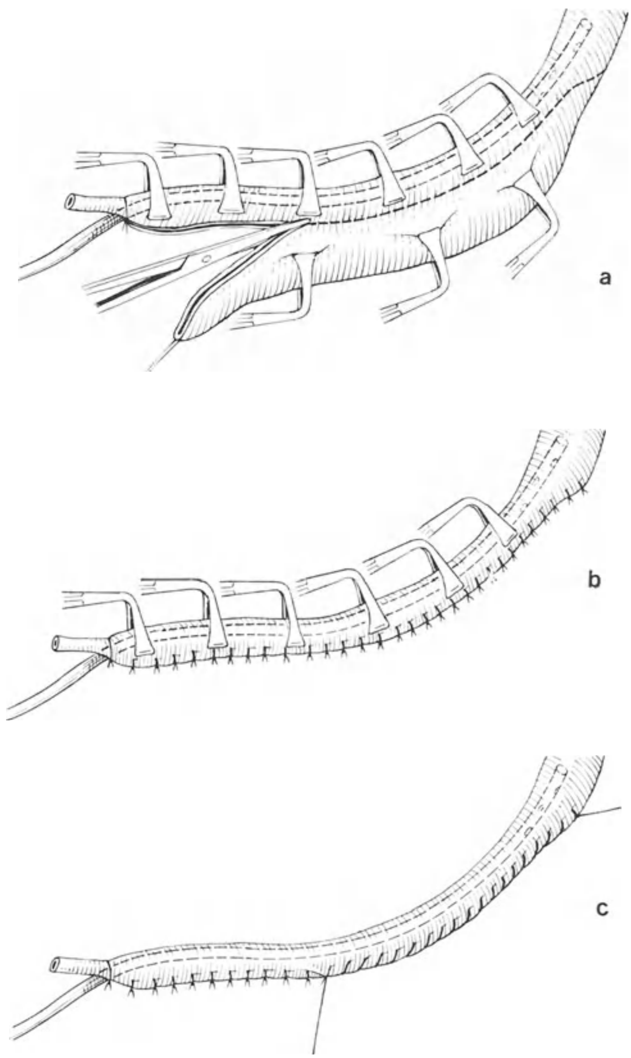


Fig. 205 a—c. Details of the Hendren technique (with his special instruments). (a) Section. (b) Suture. (c) Additional suture line

b) Tailoring the Lumbar Ureter

The upper ureter is approached through the loin or by BAZY's antero-lateral extraperitoneal incision. The ureteral tortuosities are dissected but complete liberation should be confined to the segment of ureter to be resected. Great care must be taken to preserve the blood supply of the pelvis above and the distal ureter below. The ureter is then tailored, if necessary, by resecting a longitudinal strip from the outer aspect, as far as possible from the meso-ureter which lies medially and posterior; it is important not to remove too wide a strip and

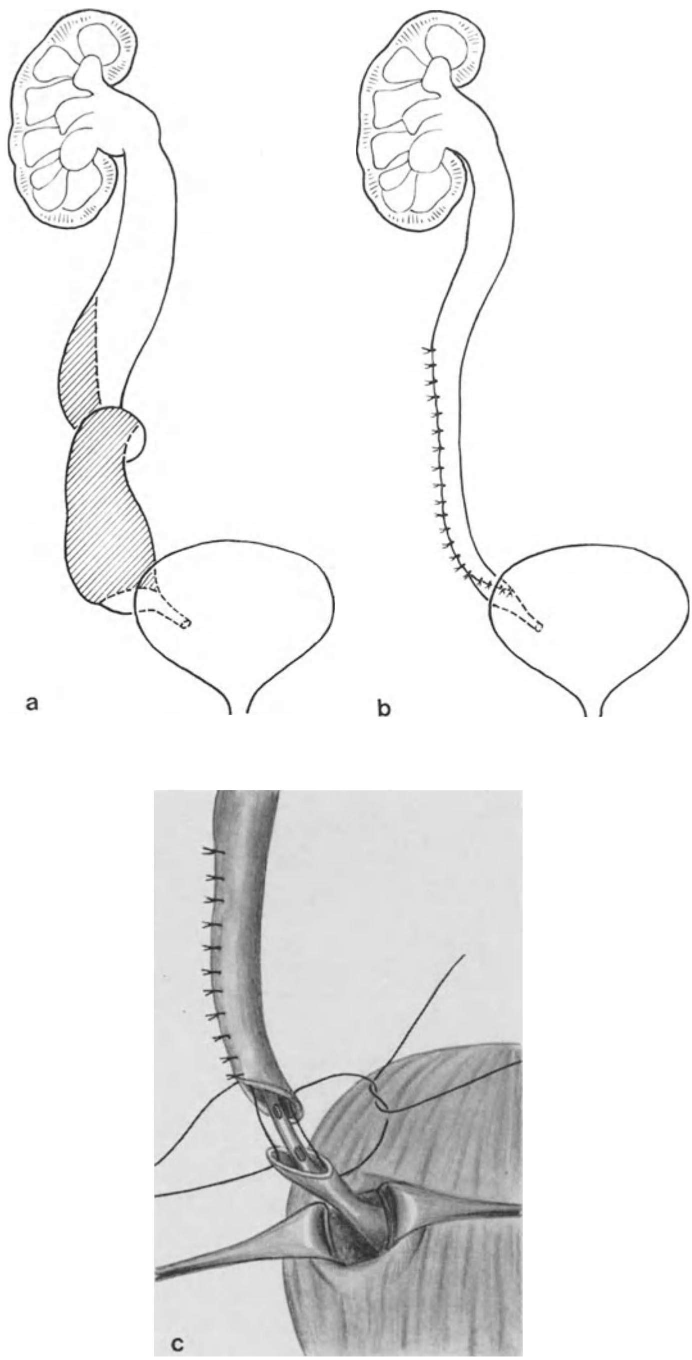


Fig. 206a—c. Resection and tailoring of the ileo-pelvic ureter by the Bischoff technique. (a) Extent of the resection. (b) Result. (c) Detail of the suture of the tailored ureter to the terminal stump left in place

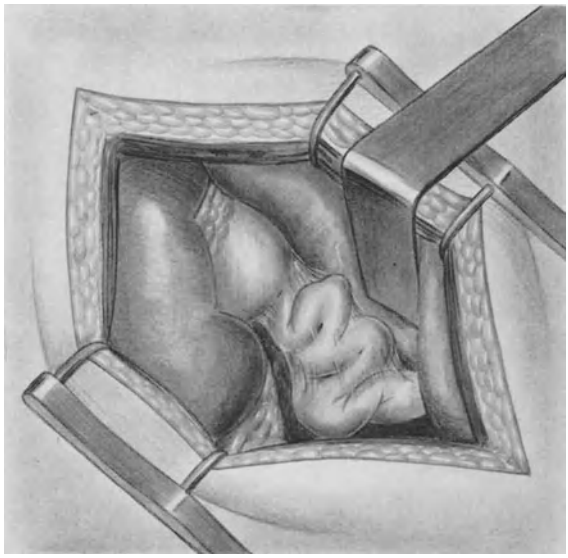


Fig. 207. Upper tract reconstruction by the Gregoir technique. Display of the lesions

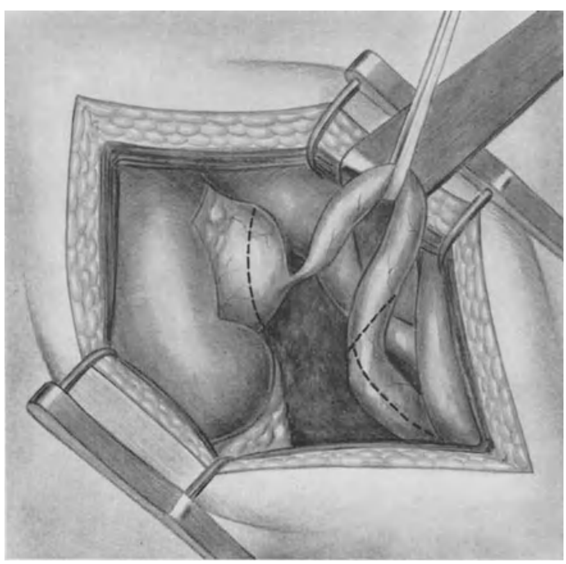


Fig. 208. Upper tract reconstruction by the Gregoir technique (continued). Section of the pelvis and freeing the ureter

to avoid any stenosis, even relative. It may also be necessary to resect a dilated renal pelvis and the uretero-pelvic junction. The ureter is reimplanted into the pelvis as described in Chapter IV. Interrupted 000 or 0000 chromic catgut is used for all sutures. Drainage is provided by a multi-eyed silastic tube brought

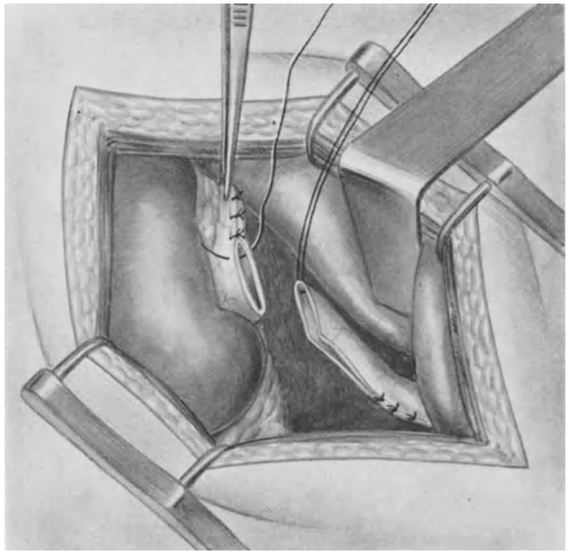


Fig. 209. Upper tract reconstruction by the Gregoir technique (continued). Beginning the pelvic suture—longitudinal tailoring

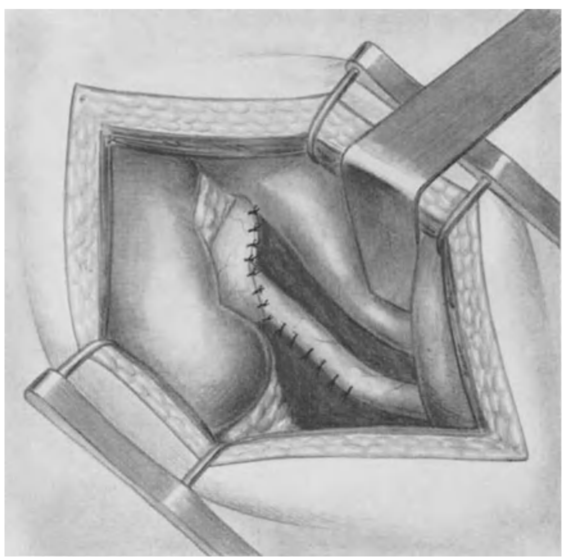


Fig. 210. Reconstruction of the upper tract by the Gregoir technique (concluded). Uretero-pelvic suture by the Küss technique

out through the lower calyx as a nephrostomy. The retroperitoneal space below the kidney is drained (Figs. 207 to 210).

It is impossible to lay down any precise rules about the extent and site of resection or the need for tailoring the remaining ureteral segment because of the great variety of possible lesions. Each case has to be considered on its own merits. At the end of the procedure, a ureter of reasonable calibre, running a straight course but without tension. should be reimplanted into the lowest point of a renal pelvis of acceptable volume.

C. Ureteral Replacement

Replacement of the ureter may be indicated in *pelvic megaureter in adults*, when there is serious damage to the ureteral wall due to stone and infection. The segment of ureter may then be replaced by a tubed bladder flap of the Boari-Küss type or by a pelvic ileo-ureteroplasty.

In children, on the other hand, replacement of a megaureter is an extreme operation, rarely indicated. It presupposes that the severity of the ureteral lesion is such that any reconstruction of the ureter is impossible while the kidney above is still sufficiently good to justify preservation.

1. Total ureteral replacement by a very long tubed bladder flap ("total Boari") is technically possible under certain conditions. It is often possible in children because of the very large size of the bladder, the abdominal situation of the bladder and the shortness of the trunk. It has been used too seldom (chiefly in treating certain cases of giant hydronephrosis) to give an accurate opinion about the results).

2. Total entero-ureteroplasty, more particularly ileo-ureteroplasty, has been used and advocated for the treatment of megaureter principally by Swenson. At a first stage he isolates and tailors the ileal graft, reducing its circumference to $^1/_4$ and at a second operation he removes the megaureter and attaches the graft to the renal pelvis and to the bladder.

After an experience of more than 13 years in adults, we can attest to the good function of the ileal neo-ureter, the preservation of function in the kidney above and the low incidence of electrolyte disorders, at least in the absence of renal insufficiency. Tailoring the graft and dividing the operation into two stages may be an unnecessary refinement.

But the legitimacy of routine replacement of a megaureter by an ileal graft is far from proved. Most megaureters contract vigorously, if not effectively, and over the years there has been little proof of the "neurogenic" theory of megaureter. In our opinion it is better to regard ileo-ureteroplasty as an operation of necessity, indicated to deal with the failure of other procedures rather than by pathogenic concepts.

4. Indications for Surgery

It would be vain to attempt to lay down general rules for the treatment of megaureter. There are too many unknowns and too many variables in the very concept of the malformation to allow any clear enunciation of principles of treatment. It is possible, however, to lay down same practical guide lines. The problem is very different in children and in adults.

A. In Children

a) Is Surgery Indicated for All Megaureters?

Opinions vary. Some authors consider that early and extensive surgical repair is necessary in every case of megaureter (HENDREN). Other workers, disappointed by the too frequent mediocre results of reconstructive operations, rely on medical treatment of the urinary infection with little place for surgery which is reserved only for the complications: "surgical intervention is indicated when stones are present, when infection cannot be controlled and when dilatation is progressive" (INNES WILLIAMS).

In our opinion, there is no indication for surgery in at least two types of lesion:

– Stenosis of the uretero-vesical junction perfectly tolerated in older children, uninfected, with only moderate ureteral dilatation and normal kidney function, does not necessarily require surgical correction. The physician may be content to watch the situation, ready to intervene as soon as any complication develops.

– In the megaureter-megacystis syndrome, many and varied attempts at surgery have failed, including ureteral reimplantation, translocation of the ureter into the psoas muscle or into the wall of the intestine, sympathetic surgery and resection of the bladder neck. No worthwhile result has been achieved with any of these techniques. and it would seem prudent at the present time to confine treatment to the treatment of any infection with no attempt to improve urinary dynamics.

Apart from these special cases, surgery should be considered in most cases.

b) Surgical Tactics and Technique

These depend essentially on the state of the ureter and the condition of the kidney above.

1. Function of Kidney and Ureter

If kidney function is good and the ureter remains tonic and contractile, we prefer to resect the terminal ureter, whether there is reflux or stenosis or any ureterocele, and to make an anti-reflux uretero-vesical reimplantation by a combined approach. Others, such as GREGOIR, use side-to-side anastomosis combined with anti-reflux surgery by an extravesical approach.

Is it necessary to do more and to "tailor" the megaureter, in whole or in part? There is a great divergence of opinion on this question. BISCHOFF, with his technique of "deployment, shortening and tailoring" of the pelvic megaureter, with reconstruction of the upper ureter in some cases, attaches primordial importance to this stage in treatment and he then reimplants the tailored megaureter into the juxtavesical ureteral stump without any attempt to correct the functional disorder of the uretero-vesical junction. The diametrically opposite opinion was expressed by BOEMINGHAUS in 1960 at the French Congress of Urology: "in young patients any plastic remodelling of the ureter is a totally unnecessary exercise". The essential step is the exclusion of the diseased zone of the ureter; cure of infection and the process of growth will then cement a good final result. In our opinion, tailoring is rarely indicated, only when there is a very dilated ureteral segment with gross stasis and acute kinks, producing relative but definite obstruction. But in most cases, and especially in very young children, removal of the terminal obstruction is enough and there is every hope that during the normal process of growth the morphology and especially the function of the ureters will return to near normal.

Secondary reflux poses a different problem. Some authors advise that in every case ureteral reimplantation should be combined with treatment of the obstruction. Except where preliminary diversion is indicated, it seems more reasonable to begin by treating the obstruction in the lower urinary tract by resection of valves of the posterior urethra, or YV-plasty of the anterior lip of the bladder neck or resection or dilatation of congenital stricture of the urethra or a urethral diaphragm. Unfortunately, improved bladder emptying does not always resolve the problem of the megaureter above. Certainly if there is reflux, the clinical and functional improvement and the relief from infection are often considerable. In cases of stenosis the problem is more complex and the megaureter often remains unchanged or may even get worse. After removal of the obstruction it may be necessary at a second stage to deal with the uretero-vesical junction and the megaureter itself.

Megaureter secondary to neuropathic bladder presents special problems. Functional re-education, pharmaco-dynamic therapy, nerve blocks and surgery of bladder innervation constitute the first line of attack. Surgical correction of megaureter in these cases should be avoided wherever possible and the place of surgery in these lesions is often limited to the cure of any reflux.

2. Kidney Destroyed

In other cases the kidney is already destroyed and the only treatment is nephroureterectomy. When the lesion is unilateral and the urinary tract on the other side is healthy, attempts to preserve a mediocre kidney with a very diseased ureter should be avoided at all costs: it is better to remove the infective focus and produce definitive cure by nephro-ureterectomy than to try urinary diversion which is often very unsatisfactory and adds, even if only temporarily, to the infirmity.

3. Good Kidney, Non Peristaltic Ureter

When the ureter is badly damaged but the kidney above is still functioning well, urinary diversion may be indicated and total replacement can be considered (HENDREN). In most cases the diversion will take the form of lateral cutaneous ureterostomy. After some months, or even years, it may be possible to judge the possibilities of recovery of renal and ureteral function with improvement of evacuation and cure of infection.

There are then many possibilities.

a) If there is adequate improvement in ureteral tone and contractility and in renal function, the ureterostomy may be closed with re-eastablishment of continuity after treating the lesion of the uretero-vesical junction.

b) If there is progressive development of pyelonephritis with serious diminution of kidney function and the excretory tract remains infected and adynamic, secondary nephro-ureterectomy is indicated if the disease is unilateral.

If both sides are affected, the only solution is permanent diversion.

Direct cutaneous ureterostomy may then be transformed into trans-ileal ureterostomy if kidney function is such that prolonged survival may be anticipated. If the ureter seems to have lost all its transport function it may be removed and replaced by trans-ileal cutaneous pyelostomy. In fact, the proper treatment of progressive renal failure in these children is probably kidney transplantation, providing not only a healthy kidney parenchyma but also a new and normal excretory tract.

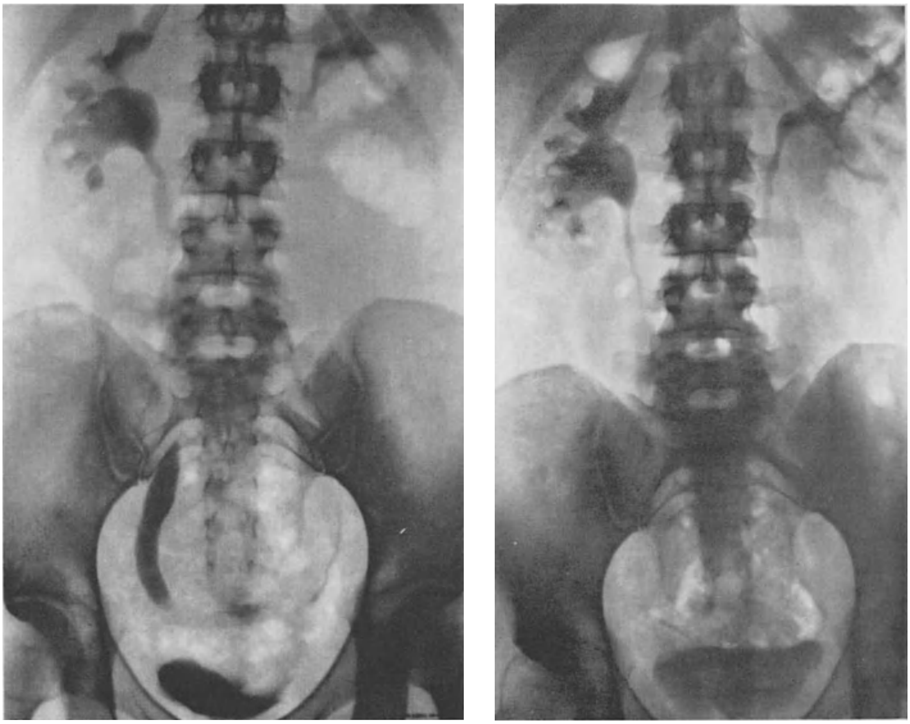
The problems are even more difficult if progressive renal atrophy coexists with an excretory tract capable of functional recovery. Reconstructive surgery may avoid the disability of external diversion in these children while they await kidney transplantation and this will not necessarily accelerate the progressive and inevitable deterioration of kidney function.

c) The final situation to be considered is one in which the kidney preserves or recovers very satisfactory function but the ureter remains dilated, adynamic and infected because the ureteral muscle has undergone irreversible fibrous degeneration. The therapeutic decisions merit discussion. If the lesion is unilateral, nephro-ureterectomy is immediately curative, whereas preservation of the kidney (excluding any idea of permanent unilateral diversion) will require total entero-ureteroplasty, a much more serious and more complicated operation with an uncertain result and requiring prolonged supervision.

If the disease is bilateral, it is certainly acceptable, if this will produce better kidney function, to maintain permanent diversion which, to be logical, should exclude the ureter and make use of an intestinal graft (trans-ileal cutaneous pyelostomy). It is a more attractive proposition to remove the entire ureter and to reconstruct the excretory tract by total entero-ureteroplasty but these operations are less certain in their results in children than in adults.

B. In Adults

Here the therapeutic problems are very different. Congenital stenosis of the uretero-vesical junction that has been clinically silent during childhood may be discovered in adult life. At this stage it is relatively easy to judge the effect on the kidney. Sometimes the kidney is destroyed and it is a simple matter to decide on removal. Bilateral disease may have arrived at the stage of renal failure; in the absence of functional disorders or infectious complications there is little indication for surgery. It may be too late for diversion, in which case the only therapeutic indication is for medical control of the renal failure while awaiting transplantation. In other, more fortunate cases the megaureter causes no clinical problems; there is no infection and the kidney functions normally and empties



a b

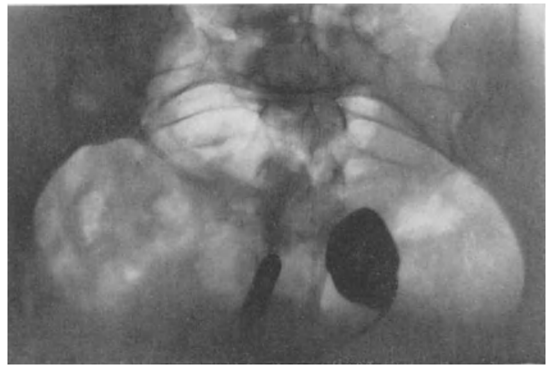
Fig. 211a and b. Pelvic megaureter in an adult. (a) I.V.P. (20 mins)—woman aged 22 years. Recurrent right pyelonephritis. Infected pelvic megaureter with micro-lithiasis. (b) I.V.P. (20 mins) 6 months after resection—reimplantation. Little change in the morphology of pelvis and calyces but good emptying of the pelvic ureter; disappearance of all symptoms; urine sterile

well; here again there is no indication for surgery. A functional balance between the kidney and its excretory tract has been established and, to say the least, it would be imprudent to interfere. Any plastic surgery on the urinary tract may be complicated by infection and this is an additional argument in favour of conservatism.

a) Isolated Pelvic Megaureter

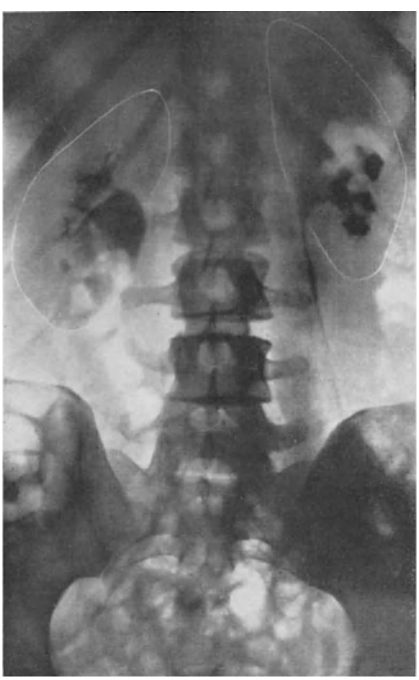
in adults is a particular case. No obstruction can be demonstrated and the "pocket" in the pelvic ureter, which can be vast, a pure abnormality of the ureteral wall, produces no clinical manifestation during childhood in most cases. It is discovered in adult life during investigation of some infection or of symptoms due to stone arising in the kidney and then lodging in the dilated terminal ureter. Surgery is indicated only when complications arise. If the ureteral wall has retained its flexibility, tailoring of the pelvic ureter may suffice. If the ureteral wall is very damaged by infection or prolonged contact with stone and there is extensive peri-ureteritis it is better to replace the pelvic ureter and then a tubed

a



b

Fig. 211′a—d. Total megaureter in an adult. (a) I.V.P. (90 mins): left megaureter. (b) Retrograde ureteropyelogram demonstrating the causal lesion; congenital stenosis of the ureterovesical junction. (c) I.V.P. (25 mins) 5 years after left Boari-Küss operation. Excellent function of the left kidney; no dilatation. Clinically completely normal. (d) Nevertheless, retrograde cystogram demonstrates reflux which is tolerated perfectly



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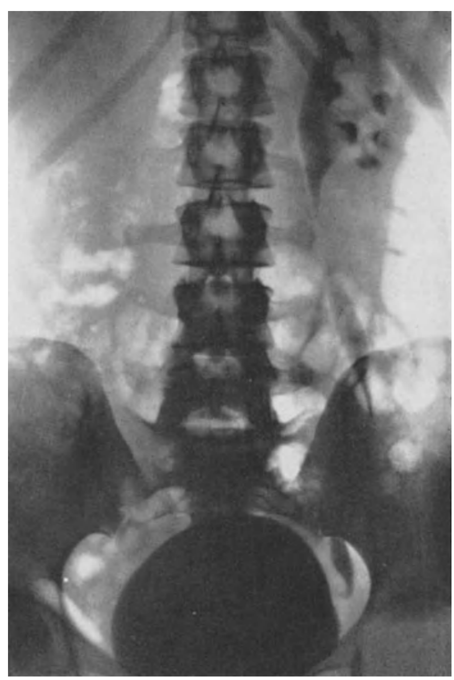

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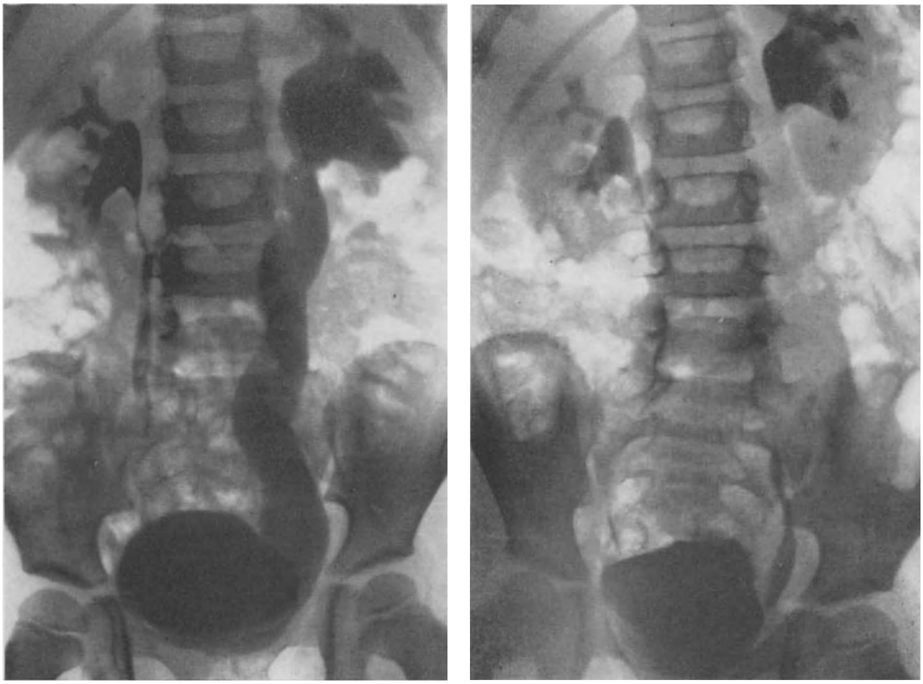


a b

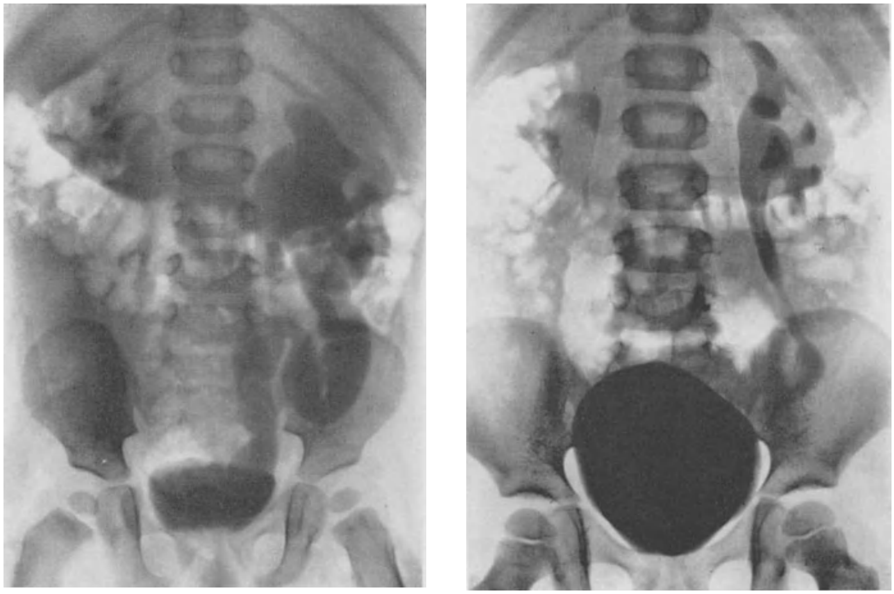
Fig. 212 a and b. Infantile megaureter (congenital stenosis of the uretero-vesical junction). Girl aged 4 years. Recurrent urinary infection. (a) I.V.P.: left megaureter; congenital stenosis of the ureterovesical junction. (b) I.V.P. 2 years after resection of the uretero-vesical junction and anti-reflux reimplantation by a combined approach without any tailoring of the megaureter. Disappearance of all clinical signs. Parallel improvement in mercury fixation

bladder flap is usually the most suitable procedure (Fig. 211) (cf. Chap. VI). Partial entero-ureteroplasty need not be considered unless there is concomitant disease of the bladder wall (cf. Chap. VI).

5. Results

It is very difficult to assess the results of the surgical treatment of megaureter, for three reasons:

– Firstly, there is a great variation in the types of lesion and, above all, in their severity: the degree of damage to renal function (varying from slight disturbances of tubular function to gross disorder of glomerular filtration); the presence or absence of associated lesions of the renal parenchyma (dysplasia, segmental hypoplasia); the extent of the histologic lesions of the ureteral wall and the degree to which they affect ureteral dynamics, and the amount of infection and the extent to which it is treatable and curable. All these factors mean



a b

Fig. 212′a and b. Therapeutic result of infantile megaureter after temporary cutaneous uretero-stomy. Boy aged 1 year. (a) I.V.P. ($3^1/_2$ hrs): left megaureter secondary to congenital stenosis of the uretero-vesical junction. (b) I.V.P. (2 hrs) $3^1/_2$ years after temporary diversion by loop ureterostomy with a skin bridge followed by anti-reflux resection—reimplantation and re-establishment of continuity. No infection. Glomerular filtration 99 ml/mn. Maximum specific gravity: 1021

that every one of these little patients with a diseased urinary tract has to be considered as an individual problem.

– Secondly, the results can be considered in many terms: in terms of the new uretero-vesical junction, of the ureteral dynamics and of kidney function.

– The last problem is the multiplicity of techniques employed. Some authors have found the results so disappointing that they advise no more than medical management of infection and the treatment of any complications. Others are enthusiastic advocates of heroic surgery but the results in terms of function and long term follow up are not always expressed clearly. In purely mechanistic terms of restoration of the uretero-vesical junction, the results are very good. In 80 per cent of cases the new opening is patent without reflux (Fig. 212). Unhappily, this anatomic restoration is no guarantee of a good result if this is considered only in terms of improvement in the function of the kidney and ureter, or at least stabilization of the former and amelioration of the latter. Infection and the extent of the initial lesions of the renal parenchyma and of the ureteral wall are the predominant factors in prognosis.

In patients who need diversion or tailoring, good long term results are achieved in less than 60 per cent. The initial state of the ureteral wall is by far the most important prognostic factor (Fig. 212′).

X. Surgery of Ureterocele

Ureterocele is due to a developmental abnormality followed by distension of the "floor" of the intramural ureter but it can not be considered as a single entity.

Some, the so called "simple" ureteroceles, develop in a single ureter. They rarely have important pathologic consequences and for this reason they are seldom discovered before adult life.

Others involve one of two duplex ureters and affect the ectopic ureter corresponding to the superior pyelon. These "ectopic" ureteroceles are only one of the elements of a complex malformation of the urinary tract that is nearly always discovered during childhood because of the clinical complications.

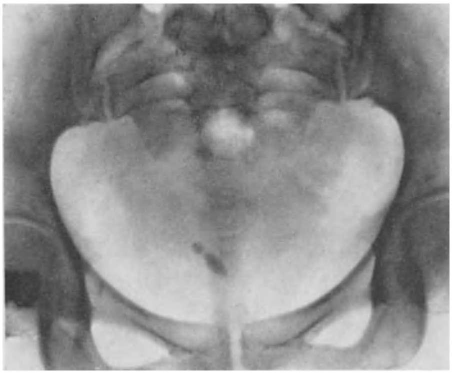
1. Simple Ureterocele ("Adult Type")

Some are discovered incidentally during routine urographic investigation. The characteristic club shaped dilatation of one or both terminal ureters is not associated in most cases with any dilatation of the ureter or kidney above. In the absence of clinical manifestations no treatment is necessary.

Others come to light in adults because of some complication such as stone trapped in the dilated terminal ureter or secondary infection (Fig. 213). In some rare cases, simple ureterocele is discovered in children or young adults, often huge and accompanied by megaureter above (Fig. 213′). In all these circumstances, there are two possible lines of action, either a limited endoscopic attack or a more extensive approach by open surgery.

a) Endoscopic Incision

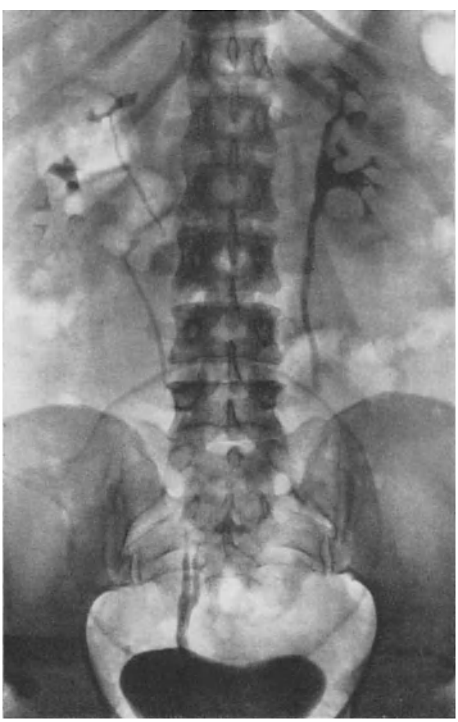
of the ureterocele simply and quickly resolves the problem of obstruction with secondary infection or of relief of trapped stones. Simple, linear, endoscopic incision may leave floating flaps that are better resected. But both incision and resection by the endoscopic route produce an undesirable vesico-ureteral reflux. If the ureter is not dilated and is contractile there may be no serious pathologic consequences in adults such as may occur in children and the reflux may even disappear after a certain lentgh of time. There are methods of preventing this reflux. Limited incision of the lower part of the ureterocele has been suggested but this is by no means certain to prevent reflux.



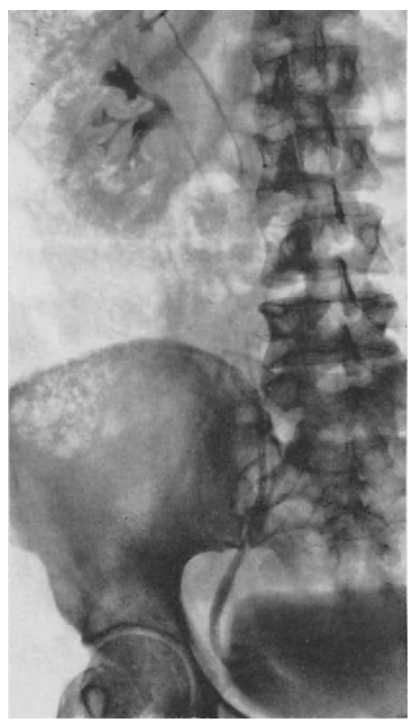
a

Fig. 213a—d. Simple ureterocele in an adult. Woman aged 45 years. Attacks of right renal colic, hematuria and repeated "cystitis". (a) Plain film: 2 stones in the bladder region. (b) I.V.P. (15 mins): the stones are in a ureterocele and this is of adult type despite the extensive duplication. (c) I.V.P. (15 mins) 10 days after surgery: excision of the ureterocele (ulcerated by one of the stones) and anti-reflux reimplantation of the ureter. (d) I.V.P. (20 mins) 10 months later: emptying is now normal; the submucous track of the ureter is clearly visible

b

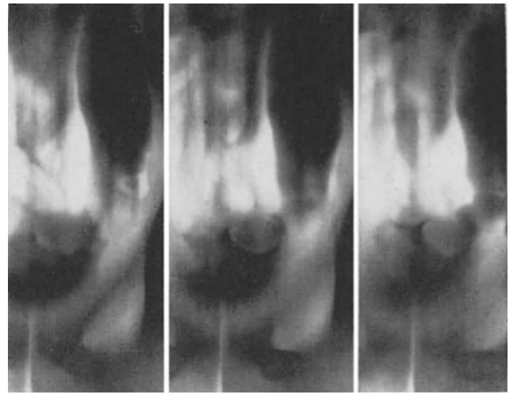


c



d

a



b

Fig. 213′a—c. Adult ureterocele with megaureter. Man aged 22 years. Left loin pain and pyuria. (a) I.V.P. (70 mins). Left megaureter with gross dilatation of pelvis and calyces; note the presence of a stone in the lower calyx. The lesion responsible is not positively identified. (b) Urotomogram of the lower ureter: it is a simple ureterocele. (c) I.V.P. (post-micturition film) one month after surgery: excision of the ureterocele and antireflux uretero-vesical reimplantation with resection and tailoring of the megaureter for 8 cm, and also removal of the calyceal stone. The same one year later. Clinically normal; urine sterile

c

b) Open Surgical Excision

is preferable when the ureterocele is large or the ureter is dilated. The approach is transvesical, through a horizontal or vertical suprapubic incision. The ureterocele is circumcised and removed completely. If nothing more is done there will be massive vesico-ureteral reflux and so this should be prevented by freeing the terminal ureter for several cms and reimplanting it with an anti-reflux procedure: the Leadbetter-Politano technique is the best adapted to this particular problem (Figs. 213″ to 217).

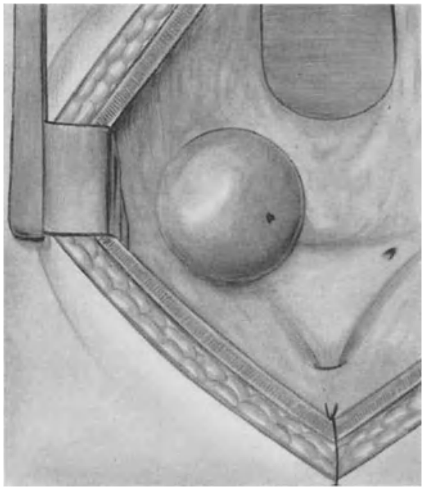


Fig. 213″

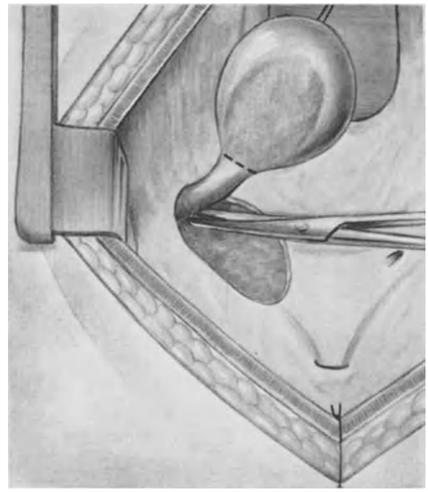


Fig. 214

Fig. 213″. Surgical cure of simple ureterocele. Surgical excision of the entire ureterocele with anti-reflux reimplantation of the ureter. Transvesical approach. Seen from within the bladder

Fig. 214. Surgical cure of simple ureterocele (continued). Dissection of the ureterocele at the terminal ureter

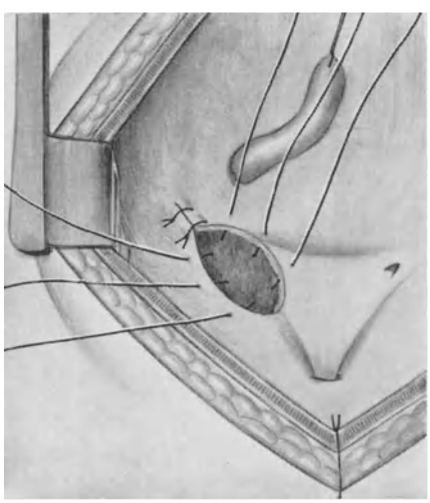


Fig. 215

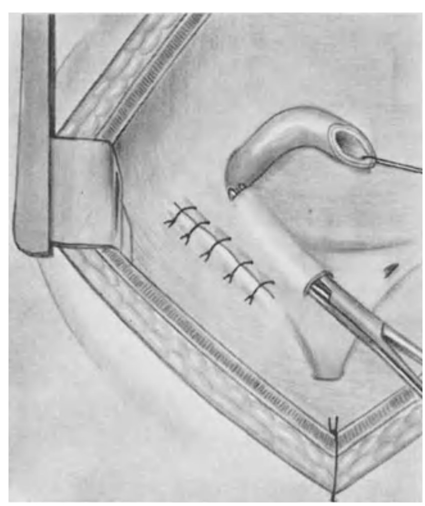


Fig. 216

Fig. 215. Surgical cure of simple ureterocele (continued). Suture of the bladder wound— beginning ureteral reimplantation (ureter passed through a new part in the bladder wall)

Fig. 215. Surgical cure of simple ureterocele (continued). Making the submucous tunnel

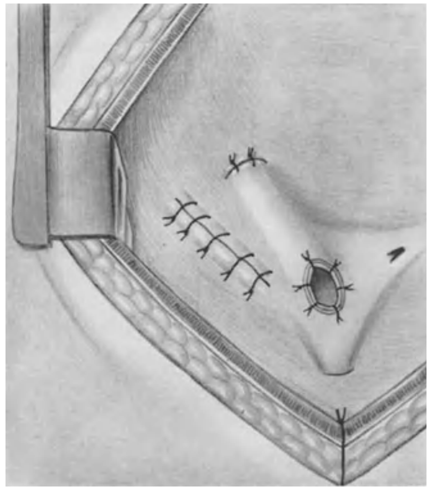


Fig. 217. Surgical cure of simple ureterocele (concluded). The reimplantation completed

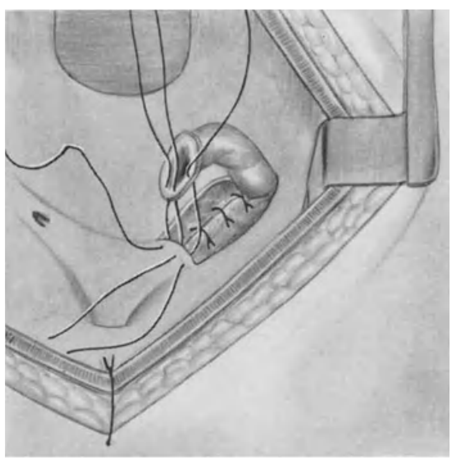


Fig. 218. Technique of HUTCH and CHISHOLM

c) The Technique of Hutch and Chisholm

has a somewhat different effect. The ureterocele is dissected out completely (including the "floor") and the ureter is freed from its attachments to the detrusor. The posterior gap in the bladder wall is sutured, the ureterocele dilatation is excised, preserving a mucous collarette attached to the tip of the ureter which is drawn into the bladder and sutured to the trigone. Suture of the bladder mucosa above this new terminal ureter completes the anti-reflux procedure (Fig. 218).

2. Ectopic Ureterocele ("Infantile Type")

The therapeutic problems in this type of ureterocele are much more complex because:

– the intravesical pocket may affect the bladder neck and the urethra and interfere with bladder emptying.

– the corresponding megaureter and upper pyelon may require treatment.

A. Excision of the Ureterocele

a) Transvesical Approach

This is a surgical excision of the "roof" of the ureterocele pocket. This follows the same plan as trans-vesical excision of simple ureterocele. Endoscopic resection should not be considered in such cases because the pocket is so big and its walls are thick and vascular and also because it is usually found in very young children. Simple incision produces large mobile flaps within the bladder cavity that may obstruct bladder outflow.

It is essential to resect all the projecting tissue of the ureterocele. The incision of the pocket begins at the upper, lateral aspect and is gradually extended to circumscribe the ureterocele. At the level of the ureteral meatus, care must be taken to avoid damage to the homolateral inferior pyelon; this usually lies above and laterally but may lie on the projecting part of the ureterocele and may be very difficult to identify; great care must be taken to avoid it (Fig. 219). The ureterocele may impinge on the bladder neck and here the operation becomes

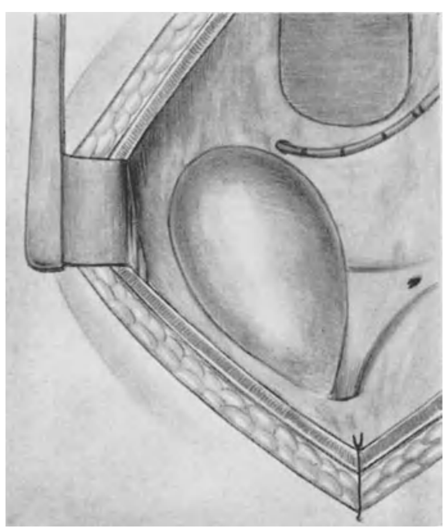


Fig. 219. Surgical cure of ectopic ureterocele—the bladder stage. Surgical excision of the cape (transvesical approach)—seen from within the bladder—the orifice of the lower pyelon is indicated by a catheter

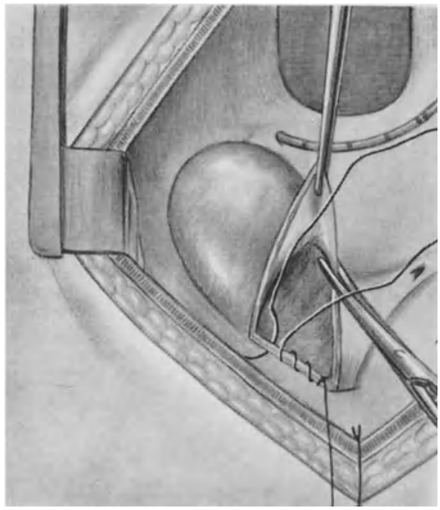


Fig. 220. Surgical cure of ectopic ureterocele—the bladder stage (continued). Section of the wall of the ureterocele

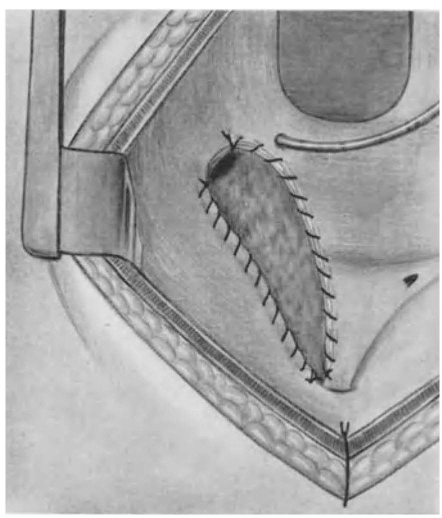


Fig. 221. Surgical cure of ectopic ureterocele—the bladder stage (concluded). Suture of the edges of the pocket

more difficult because it is more difficult to get a clear view and the tissues to be divided are thicker and more hemorrhagic. It is, however, essential to continue the excision to include the orifice, otherwise the resultant double channel effect may cause incontinence. Sometimes the ectopic orifice is very close to the urethral meatus (explaining the possibility of direct catheterization of the ureterocele) and a long lateral ureteral channel must be destroyed (Fig. 220).

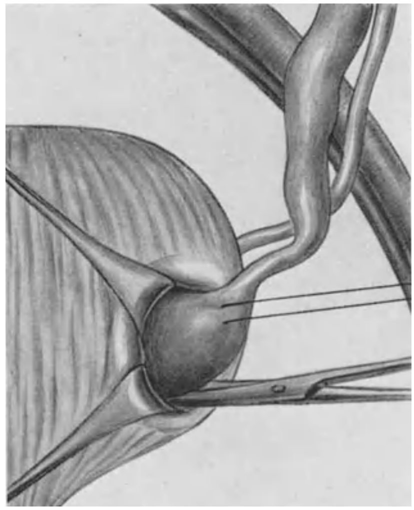


Fig. 222. Excision of ureterocele by extravesical approach

The difficulties may be even greater in bilateral ureterocele which, often asymmetrical, may straddle the midline, separating the bladder neck from the ureteral opening of the inferior pyelons. Hemostasis can be ensured by meticulous suture of the line of section with great care to avoid a nearby inferior ureteral orifice (Fig. 221). In girls, ureterocele may prolapse through the urethra and present strangulated in the vulva; emergency surgical excision is then required but the technical difficulties are extreme because of edema, necrosis and the drawing down of the adjacent bladder wall.

b) Combined Approach

The trans-vesical approach to ureterocele is not the only possible solution. Some authors advise beginning the dissection of the ureterocele by an extravesical approach and then completing the removal, which in these cases is complete, by transvesical division of the mucosa. The large gap in the bladder wall is then sutured (Fig. 222).

B. Treatment of the Upper Urinary Tract

The megaureter above a ureterocele and the superior pyelon may also require surgical treatment. This depends essentially on the function of the relevant upper part of the kidney. This can be assessed by intravenous urography, by a renal scintiscan and by separate function studies if previous elective cutaneous diversion has been employed.

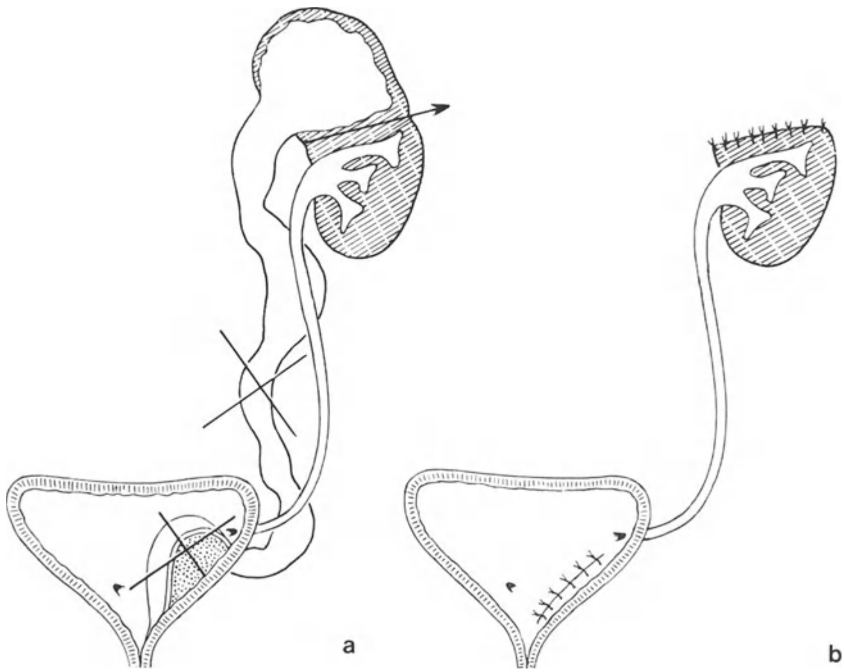


Fig. 223 a and b. Surgical cure of ectopic ureterocele—the "upper" stage. No significant function in the upper pyelon (as is usual)—total upper heminephroureterectomy and removal of the ureterocele. (a) The lesion. (b) The removal

a) Upper Heminephro-Ureterectomy

In most cases the upper renal segment has no or little value and is dilated and infected. Furthermore, there must be a strong suspicion of dysembryoplastic lesions (dysplasia) which are very common in these complex malformations of the excretory tract. *Upper heminephro-ureterectomy* is then indicated (Fig. 223). This requires two incisions, one in the loin and one in the pelvis. The entire ureter must be removed. At the lower end the two ureters are intimately united in a common sheath and, especially if there is fibrosis due to secondary infection, the dissection runs the risk of damaging the narrow, healthy ureter of the lower pyelon. The dissection must be performed with great care and it may be better to leave the terminal extremity of the abnormal ureter rather than risk damage to the all important normal ureter.

b) Conservation of the Upper Pyelon

In some cases there is still good function in the upper pyelon (or it has recovered after diversion). If the opposite kidney is diseased, it is all the more important to preserve this upper pyelon.

Two methods are possible:

– If the ureter is not much dilated and contracts well, it may be reimplanted But the close proximity of the healthy ureter of the inferior pyelon renders this

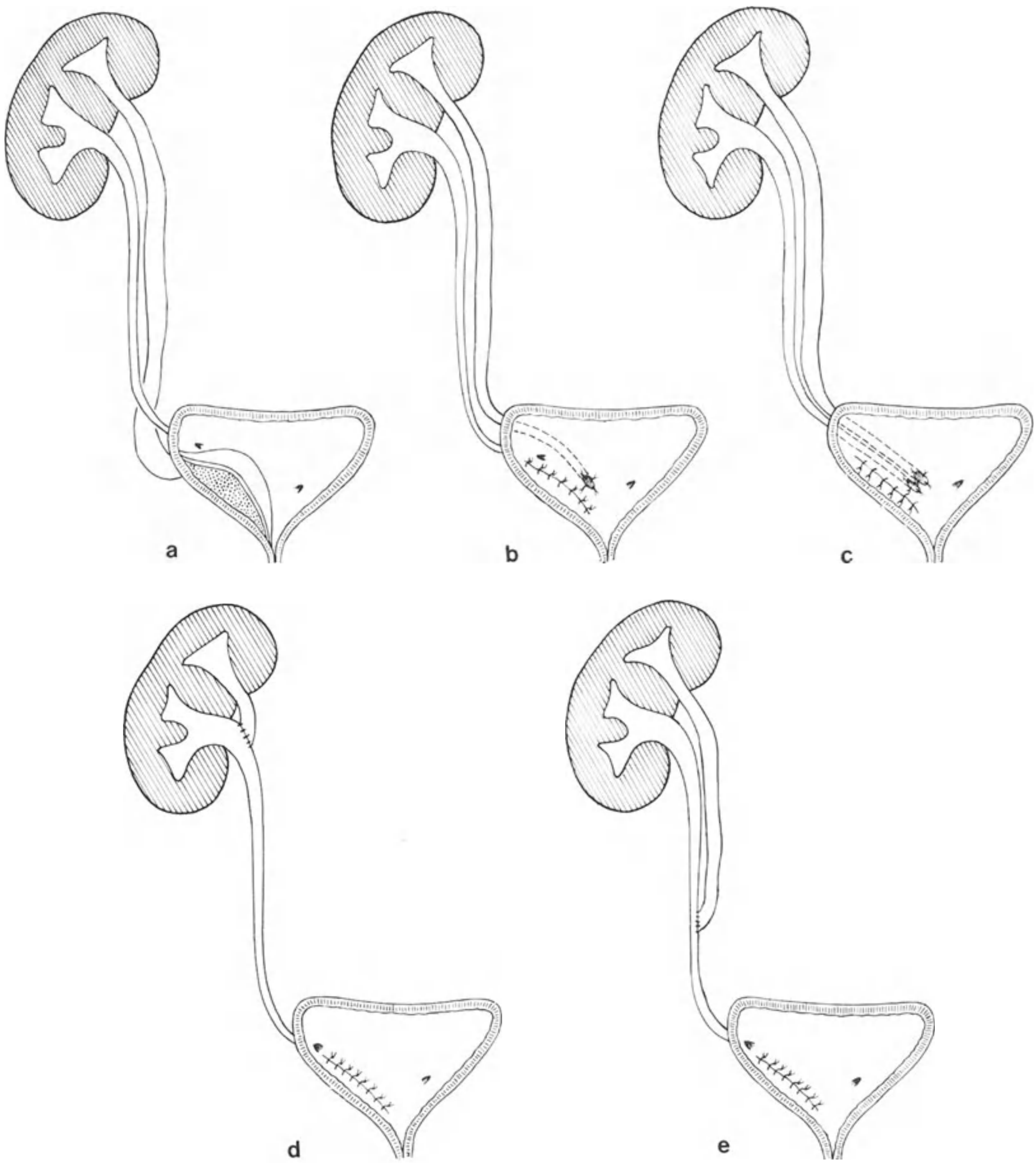


Fig. 224a—e. Surgical cure of ectopic ureterocele—the "upper" stage. Significant function in the upper pyelon (unusual)—the therapeutic solutions. (a) The lesion. (b) Removal of the ureterocele and anti-reflux reimplantation of the ureter. (c) Removal of the ureterocele and "double-barrelled" reimplantation. (d) Removal of the ureterocele and ureterectomy with ureteropyelostomy. (e) Removal of the ureterocele and ureterectomy with homolateral uretero-ureterostomy

technique difficult. "*Double-barrelled reimplantation*", with a common submucous path, is sometimes the only possible solution unless homolateral uretero-ureterostomy in the iliac region is possible.

– If the megaureter is very dilated with poor contractility it is better removed, preserving the upper renal segment by a uretero-pyelostomy (Fig. 224).

C. General Principles of Treatment

It is not always a simple matter to articulate the different stages of this surgical treatment and the sequence and nature of the surgery may have to be modified under certain circumstances.

1. *In the usual case* where there is no function in the upper pyelon the treatment is removal of the ureterocele and corresponding heminephro-ureterectomy.

Some urologists have performed simple heminephro-ureterectomy and have left the ureterocele itself alone on the assumption that the intravesical pressure would gradually eliminate the ureterocele; they have found no obstruction to bladder function, at least in the short term. Other surgeons have contented themselves with simple aspiration of the contents of the ureterocele while performing the ureterectomy. Because we have often seen, even in adults, obstruction of the bladder neck due to ureteroceles left in place, we feel that careful and complete removal, especially close to the bladder neck, is a better guarantee for the future.

Resection of the ureterocele creates massive reflux in the megaureter above and so, if the condition of the child permits, the entire treatment should be managed in one stage, through two incisions:

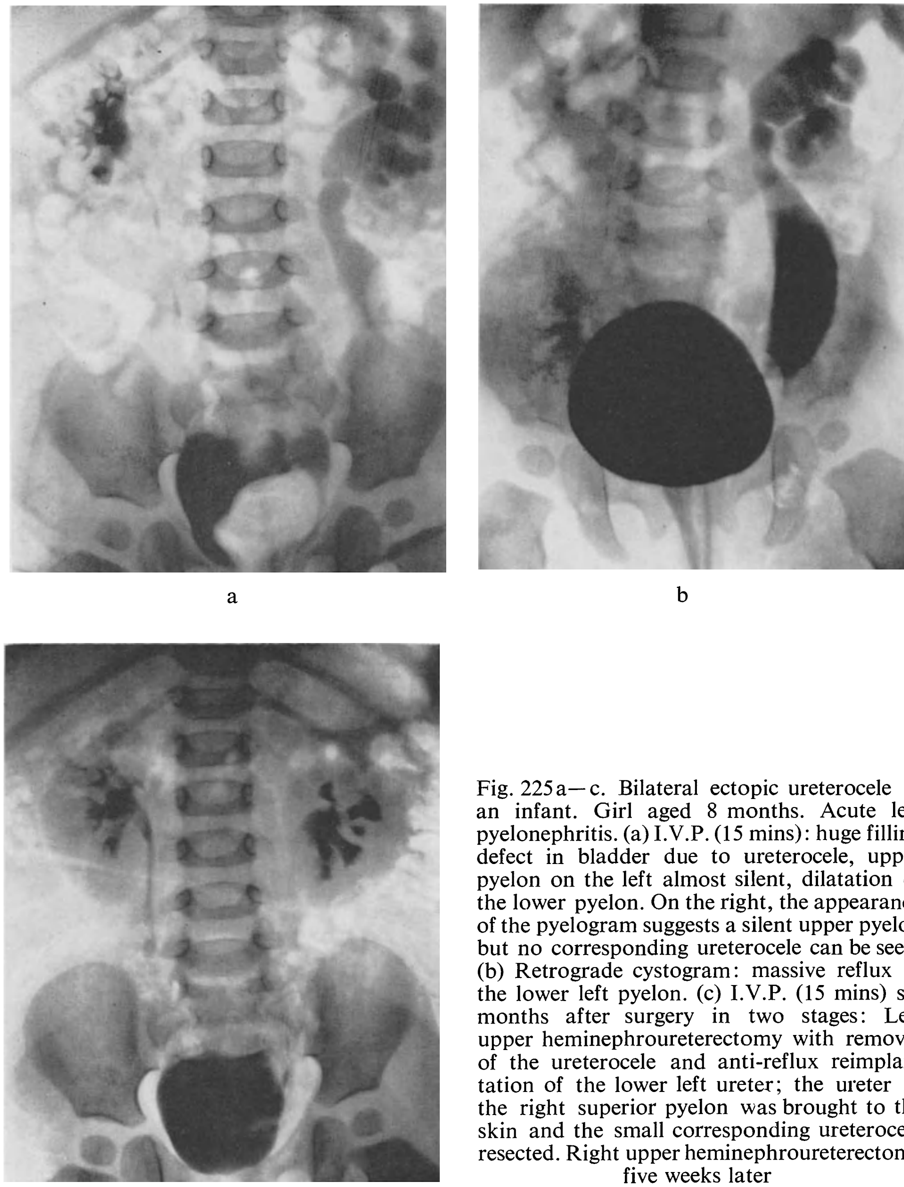
– a pelvic incision, with a combined intra-vesical and extra-vesical approach will allow removal of the ureterocele and terminal ureterectomy up as far as the pelvic brim.

– the loin incision allows removal of the upper renal segment and the corresponding ilio-lumbar segment of ureter.

This is a major surgical procedure, time consuming and sometimes bloody.

In very young children in poor condition because of recurrent infection or relative renal insufficiency, prudence indicates the need for operation in two stages. To begin with removal of the upper renal segment and corresponding upper ureter, leaving in place a large ureterocele and pelvic ureter, runs the risk of septic retention in the lower stump which empties poorly; the severe infection due to pyo-ureter may be aggravated still further by disorders of micturition due to inflammatory reaction around the bladder neck. On the other hand, to begin with removal of the ureterocele, creates an undesirable massive reflux of infected urine and two incisions are still necessary for the second stage. Removal of the ureterocele and terminal ureter with terminal cutaneous ureterostomy in the iliac region provides a reasonable solution in these difficult cases and it has the further advantage that a second stage requires only a single loin incision and, furthermore, after the first stage, it is possible to make an exact assessment of the function of the upper renal segment.

2. *When there is good function in the upper renal segment*, the heminephrectomy is replaced by uretero-pyelostomy or uretero-ureterostomy or, alternatively, the lower ureterostomy is replaced by an anti-reflux reimplantation of



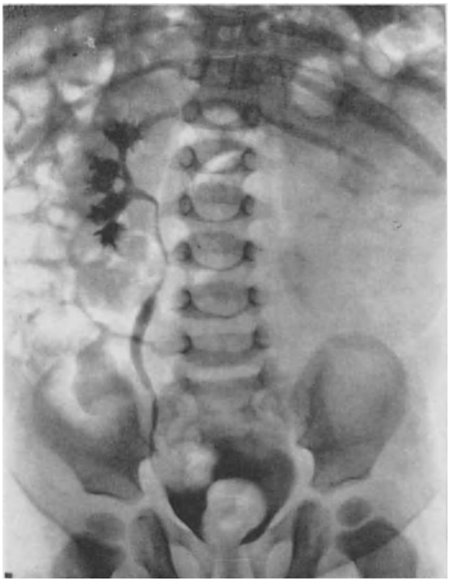
a b

c

Fig. 225a—c. Bilateral ectopic ureterocele in an infant. Girl aged 8 months. Acute left pyelonephritis. (a) I.V.P. (15 mins): huge filling defect in bladder due to ureterocele, upper pyelon on the left almost silent, dilatation of the lower pyelon. On the right, the appearance of the pyelogram suggests a silent upper pyelon but no corresponding ureterocele can be seen. (b) Retrograde cystogram: massive reflux in the lower left pyelon. (c) I.V.P. (15 mins) six months after surgery in two stages: Left upper heminephroureterectomy with removal of the ureterocele and anti-reflux reimplantation of the lower left ureter; the ureter of the right superior pyelon was brought to the skin and the small corresponding ureterocele resected. Right upper heminephroureterectomy five weeks later

one or both ureters. In the latter case, a single incision will suffice but in the former case two incisions are still required.

3. *Bilateral ureteroceles* pose the same problems, but a little more complicated. To correct the malformation in a single stage requiring three incisions would seem out of the question because the extra risks are not justified by any advantages. The vesical stage should deal with both ureteroceles and then, depending



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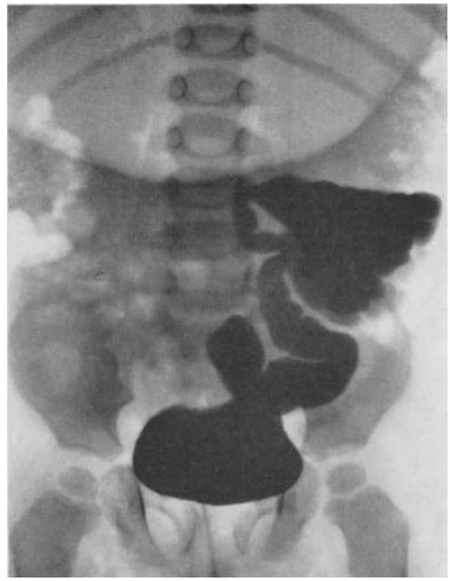

b

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Fig. 225′a—c. Unilateral ectopic ureterocele. Boy aged 19 months. Recurrent urinary infection. (a) I.V.P. (15 mins): filling defect in the bladder caused by ectopic ureterocele; the left upper pyelon is silent but the lower pyelon is also very dilated and function is very poor. The right kidney is normal. (b) Retrograde cystogram: massive reflux into destroyed inferior pyelon. (c) I.V.P. (15 mins) 8 years after total left nephroureterectomy. Following surgery, the child had no further urinary problems

upon the condition of the child, either both megaureters can be brought to the skin surface or one can be brought to the skin and treatment completed on the other side.

4. *The ureterocele may affect the inferior pyelon or the opposite kidney* by stretching and dislocation of the ureteral orifice, causing both compression and reflux. In such cases, nephroureterectomy is indicated if there is total destruction (Fig. 225) or anti-reflux reimplantation if function remains good (Fig. 225′). Therapeutic decisions may be difficult, especially in bilateral disease and it may be very necessary before any surgery to obtain the most detailed possible information about the functional status of every one of the four pyelons.

5. *Renal insufficiency* may, in some particularly severe cases, necessitate preliminary diversion of one or more pyelons. INNES WILLIAMS uses nephrostomy. We prefer lateral loop cutaneous ureterostomy in these cases. Subsequent management is dictated by the degree of functional recovery of each element.

The therapeutic problems, very simple in adults, may be particularly complicated with ectopic ureteroceles; multiple surgical stages are often necessary because of the lesions in the upper urinary tract. If bladder neck obstruction is treated in time, destroyed renal parenchyma is removed and healthy parenchyma is protected by anti-reflux reimplantations or ureteral anastomoses, long term prognosis is good in the majority of cases, provided that associated malformations of the renal parenchyma are not too extensive.

XI. Surgery of Retrocaval Ureter

Although venous in origin, this malformation of the ureteral path may damage the excretory tract and kidney above. It is not rare, although often unrecognised: SESBOUE collected 56 cases published between 1893 and 1952 and BITKER found 84 more between 1952 and 1964. 39 cases were published after 1965 and we have seen many cases in the past decade. Although congenital, it is rarely discovered before adult life (CENDRON: 4 cases in 15 years [1972]).

1. General Therapeutic Indications

The mere presence of a retrocaval ureter is not necessarily an indication for surgery. This abnormality, discovered by chance at urography, may not affect excretion of the kidney above; in the absence of infection or disorder of renal function, there is no need for immediate surgery and only simple supervision is indicated.

In some cases, on the other hand, the retrocaval segment of the ureter acts as an obstruction. The exact nature of the obstruction is still uncertain and probably varies from case to case. The obstruction may be *anatomic*, due to congenital segmental atresia, or it may be due to peri-ureteritis or to simple inflammation. Purely extrinsic compression by the vena cava seems unlikely. Alternatively, the obstruction may be *functional*, due to some indeterminate, intrinsic defect.

Whatever the actual cause, operative intervention is indicated for the consequences of the obstruction, such as repeated attacks of pain, hydronephrosis and even anuria (cases have been reported involving a single kidney). The urographic appearance alone is not sufficient justification; dilatation above the retrocaval segment may be tolerated perfectly well; sometimes regression of this dilatation after operation affords retrospective confirmation of the indications for surgery.

What should be done if active intervention is indicated?

Either the ureter or the vena cava must be divided (Fig. 226).

Although *section of the vena cava* has been performed in a few rare cases (CATHRO, GOODWIN) with apparently good results, this procedure does not seem advisable: the results are uncertain because they presuppose the responsibility

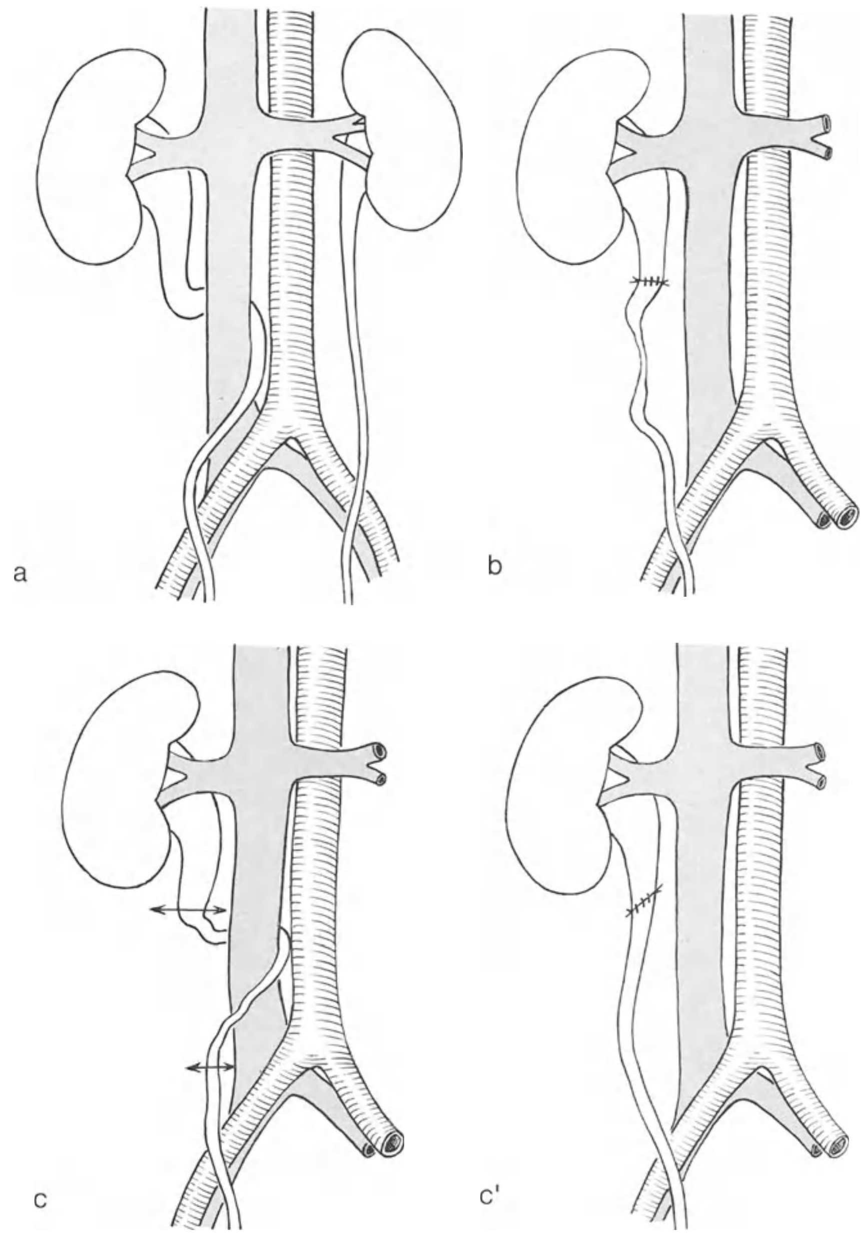
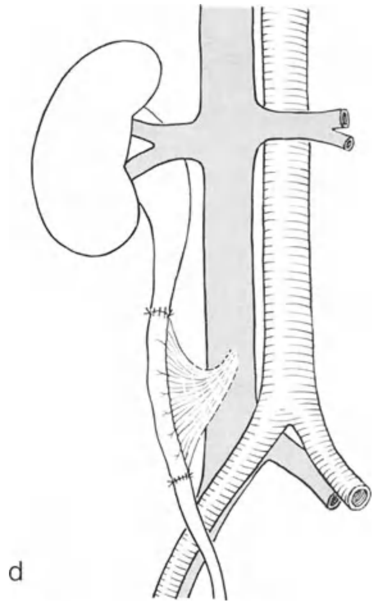
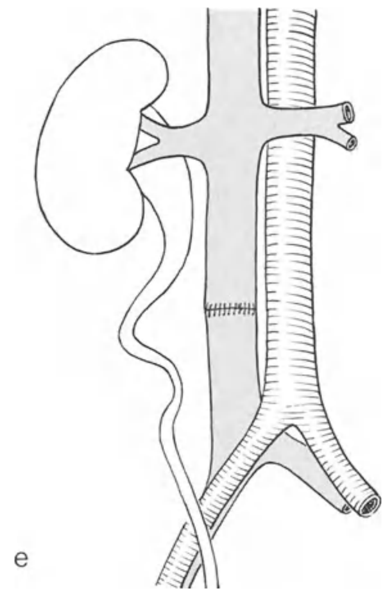


Fig. 226a—c′

of the vena cava for the obstruction, and in our opinion, it is much safer to divide the ureter, even if the kidney is solitary.

Division of the ureter would seem a more sensible approach, better adapted to the treatment of the problem which is urinary and not vascular.





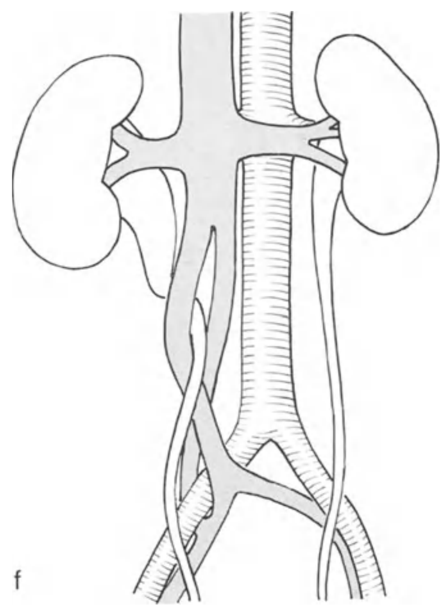


Fig. 226a–f. Retro-caval ureter—the therapeutic possibilities. (a) The malformation. (b) Un-crossing—suture of the ureter. (c) Resection—anastomosis of the ureter; level of section. (c′) Resection—anastomosis: suture. (d) Ureteroplasty using the appendix. (e) Section and suture of the vena cava to uncross the ureter. (f) Venous anomaly treatable by resection of venous anastomosis

Should the ureter be simply "uncrossed" or should the possibly abnormal retrocaval segment of ureter be resected?

The operative findings vary. In some cases, the retrocaval segment of ureter seemed normal, healthy and contractile and then division of the ureter to the right of the vena cava with uncrossing and end-to-end anastomosis was all that appeared to be necessary. In other cases, the retrocaval segment was definitely atretic and poorly contractile: in such cases there was an obvious need for resection.

The problem in fact is whether *the retrocaval segment should be excised in every case* on the grounds that it is functionally defective even when it seems morphologically normal. BITKER in 1965 analysed a series of 36 operations for retrocaval ureter (11 with ureteral resection, 25 without resection) and it was his impression that the results were better after resection although he deplored the lack of follow up in many cases.

In our experience, the retrocaval segment has always seemed sufficiently abnormal to justify resection.

There are *certain special circumstances to be considered*:

– complete or almost complete destruction of the kidney is an indication for nephrectomy if the other kidney is healthy.

– associated lithiasis should be treated on its merits and is not necessarily an indication for treatment of the retrocaval ureter.

2. Operative Technique

a) Surgical Approach

This may be transperitoneal or extraperitoneal. In obese patients the extraperitoneal approach is preferable but in all other cases the anterior transperitoneal approach is best, either through a midline incision or a Barraya approach in which a midline incision is carried obliquely upwards and laterally towards the right costal margin. Reflection of the right colon gives excellent exposure of the kidney, ureter and vena cava.

b) Ureterolysis

The retrocaval segment is explored and dissected. The difficulty of the dissection varies greatly from case to case. Sometimes there are few adhesions and the ureter is quickly and easily displayed but in other cases the retrocaval segment of ureter is surrounded by a dense fibrosis intimately adherent to the vena cava. The dissection can be so difficult that some authors have advised dividing the ureter on each side of the vena cava and leaving the retrocaval segment in place rather than risk venous damage. During the course of the dissection, it should be remembered that there may be congenital abnormalities of the vena cava itself although these are rare despite the embryologic nature of the malformation.

Fig. 227a–d. Segmental ureteral resection for retro-caval ureter. Man aged 20 years. Right loin pain. (a) I.V.P. (50 mins): Dilatation of pelvis, calyces and upper ureter; the path of the ureter suggests retro-caval ureter. (b) Retrograde uretero-pyelogram confirms retro-caval ureter. (c) Uro-cavography. (d) I.V.P. (30 mins) three months after resection—uncrossing—suture of the ureter. All pain disappeared but moderate dilatation at the upper ureter persisted

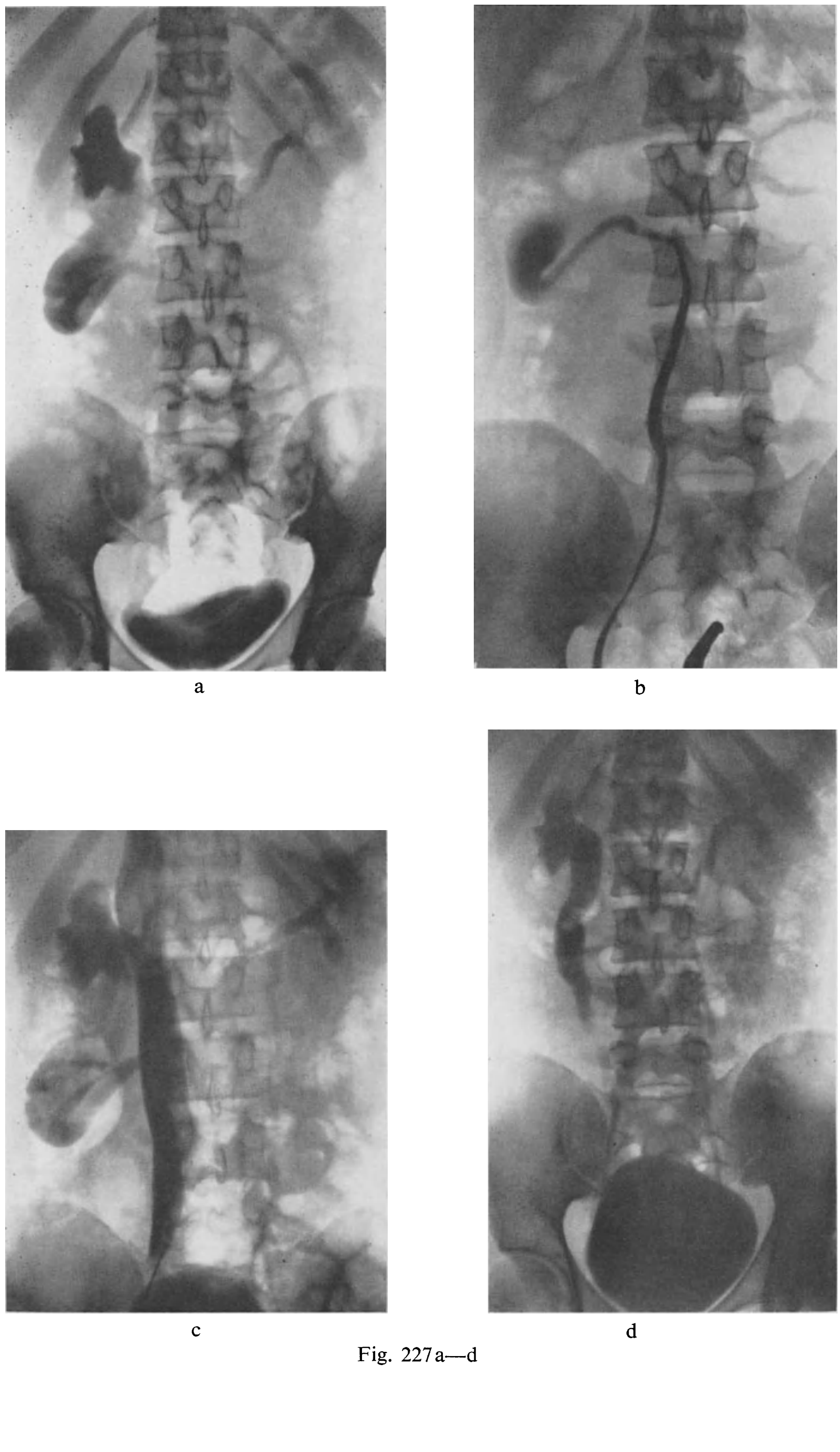


Fig. 227a—d

c) Resection of the Pathologic Ureteral Segment

The ureter is divided obliquely through healthy tissue on each side after placing marker sutures to prevent any torsion.

d) Reestablishment of Ureteral Continuity

In most cases the length of ureter, even after resection, is sufficient for end-to-end anastomosis without tension. If there is any difficulty, two or three cms can be gained by freeing and lowering the kidney. Oblique division and tailoring of the upper extremity will resolve the problem of any difference in size of the two ureteral sections. In one of our cases, the gap after resection of a long atretic segment of ureter was so great that segmental replacement was necessary: we were able to use the appendix for this purpose. The position of the appendix is very suitable for replacement of the right lumbo-iliac ureter.

e) The Retroperitoneal Space

is drained through a small stab incision.
– Complete peritonealization is achieved by reconstitution of the right paracolic gutter.
– The incision is closed.
– It is often advisable to drain a dilated kidney with a ureteral catheter. This may be lead out as a ureterostomy in situ a few cms below the anastomosis. It should be left in place for about 12 days.

3. Results

The results of corrective surgery for retrocaval ureter have been satisfactory in our experience (Fig. 227). In most cases reported in the literature the results have been good although few have been followed for any length of time. The complications and long term prognosis would seem to be those of any segmental resection of the ureter.

XII. Surgery of the Ureter in Kidney Transplantation

Every kidney transplantation requires re-establishment of the continuity of the excretory tract. This may be achieved by anastomosing the donor ureter to the recipient ureter (the recipient kidney above is removed at an earlier stage or at the same time as the transplantation) or by implanting the ureter into the recipient bladder.

1. General Considerations

The special circumstances of this ureteral surgery merit consideration.

The actual surgery, whether uretero-ureteral or uretero-vesical anastomosis, is no different from other cases except that technical minutiae must be observed with even more care than usual. The fact that the transplanted kidney is denervated does not seem to affect the function of its excretory tract or its harmonious continuity with the excretory tract of the recipient.

The *circumstances* of the surgery are much more important; they impose certain precautions to reduce complications, notably fistula of the ureteral anastomoses.

These complications are probably not due to the humoral disequilibrium caused by the renal failure, largely compensated by maintenance dialysis, because the complications occur no more frequently in transplantation between identical twins (where no immunosuppressive therapy is needed) than in the general run of ureteral surgery.

The incidence of stricture and fistula at the anastomoses is due in part to the tissue incompatibility between donor and recipient that always exists in allotransplantation and the harmful effects of the immunosuppressive drugs (Azathioprine and steroids) required to combat this incompatibility.

The higher incidence of complications in cadaver kidney transplantation, compared with related live donor transplants, underlines the significance of rejection due to histo-incompatibility in the production of urinary complications.

Fistula may result from partial disunion of the anastomosis or by necrosis at some point in the donor urinary tract, caused by ischemia due to rejection. The gravity of these complications is due to the special circumstances; the patient is anemic and treated with immunodepressive drugs and steroids and, as a result, the healing capacity and the ability to deal with infection are very reduced and so the patient is particularly exposed to the local and general complications of the infection that inevitably complicates the urinary leak.

These complications of ureteral surgery in kidney transplantation may prove fatal or necessitate removal of the transplanted kidney and certain rules must be observed if their incidence is to be reduced.

Before transplantation, a careful study must be made of the excretory tract of the donor (during removal of the donor kidney in cadaver transplantation) and especially of the recipient excretory tract so that the surgeon is not faced with serious problems during transplantation or with the necessity for unsatisfactory improvisation to deal with unsuspected lesions. In cases of great difficulty, cutaneous ureterostomy is not a satisfactory solution because of the very high risk of ascending pyelonephritis in these cases. It is important to determine the condition of the bladder, of the bladder neck and of the ureteral orifices, to discover any vesico-ureteral reflux and to determine the condition of the ureters (megaureter, stricture) and to be sure that the ureter remaining several years after previous nephrectomy retains its function; the ureter may have undergone fibrous involution and be unsuitable for re-establishment of the urinary tract.

The importance of this pre-operative investigation is evident, because although the indication for kidney transplantation in most cases is nephrologic (destruction of the kidney by glomerulonephritis, with a normal excretory tract), in certain cases the indication for transplantation is urologic and lesions in the excretory tract of the recipient must be corrected before transplantation.

Congenital lesions such as bladder neck obstruction, megaureter and reflux require preliminary treatment by endoscopic resection or even removal of a diseased ureter at the same time as removal of an infected kidney and in such cases there may be no alternative to implantation of the donor ureter into the recipient bladder.

If the bladder is diseased, with a reduced capacity, or lacking a sphincter apparatus, it may be necessary to create a new ileal or colic bladder in the recipient at a first stage (when the patient is being dialysed but is not being given immunosuppressive drugs) ready to receive the donor ureter at the time of transplantation.

2. Surgical Technique

A. Uretero-Ureteral Anastomosis

This implies removal of the recipient kidney. Bilateral nephrectomy may have been performed at an earlier stage as a routine measure to reduce the operative time at transplantation or the kidney or kidneys may have been removed because of infection or hypertension. The recipient kidney is sometimes removed at the actual time of transplantation, preferably before the vascular and ureteral anastomoses.

The uretero-ureteral anastomosis is usually iliac because the new kidney is placed in the pelvic position (we have also performed anastomosis in the lumbar region for "in situ" transplantation). The only special point about the technique is that it must be performed with extreme care, using 0000 chromic catgut or

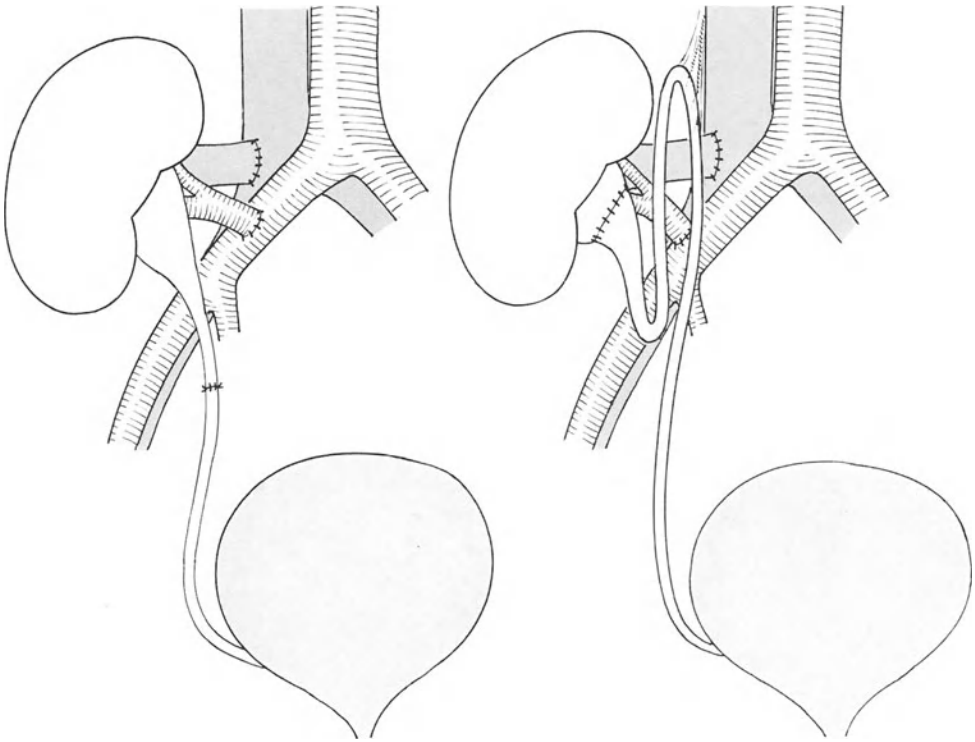


Fig. 228 Fig. 229

Fig. 228. Transplantation of the kidney in the pelvis— uretero-ureteral anastomosis

Fig. 229. Renal transplantation— anastomosis of pelvis to pelvis

an unabsorbable, monofilament suture (because healing is slow) to unite the ureteral ends after verifying their vitality and vascularization. Any anastomosis that seems imperfect should be re-constituted. Because of the risk of fistula which may require resection and a new anastomosis, it is always wise to leave the ureter "too long"; the fact that this produces bends or kinks is not important (Fig. 229).

Should the kidney be drained? The question is still debated. Some authors suggest that an indwelling ureteral catheter or a nephrostomy through the transplant kidney should be left in place for a week to prevent early leakage that might cause infection which in turn could be responsible for partial disunion. Other workers suggest that all forms of drainage should be avoided so that normal ureteral function will return as quickly and effectively as possible.

The available statistics do not point to one or other solution. We were initially in favour of using a ureteral catheter but we have now abandoned this practice. In our experience there is no period of atony and dilatation of the donor urinary tract (possibly because it is denervated) such as is normally seen above a ureteral anastomosis.

It is essential to leave a drain down to, but not in contact with, the anastomosis.

B. Uretero-Pelvic and Pelvi-Pelvic Anastomosis

In certain cases, poor vascularization of the donor ureter or the presence of uretero-pelvic obstruction may indicate the necessity for end-to-end anastomosis of the donor pelvis to the recipient ureter, using the normal technique for resection of the pelvi-ureteral junction in treating hydronephrosis.

Anastomosis of the donor pelvis to the recipient pelvis, previously mobilized in such a way as to preserve its blood supply, is preferred by some authors to uretero-ureteral anastomosis, and is particularly recommended by GIL VERNET for the following reasons:

- the anastomosis is easier;
- the anastomosis is wider and there is less risk of stenosis;
- there is a maximum reduction of the donor excretory tract; and hence of incompatible tissue liable to rejection.

This technique has certain attractions and we have used it on several occasions but it implies nephrectomy at the same time as the transplantation and the recipient renal pelvis must have a good blood supply; if fistula does occur, re-operation is difficult because the anastomosis lies in contact with the vascular anastomosis (Fig. 229).

C. Uretero-Vesical Implantation

Re-establishment of continuity by implanting the donor ureter into the recipient bladder can be achieved by the various well known methods of uretero-neo-cystostomy, either direct anastomosis after opening the bladder, with or without an anti-reflux procedure, or by extra-vesical anastomosis. We prefer the latter technique, advocated by ALEXANDRE, because it is the easiest and involves the least surgery to the bladder.

The bladder is distended with fluid and an incision 3 to 4 cm long is made on the lateral aspect, down to but not including the mucosa. At the lower end of this incision the mucosa is opened and the end of the ureter is anastomosed to the opening in the mucosa with 0000 chromic catgut; the muscle incision is closed over the ureter with closely placed interrupted sutures so that the ureter is buried in a submucosal tunnel to prevent reflux. The ureter may be fixed by a single suture where it emerges from the bladder (Fig. 183).

There is no need to leave a catheter in the ureter but the bladder should be drained by a ureteral catheter for six to eight days.

The lateral vesical space is drained for one week.

3. Results and Complications

In the great majority of cases there are no problems and the donor ureter functions normally (Fig. 230) but complications, chiefly fistula, occur in some 10 to 15 per cent of cases.

Fig. 230. Renal allo-transplantation in the lumbar position. Girl aged 18 years. Transplantation February, 1965: Splenic artery—renal vein—uretero-ureteral anastomosis. Renal function 8 years later: blood urea 100 mg per 100 ml; serum creatinine: 3.5 mg per 100 ml; endogenous creatinine clearance: 25 ml/mn

Secondary stricture (five in our 120 cases) or stone (two in our 120 cases) occurs occasionally as in all ureteral surgery but by far the most important complication is fistula (Fig. 231). In 120 kidney transplants we had 19 fistulae, 15 after uretero-ureteral anastomosis and four after uretero-vesical implantation.

The development of a fistula is a very serious matter because it may prove fatal (septicemia, spread of infection to the vascular anastomosis leading to hemorrhage, graft deterioration . . .) or may be responsible for loss of the graft. At best it is responsible for a considerable prolongation of hospital stay.

Fistula is sometimes due to partial necrosis of the urinary tract some distance from the anastomosis but in the vast majority of cases it is due to partial or total breakdown of the anastomosis and it usually appears in the three to four weeks following transplantation.

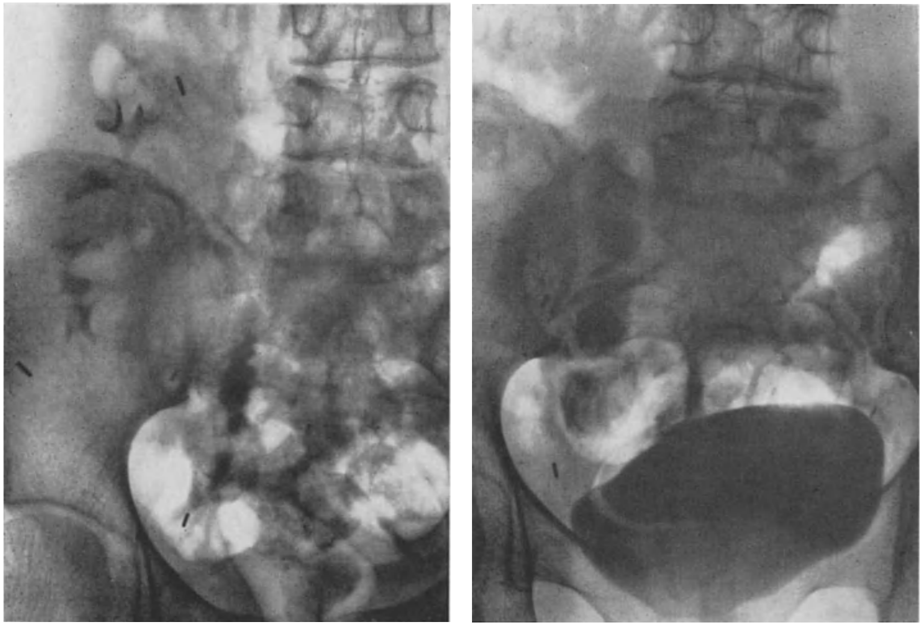
The course is variable. A fistula may close spontaneously, sometimes coinciding with successful treatment of rejection although the large doses of steroids are hardly favourable to wound healing.

Other fistulae may close if a ureteral catheter is left in place for 10 to 15 days but in the majority of cases re-operation is necessary with little delay. It may

a b

Fig. 231 a and b. Renal allo-transplantation in the iliac position—complicated by ureteral stricture. Man aged 25 years. Transplanted July 1969. Uretero-ureteral anastomosis. (a) I.V.P. (2 hrs) three months later: ureteral stricture at the level of the anastomosis. (b) I.V.P. (15 mins) 20 months after resection—suture of the strictured zone. Renal function 4 years later: Blood urea 35 mg per 100 ml; serum creatinine 1.4 mg per 100 ml; endogenous creatinine clearance 87 ml/mn

Fig. 232. Renal allo-transplantation—complicated by urinary fistula



a b

Fig. 233a and b. Renal allo-transplantation—utilization of ileo-ureteroplasty. Girl aged 18 years. Transplantation July 1968 (irradiated solitary pelvic kidney)—uretero-vesical anastomosis. Recovery complicated by fistula and stricture of the ureter. Repair by tubed bladder flap (October 1969) failed. Silastic nephrostomy drain inserted November, 1969 and left in for one year. Total ileo-ureteroplasty June 1971. Very good result. I.V.P. 7 months later showing the ileal graft with the bladder empty (a) and bladder full (b). Renal function 5 years after transplantation: blood urea 50 mg per 100 ml; serum creatinine: 1.1 mg per 100 ml

occasionally be possible to close the gap in the anastomosis by one or two sutures but in most cases the leaking anastomosis is resected and a new uretero-ureteral anastomosis performed. The results of this secondary surgery are relatively good: in 14 such cases in our series, the reanastomosis was immediately successful in 10, two required further surgery and in two patients the graft had to be removed because of hemorrhage or septicemia.

When fistula complicates uretero-vesical implantation, the treatment is more difficult because inflammation and infection around the bladder render a second implantation or the use of a tubed bladder flap distinctly hazardous. We used a bladder flap only once and this proved a failure. If fistula occurs after bladder implantation it should be treated by anastomosing the donor ureter to the recipient ureter some distance from the fistula.

Secondary surgery for the urinary complications of transplantation, usually for fistula, is undertaken only after full consideration of transplant function and the condition of the patient. If the function of the grafted kidney is poor or the patient's general condition is precarious, it is better to remove the graft and return the patient to dialysis rather than run the risks of further surgery and continued infection.

In exceptional cases, graft function and the general condition of the patient may be so good that it is worthwhile considering ileo-ureteroplasty to replace a major loss of the urinary tract; this reconstructive surgery should preferably be delayed for several months after a preliminary nephrostomy (Fig. 232).

The choice of technique for re-establishing the urinary tract in kidney transplantation is important because of the serious and sometimes fatal consequences of urinary complications.

The majority of authors (75 to 85 per cent) prefer to implant the ureter into the bladder. It is probably the safest method if there is any ischemia of the terminal part of the donor ureter; the end of the ureter is buried and protected by the muscle wall of the bladder. But although fistula at this site is less common than with uretero-ureteral anastomosis, it is more difficult to treat. Stricture is more common with uretero-vesical implantation and reflux is also frequent.

Since 1960, we have routinely used uretero-ureteral anastomosis because it is the most natural technique and most physiologic; it requires greater care and is more prone to fistula but treatment of the fistula is relatively simple.

In reality, it is impossible to give a statistical evaluation of either of these methods or of pelvi-pelvic anastomosis because the results depend not only on technique, but also and to a greater degree on the compatibility between donor and recipient and the effectiveness of immunosuppressive therapy.

No one method is applicable to every case and although we prefer uretero-ureteral anastomosis we are also happy to use uretero-vesical implantation and pelvi-pelvic anastomosis, depending on the condition of the recipient excretory tract.

General Conclusions

There has been great progress in ureteral surgery in the past 20 years and the good results, now confirmed in the long term, make it clear that it is rarely justifiable to sacrifice a good kidney for any lesion of its excretory tract.

But although it is now possible to replace the ureter in part or in whole, each case must be considered carefully if unnecessary or dangerous conservative surgery is to be avoided. It is scarcely advisable to try to preserve a kidney at any cost merely to give the patient the dubious satisfaction of "keeping both kidneys". This reconstructive or replacement surgery is indicated absolutely in patients with a solitary kidney, even if it is very defective, and in bilateral disease with the object of avoiding the disability of external diversion as far as possible but very careful consideration is necessary in every case when the other kidney is normal and likely to remain so.

The points to be considered include the age of the patient, his physical condition and character, the etiology of the disease of the excretory tract, the functional status of the kidney in comparison with the opposite kidney, the possibilities of recovery of defective function and the possible difficulties of the surgery envisaged. Here it is important to distinguish between techniques confined to the urinary tract (bladder-ureter-pelvis) with almost no mortality and the techniques requiring the use of intestine which have a significant mortality and morbidity.

If the function of the relevant kidney is good and the patient is young it is reasonable to go to considerable lengths to preserve this kidney. But the surgeon must resist the temptation to carry this policy to extremes by putting at risk a patient who might perfectly well live a normal life with the intact opposite kidney. The surgeon must be prepared where necessary to sacrifice a good kidney for the overall benefit of the patient. It is better to live with one healthy kidney than with two kidneys, one of which is very defective and a possible source of complications, further surgery and discomfort; always provided that the situation is reviewed from time to time so that any disorder of the remaining solitary kidney is discovered sufficiently early for appropriate medical or surgical treatment.

The long term prognosis of a patient with a solitary kidney known to be healthy is best illustrated by the attitude of life insurance companies: such patients are in fact accepted without a surcharge and their expectation of life is considered to be the same as that of an individual with two healthy kidneys. This attitude is reinforced by the possibility of maintenance dialysis or kidney transplantation in the unlikely event of loss of the solitary kidney.

Conversely, the presence of a healthy contralateral kidney does not in itself justify removal of a good kidney merely because its excretory tract is diseased. Reconstructive surgery of the ureter has proved so effective that nephrectomy should not be considered merely because it is "the easy way out". A decision between conservation and nephrectomy cannot be taken without a full knowledge and extensive experience of reconstructive surgery of the urinary tract, its possibilities and uncertainties, its pitfalls and successes.

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IV. Ureteral Anastomosis

1. Uretero-Ureteral Anastomosis

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2. Uretero-Pelvic and Uretero-Calyceal Anastomosis

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VII. Urinary Diversion Utilising the Ureter

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2. Ureterosigmoidostomy

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IX. Surgery of Megaureter

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