

CHAPTER LI

RENAL COLIC AND ACUTE RENAL INFECTIONS

RENAL COLIC

Is it renal colic?—that is the important question. Many cases are unmistakable; in others an intraperitoneal lesion has to be excluded, and it is then that the surgeon's diagnostic powers and judgement are taxed to the fullest degree. When in doubt a good practice is to prescribe a hot bottle and an antispasmodic—but never morphine or its derivatives—and to re-examine the patient in half an hour.

During the interval between examination and re-examination the urine should be tested again.

The choice of antispasmodics can lie between papaverine, gr. $\frac{3}{4}$ (50 mg.) intravenously, trasentin,¹ 1.5 ml. intravenously, or pro-banthine,² 30 mg. ($\frac{1}{2}$ gr.) by mouth. The antispasmodics referred to relax the smooth musculature, and frequently the pain of ureteric colic is relieved in a few minutes after the chosen drug enters the circulation. A plain radiograph is sometimes invaluable in confirming the diagnosis, but on many occasions intestinal gas obscures the shadow of a small ureteric calculus which otherwise might be apparent. In cases where a plain radiograph is unhelpful, if facilities exist, urgent chromocystoscopy or excretory urography frequently enables one to exclude or clinch the diagnosis of ureteric colic. When, after trying his best, the surgeon cannot be sure that pain and rigidity are *not* due to early acute appendicitis or other intra-abdominal catastrophe, an immediate exploratory operation is more than justified, especially if a second opinion has been obtained.

Stone in the Ureter.—When a diagnosis of ureteric calculus or stone in the renal pelvis has been confirmed radiologically, treatment with antispasmodics should be continued. The patient must drink plenty of bland fluids, and antibiotics can be administered to help to prevent infection. Daily radiographs are taken. Should the stone become impacted, according to circumstances ureteric catheterization, ureteric meatotomy via a cystoscope, or removal of the stone by operation must be undertaken.

Very exceptionally perforation of the ureter, or bursting of the dilated renal pelvis above it, occurs.

P. B., aged 52, was admitted with acute abdominal pain and vomiting. The right side of the abdomen was rigid and the maximum tenderness was in the loin. He was diagnosed as renal colic, and next morning, after a dose of morphine and atropine, he appeared better. Three days later the temperature had risen to 103° F. (39.5° C.), and there was much tenderness and slight œdema in the loin. The kidney was therefore explored. The perinephric space was found filled with purulent urine, which was issuing from a perforation of the ureter immediately above an impacted ureteric calculus. The kidney did not appear to be hydronephrotic. Through a longitudinal incision in the ureter the stone was removed and the wound was drained. He developed a urinary fistula, which failed to heal after six months, during which time attacks of local suppuration and pocketing occurred. Eventually subcapsular nephrectomy was performed, and the patient has remained well.

ACUTE PYELONEPHRITIS

Renal infection, by whichever route³ it originates, is seldom, if ever, confined to the renal pelvis. If the infection is hæmatogenous, the renal parenchyma is attacked first, and the inflammation spreads to the calices and renal pelvis. In ascending infections the bacterial inflammation implicates the calices, the pyramids, and at least some of the adjacent parenchyma, as well as the renal pelvis. The term 'pyelitis' is therefore inaccurate, and should be discarded in favour of the more accurate designation 'pyelonephritis'.

¹ Ciba Laboratories Ltd., Horsham, Sussex.

² G. D. Searle & Co. Ltd., 83, Crawford Street, London, W.1.

³ Many authorities consider that the majority of cases have a hæmatogenous origin.

Without bacterial control the treatment of pyelonephritis is highly empirical, frequently inadequate, and too often a failure. The commonest organism responsible is the *Escherichia coli* (about 65 per cent); the second most common is the *Aerobacter aerogenes*, but other organisms, notably the *Streptococcus faecalis*, *Proteus*, *Pseudomonas aeruginosa*, or a staphylococcus are either the primary infecting organism or become dominant at one time or another. The original urinary tract flora are wont to alter in the course of treatment, either to a more resistant strain of the same species or to an entirely new species. Frequently the new organism is the *Proteus vulgaris* or the *Pseudomonas aeruginosa*.

Strains of infecting organisms partially or wholly resistant to sulphonamides and the more usual antibiotics are much more frequently encountered in patients whose urine becomes infected while in hospital than in patients infected before admission. In the former group Erlanson and Jönsson found a large percentage of resistant coliform bacilli and resistant enterococci which were not demonstrated in the urine of patients infected before admission. These uniform findings strongly support institutional infection.

Acute Pyelonephritis without Retention of Bladder Urine is the commonest disease of the kidneys. It occurs much more frequently in females¹ than in males, especially during childhood, at puberty, soon after marriage ('Honeymoon pyelitis'), during pregnancy, and at the menopause. It attacks the right side more often than the left; rarely it is bilateral.

Diagnosis.—The onset is sudden, often commencing with a rigor. There is acute pain in the flank and the hypochondrium. In a minority of cases the pain radiates from the loin to the groin—ureteric colic. The temperature rises to 102°–103° F. (38.8°–39.5° C.), and is remitting. Soon after the onset increased frequency of micturition due to cystitis sets in, and when, as is usually the case, the urine is acid, micturition is accompanied by a scalding pain in the urethra. On examination there is tenderness in the hypochondrium and in the angle between the last rib and the sacrospinalis, accompanied by a varying degree of muscular rigidity. In the early stages, when it is imperative to make a correct diagnosis, the urine is clear macroscopically.

Severe Cases.—There are repeated rigors and the temperature rises to 104°–105° F. (40°–40.5° C.), often without a corresponding rise in the pulse-rate. There is vomiting, sweating, and great thirst, and the patient looks and feels ill. The blood-culture, if a specimen is taken soon after a rigor, often gives a positive result. Some hours later the pain is localized in one, or rarely both, loins. The urine is scanty and highly concentrated, and is frequently teeming with coliform organisms and pus cells, in which case the diagnosis is simplified. In hæmatogenous infections the organisms and pus cells do not appear in the urine until the infection has spread from the cortex to the medulla—a matter of many hours, and sometimes several days. As the abdominal rigidity abates, often the enlarged affected kidney can be palpated.

Side-room Examination of the Urine.—An opalescent, acid urine is suspicious. If, on microscopical examination, pus cells are found, it makes the diagnosis of pyelonephritis very probable. However, after twelve hours from the onset of the attack such findings, by themselves, cannot be regarded as conclusive. In serious cases, clumps of pus cells are present, and in ultra-serious infections casts and red cells are present, also.

Bacteriological Examination of the Urine.—A mid-stream specimen or, if that is impractical in the female, a catheter specimen,² should be collected in a sterile bottle; the urine is centrifuged and examined microscopically. In early acute pyelonephritis there are typically a few pus cells and many bacteria. It should be noted that the presence of coliform bacilli without pus cells is not confirmatory evidence of pyelonephritis, for these organisms are often present in the urine—especially in women—without giving rise to symptoms. When pyelonephritis has been present for 24 hours or more, the urine is often cloudy, and pus cells abound. In all cases the investigation includes examination of the sediment stained by Gram's method, culture of the specimen, and an investigation of the sensitivity of the organism or organisms to various antibiotics and selected sulphonamides. Sensitivity to antibiotics and sulphonamides is usually expressed as 0, +, ++, +++, according to the width of the zone of inhibition produced.

¹ So often is *Esch. coli* infection of the urinary tract associated with *Trichomonas vaginalis* infection of the vagina that it is considered likely that the *Esch. coli* is transported from the vagina to the urinary tract by the *T. vaginalis* (B. H. Kean).

² Exclusion of the first portion of the specimen of urine is essential.

Differential Diagnosis.—When the symptoms and signs are typical, the diagnosis is straightforward. In other circumstances there may be difficulty in distinguishing the condition from pneumonia, acute cholecystitis, and particularly acute appendicitis. The urgent need is to differentiate acute appendicitis from acute pyelonephritis. The fact that the pain commenced in, and did not pass to, the right side greatly favours the latter condition; on the other hand, in acute appendicitis, when a retrocaecal appendix lies alongside the ureter, pus, and even blood, can be present in the urine (*see p. 257*). Excretory pyelography may prove of great diagnostic assistance, for in early acute pyelonephritis limited to the right kidney, the concentration of medium in the renal pelvis and calices on the affected side is often so poor that no shadow, or a very indefinite shadow, is cast.

TREATMENT OF ACUTE PYELONEPHRITIS

If the urine is acid, as is common in the coliform infections, alkalization of the urine has a most beneficial effect in relieving the symptoms, in inhibiting the growth of these organisms, and in enhancing the bactericidal effect of sulphonamide and antibiotic therapy. To render the urine alkaline, the following mixture given four-hourly, or more often, is efficacious.

Sodium citrate	gr. 20 (1·3 G.)
Sodium bicarbonate	gr. 20 (1·3 G.)
Syr. auranti	q.s.
Aqua, ad	$\frac{1}{2}$ oz. (15 ml.)

To diminish pain, Tinct. hyoseyamus, min. 20 (1·2 ml.) can be added to the mixture with advantage.

In ultra-acute cases alkalization of the urine can be brought about rapidly by an injection of 10 ml. each of an isotonic solution of sodium lactate and a saturated solution of sodium bicarbonate (*see p. 63*). When pain is severe pethidine 2 ml. (100 mg.) intravenously three times a day brings relief. Heat applied to the loin is sometimes comforting.

The patient should be instructed to imbibe large quantities of barley water and 5 per cent dextrose solution flavoured with fruit juices. In severe cases with vomiting or dehydration, intravenous dextrose-saline is given until the dehydration has been rectified and the vomiting has ceased.

While awaiting the bacteriological report, in an average case a sulphonamide can be given as directed below, but in a fairly severe case streptomycin or aureomycin should be substituted. When the bacteriological report is to hand, more specific treatment can be commenced if the interim measures have not proved entirely satisfactory.

Chemotherapeutic and Antibiotic Agents.—

Sulphonamides: Sulphatriad (a combination of sulphathiazole, sulphadiazine, and sulphamerazine), sulphadimidine, and sulphamethiazole (urolocosil) have all proved extremely effective in the majority of cases of acute pyelonephritis. The possibility of producing sulphonamide crystalluria with any of these preparations is extremely low. The dose for an adult is

Sulphatriad :

Initial dose: 1·5 G. orally given with an intravenous injection of 2 G. of the sodium salt of one of the heterocyclic derivatives of sulphanilamide (sulphadiazine sodium, for example).

First two days: 1·5 G. orally every four hours day and night (if awake).

Third and fourth days: 1·0 G. orally every four hours.

Fifth and sixth days: 1·0 G. orally every six hours.

Sulphadimidine :

Initial dose: 4–6 G. orally (or, in emergency, 4–6 G. of sulphadimidine sodium by intravenous injection).

First two days: 1·5 G. orally every four hours day and night (if awake).

Third and fourth days: 0·5 G. orally every four hours, or 1 G. orally thrice daily.

Fifth and sixth days: 1 G. orally thrice daily.

Sulphamethiazole :

One tablet (0·1 G.) four-hourly by mouth for the first two days (both by day and by night, if awake). During the third and fourth days four doses are given, and on the fifth and sixth days, three doses.

Streptomycin is inimical against Gram-negative bacilli generally, and has an adequate action on most staphylococci and streptococci as well. In addition to the benefits derived

from the circulation of streptomycin in the blood, 75 per cent of the drug is excreted unchanged in good concentration in the urine. L. P. Garrod advises that the drug¹ should be given intramuscularly in four-hourly doses of 0.5 G. It is useless and dangerous to continue this treatment for more than three days; usually two suffice. According to Garrod, there is good reason to believe that the issue is settled one way or the other during the first day.

If the bacteriological reports and clinical progress so dictate, either or both the above drugs are stopped immediately in favour of one of the following:—

Aureomycin: Longley and Thompson, of the Mayo Clinic, found that acute pyelonephritis due to either *Esch. coli* or *Aerobacter aerogenes* (the two most common infecting organisms) was controlled by small doses of aureomycin, despite the fact that the results of sensitivity tests made on the urine collected before treatment was commenced sometimes indicated the contrary.

Terramycin or *achromycin*, 250 mg. four times a day for ten days, followed by a course of sulphonamide four times a day for six weeks, has proved an excellent method of combating and eradicating the infection in all but exceptional cases (R. D. Taylor).

*Furadantin*² is a synthetic antibacterial agent, one of the antimicrobial nitrofurans. It is supplied in grooved tablets containing 0.5 G. Furadantin has been found effective in a number of infections due to *antibiotic-resistant organisms*, including *Esch. coli*, *Proteus*, and *A. aerogenes*. It is of no avail in infections due to *Pseudomonas aeruginosa*. The average dose by mouth is 5–8 mg. per kilo (2.2–3.6 mg. per lb.) of body-weight every 24 hours. One-quarter of this dose is administered immediately after meals and on retiring; cold milk should be given with the last dose at night. For refractory infections the dose may be increased to a maximum of 10 mg. per kilo (4 mg. per lb.) of body-weight per 24 hours. Accurate dosage is essential to minimize nausea and vomiting. If this occurs, the dose must be reduced.

Contra-indications: When there is inadequate urinary output. At present it is inadvisable to employ this drug for infants and children.

Criteria of a Cure, and Investigation to reveal an Underlying Obstructive Lesion.—The duration of some form of the foregoing therapy should be continued for seven to ten days. A cure should be pronounced only when there are two or three negative urinary cultures after all traces of sulphonamide and antibiotics have disappeared from the urine. A complete urinary tract investigation, which is usually undertaken one week after the subsidence of all symptoms, must be made in all cases of acute pyelonephritis.

Chemotherapeutic and antibiotic agents usually fail to sterilize the urine in patients with abnormalities of the urinary tract. When an obstructive lesion is demonstrated by pyelography, as soon as the infection has been controlled, an operation to rectify the obstruction must be performed.

Proteus and Pseudomonas Infections are responsible for about 20 per cent of infections of the urinary tract, and many strains of these organisms are resistant to the drugs usually employed in the treatment of pyelonephritis.

Directly the bacteriological report is to hand, and *Proteus* is reported present, the patient is best treated by the administration of furadantin. *Ps. aeruginosa* is resistant to most drugs, except polymyxin B or neomycin, which are the least desirable, because they are nephrotoxic. Polymyxin is given intramuscularly in doses of 10,000 units per kilo body-weight four-hourly for five days, or longer. Neomycin is the only drug that will eliminate some strains of *Ps. aeruginosa*. The dosage is 0.25 G. intramuscularly every six hours for a maximum of five days. If, when either of these antibiotics is being employed, the urinary output declines, the antibiotic must be stopped.

ADDITIONAL MEASURES IN EXCEPTIONAL CASES

Indwelling Ureteric Catheter.—A whistle-tipped catheter provides the best drainage. The eyes of the catheter must rest in the renal pelvis. If the catheter is properly in place, the drainage it provides often relieves the symptoms dramatically. A special nurse is desirable to watch the drainage, for if the catheter becomes blocked it is worse than useless. Gentle lavage of the renal pelvis helps to prevent blockage: lavage should be carried

¹ Streptomycin is very liable to cause damage to the 8th nerve when renal function is depressed.
² Duncan Flockhart & Co. Ltd., Edinburgh.

out every four hours, using normal saline solution. The insertion of an indwelling ureteric catheter should only be considered in female patients, for the necessary instrumentation, particularly in the presence of oliguria, is far too dangerous in the male.

Operation.—In ultra-acute cases complicated by oliguria which do not respond to the above measures, I have had a number of pleasing results by performing pyelostomy (see p. 621) or, in certain cases where that measure would prove unsuitable, by nephrostomy (see p. 619), and afterwards administering continuous intravenous fluid therapy commenced cautiously. The advisability of performing pyelostomy, or, when that measure is unsuitable, nephrostomy, will now be discussed.

Indications.—When the temperature continues to reach 103° – 103.5° F. (39.5° – 39.8° C.) in spite of alkaline, sulphonamide, or antibiotic therapy, and the patient is obviously toxic, and the urinary output is low, instrumentation should be eschewed. In such cases the infection has commenced in, or spread to, the parenchyma of the kidney. This group will include those in which the ureter is obstructed, and those where the infection follows an operation on the urinary tract, a cystoscopic examination, or urethral catheterization. A manifestly unilateral lesion should embolden the surgeon to advise an operation. The danger of waiting after conservative measures have been given a reasonable trial (two or three days) and have failed is the onset of a combination of septicæmia and anuria.

B. Bibus has found that, although usually of enormous benefit, antibiotics do not always obviate the necessity for operation in grave cases of pyelonephritis. On exposing the affected kidney in such cases extensive cortical foci are found, sometimes in connexion with perinephric suppuration. In some severe cases of acute pyelonephritis where the commencement of correct treatment has been delayed on account of difficulty in diagnosis or failure to ascertain the bacteriology of the urine, antibiotic therapy at times creates a false sense of security. There is a fall in the high temperature, and a diminution of the number of leucocytes, but, in spite of adequate doses of the antibiotic indicated, the general condition gradually worsens; sometimes the cachexia of patients with advanced malignant disease is simulated. Deterioration of the general condition can be prevented only by timely operation.

PYELONEPHRITIS OF PREGNANCY

If the patient is placed in the knee-chest position, pressure upon the ureters is removed, and often temporary relief obtained. When postural treatment, together with alkalization of the urine and sulphonamide, with or without antibiotic therapy, is not effective, catheterization of the ureter or ureters is often beneficial. It is quite common for 10–50 ml. of residual urine to be evacuated from the renal pelvis, with immediate relief. Should improvement be but temporary, there is no objection to repeating the catheterization in three or four days.

When the condition is bilateral, and particularly when it occurs in the early months of pregnancy, the prognosis is grave. In these circumstances, if the blood-urea is elevated considerably, the wisest course may be to terminate the pregnancy.

ACUTE PYELONEPHRITIS IN INFANTS

Probably the peak incidence of urinary infections occurs under the age of 2 years, when the two sexes are affected equally. At this time of life the diagnosis is sometimes particularly difficult. For instance, in severe infections the accompanying bacteræmia gives rise to a hectic temperature, apathy, and limpness, with occasional twitching, or even a convulsion; unless the correct diagnosis is made early, and appropriate treatment is commenced forthwith, the patient frequently goes downhill rapidly and often dies as a result of multiple renal abscesses. Should recovery occur in these circumstances, the kidneys are so scarred that frequently the patient develops hypertension and renal insufficiency. At other times the affected infant is pale, restless, vomits frequently, refuses food, and has a high temperature; alternatively one encounters a fat, flushed, feverish, restless, and whimpering baby. Typically the attack commences with rigors, and attacks of screaming due to ureteric colic occur; slight terminal hæmaturia is sometimes present. In some cases a clue to the origin of the infection is apparent: in females vulvitis extends around the external urinary meatus; in circumcised males there is atresia meati with or without meatitis, while in the uncircumcised balanitis may be present. However, in the majority of cases the infection is blood-borne, and these signs are absent.

Even when there is only a remote possibility that the symptoms are due to pyelonephritis, it is necessary to examine the urine clinically and bacteriologically. Some ingenuity is required to collect a specimen of urine from an infant. Attachment of a test-tube to the penis, so long as there is sufficient space around the penis to allow the escape of air, is the best method. The female infant presents a more difficult problem. To place the baby on warmed sandbags with a shallow dish between them is the most practical. Catheterization should be avoided if possible, but, when considered necessary in the female, the urinary meatus must be cleansed thoroughly before the catheter is passed. The bedside and laboratory confirmation of the diagnosis of pyelonephritis from an examination of the urine differs in no respect from that in an adult.

Treatment.—The urine should be rendered and kept alkaline with a mixture of sodium bicarbonate and potassium citrate in equal parts, 5–10 gr. (0.3–0.6 G.) with each dose of sulphonamide. Sulphatriad or sulphadimidine, 0.25 G. 8-hourly for an infant under 3 months of age, and 6-hourly for one between 3 months and 2 years of age, with plenty of dextrose solution by mouth, is usually eminently satisfactory, provided of course there is no obstruction in any part of the urinary tract. When the sensitivity tests and lack of progress so indicate, a suitable antibiotic is given in addition. Deepening toxæmia, drowsiness, oliguria, persistent vomiting, and possibly œdema of the face, together with casts of pus cells and erythrocytes in the urine, are clear indications of advanced renal parenchymal involvement. In such cases one of the tetracyclines intravenously, 10–20 mg. per kilo of body-weight, daily for five days, is the best means of combating this very serious infection. In infancy the infecting organism in a very high percentage of cases is *Esch. coli* or, much less frequently, a staphylococcus which may be penicillin-resistant.

Complications.—

Secondary Meningitis: Twitchings or convulsions due to cerebral irritation are not infrequent, and are usually due to the accompanying toxæmia. However, if the anterior fontanelle shows increased tension, secondary meningitis must be excluded by lumbar puncture.

Diarrhœa or Vomiting is liable to appear at any time during an acute urinary infection. Special care must be taken to fulfil the fluid requirements, otherwise oliguria will exacerbate the pyelonephritis.

Oral Sepsis, including thrush, often supervenes when the general care, including oral hygiene, is inadequate.

Fatty Degeneration of the Liver, as evinced by an enlarging liver with, possibly, a tinge of jaundice, is more apt to occur when the fluid and dextrose intake has been insufficient. It adds greatly to the danger of suppression of urine.

Hæmaturia occurring during the course of the disease should always arouse a suspicion of sulphonamide crystalluria, and the urine must be examined for sulphonamide crystals.

Acute Osteomyelitis and Pericarditis must be kept in mind as possible complications when *Staphylococcus aureus* is the cause of the urinary infection.

ACUTE PYELONEPHRITIS WITH RETENTION OF BLADDER URINE

The retention of urine can arise from pre-existing obstruction of the lower urinary tract, spinal injury or disease, or be a complication of an operation (post-operative retention). The retention is not necessarily complete and the patient may be able to urinate, but there is a varying amount of residual urine, from a few ounces to several pints. In a great majority of cases the pyelonephritis is bilateral. Occasionally the condition arises spontaneously, but as a rule it follows the passage of a catheter or other instrument per urethram, which need not necessarily have been passed without every sterile precaution; lighting up of infection lying dormant in a pool of the residual urine or of chronic prostatitis can conceivably give rise to this condition. Proof as to whether organisms were introduced at the time of instrumentation is nearly always a matter for conjecture. In the days of unsterile catheterization this condition, known as 'surgical kidneys', was frequent, and dreaded. Recent careful analysis of hospital records has shown that the proportion of cases of acute pyelonephritis in which the infection was probably acquired in hospital is much higher than is believed generally.

Diagnosis.—In the comparatively hale the symptoms are often severe, but they do not differ from those of acute pyelonephritis described already. Usually there is rigidity

and tenderness in both loins, though often more in evidence on one side than the other. Depending on the amount of back-pressure effects upon the kidneys, a varying degree of renal failure is likely to develop.

Often in the old and frail the symptoms and signs are misleading, and the only indications that acute pyelonephritis has set in are lassitude and deepening coma.

Treatment does not differ from that of acute pyelonephritis given already, except that it is essential to empty the bladder and keep it empty, usually by means of an indwelling catheter (*see* Chapter LVI). The infection is frequently due to an organism resistant to the more usual antibiotics. Although it requires much judgement as to when to perform it, and considerable courage, a swift bilateral operation to drain infected kidneys that are probably, or certainly, hydronephrotic sometimes offers the greatest, or even the only, hope of saving the life of the patient.

PYONEPHROSIS

Pyonephrosis is not, as a rule, a very urgent condition; by which is meant that a few hours can be spent in observing the patient and making as full an investigation as circumstances permit. Nevertheless nephrostomy should be performed as soon as the diagnosis can be established. Excretory urography and cystoscopy after an intravenous injection of indigocarmine will help in arriving at a correct diagnosis. Those cases of pyonephrosis that are operated upon during the first few days usually recover; whilst those in which the treatment is delayed (usually because of difficulty in diagnosis) frequently die in spite of operation. In nearly all cases it is simple nephrostomy and not nephrectomy which should be performed in the first instance. A drainage tube is inserted into the centre of the pus sac through the convex border of the kidney towards the lower pole. A soft rubber drain is also inserted into the perirenal space. Unless the cause of the obstruction can be removed at the time of the operation—e.g., a stone dislodged from the pelvis of the kidney or the commencement of the ureter—further operation will be necessary later on; otherwise the pyonephrosis will recur, or permanent renal fistula result. One of my patients, in whom nephrectomy was contra-indicated on account of enormous obesity and mitral stenosis, returned three times at intervals of about six months with a recurrent pyonephrosis which was drained in each instance. Further details of the operation of nephrostomy are given on page 619.

PERINEPHRIC ABSCESS

The term 'perinephric abscess' probably embraces a number of different conditions in which the abscess is but an important incident. There is, however, a clinical entity 'perinephric abscess'. Here the perinephric fat appears to be primarily attacked by a blood-borne infection. Bacteriological examination of pus from the abscess frequently shows *Staphylococcus aureus*.

An ordinary examination of the urine usually reveals no abnormality, but if the last 50 ml. of voided urine be collected in the male, and a catheter specimen taken from the female, Gram-positive cocci are often found after prolonged centrifugalization.

The early diagnosis of perinephric abscess is difficult. In 43 cases the diagnosis was not made for (on an average) five weeks (Habein). Some improvement on these figures can be hoped for by the use of radiographic studies. Absence of the psoas shadow is inconstant, and not confined to cases of perinephric abscess. A more reliable radiological sign is what is known as the sign of Mathé. The normal excursion of a kidney between the Trendelenburg and vertical positions is not less than the width of one vertebra. This can be shown by excretion pyelography. Even in early cases of perinephric abscess these excursions are limited.

Another method of making an early diagnosis of perinephric abscess is by means of a lateral retrograde pyelogram, which frequently reveals a displacement of the kidney. The typical radiological finding is displacement forward, producing a characteristic arch-like appearance of the kidney and ureter (J. G. Menville). The only specific X-ray indication of a perinephric abscess is extravasation of contrast media into the perirenal region, as displayed on intravenous or retrograde pyelography (R. S. Hotchkiss).

In any case *one should not wait for fluctuation, but explore as soon as the condition is strongly suspected*. If there is a fluctuating swelling, an incision and the insertion of a tube is all that is required. It is, however, a good practice to examine the kidney at the

same time. Sometimes a renal carbuncle which has burst through the renal capsule is found. In one of my cases there was merely a shell of kidney substance containing caseous matter, so nephrectomy was performed; but this is most exceptional.

When the pus is not near the surface, the abscess is approached by the usual incision to expose the kidney.

CARBUNCLE OF THE KIDNEY

Often the diagnosis of renal carbuncle (*Fig. 793*) is even more difficult than that of perinephric abscess, for which the condition is frequently mistaken, and with which it is occasionally associated. More often than in other staphylococcal bacteræmias, a portal of entry is to be found in the form of a purulent skin lesion or an abscess, e.g., an abscess of the breast. As in perinephric abscess, the leading feature is pyrexia. By a process of elimination and signs of tenderness in one loin an inflammatory lesion of the kidney itself is suspected. Excretory pyelography usually merely demonstrates that the diseased kidney is functioning poorly; on occasions obliteration of a calix or calices adds strength to the diagnosis. Curiously, pyuria is seldom in evidence, although in some instances staphylococci are found in the urine from the affected kidney: thus the lesion is differentiated from severe pyelonephritis.

Treatment.—There is seldom need to perform nephrectomy in this condition; partial nephrectomy is never required. Some early cases respond quickly to systemic antibiotic therapy and the infection is aborted, but one can never be sure of the diagnosis unless the lesion is exposed by operation. When the response to antibiotic treatment is not dramatic, exploration of the kidney should be carried out. T. F. Rose recommends making an incision into the carbuncle and scooping out the necrotic material with the finger. Hæmorrhage, which usually is not excessive, can be controlled by the application of pressure over a moist warm pack. A drainage tube is placed down to, but not into, the resulting cavity in the kidney. Penicillin or, if the staphylococcus is penicillin-resistant (*Fig. 794*), another antibiotic, is continued for at least ten days.



Fig. 793.—Carbuncle of the kidney.
(I. L. Dick.)

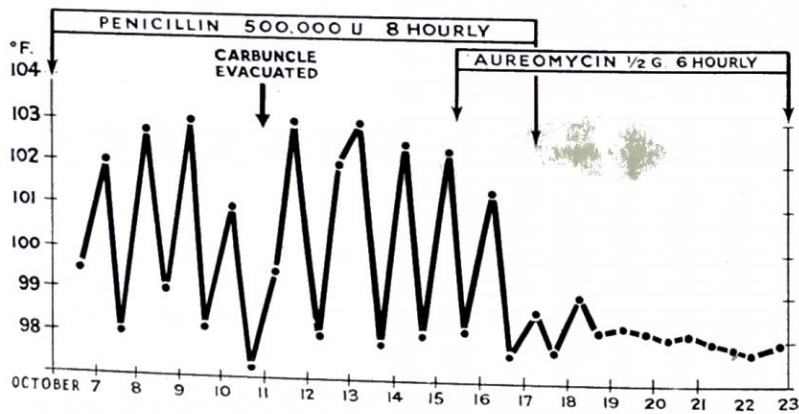


Fig. 794.—Temperature chart of a case of renal carbuncle due to a penicillin-resistant staphylococcus. (After T. F. Rose.)

The only cases in which nephrectomy is likely to be required are those that are delayed unduly, usually in the hope that operation can be avoided by persisting with antibiotics.

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CHAPTER LII

INJURIES TO THE KIDNEY AND URETER

RENAL injuries can be divided into slight, severe, and critical.

Slight injuries comprise those where the parenchyma is damaged without rupture of the capsule or extension of the laceration into the renal pelvis or a calix. (*Fig. 795 A, B.*)

Severe injuries are those where the capsule is broken and/or disruption into the renal pelvis or calices has occurred. (*Fig. 795 C, D, E.*)

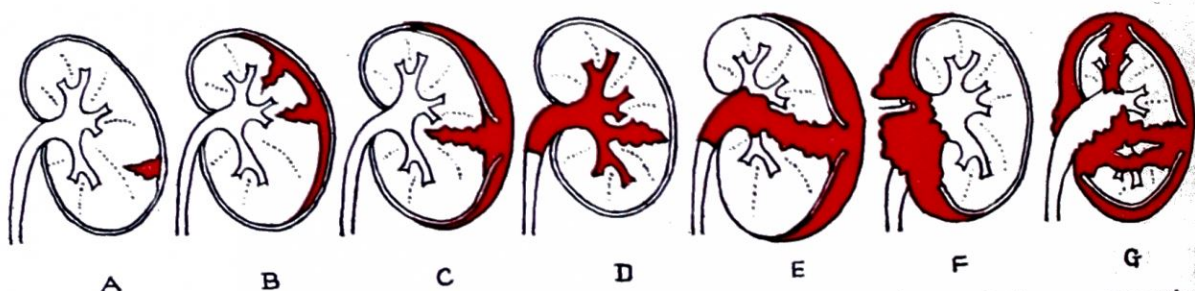


Fig. 795.—Various types of renal injuries: A, Small subcapsular hæmorrhage; B, Large subcapsular hæmorrhage; C, Cortical laceration with perinephric hæmatoma; D, Medullary laceration with bleeding into the renal pelvis; E, Complete rupture; F, Avulsion of the pedicle; G, Fragmentation.

An injury is termed critical when the vessels of the renal pedicle are torn or the kidney is shattered. (*Fig. 795 F, G.*) As a result of a study of 71 cases C. V. Hodges et al. found that the distribution was as follows:—

Slight	66 per cent
Severe	32 „ „
Critical	2 „ „

The injuries to a kidney incurred in civil life are very seldom the result of an open wound. Blows or falls on the loin are the most fruitful sources of such injuries, while blows from in front, crushing accidents, and falls on the buttocks or feet add their quota (*Fig. 796*). The injury is nearly always extraperitoneal; in 108 cases I reviewed, all were extraperitoneal. In children below the age of 10, in whom there is little if any perinephric fat, very occasionally the peritoneum is torn in addition to the renal

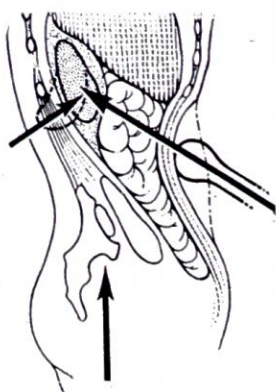


Fig. 796.—With a blow from behind, the kidney is thrown against the liver. With a blow from in front, it is liable to be impinged against the 12th rib. As a result of a fall on the buttocks, the vascular pedicle may be damaged. (*After F. Papin.*)

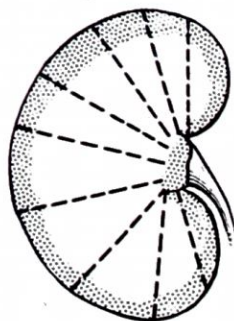


Fig. 797.—Diagram to show the usual lines of rupture of the kidney.

capsule, allowing blood, and perhaps urine, to escape into the peritoneal cavity. Tears of the renal parenchyma follow the lines of the uriniferous tubules (*Fig. 797*). One pole, nearly always the lower, may be wholly or partially detached, always along one of the aforesaid lines (*Fig. 798*).

Clinical Features.—

The sex incidence is truly remarkable. In all large series of cases males predominate in a proportion of nearly 10 to 1. It is difficult to believe that so great a discrepancy can be accounted for solely by the more strenuous life of the male. Contributory factors that lessen the liability of females to renal injury are greater renal mobility in females, and the wearing of corsets.

In all large series the incidence of renal injuries is somewhat greater on the left side.

Hæmaturia, the cardinal sign of a traumatized kidney, is present to a lesser or greater degree in over 99 per cent of cases; nevertheless, frequently it does not make its first appearance until some hours after the accident, the urine voided soon after the accident being clear. Rarely, macroscopic hæmaturia ceases within a few hours; this, of course, is likely to occur when the injury is trivial; nevertheless one must not jump to this conclusion, for cessation of hæmaturia occurs also when the ureter becomes occluded by blood-clot.

Clot passing down the ureter occasionally gives rise to clot-colic, which is not as severe as the colic produced by a calculus. Hæmaturia is entirely absent in renal injuries only when the renal pelvis is avulsed from its ureter.

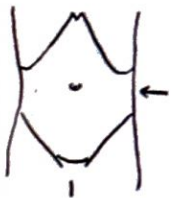


Fig. 799.

Shock.—A variable degree of shock is present in all but very slight injuries. When shock is profound and fails to respond quickly to treatment, if there is no other more obvious injury to account for it, a

concomitant intra-abdominal lesion should be suspected, and the commonest dual lesion is rupture of the spleen and the left kidney.

Rigidity of the anterior abdominal wall on the affected side is present constantly in cases of even moderate severity.

Local tenderness is rarely absent.

A *perinephric hæmatoma* should be suspected if there is even a slight flattening of the normal contour of the loin (Fig. 799). Rarely is abdominal relaxation sufficient to permit accurate palpation of the renal region, although when perirenal bleeding is extensive a mass can be felt in spite of the overlying rigidity.

Meteorism.—In many cases of renal injury abdominal distension comes on within 36 hours of the accident. On several occasions I have verified that it is ballooned colon, as opposed to small intestine, that gives rise to this diagnostically confusing distension.

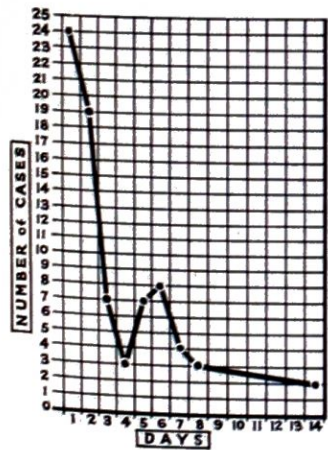


Fig. 800.—Graph showing the duration of hæmaturia in cases treated expectantly.

abnormality. The reason for this precaution is that secondary hæmorrhage into the bladder is fairly frequent, and is most common during the second and third week after injury. It is not unusual for this late hæmorrhage to be severe. Most cases can be forestalled if retrograde pyelographic studies of the injured kidney are made.



Fig. 798.—Ruptured kidney from a run-over accident.

MANAGEMENT AND TREATMENT

Even when there are no general or local signs, every patient with hæmaturia (Fig. 800) following an accident should be put to bed and kept there for at least a week after bleeding has ceased and pyelographic studies reveal no gross

To prevent infection penicillin is administered intramuscularly, and sulphatriad with an alkaline mixture is given by mouth.

Treatment of Shock, if present, is commenced as soon as possible, and in shocked patients frequent re-examinations are required to exclude a concomitant intraperitoneal lesion.



Fig. 801.—Ruptured kidney following a kick from a horse—anæmic infarction of lower pole.

Blood Transfusion.—It is advisable to have all patients with a renal injury grouped in readiness for blood transfusion. Hæmoglobin estimations and red-cell counts are made, and repeated as necessary. These tests are valuable in assessing the need for transfusion and the amount of blood required, except during the first few hours after admission when, on account of the unreliability of these tests at this time (see p. 45), the necessity for blood transfusion must be adjudicated entirely on clinical grounds.

Recording the Pulse-rate.—When a patient with hæmaturia following an accident is admitted, the pulse-rate should be recorded hourly. In cases that respond to expectant treatment the frequent pulse-reading and watchful care must be continued over a longer period than the patient's general condition would seem to justify, for signs of extensive laceration may be delayed. Sometimes the pulse is an unreliable indicator.

A youth was kicked in the right loin by a horse. On admission, pulse 86, temperature 97.8° F. (36.5° C.). There was no sign of external injury or swelling in the loin. Considerable tenderness of right side of abdomen was present, also rigidity of upper right rectus. The urine contained blood. Slight hæmaturia continued for five days. During this time the rigidity persisted and the patient complained of pain in the right side. Pulse remained full and unaccelerated. Suddenly, at 1.30 p.m. on the sixth day there was a torrential hæmaturia. The lad became collapsed. After morphine and posture had improved the general condition, a lacerated kidney was extirpated (Fig. 801). Recovery.

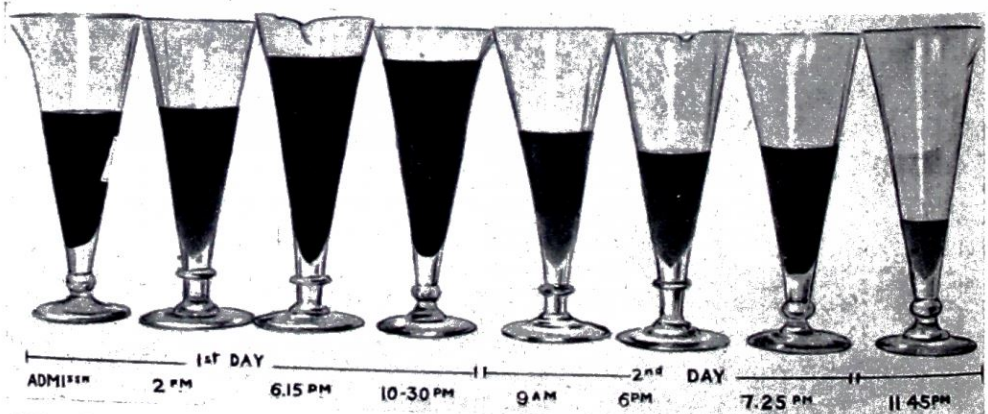


Fig. 802.—Injury to the kidney. The urine is saved and placed in glasses labelled with the time of passing. In this way one sample of urine may be compared with a later specimen, and an estimation can be formed as to whether the bleeding is progressive or not. In this case the hæmorrhage, which was at first severe, abated after thirty-four hours, and the patient recovered with expectant treatment.

In spite of the fortunate outcome, this case exemplifies the dictum that no patient with an injury of a kidney in whom pain and rigidity persist for 48 hours should be treated expectantly. In this case an earlier operation would probably have permitted partial nephrectomy to have been undertaken.

Saving Specimens of Urine for Inspection.—In all cases the urine should be saved and placed in glasses bearing a label indicating the time of voiding. It is then possible to compare one sample of urine with a later specimen, and thus to estimate whether the external bleeding is progressive or not (Fig. 802). In comparing two samples—especially

in an artificial light—it is sometimes helpful to dip a strip of white blotting paper into each specimen after stirring. For purposes of comparison, the concentration of blood in the urine is seen more readily in the absorbent paper. The presence of clots in one sample would, of course, vitiate the result.

General Rest.—Once a diagnosis of rupture of a kidney has been made, morphine is administered, and repeated as necessary. The patient is permitted to lie in the position he finds most comfortable.

Forestalling Meteorism.—Although the distension is originally colonic, in severe cases it is a wise precaution to pass a gastric aspiration tube and to keep it in position as long as the amount withdrawn justifies its retention.

Radiography.—

A *Plain Radiograph* of the abdomen is always worth while, for when a kidney is injured the film sometimes reveals one or more of the following abnormalities :—

1. Slight 'protective' scoliosis—concavity towards the side of the lesion.
2. Obliteration of the psoas shadow.
3. Loss of the kidney outline.
4. Injury to the bony skeleton, usually the 12th rib or an upper lumbar transverse process or processes.
5. Meteorism, more pronounced on the side of the lesion.

Excretory Urography (Fig. 803).—When facilities exist, the sooner excretory urography¹ can be carried out after the patient has recovered from shock, the better. Comparatively little attention should be paid to excretory pyelographic appearances on the injured side, for they are often misleading. Blood and blood-clot in the renal pelvis is liable to prevent clear delineation; the excretion of the medium is often delayed or absent, which is in keeping with what might be expected. In one case the comparatively normal pyelographic picture vitiated my clinical judgement.

Twenty-four hours after a street accident, although profuse initial hæmaturia had lessened, a middle-aged woman remained exceedingly tender in the right loin and some degree of meteorism was present. As blood transfusion had rendered her general condition tolerably good, it was decided that operation should be performed later in the day. In the interval

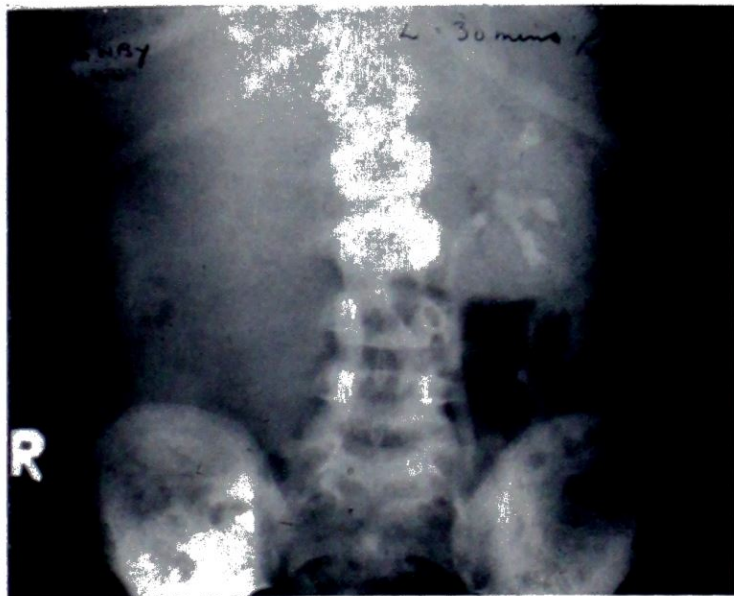


Fig. 803.—Excretory urography showing (1) scoliosis; (2) loss of right renal outline; (3) normal left kidney. (D. E. Truscott.)

excretory pyelography was carried out. Both kidneys were visualized, although on the injured side the outline was a little bizarre. Operation was cancelled because of the relatively normal pyelographic appearance. Four days later her condition deteriorated, and in spite of resuscitative measures, she expired during the night. Abdominal distension had become immense. Necropsy showed what might have been a reparable lesion of the parenchyma, with widespread retroperitoneal extravasation of blood and urine.

Emphatically, we should rely, not on excretory pyelographic appearances, but on clinical signs aided when in doubt by *retrograde* pyelography, to decide whether to explore or to continue conservative treatment. The value of excretory pyelography in injury to a kidney lies in the demonstration of a functioning contralateral organ, for the concrete proof of which the surgeon should be truly thankful.

¹ With the newer compounds such as hypaque (Bayer Products Ltd., Kingston-on-Thames, Surrey) it is best to undertake excretory urography with the patient's body tilted at 10° by the head. When undertaking urography for suspected renal injury, in no circumstances must compression be used, as is usual in non-traumatic cases.

Retrograde Pyelography.—Many surgeons are prejudiced against retrograde pyelography. They believe that injection of the contrast medium will incite renewed bleeding, irritate the ruptured parenchyma, and disseminate infection. There is no evidence to support any of these contentions. Provided the patient is in excellent general condition and the surgeon is an experienced cystoscopist, retrograde pyelography should be performed in all cases where the advisability of operation is not evident on clinical grounds. Only retrograde pyelography can delineate accurately the extent of the injury and provide evidence that will enable the surgeon to forestall catastrophes such as have been exemplified by the two cases quoted. Concomitant administration of antibiotic and chemotherapeutic agents, together with aseptic cystoscopy and the use of modern non-irritating contrast media, render retrograde pyelography quite safe. However, if by retrograde pyelography a rupture is demonstrated, one should be prepared to explore the kidney without delay, lest renewed serious hæmorrhage recommences as a result of the examination.

The Diagnosis of Ruptured Kidney has been made, but is there an Intraperitoneal Lesion also?—

When the surgeon is unable to exclude an intraperitoneal lesion indubitably he should explore the abdomen. For this purpose a midline incision immediately above the umbilicus, just large enough to allow the hand to be inserted, is sufficient. Having ascertained that there is not an undue amount of free fluid in the peritoneal cavity, and having verified the presence of a bulging hæmatoma in one loin and a normal kidney in the other, much the best course is to close the laparotomy incision and expose the kidney from the back. Abdominal nephrectomy in the presence of even moderate meteorism is a Herculean task.

A well-developed youth was knocked off his bicycle. He arrived in hospital in a shocked condition complaining of severe left-sided abdominal pain. The first specimen of urine was full of bright-red blood, but subsequently he passed almost clear urine several times. During the night his pulse-rate rose from 90 to 125; it was at this time that I was called to see him. He was obviously anæmic. The abdomen was distended and shifting dullness could be elicited. As soon as practicable the abdomen was opened through a limited midline upper abdominal incision. Serous blood-stained fluid ran out. The spleen and liver were intact; the palpating hand readily made out a large retroperitoneal hæmatoma on the left side. The right kidney was present. The abdominal incision was speedily closed. Turning the patient over, the left kidney, surrounded by blood-clot, blood, and urine, was exposed. The renal pelvis was torn across almost completely; indeed, the kidney was practically avulsed from its pedicle. Nephrectomy was performed (*Fig. 804*). The perirenal space was packed firmly with dry gauze. Suturing the wound was omitted save for the skin stitches. The patient was now pulseless and no time was lost in giving him a blood transfusion, for matched blood was now in readiness. The gauze pack was removed on the fourth day uneventfully. Convalescence was smooth, the only complication being slight suppuration in the lumbar wound.



Fig. 804.—The specimen taken from the patient referred to in the text. The kidney was practically avulsed except for vessels entering the upper part of the pedicle (X).

It is unlikely that this patient would have recovered if abdominal nephrectomy had been attempted.

When an intra-abdominal lesion is found the wound must be enlarged as necessary, and the ruptured viscus dealt with effectively. Then, and then only, is the time to decide whether the patient is in dire need of operative treatment for the renal lesion. It is often good judgement to close the abdomen, return the patient to bed, and to treat the renal injury expectantly, at any rate *pro tem*. On the other hand, if there is a considerable retroperitoneal hæmatoma in a renal area and the patient's general condition is satisfactory, it is advisable to proceed. It is difficult to determine the extent of the renal damage if the posterior layer of peritoneum has been opened over the kidney, and such a step often results in nephrectomy being performed unnecessarily.

Transabdominal nephrectomy is particularly hazardous, bears a high mortality, and should rarely be undertaken (Meredith Campbell). To proceed as in the case quoted above is the better course.

Dual Injuries.—As would be expected, the outcome of severe injury to more than one organ is always doubtful. It is therefore encouraging to learn that of 46 cases of the commonest dual lesion—ruptured spleen and left kidney—treated by combined splenectomy and nephrectomy collected by R. Desjacques before the era of blood-banks, 22 recovered.

The Triad of Injuries.—Concomitant ruptured left kidney and ruptured spleen is not infrequently associated with rupture of the left side of the diaphragm. This triple injury is the result of crushes or high-velocity impact upon the left side of the trunk. When the diaphragm is torn, usually the stomach herniates into the thorax; consequently the most important radiological sign of a ruptured diaphragm is elevation of the gastric bubble. Adams and Musselman, in discussing this triad of injuries, have found that the thoracic approach with enlargement of the diaphragmatic rent has allowed them to perform splenectomy and left nephrectomy. After inserting a drainage tube through the left flank, the diaphragm is repaired and the thorax closed with water-seal drainage.

A Concrete Diagnosis of Uncomplicated Ruptured Kidney has been made: Indications for Exploration by the Lumbar Route. (For technique see p. 610.)—

1. The immediate hæmorrhage is severe enough to endanger the patient's life.
2. The hourly pulse-reading is rising.
3. Unabating hæmaturia continuing more than 24 hours.
4. Persistence of considerable local rigidity and tenderness for a like period.
5. Large perinephric hæmatoma discernible within the first 48 hours.¹
6. Pyelographic evidence of a major lesion.

In about 96 per cent of cases the kidney is the only organ damaged and the rupture is extraperitoneal. Consequently it is *lumbar* exploration that is indicated in nearly all cases.

Determining the Presence of the Other Kidney.—Reference has been made already to the inestimable value of excretory urography in this respect.

When pyelographic evidence is not available the surgeon should reflect on the fact that congenital absence of one kidney occurs sufficiently frequently to make it imperative to ascertain the presence of a second organ. It is never permissible to neglect this step, as the following unfortunate coincidence emphasizes.

A patient, having been gored in the loin by a bull, was rushed to a hospital in the nearby city. His lacerated kidney was removed promptly, but he passed no urine, although he survived for several days. Necropsy showed that the only functional organ had been excised. A few months later, into the same hospital was admitted a second patient who had been gored by a bull. It was found that the kidney had been wounded, and it was removed. He, too, passed never a drop of urine, and the post-mortem revealed that the contralateral organ was congenitally absent.

It is possible to prove the presence of the contralateral organ by chromocystoscopy. An irrigating cystoscope is essential, for the bladder probably contains blood-clot. When the surgeon is familiar with the use of the irrigating cystoscope, and has available the services of a competent theatre staff, unless the condition of the patient brooks of no delay, this measure is practicable.

A general anæsthetic sometimes inhibits the excretion of dye by the kidneys; moreover, cystoscopy in the presence of blood-clot in the bladder may prove time-consuming. It is for these reasons that it is recommended that this investigation should be carried out before a general anæsthetic is administered. With suitable preliminary medication, cystoscopy can be performed under local anæsthesia, or, better still, under low spinal anæsthesia, which does not add to shock. In necessary cases blood transfusion or plasma can be given while cystoscopy is in progress.

Theoretically, when the condition of the patient or other circumstances make chromocystoscopy impracticable, the information required should be made available by opening the peritoneum in the ventral portion of the lumbar incision, and after having the patient rolled sufficiently to enable one to insert the hand into the peritoneal cavity, to palpate the kidney of the other side. Having obtained the necessary information, the peritoneum is closed. I have tried this expedient, and have found that it is possible, but time-consuming and disturbing to the even tenor of the operation. It is my conviction that in extenuating circumstances the interests of the patient are best served by making a

¹ Shattered kidney is a prime indication for urgent operation. The condition is manifest by unrelenting shock and a rapid increase in the size of a mass in the flank.

small midline incision in the anterior abdominal wall, and through this ascertaining the presence of the contralateral organ, the existence of a perinephric hæmatoma on the affected side, and the absence of an intraperitoneal lesion. Armed with this knowledge, having sewn up the anterior incision rapidly, the patient is turned over and the surgeon can proceed with a set lumbar operation in an orderly manner, and with a quiet mind that is the outcome of an established diagnosis.

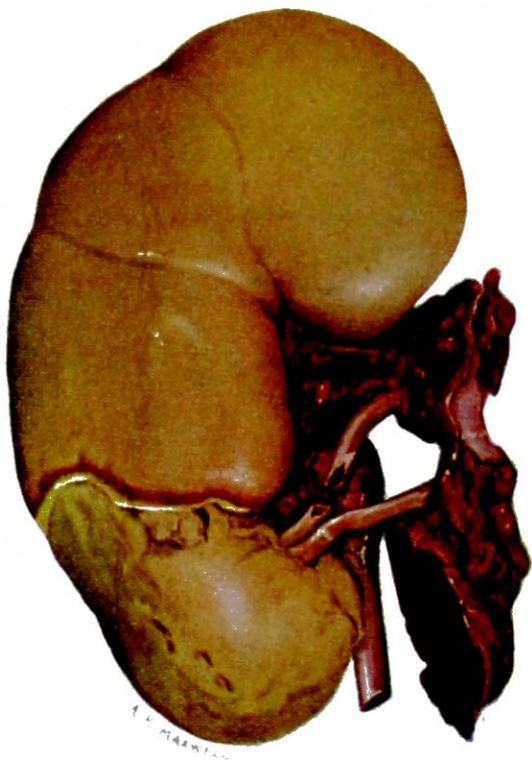


Fig. 805.—Anæmic infarction of the lower pole of the kidney. (A. Fullerton, 'British Journal of Surgery'.)

NEPHRECTOMY

(for TECHNIQUE, see p. 614).

Indications.—

1. The vascular renal pedicle is torn.
2. The ureter is avulsed.
3. The parenchyma is lacerated in several places.
4. There is a tear extending towards the renal pelvis, but the kidney has a short pedicle and cannot be delivered completely; it is impossible to suture a rent that cannot be displayed.

5. Anæmic infarction. It is dangerous (severe sepsis; secondary hæmorrhage) to conserve infarcted tissue. Fig. 805 shows the coloration of the tissue of which to beware. Nephrectomy, or partial nephrectomy, is always indicated in the presence of infarction.

When the renal pedicle has been surrounded by blood and blood-clot for more than 48 hours it becomes friable and a mass ligation around its constituents is liable to cut out. For this reason it is essential to exercise special care in applying ligatures to the renal vessels. Segmental ligation (see Fig. 829, p. 614) should be the unwavering rule. In desperately urgent cases, rather than consume time in ligating the renal pedicle, occasionally it is good judgement to rely on hæmostats, which are left in position. The wound is closed with the minimum of sutures; indeed, on one occasion I left the wound entirely unsutured. The hæmostats are loosened and removed on the third or fourth day.

CONSERVATIVE OPERATIONS

In cases of injury to a kidney it is conservative to operate early: when in doubt, operate.
(O. S. Lowsley.)

If displayed within 24 hours many ruptured kidneys that later would require nephrectomy can be saved. Various procedures are available; which to employ requires surgical judgement. The nature of the lesion, the experience of the operator, and the facilities available are all factors that must be taken into consideration.

Packing.—When a sole existing kidney is ruptured, when the presence of a contralateral organ has not been ascertained, when the condition of the patient is poor, when the operator is relatively inexperienced and the facilities available in the matter of assistance are inadequate, this expedient has everything to recommend it. Three rolls of gauze are required. Having cleared the perinephric space of blood and blood-clot, one piece of gauze is packed on the medial aspect of the kidney, another on the lateral aspect, and a third fills the wound. The skin is brought together loosely. The patient is watched most carefully. Blood transfusion is given, as necessary. In the unlikely event of excessive hæmaturia or oozing under the dressings, the wound must be reopened without any delay. Usually a second stage can be safely postponed until the third day. Then, under the best possible conditions that can be arranged (and by this time a better knowledge of the function of the contralateral kidney, if present, having been obtained) the packing is removed.

The kidney will be found in a much less alarming state ; instead of being congested and bleeding, it will be dry and relatively anæmic. It should be scrutinized carefully for anæmic infarction. It may well be that another of the conservative measures can be carried out, or even that the kidney can be dropped back into the wound with a

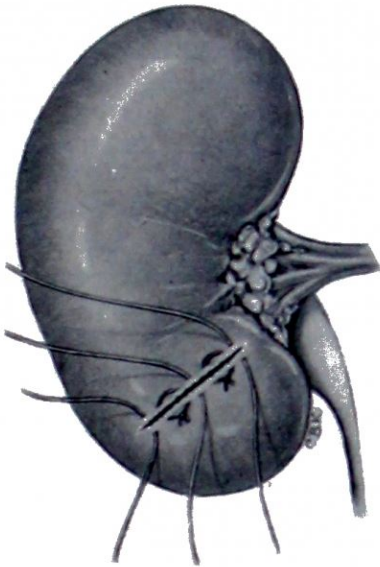


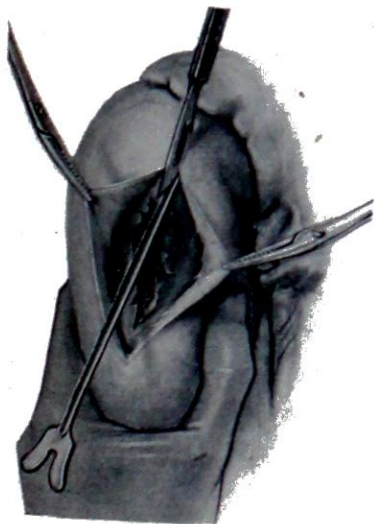
Fig. 806.—The edges of the rent having been approximated, three stitches are passed as shown. These will be tied over a muscle-graft.



Fig. 807.—A muscle-graft taken from the sacro-spinalis. The forceps make an efficient 'spreader' whilst the muscle is being transferred to the kidney and sutured into position.

reasonable assurance that healing can occur. The wound is sutured and a $\frac{1}{4}$ in. (6 mm.) drainage tube provided.

Suture.—All of a sufficient number of mattress sutures to close the rent are inserted before they are tied. Each stitch is passed through the parenchyma to a depth of about $\frac{1}{4}$ in. (6 mm.). The catgut must be pliable, and the knot tightened steadily so as to avoid a sudden jerk.



A



B



RUBBER CATHETER

C

Fig. 808.—Repairing a ruptured kidney with ribbon catgut. A, Incising the capsule ; B, Cutting slots in the capsule ; C, Standard method of binding the kidney with ribbon catgut. In this instance nephrostomy was performed in addition. (After Lowsley and Menning.)

These sutures are not tied tightly (a) to prevent cutting out ; (b) to obviate strangulating renal tissue included in the mattress (see Fig. 740, p. 535). The edges of the wound having been approximated satisfactorily, three further stitches are passed (Fig. 806), one near

one end of the laceration, one near the other, and one in the middle, but they are not yet tied. A muscle-graft (*Fig. 807*) is cut, and the sutures referred to are tied over the graft to reinforce the suture line. In place of a muscle-graft absorbable gauze or gelfoam can be used, but they offer no advantage over muscle, which is material *par excellence* for this purpose. Repair by suture should be limited to solitary linear tears. In tears of the middle of the kidney communicating with the caliceal system suture can, with advantage, be combined with nephrostomy. A small catheter with a second eye cut near its termination is passed into the renal pelvis, and the rent on either side of it is repaired in the manner just described.

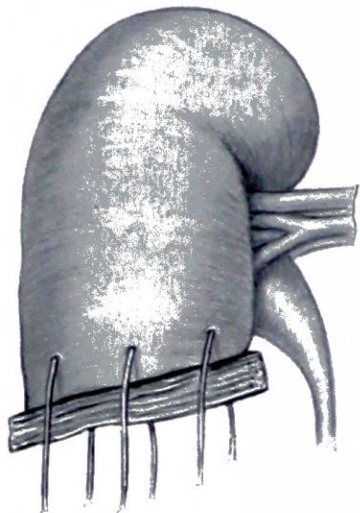


Fig. 809. — Partially avulsed lower pole treated by completing amputation and covering the raw area with a muscle-graft.

Binding the Kidney with Ribbon Catgut is an alternative procedure to the above. Provided Lowsley's ribbon catgut is available and the surgeon is experienced in renal surgery and the patient is in good condition, this method can be used from time to time. The renal capsule is opened along the convex border. Clots and loose pieces of renal parenchyma are removed. After constructing slots in the capsule in the manner shown in *Fig. 808*, ribbon catgut is employed to bind the ruptured organ.

Partial nephrectomy : *Indications.*—

1. When the damage is confined to one pole.
2. Anæmic infarction limited to the lower pole.

The raw surface left after removal of an avulsed pole (nearly always the lower pole) is well safeguarded by stitching an ample muscle-graft against it (*Fig. 809*). Less kidney substance is wasted than in the customary wedge-shaped method of repair (Campbell Begg), the sutures are in less danger of cutting out, and dead space is obliterated. After this method of repair post-operative bleeding, urinary fistula, and sloughing are conspicuous by their absence.

Emphasis has been placed upon the necessity of removing infarcted renal tissue. When the area is localized strictly to the lower pole it should be excised in the customary V-shaped manner, after stripping back the capsule. The edges are approximated by suture, the capsule is sutured over the stump, which is reinforced by a muscle-graft. In cases of infarction a torn aberrant renal artery should be sought and, if present, ligated.

CONSERVATIVE TREATMENT OF RENAL INJURIES

Although much emphasis has been placed upon operative measures, the indications for them have been defined clearly. In about 70 per cent of cases if the patient is treated as described on p. 583 operation never becomes necessary. The rationale of conservative treatment lies in the fact that bleeding from an injured kidney tends to be self-limiting. This is due to the tamponade effect of the true capsule if the tear is intracapsular, or of the perirenal fascia if the tear is extracapsular. Thus, unlike the liver or the spleen, the kidney may be said to possess a double capsule.

The attitude to be adopted in injuries of the kidney is to be prepared to operate, but to withhold one's hand unless there are definite indications that the damage calls for more help in repair than Nature can provide. Furthermore, however seemingly well the patient may appear, one must not relax the vigil on the pulse, temperature, and urine for at least ten days. Above all there must be no 'early rising'—strict bed rest is the order of the day. It is most instructive and a great safeguard to watch the progress of the case with the assistance of serial excretory urographs. In hospitals with a portable X-ray machine, this routine should always be followed.

RUPTURE OF A DISEASED KIDNEY

A surprisingly high proportion of ruptured kidneys are found to be diseased. In a series of 26 cases of injury to a kidney requiring exploration I found 6 to be abnormal. Of these, 4 showed varying degrees of hydronephrosis, 1 contained a calculus, and 1 was a congenital cystic kidney. In only 2 of these cases was the injury comparatively slight—falls to the ground while walking in the street.

In a radiological investigation of renal injuries M. R. Hall also was surprised at the high incidence of pre-existing disease of the injured organ. In no less than 23 per cent the ruptured kidney showed clear radiological evidence of disease, which was later confirmed at operation. None of the patients was aware that the kidney was abnormal.

In cases of rupture of a considerable hydronephrosis it is the renal pelvis that is usually torn, and consequently the symptoms are unlike those of rupture of a normal kidney; there is no hæmaturia.

H. W. L. Molesworth's Case.—A woman of 50 fell and struck her left side. Violent abdominal pain followed, and shortly afterwards she vomited. When examined, abdominal rigidity was evident, especially on the left side. Under general anæsthesia an abdominal swelling was apparent. The abdomen was opened, and a large retroperitoneal swelling was found. The laparotomy incision was closed and a ruptured hydronephrotic kidney was removed by the lumbar route. Recovery.

Coincident tearing of the overlying peritoneum has been found in 25 per cent of cases of ruptured hydronephrosis. When a hydronephrosis has ruptured into the peritoneal cavity, abdominal nephrectomy should be undertaken. If, however, the fluid mass is extraperitoneal, unless the pre-operative diagnosis is assured (in which case lumbar exploration is carried out), the correct method of procedure is as described in the above case. When the kidney of the opposite side is diseased, and the wall of the hydronephrosis contains even a small amount of kidney substance, an endeavour should be made to save the organ by stitching it up around a drainage tube.

TRAUMATIC PERIRENAL HÆMATOMA

Although there is no need for haste, it is better to drain a palpable perirenal hæmatoma and, at the same time, explore the damaged kidney within 24 to 48 hours of the accident. To adopt an expectant attitude is to take unjustifiable risks, for without the aid of retrograde pyelography the extent of the laceration is unknown. Other reasons for advising early operation are that these extravasations of blood are liable to become infected; even should they resolve—a slow process—further trouble is not necessarily at an end. I have met with two cases where the contracture of fibrous tissue resulting from the resolution of a perirenal hæmatoma literally strangulated the kidney within it. In late cases of perirenal hæmatoma (by which is meant that the patient first comes under observation upwards of six days after the accident), when his general condition is good and there is no hæmaturia, it is best to drain the collection of blood with the least possible disturbance to the kidney. In some instances the extravasated blood burrows along the sheath of the psoas muscle towards the iliac fossa; exceptionally it tracks along the spermatic vessels and produces ecchymoses at the external abdominal ring. In two such cases ten days after the accident, a large quantity of dark blood was drained by making a gridiron incision as for appendicectomy. When the peritoneum was reached it was pushed medially and the retroperitoneal tissues were opened up with the finger. In suitable cases this is an excellent expedient, for the extravasated blood is drained from its lowest point with minimum disturbance to the ruptured kidney, which by this time is most probably in a stage of natural repair.

Spontaneous Perirenal Hæmatoma.—The classical triad of abdominal pain, signs of internal hæmorrhage, and a swelling in the loin, are often obscured by the resemblance to an acute abdominal catastrophe. There is no single underlying cause—some cases are due to bursting of an aneurysm of the renal artery, others are caused by renal neoplasms or inflammation, still others are probably due to obstruction of the renal veins. In a few cases the cause has been found to be periarteritis nodosa. Without operation the condition is said to be always fatal. The largest proportion of recoveries have followed urgent nephrectomy, and it is advisable to carry out this step in most cases. In unfavourable circumstances this is an occasion for the use of packing (*see p. 588*). When necessary the kidney can be removed at the second stage of the operation.

INJURIES OF THE URETER

Traumatic Rupture of the Ureter is very uncommon. Avulsion of the ureter proper from the pelvis of the kidney is the most usual variety. The lower third of the ureter has been wounded by a spicule of bone from a fracture of the pelvis. Rupture of the ureter often remains unrecognized until extravasation of urine into the deep planes of the loin arrests attention by causing a lumbar swelling. Perirenal extravasation of urine needs drainage. One is fortunate if, in the course of carrying this out, the site

of leakage can be displayed; more often drainage is all that can be accomplished in the first instance.

If repair is possible, end-to-end anastomosis of the ureter (*see below*) will be the most generally applicable measure.

Injuries to the Ureter during Hysterectomy and other Pelvic Operations occur rather commonly, doubtless much more frequently than would appear from the literature. The accident could be minimized considerably by the preliminary passage of ureteric catheters. As a result of the operation accident the ureter is sectioned transversely or obliquely, or a piece may be removed from its side wall. More often the ureter or ureters are occluded by a ligature, or ligation of a blood-vessel in the immediate neighbourhood causes an obstructive kink. Finally, an occasional complication after radium implantation for carcinoma of the cervix is necrosis of the juxta-cervical portion of the ureter which leads to a urinary fistula.

The site of the lesion is usually in the broad ligament near the uterine artery (*see Fig. 773, p. 560*), but it sometimes occurs somewhat higher. The injury may be recognized (1) at the time of the accident, (2) during the immediate post-operative period, or (3) later.

INJURY RECOGNIZED AT THE TIME OF THE OPERATION

It is highly important to recognize the divided ureter promptly and avoid being lulled into the belief that it is a vessel which has been clamped and severed. A divided ureter pouts, whilst a divided artery retracts (*Fig. 810*). A divided ureter also shows its classical worm-like peristalsis on gentle pinching.

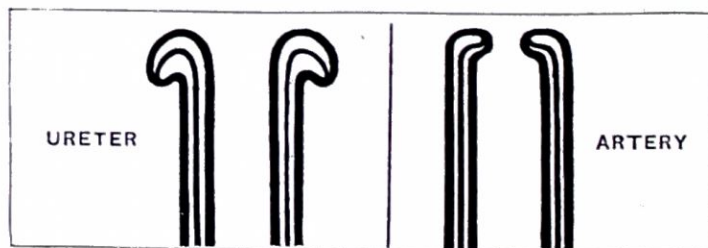


Fig. 810.—The differential diagnosis between a cut ureter and a blood-vessel. The divided ureter pouts, whilst a divided artery retracts.

Having satisfied oneself that it is the ureter which is damaged, several alternative procedures are available. Each will be discussed and its relative merits and demerits explained:—

1. Ligation of a Cut Ureter *per se* should be condemned. It is true that, provided the contralateral kidney is healthy, in 58 per cent of cases renal atrophy follows quietly. But what of the remaining 42 per cent? Three per cent die of renal failure, 24 per cent develop a fistula, and 15 per cent require nephrectomy for hydronephrosis that is often infected (A. B. Hepler). Ligation followed by temporary nephrostomy which, in cases where speed in concluding the operation is imperative, can be postponed for 24–48 hours, has much to recommend it. A reparative operation, or failing that nephrectomy, can be undertaken in two or three weeks time.

2. Cutaneous Ureterostomy has its advocates, but the disadvantage is that it shortens the ureter available for subsequent implantation into the bladder. Moreover in a not inconsiderable percentage of cases the distal half-inch (1.3 cm.) of the ureter sloughs, making implantation into the bladder less feasible.

3. Abdominal Nephrectomy.—On two occasions I have been summoned to the operating theatre to perform abdominal nephrectomy when the gynæcologist considered it unwise to attempt a conservative operation. In one of these cases the kidney, the ureter of which had been divided, was hydronephrotic. When the contralateral kidney is normal this is a certain method of preventing the serious complications of unsuccessful repair. Nevertheless to remove a healthy kidney is not in keeping with the ideals of surgery, and it should be performed only when there are good reasons for not undertaking a restorative operation.

4. End-to-end Anastomosis.—Although this is not a difficult procedure, it must be condemned because the results are extremely bad. A stricture develops in all (Graham

and Goligher), or almost all cases. In the rare event of the ureter being severed at a considerable distance from the bladder, end-to-end anastomosis is the only alternative to nephrectomy. The cut ends are trimmed obliquely, and four 000 plain catgut sutures are used to effect the anastomosis (*Fig. 811*). The best way of affording rest to the suture line is to incise the ureter vertically above the anastomosis, and insert a ureteric catheter into the pelvis of the kidney. The catheter is retained for a week.

5. Implantation of the Ureter into the Bladder.—Provided the operation is carried out extraperitoneally with drainage to the site of implantation and drainage of the bladder suprapubically or by an indwelling catheter, the results are excellent, especially after the Boari operation (*see below*).

The lower end of the ureter can be exposed extraperitoneally through an incision comparable in every way to that described for displaying the external iliac artery (*see p. 950*), but the incision is carried to the middle line just above the pubic symphysis. Küss and Holzer have employed this incision in 18 cases of cut ureter, and speak highly of it. The ureter adheres to the peritoneum, and as the latter is lifted from the bifurcation of the common iliac vessels the ureter will be displayed. It is mobilized from the peritoneum in an upward direction for at least 6 in. (15 cm.). The bladder is distended with 200–300 ml. of water in order to facilitate exposure of the lateral bladder wall. The lower end of the ureter is ligated if it can be found conveniently.

Method 1.—When the ureter is of sufficient length to lie without tension on the bladder wall, this simple method suffices. The ureter is bisected longitudinally for $\frac{1}{2}$ in. (1.3 cm.). A mattress suture of 000 plain catgut is inserted into each flap from within, outwards. A stab incision is made through the bladder wall in an oblique direction, to imitate the intramural course of the ureter. The split ureter is carried into the bladder by means of passing the attached sutures through the bladder wall from within, outwards (*Fig. 812*). It is important that these sutures should be passed far enough from the incision in the bladder to splay the flaps completely. The sutures are tied, the opening in the bladder is closed snugly around the ureter, and the anastomosis is reinforced by the two sutures passing through the adventitia of the ureter and the superficial part of the bladder wall. The abdominal wall is closed with corrugated rubber drainage down to the site of the anastomosis; this should not be removed completely for 5 days. An indwelling catheter is retained for a week. Penicillin and sulphatriad are administered for at least 10 days.



Fig. 812.—Implantation of the ureter into the bladder.

and the edges are united by closely placed interrupted sutures of 000 plain catgut placed with minute care into the bladder musculature. The distal extremity of the newly-formed tube of bladder is united to the adventitia of the emerging ureter with similar sutures. Into the opening into the bladder from which the pedicle graft was cut is placed a Malecot catheter. This portion of the bladder is closed about the Malecot and ureteric catheters (*Fig. 813 C*) which are brought out of the abdominal incision at a convenient place. The prevesical space is drained. The Malecot and ureteric catheters are withdrawn on the sixteenth day, and a urethral catheter substituted for a further few days. Urinary antiseptics are given during the post-operative period, as directed in method 1.

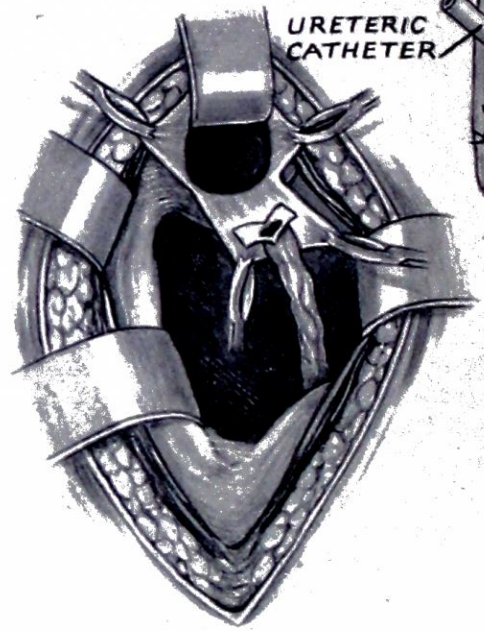


Fig. 811.—End-to-end anastomosis of a ureter.

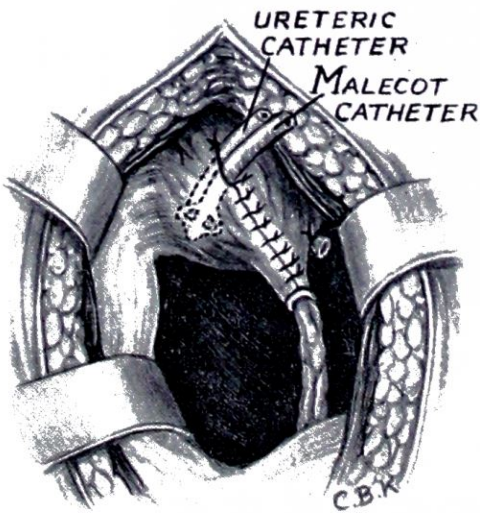
Method 2 (the Boari Operation).—When it is found that the ureter is too short to lie on the bladder wall without tension, a ureteric catheter is placed in its upper portion to divert the urinary stream for a while. A rectangular flap of bladder is outlined (*Fig. 813 A*). The bladder is then emptied. The flap is cut in such a way as to leave it hinged at its base, which should be near the trigone (*Fig. 813 B*). The ureter is then split longitudinally as in method 1, and it is anchored to the distal part of the bladder flap, as shown in *Fig. 813 inset*. The ureteric catheter is reinserted. The flap is rolled around the catheter to form a tube,



A



B



C

Fig. 813.

A, The bladder flap is outlined.

B, The flap is cut, and the split ureter is attached to the mucosal surface of the distal part of the flap as shown in inset.

C, Tube pedicle graft of bladder completed. The Malecot catheter inserted into the bladder, and the wound closed around the Malecot and ureteric catheters. (After E. K. Landsteiner.)

N.B.—For the sake of clarity in this instance the operation is being conducted through a paramedian incision in an unscarred abdominal wall.

INJURY RECOGNIZED DURING THE IMMEDIATE POST-OPERATIVE PERIOD

a. Anuria after Hysterectomy usually means that both ureters have been ligated. On no account should deligation be attempted—it is difficult and dangerous. The correct treatment is bilateral nephrostomy, if possible under local anæsthesia. To attempt to explore the abdomen at this stage, when structures are œdematous and matted, combined with the uncertainty of finding the occluded ureter, is to court disaster. Nephrostomy

(p. 619) is a certain method: when the patient is out of immediate danger is time enough to attend to the actual lesion.

R. V. Day's case.—

A woman of 28 was seen four days after an operation for hysterectomy. She had passed no urine since the operation, and the bladder was empty. Day performed bilateral nephrostomy. Two months later the left ureter was transplanted into the bladder. It was found that the right ureter had been sectioned too high for an anastomosis with the bladder, so nephrectomy was performed on that side. The patient made a good recovery.

J. R. Caulk's case.—

Both ureters had been ligated in the course of a hysterectomy. Caulk performed bilateral nephrostomy eight days after the operation. On the fifty-eighth day both nephrostomy wounds closed, the urine coming normally from both kidneys. Five years later this patient was seen, and had been perfectly well in the interval.

This, undoubtedly, was a case where the ureters had been ligated with catgut, which ultimately became absorbed.

Accidental Ligation of One Ureter.—Often (58 per cent of cases) the patient experiences no symptoms and the kidney atrophies quietly. At other times there are early symptoms of lumbar pain or renal colic. Such symptoms occurring after panhysterectomy (abdominal or vaginal), or following excision of the rectosigmoid, should always suggest the possibility of this accident, and call for an investigation of the kidneys. Excretory urography is the simplest method of proving the integrity of the ureters. Failing that, chromocystoscopy should be performed. If one kidney is not functioning, urgent nephrostomy is the best course. Possibly a catgut ligature occluding the ureter will be absorbed. During the second week after nephrostomy catheterization of the ligated ureter should be attempted. If this is unsuccessful, the attempt is repeated during the third week, and if still unsuccessful, the lower end of the ureter must be explored. Sometimes deligation of a silk ligature is all that is required; at others the ureter must be severed and implanted into the bladder.

b. Urinary Fistulæ following accidental wounding of the ureter during pelvic operations are usually external. The leak occurs through the abdominal incision or, in cases following panhysterectomy, through the vagina. Constant seepage of urine from the vagina is often first mistaken for a serous discharge, and later for a mild degree of incontinence of urine; sometimes it is many days before a ureteral fistula is considered as a possible cause. It is, of course, necessary to differentiate between a leak from a ureter and a leak from the bladder. This is accomplished readily by the following procedure. The patient is placed in the lithotomy position, a vaginal speculum is inserted, and the vagina is sponged dry. A soft rubber catheter is passed into the bladder which is distended with a solution of methylene blue. If the blue fluid is observed escaping into the vagina, it proves that the leak is from the bladder; conversely, if no blue appears in the vagina, but urine continues to escape, it is conclusive evidence that the lesion is in one or other ureter. It will then be necessary to make a cystoscopic examination following the injection of indigo-carmin intravenously to decide which ureter is involved. An endeavour is made to pass a ureteric catheter on the side of the lesion; in the unlikely event of a steady drip of urine being obtained the catheter is retained and its position in the ureter is ascertained by radiography. Excretory urography usually provides additional helpful information.

Less commonly the urinary extravasation is wholly or partially internal, the amount being inversely proportional to the extent of the drainage provided at the time of the operation. Occasionally the urine escapes into the peritoneal cavity, giving rise to what is known as urinary ascites. If the urine is sterile the patient does not necessarily become seriously ill for as long as a week, but eventually diffuse peritonitis supervenes.

When sterile urine permeates undrained soft tissues it causes necrosis, sloughing, and suppuration. Infected urine in undrained tissues accelerates this vicious reaction. Extravasation into the retroperitoneal tissues usually gives rise to early symptoms of pyrexia, increased pulse-rate, nausea, and vomiting, and the patient becomes gravely ill sooner than in the case of leakage of non-infected urine into the peritoneal cavity.

Treatment.—To attempt to repair a cut ureter when the tissues are œdematous and probably infected is often difficult, and attended by shock; moreover, if accomplished, the anastomosis is liable to break down. A far better course is to perform temporary nephrostomy and, if necessary, provide freer drainage to the site of the lesion. In the

case of urinary ascites suprapubic intraperitoneal drainage is carried out. It is inadvisable to attempt a reparative operation for four or five weeks. Following this plan, I implanted successfully the left ureter into the bladder¹ four weeks after it had been cut during an operation for excision of the rectum. Urgent operation is required only in the case of extensive leakage into the retroperitoneal tissues, in which case, provided the contralateral kidney is healthy, it is probably always advisable to perform lumbar nephrectomy as soon as the patient can be got into a fit condition to withstand that operation. Blood transfusion is helpful in this respect. When, on account of the poor condition of the patient or the perilous state engendered by the absence of or impaired function of the contralateral kidney, nephrectomy is impractical, to expose the kidney on the side of the traumatic lesion, tie its ureter near the renal pelvis, and then perform nephrostomy is the course most likely to succeed.

In all cases antibiotic therapy and the administration of sulphatriad should be commenced at the earliest possible moment, and continued until the patient is convalescent.

¹ When the gap between the proximal end of the ureter and the bladder is too wide to permit implantation into the bladder, the advisability of the interpositioning of a segment of small intestine between these structures or, though less desirable, implantation of the ureter into the bowel, should be weighed carefully in cases where the function of the contralateral kidney is impaired.

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CHAPTER LIII

OLIGURIA, ANURIA, AND URÆMIA

OLIGURIA should be defined as an excretion of less than 20 oz. (568 ml.) of urine in 24 hours. *Anuria* is an absence of excretion for 12 hours or more.

For purposes of diagnosis and treatment there is no better classification of anuria than:—

1. *Pre-renal anuria* (*syn. circulatory renal insufficiency*) due to a fall in the blood-pressure below the point where excretion of urine is possible.
2. *Renal anuria consequent* upon failure of renal epithelium to excrete urine.
3. *Obstructive* (*syn. post-renal*) *anuria*: Necessarily this must be bilateral, or involve a sole functioning kidney.

After taking a careful history and making a clinical examination that includes taking the blood-pressure, it is nearly always possible to classify the case in accordance with the above table. Then, and then only, is the surgeon in a position to commence the correct treatment—so dissimilar in each of the three varieties of anuria. Should there be facilities for an estimation of the blood-urea, no time should be lost in taking advantage of them.

PRE-RENAL ANURIA

Pre-renal Anuria due to Peripheral Circulatory Failure.—Normally the blood-pressure in the glomeruli is about 90 mm. Hg; when the systolic blood-pressure falls below 70 mm. Hg filtration from the glomeruli ceases. If the glomeruli are diseased, a higher pressure up to 100 mm. Hg may be inadequate to maintain filtration.

The causes of pre-renal anuria are traumatic shock, severe hæmorrhage, spinal anæsthesia, extensive burns, dehydration from vomiting, diarrhœa or excessive sweating, and cardiac failure.

Often this form of suppression of urine develops when least expected and when, rightly, treatment is being directed towards resuscitation of a shocked patient. In the concern to restore an adequate blood-pressure those in attendance are liable to miss by many hours the fact that the patient has passed no urine. What is unpardonable, having restored the blood-pressure to a satisfactory level, is to forget to ascertain whether the patient has passed urine, and if he has not done so, to continue to load the circulation with fluid and electrolytes. This rather frequent happening so disrupts the patient's fluid and electrolytic balance as to prejudice his ultimate recovery from anuria. Unquestionably, the treatment of peripheral circulatory collapse must be pursued in the presence of anuria, always hoping that the rectification of the first condition will remedy the second, but if within half an hour of the restoration of an adequate blood-pressure no urine has been passed since the treatment was commenced, and little or none can be obtained by catheterization, the drip should be slowed to an absolute minimum, and on no account is an electrolytic solution permitted; the further administration of blood (if any has been given) is inadvisable—only plasma, or better dextran, should be employed. Dextran 6 per cent in 5 per cent dextrose is now available, and it is better than dextran in saline solution for patients who are unable to excrete sodium chloride. As soon as it is considered safe to do so, the drip is stopped.

When hypotension and its resultant anoxia is of long duration, damage to the renal epithelium results, and the condition passes on to one of renal anuria. During anuria due to shock, cortical necrosis can occur, and if this is complete the prognosis is hopeless; but this must never be assumed, because when the lesion is less extensive and the main changes are confined to the renal tubules, the prognosis is good, provided the treatment of renal anuria described on p. 599 is commenced as soon as practicable.

Pre-renal Anuria due to Dehydration is relatively uncommon, and its treatment is the antithesis of the foregoing. That the patient has lost a prodigious amount of body fluid is usually obvious. The amount of fluid replacement required can be estimated by the

specific gravity of the plasma ; a method of ascertaining this in the side room is described on p. 1085. As a rule, the fluid loss is remedied by the administration of dextrose-saline solution intravenously, which usually restores urinary excretion.

RENAL ANURIA

Non-obstructive is much more frequent than obstructive anuria (Styron and Leadbetter).

Acute renal failure is a disease of which patients frequently die because of mismanagement (Swann and Merrill).

Renal anuria results from damage or destruction of the renal epithelium (*Fig. 814*). The principal causes of renal anuria met with in surgical and gynaecological practice are :—

1. Incompatible blood transfusion (*see p. 63*).
2. Ultra-acute pyelonephritis, especially that occurring with retention of bladder urine.
3. Traumatic anuria.
4. Concealed accidental uterine hæmorrhage.
5. Reflex anuria.
6. Acute pancreatitis.
7. Congenital polycystic kidneys.
8. Advanced bilateral renal tuberculosis.

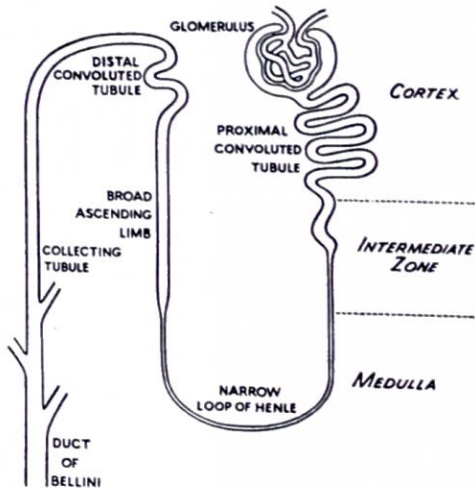


Fig. 814.—Necrosis of the proximal convoluted tubule produces immediate anuria in that nephron. Renal ischæmia lasting two hours results in death of the epithelium of these tubules. (*H. L. Sheehan.*)

Although acute renal failure is commonly and conveniently referred to as anuria, cases in which collection of urine has been undertaken carefully by catheterization show that at least a small volume of urine (sometimes less than 50 ml.) is passed daily. The patchy distribution of renal tubular lesions seen at necropsy and the continued urinary flow, however scanty, are proof that some nephrons are functioning partially or completely.

The average duration of the oliguric phase is about 10–12 days. The clinical findings during the first few days are largely those of the causative condition and/or a result of over-administration of salt or water. If the former resolves, and the latter is no longer allowed to occur, towards the end of the first week the main symptoms are lethargy and nausea ; indeed, the paradoxical situation of clinical improvement with progression of abnormal blood chemistry is often encountered.

Unless diuresis sets in, during the second week clinical deterioration follows. Vomiting usually commences. Oral feeding aggravates the vomiting, which frequently lessens or subsides when the intake is shifted from the oral to the intravenous route. Abdominal distension is seldom absent. The systolic blood-pressure, even in a young, previously healthy adult, rises to between 140 and 200 mm. Hg. As a rule diarrhœa does not develop until late in the oliguric phase, or until after the onset of diuresis. With prolonged oliguria somnolence may progress to stupor, mild delirium, or coma. Convulsions in oliguria nearly always signify excessive administration of water and sodium.

Contrary to earlier beliefs, the most important substances in the genesis of uræmia are not urea and the other organic end-products of nitrogen metabolism, but water and electrolytes. The manifestations of the more common of these aberrations of water and electrolytic balance are, in order of frequency :—

Over-hydration.—One of the earliest signs is a full external jugular vein (*see Fig. 115, p. 65*). Pitting œdema should be looked for.

Acidæmia.—The clinical picture is dominated by deep sighing respirations, and is accompanied by various degrees of progressive clouding of consciousness. The most common accompaniments are restlessness, headache, and nausea. The diagnosis can be substantiated by a reduced bicarbonate level.

Hyperpotassæmia.—The reprehensible practice of prescribing *potassium* citrate for a patient on the threshold of anuria has caused many deaths. On the other hand, the high-carbohydrate-no-protein diet reduces the incidence of this much feared complication very considerably. It is unfortunate that in most patients there are no presenting symptoms and signs of hyperpotassæmia. The patient dies suddenly of cardiac arrest. Adequate warning of progressive hyperpotassæmia can be obtained by serial electrocardiography

and serial determinations of the concentration of serum-potassium. Neither is an adequate substitute for the other. For other aspects of hyperpotassæmia see p. 603.

Hypopotassæmia.—In the early diuretic phase of tubular necrosis, hypopotassæmia is prone to occur due, it is believed, to a tubular defect in the resorption of potassium. Hypopotassæmia is discussed on p. 34.

THE MANAGEMENT OF RENAL ANURIA

Water Balance.—The danger of over-hydration of an anuric patient is greater than that of under-hydration, and the previous daily allowance of 1 litre of water to balance the insensible loss through the lungs and skin is now considered excessive in a temperate climate. It is estimated that there is a daily production of 400 ml. of water from the oxidation of body fat and proteins, consequently to avoid over-hydration the daily fluid intake should be limited to 500 ml. plus an amount equal to that of the water vomited or recovered by gastric aspiration. Particularly unsound is the rule of thumb that the amount of vomitus should be replaced by an equal amount of normal saline solution. The frequency with which attempts to correct sodium loss by giving solutions containing sodium have eventuated in cardiac failure, has led to increasing reluctance to administer sodium during the oliguric phase. Additions must also be made for excessive sweating, and for diarrhœa.

As opposed to laboratory tests, bed-side evaluation—thirst, moisture of the oral mucous membrane and the skin, the amount of vomitus, and the condition of the lungs—is an excellent guide as to whether the ration of 500 ml. of water should be exceeded in a patient who is virtually a closed system in regard to the excretion of water and salts. In essence, the intake of fluid above the bare minimum should be governed by the patient's thirst. When the weather is exceedingly hot, tea or water sweetened with lactose just sufficient to slake thirst, is allowed, but even in these circumstances the fluid intake should rarely exceed 1000–1200 ml. per 24 hours.

Electrolytic Balance.—From the above remarks, it will not be a surprise to learn that the patient must not receive any electrolytes until diuresis has commenced. When, as is usual, there is a depression of chloride and HCO_3 ions without specific symptoms of lack of these substances, this should be looked upon as adaptive, and in no way a call for meddling adjustment.

Daily Carbohydrate Intake.—The diet now recommended is entirely carbohydrate. This not only supplies the necessary number of calories, but obviates the catabolism of exogenous protein and minimizes the catabolism of endogenous protein, both of which release potassium. The potassium freed by protein catabolism is far more injurious than the nitrogenous waste products thus produced. Incidentally, as a result of a protein-free high carbohydrate diet the production of the latter is reduced greatly. (Fig. 815). Bull advises a daily intake of 300 G. to prevent hyperpotassæmia due to tissue breakdown. The earlier diet, supplementing carbohydrate with fat, is now not recommended, for two reasons: (1) Fat increases the nausea and vomiting of uræmic states; (2) Fat, especially some batches of pea-nut oil (the fat that was employed widely for this purpose) provokes diarrhœa.

The choice of a particular carbohydrate, its concentration, and the route by which it is to be administered, requires careful consideration. When the patient can take fluid by mouth without vomiting or undue nausea, a daily intake of 500 ml. of 20 per cent lactose given in small frequent amounts is likely to be acceptable, because the solution tastes less sweet than dextrose (Oard and Walker). When, as is often the case, the anuric patient is anorexic, nauseated, and prone to vomit at the least provocation, it is imperative to give the daily allowance of water and carbohydrate intravenously. When the daily intake of carbohydrate has to be administered intravenously, it must be given in a concentrated solution—40 per cent dextrose—in order to supply the necessary amount of dextrose without exceeding the 500 ml. limit of water. Because solutions in this high concentration cause thrombosis when administered into a peripheral vein, a fine polythene tube should be passed into the inferior vena cava (see p. 20) where the

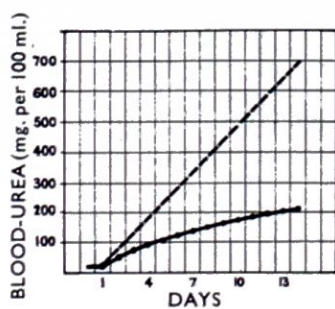


Fig. 815.—Dotted line, rise of blood-urea in untreated renal anuria; Solid line, the same when treated by fluid limitation and a carbohydrate diet. (After G. M. Bull.)

solution becomes rapidly diluted as it is swept into the large volume of blood returning to the heart.

The Daily Vitamin Intake should be identical with that of a patient subsisting wholly on parenteral feeding (*see p. 31*).

The Prevention and Control of Infection.—In acute renal failure a very frequent cause of death is intercurrent infection, therefore all who come in contact with the patient should be gowned and masked, and 1,000,000 units of penicillin given each day in a single dose. Because of the renal failure, all antibiotics are excreted at a reduced rate. This is of no importance in the case of penicillin, but with other, more toxic, antibiotics it soon leads to a dangerous concentration in the body. Consequently, when it is necessary to administer an antibiotic other than penicillin to an anuric patient, the dose must be reduced to half or quarter of the usual dose, and the level of the blood-urea is a good guide as to which of these amounts should be chosen. Penicillin excepted, erythromycin 2 G. on the first day and 1 G. on the following days seems to be the antibiotic against which least objection can be made (W. J. Kolff).

Hormonal Treatment.—When they are given the anabolic hormone testosterone, nephrectomized animals survive longer than controls. Therefore it is advised to give 5–10 mg. of this hormone per day, which does no harm, and may be beneficial.

Waiting for a Resumption of Renal Activity.—As the days go by and the anuria persists, naturally the surgeon's anxiety concerning his patient increases. The unknown factor is whether or not the renal damage is limited mainly to the tubules. It should be envisaged that the epithelium of the tubules is capable of regeneration, and that tubular regeneration commences on the second day, and is often complete by the fourteenth day. Of course, should the tubules merely be blocked by hæmoglobin casts, and the epithelium comparatively undamaged, resumption of excretion of urine occurs earlier. When by the seventeenth day little or no excretion has occurred, at least some glomerular damage must be presumed.

Acute Progressive Unrelenting Renal Failure is usually caused by either (a) A prolonged period of shock; (b) extensive cortical necrosis in cases of premature separation of the placenta. There is extensive damage to the upper, as well as the lower, portion of the renal tubules, and probably necrosis of many glomeruli. There is no means of distinguishing this variety of anuria from that in which the lesion is reversible, except by the passage of time: the stage of diuresis is never reached.

Diuretic Phase is defined as commencing when the daily urinary volume exceeds 400 ml. The rate at which the urinary volume increases from day to day in the latter part of the oliguric phase bears a relation to the duration of the oliguria. It increases slowly when the oliguric phase has lasted two weeks or more, it increases more rapidly when oliguria is of shorter duration. The onset of diuresis warrants as much careful vigil as appertained during the anuric phase: 25 per cent of deaths occur after the onset of diuresis. Although the fluid intake must be increased, for the first three days it should not be equal to the insensible loss plus the amount of urine passed; rather, the balance must show a slight deficit on the intake side. Most patients lose much weight during diuresis, indicating previous over-hydration despite rigid fluid restriction and the absence of clinical signs of œdema during this period. It must be assumed that the over-hydration takes place before the restricted fluid régime is instituted, and that the cellular fluid excess is not unloaded during the anuric phase. In cases where the oliguric period is of short duration, rapid improvement often follows. When the urinary volume increases slowly, and particularly in cases in which the oliguria is prolonged more than two weeks, the effects of renal insufficiency continue to progress, and rapidly progressing hyperpotassæmia, acidosis, delirium, convulsions, or pulmonary congestion may mar the hopeful issue. Too often these complications are the result of disregarding the therapeutic principles that staved them off during the oliguric phase, or withholding therapeutic adjuncts (*see p. 601*) when they are indicated.

In the early days of the diuretic phase the urine excreted is little more than a glomerular filtrate; it must be analysed each day, and on the findings sodium chloride is administered very cautiously. The fluid intake is increased gradually to approximately 2.5 l. daily, and later in the diuresis an intake of sodium approximately 75 mEq. daily is what should be given in an average case, but it should be governed by frequent analyses of the urine for sodium and chloride loss. It is apparent that excessive diuresis is not always due to

the inability of the renal tubules to resorb water and salts, but rather that there is an excess of salt and water in the body. Failure to recognize this explanation and to attempt to replace early losses increases and perpetuates the diuresis. A low-grade fever usually commences in the second week of the diuretic phase. The temperature is elevated, usually not more than $1\frac{1}{2}^{\circ}$ F (0.8° C.).

Excessive Diuresis.—Sometimes during the stage of diuresis the volume of urine becomes excessive due to :—

1. Deficient resorption of water and electrolytes from the damaged tubules.
2. The overload of urea for excretion.

Polyuria brings the threat of excessive electrolyte loss. When required, electrolytes should be supplied, if possible by mouth. A correct amount of sodium chloride should be given each day. By repeated checking, this has been found to be 50–75 mEq. per litre of urine passed (G. M. Bull). Fruit juices, allowed *ad libitum*, usually supply sufficient potassium to maintain equilibrium. Should the serum-potassium fall below 3.5 mEq. per litre, potassium citrate, 3–5 G. dissolved in water or fruit juice, can be given three times a day. When the urinary volume exceeds 5 l. per 24 hours, it is preferable to resort to a 12- or even a 6-hourly schedule of replacement, otherwise serious deficits of water and salt are liable to develop.

After the urinary flow has become satisfactory and stabilized, death from bronchopneumonia or pulmonary embolus is a discouraging outcome in some of these patients.

ADJUVANT METHODS OF TREATMENT

A major achievement of recent years has been the recognition that an organic lesion capable of natural repair is responsible for the oliguria in many cases of acute renal failure. As a result renal denervation, renal decapsulation, and diuretic agents to stimulate urinary flow have been abandoned. Nevertheless, excellent as it is in the majority of cases, a strictly limited fluid intake combined with a pure carbohydrate diet will not save all patients.

Exchange Transfusion.—The chief indication is in the initial phase of anuria following incompatible blood transfusion for the removal of free hæmoglobin, hæmolytic toxins, and damaged erythrocytes. French surgeons prefer to withdraw the blood through a plastic tube inserted into the inferior vena cava (Fig. 816). The amount of blood required to make exchange transfusion worth while for the removal of free hæmoglobin is equal to, or twice, the volume of the patient's blood.

Much work has been done in France and Italy on exchange transfusions in uræmic states. The technique differs from small venesection and transfusions, to continuous exchange. Nevertheless, exchange transfusion or, for that matter, any form of blood transfusion carried out in the oligæmic state carries serious disadvantages :—

1. Excessive variations in blood volume are liable to lead to shock.
2. Transfusion reactions are more liable to occur than in other conditions.
3. There is a smaller removal of diffusible toxic substances than with dialysis.

The advantage of exchange transfusion is its simplicity, as compared with dialysis.

Transperitoneal Dialysis.—Excellent clinical results in seriously ill patients have been reported, and the prime advantage of lavage is that little special equipment is required. The chief indications are : (1) When conservative treatment has failed to control progressive hyperpotassæmia ; (2) When the symptoms and signs of advancing uræmia (blood-urea over 200 mg. per cent) develop in spite of conservative measures—in these circumstances the possibility of recovery by conservative measures becomes less than the risk of resorting to extra-renal means of excretion ; (3) Acidæmia severe enough to produce clinical symptoms.

Contra-indications : (1) Recent abdominal operation ; (2) Infection of the skin of the anterior abdominal wall ; (3) Probable extensive intra-abdominal adhesions from a previous operation ; (4) Pronounced obesity ; and (5) Profound paralytic ileus.

Armamentarium consists of flasks containing the irrigating fluid (these preferably contain 2 l., and 15 flasks should be made up), an ordinary intravenous infusion set, a



Fig. 816.—Method of performing exchange transfusion in anuria. (After P. Milliez et al.)

cannula with two trocars (one sharp and the other blunt ; these should be 20 cm. in length and the cannula should have an outside diameter of 2.5 mm.), two plastic tubes 12 in. (30 cm.) in length with an external diameter that will permit them to be inserted through the cannula ; eight to ten small holes should be made in the distal part of each tube. Tubes of polyvinyl chloride, which can be autoclaved, are to be preferred. These can be hardened to the desired stiffness (and they must be stiff enough to permit insertion without kinking) by immersion in mineral oil that has been heated almost to boiling-point. Two metal adaptors serve to connect the plastic tubes to the intravenous infusion apparatus on the one side and the exit tube on the other.

Composition of the Irrigating Fluid.—The ideal fluid should be : (1) Non-irritating to the peritoneum ; (2) Moderately hypertonic ; (3) It should permit maximum diffusion into it of nitrogenous and other waste products of a crystalloid nature.

Kolff's solution :—

NaCl	6.0 G. per litre	MgCl ₂ (anhydrous)	0.1 G. per litre
KCl	0.2 G. " "	NaH ₂ PO ₄	0.05 G. " "
CaCl ₂ (anhydrous)	0.1 G. " "	NaHCO ₃	3.0 G. " "
	Dextrose	20.0 G. per litre	

Oxytetracycline (terramycin) 250 mg. per litre is added before administration, to inhibit bacterial growth of any contamination of the fluid.

Technique.—Before proceeding, a plain film of the abdomen, taken after an enema has been given, should be examined in order to visualize bowel filled with gas or faeces. The patient is prepared suitably with a sedative. He should lie flat on his back with the

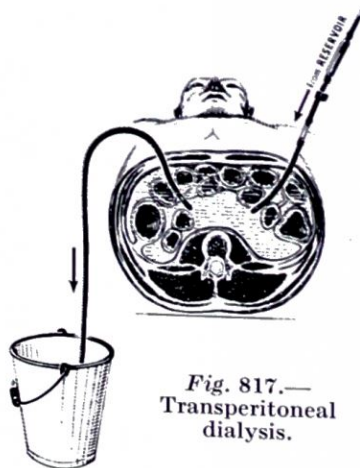


Fig. 817.—
Transperitoneal
dialysis.

head and shoulders supported by a pillow. The skin is prepared as for laparotomy and a point in the left iliac fossa comparable with that of McBurney's point on the right side, is infiltrated with 1 per cent procaine. It is advisable to insert the first tube on the left side, to avoid the possibility of entering the distended, relatively immobile, caecum. A small incision is made. The cannula, with the sharp trocar in place, is directed through the subcutaneous tissues, then, with a sharp thrust, the external oblique is penetrated. At this juncture the sharp trocar is replaced by the blunt one, and the remaining muscle and the peritoneum are traversed with another firm thrust. The trocar is removed and the plastic tube is inserted through the cannula into the peritoneal cavity for a distance of 8 in. (20 cm.). The cannula is then removed. The tube is connected to the intravenous set containing the irrigating fluid, which has been warmed

to body temperature. The tube is strapped to the abdominal wall by adhesive plaster, and covered with a sterile towel. The flow of fluid into the peritoneal cavity is then regulated to an almost continuous stream. Forty-five minutes later, when distension dull to percussion is present, the outflow tube is inserted on the right side, using the same technique. This tube is connected to a rubber tube that leads into a collecting flask on the floor (Fig. 817). It is essential that the rate of inflow be regulated to that of the outflow, and optimum results are obtained with a flow maintained at between 2–3 litres per hour. The flow should be continued for 12–15 hours. At the end of the procedure the inflow tube is removed. Moderate abdominal pressure helps to remove some of the fluid through the outflow tube ; the outflow tube is then removed. In spite of this, approximately 1000 ml. of fluid is left in the peritoneal cavity. This residue must be accounted for in the estimations of the fluid requirements during the 36 hours following the dialysis. The irrigation can be repeated in 48 hours without harm.

Difficulties.—Change of position of the tubes, or reversing the direction of the flow, often help to overcome difficulties in maintaining an adequate flow. If the abdomen is allowed to become overdilated with fluid, pain will occur. In a French series only 3 of 100 patients treated by this method gave evidence of infection.

The Artificial Kidney.—It is necessary to have a trained team to operate the artificial kidney. Such a team is usually under the charge of a physician. As the apparatus and the trained team are only available in a few centres, this method will not be described here.

COMPLICATIONS OF RENAL ANURIA

Overhydration.—If by some mischance the anuric patient becomes grossly overhydrated, immediate venesection is sometimes a life-saving procedure (*see* p. 608). During venesection the blood-pressure must be taken. The withdrawal of 300–500 ml. of blood is sometimes sufficient. The blood should be withdrawn into 3·8 per cent citrate solution, so that if the patient is anæmic the erythrocytes, after sedimentation, can be retransfused.

In patients with anuria who have received already more than the basic allowance of fluid, which often appertains in cases secondary to shock, no fluid should be given parenterally, and virtually no fluid by mouth, for 24 hours.

Acidæmia.—It is undesirable to allow acidæmia to reach a level sufficient to increase the depth and rate of respirations. When the carbon-dioxide-combining power has fallen below 35 volumes per cent, 4–6 G. of sodium bicarbonate can be given by mouth in divided doses of 1 G. per hour. Alternatively, 3·75 G. of sodium bicarbonate can be added to the 500 ml. daily allowance of dextrose solution for intravenous administration, or possibly better is it to employ an isotonic solution of sodium lactate (18·7 G. per litre).¹

Hyperpotassæmia.—When the need for reducing the serum-potassium level is not a matter of great urgency, a new treatment of considerable promise is the administration of sodium cycle resin.²

In the alimentary canal the sodium ions of the resin are exchanged for those of potassium in the blood (*Fig.* 818). Fairly prompt lowering of the plasma-potassium has resulted from the administration orally or by nasogastric tube of 30–60 G. of sodium cycle resin per 24 hours: the approximate uptake of potassium is 1 mEq. per G. of resin. It has been found that the best method of administering the resin, which is unpalatable, is by giving small doses of 5 G. eight to twelve times a day. The resin is suspended in water containing ice chips, and lactose or sucrose is added, as well as artificial flavouring (B. L. Martz). Chlorpromazine is very helpful in aiding the control of nausea during the treatment.

A vegetable laxative must be given in conjunction with this treatment, otherwise the resin tends to cause fæcal impaction.

Only very exceptionally does the released sodium cause hypernatræmia; this can be corrected by the prompt administration of hydrogen cycle resin.

When reduction of the serum-potassium is a very urgent matter (above 7 mEq. per litre), or when the resin is vomited, recourse must be made to exchange transfusion or dialysis.

When the serum-potassium level rises above 7 mEq. per litre one of the more radical methods of removing the excess of potassium is indicated (*see* p. 601).

Cardiac Dysfunction is the most serious complication of acute renal failure, and is the principal cause of death. There are two forms of cardiac dysfunction. The first and most common culminates in pulmonary œdema. The second is associated with hyperpotassæmia. Heart failure with pulmonary œdema is treated by opiates, phlebotomy, oxygen, or dialysis. Diuretics are contra-indicated; digitalis has a limited value.

Infection.—The cardinal importance of endeavouring to prevent, and to treat early, infections, which are so prone to occur, has been emphasized already.

Vomiting.—While, of course, vomiting should be forestalled by gastric aspiration, if aspirate continues to be plentiful after the intake is entirely intravenous, an attempt to determine its chemical basis, e.g., cellular overhydration, and to correct it should be made. Sometimes no obvious cause can be found. In these circumstances chlorpromazine in doses of 25–50 mg. three times daily, by injection, is moderately effective. Given to a uræmic patient, chlorpromazine leads to a state close to hibernation. Doctors unaware of this may think, erroneously, that the patient is moribund.

Abdominal Distension is a frequent and troublesome complication, particularly if attempts are made to feed the patient. If it becomes excessive, and only then, gastrointestinal aspiration is required, and the amount of fluid removed must be replaced intravenously.

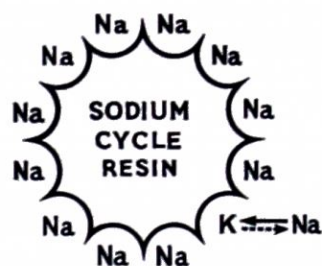


Fig. 818.—Mode of action of sodium cycle resin.

¹ Sterivac (Allen & Hanburys) No. 12 solution.

² Eli Lilly & Co. Ltd., Basingstoke, Hants.

Anæmia.—The severity of the anæmia parallels that of the azotæmia, as shown by the blood-urea. However, once it becomes moderately severe, its progression slows or stops, even though the oliguria continues. It is striking how well severe anæmia is tolerated in the oliguric period, and although it may be responsible for some signs of cardiac dysfunction, one should be diffident about remedying it, because blood transfusion is so often followed by pulmonary congestion, indicative of cardiac failure. In cases where the hæmoglobin becomes very low, and especially in the diuretic phase, the hæmoglobin level should be kept above 70 per cent by means of transfusion, always employing packed red cells (*see p. 51*).

Diarrhoea is sometimes very troublesome. If it does not improve after the administration of 0.25 G. of erythromycin twice daily by mouth, all feeding must be stopped in favour of the administration of the necessary fluid, carbohydrate, and possibly electrolytes, intravenously.

Epistaxis.—The danger of epistaxis in a semi-comatosed patient in a recumbent position is not realized sufficiently, for the blood is liable to be inspired. A bleeding nose must be packed securely. If blood is inspired, endotracheal suction, unless performed very early, is unlikely to remove clotted blood. Tracheostomy and suction offer a better prospect.

Stomatitis is common in severe cases. Frequent mouth-washes and sucking bradosol lozenges usually keep it under control.

Purpura is common in the terminal uræmic state. There is no specific treatment.

Pericarditis also occurs in terminal renal failure. A watch must be kept for a pericardial effusion.

SPECIAL FORMS OF RENAL ANURIA

Anuria due to Incompatible Blood Transfusion.—(*See p. 63*).

Anuria due to Concealed Accidental Uterine Hæmorrhage is caused by combined hypotension and a temporary intense spasm of the cortical arteries. The areas of renal cortical necrosis are lost irretrievably; consequently this results in acute progressive unrelenting renal failure.

Anuria due to Abortion.—It is not quite clear how abortion gives rise to intravascular hæmolysis; the most probable explanation is an infection by *Cl. welchii* or the accidental injection of soap solution into the blood-stream by way of the uterine sinuses (H. L. Sheehan).

Reflex Anuria.—A minority doubt the existence of this phenomenon, and suggest that so-called reflex anuria following rapid emptying of an overdistended bladder is due to infection. The rapidity with which anuria sometimes follows this happening (*see p. 631*) would appear to put this theory out of court. Reflex anuria occasionally and unexpectedly follows the passage of a cystoscope or other instrument.

Margraves and Bogen's Case.—Following cystoscopy, a man aged 29 developed anuria. After 66 hours of complete suppression of urine, he was given a spinal anæsthetic. Within fifteen minutes this was followed by copious diuresis.

Because of the danger of anuria, C. P. Mathé advises an interval of at least three days between intravenous and retrograde pyelography. On rare occasions reflex anuria supervenes after nephrectomy:—

A woman aged 42 had right nephrectomy performed for extensive calculus formation. Previously the left kidney had been shown to be perfectly healthy by chromocystoscopy, ureteric catheterization, and pyelography. Thirty-six hours later she had passed no urine, and the bladder was empty. Her general condition was excellent. Twenty-four hours later only 1½ oz. (45 ml.) of urine had been passed, and a further 2 oz. (60 ml.) was retrieved by catheterization. Twelve hours later the blood-urea had risen to 123 mg. and the patient began to vomit. The left ureter was catheterized without the difficulty that would be expected if it were obstructed, and urine commenced to drip steadily from the left kidney. The catheter was left in place for 36 hours, after which the patient's progress was straightforward.

Anuria due to Acute Pancreatitis.—The renal lesion is at least partly due to fat embolism as a sequel of fat necrosis. Oliguria is more common than complete anuria. Even after clinical recovery, renal interstitial fibrosis usually follows.

Traumatic Anuria occurred frequently among air-raid victims when a limb (or limbs) was crushed beneath fallen masonry (the crush syndrome). It also occurred in battle casualties as a result of severe muscle damage and general tissue catabolism. The

phenomenon occurs, though less often, in severe crushing injuries of civil life. Unless treated expeditiously and correctly, the mortality is very high, death from uræmia on the seventh or eighth day being singularly constant.

The kidneys in crush syndrome are large and pale. Microscopically the collecting tubules reveal degenerate epithelium and their lumina are packed with the debris of red corpuscles.

In cases of the crush syndrome an Esmarch's, or an elastic web bandage should be applied to the limb directly after the victim's extrication, the better to prevent the mass release of toxins. If the limb is spared amputation, the bandage should be loosened inch by inch after a lumbar sympathetic block.

Technique of Lumbar Sympathetic Block.—For the unilateral block, three lumbar puncture needles are required; for bilateral block, six. The interspaces between L. 1, 2, and 3 are located, and at a point two fingerbreadths lateral to the middle line a weal of 1 per cent procaine is raised. When all the intradermic weals have been made, the lumbar puncture needle is introduced through the weal and pressed straight down until it hits the transverse process. The depth at which this occurs is noted on the shaft of the needle; the needle is then almost withdrawn. The needle is then tilted, so that its point will pass more towards the head of the patient, the objective being to introduce the point of the needle just above the transverse process. The needle, thus tilted, is reintroduced to the previously noted depth, and to this is added 2 cm. In muscular individuals it may be necessary to advance the point of the needle a little more. If the correct plane has been reached, injection of fluid is easy, and nearly free from resistance. If the fluid does not enter readily, it is being injected into muscle, and the needle should be advanced a little more and the injection tried again. Before each injection, aspiration should be attempted, to make certain the point of the needle is not within the lumen of a blood-vessel. One ml. of 1 per cent procaine should be injected into each interspace.

While the treatment of traumatic anuria does not differ in principle from that of other forms of renal anuria, the frequency and rapidity of potassium intoxication constitutes the most important difference between traumatic anuria and the more usual forms of acute renal failure seen in civilian practice. Meroney and Herndon, after a considerable experience of this type of injury in the Korean War, recommend the daily intravenous administration of 550 ml. of water containing 100 G. of dextrose, 3.75 G. of sodium bicarbonate, and 10 G. of calcium gluconate, together with 50 units of insulin. Both sodium and calcium are antagonistic to potassium, while the dextrose and insulin encourage potassium to re-enter the cells. Electrocardiographic control was particularly helpful in following the effects of this treatment in cases complicated by hyperpotassæmia.

Other military surgeons have found that in severe hyperpotassæmia dialysis with an artificial kidney is the best and, indeed, in the case of a patient with an abdominal wound, the only method of reducing the plasma-potassium level.

Excision of necrotic tissue and drainage of accumulations of blood, if present, are imperative.

The tendency of œdema of the wound and delayed healing caused by high serum-potassium level necessitates precautions being taken in the case of abdominal wounds to avoid burst abdomen.

OBSTRUCTIVE ANURIA

Calculous Anuria usually supervenes in one of the following ways: (1) Both ureters become blocked with stones; (2) A calculus becomes impacted in the ureter of a sole existing kidney, the other kidney being congenitally absent, previously removed, or destroyed by disease.

As is well known, there is a period of tolerance during which the patient, although in fairly good condition, passes no urine. I watched a boy of fourteen, who had had nephrectomy performed (for injury) upon what proved to be his only kidney, live fourteen-and-a-half days. Do not let this very variable period of tolerance deceive you into temporizing and wasting time; no one can tell how long the period of tolerance will last; it may be but a few hours.

The patient is seen during the period of tolerance.

1. *Distend the bladder* with warm lotion, which stimulates the ureter to contract and occasionally results in the passage of a ureteric calculus.

2. *Radiography.* If facilities exist a radiograph is taken. In only three instances were stones demonstrable in a series of seven cases of calculous anuria (Cahill and Gile). Gaseous distension of the intestine no doubt accounts for this surprisingly large percentage of negative X-ray findings. On no account should excretory pyelography be attempted.

3. *Cystoscopy.* As soon as possible, cystoscopy should be carried out under local anæsthesia; œdema of, or a hæmorrhagic exudate from, one ureteric orifice will indicate the side that requires immediate relief. When a ureteric catheter can be made to pass up a ureter, but no urine passes down its lumen, it suggests that the obstruction must be near the kidney. Sometimes a ureteric catheter can be made to pass alongside a stone blocking the ureter, in which case pent-up urine drips through the catheter's lumen almost at once. In this happy event, the catheter should be left in position for as long as it continues to function, and the longer the better. A steady drip of urine through a ureteric catheter is sufficient to tide the patient over his desperate condition while further and better investigations are being carried out. In other circumstances, very early operation is indicated.

4. *Deciding upon which side to operate.* A good rule is—select the side on which the patient last experienced pain. *Signe de Legueu:* Muscular resistance is greater over the kidney last to be obstructed. Such resistance is demonstrable on abdominal palpation.

5. *Operation.* The simplest operation that will relieve the obstruction is the one of choice. Pyelostomy (see p. 621) fulfils these requirements. Nothing more should be attempted unless the stone causing obstruction is felt and seen in the renal pelvis or the commencement of the ureter, when it should be removed by incising the wall over the stone. In some circumstances nephrostomy, notably when the pelvis of the kidney is intra-renal (see Fig. 839, p. 621), will be indicated.

6. *After-treatment.* Those in attendance should disabuse their minds of the idea that because an operation has been performed their labours on behalf of the patient can be reduced. On the contrary, constant care, considerable skill, and as likely as not visits during the night, will be required. The amount of urine excreted within 8 hours of relieving the obstruction is, as a rule, disappointing. When the obstruction is relieved during the period of tolerance, in order to kindle renal activity the very slow administration of 10 per cent dextrose solution (or an isotonic solution of sodium sulphate) is given intravenously. If after the gravitation of half a pint (0.28 l.) there is not a satisfactory output of urine *the infusion should be discontinued.* In any case only one pint should be given until the surgeon has seen the patient himself, and in the meantime not more than a litre of fluid plus an amount equal to the quantity of urine passed per 24 hours is allowed by mouth. When the output of urine at the end of 24 hours is unsatisfactory, or before that time if the patient has symptoms of uræmia, the régime of restricted fluids detailed on page 599 must be instituted.

When nephrostomy (as opposed to pyelostomy) has been necessary, it is most important to be prepared for post-operative hæmorrhage, and it is a good practice in all cases to make full arrangements for blood transfusion, in case bleeding from the incised kidney becomes excessive.

Calculus Obstructing the Outflow of a Single Functioning Kidney.—

Case 1.—A woman of 45 had passed no urine for forty-eight hours. A catheter was introduced, but not a drop of urine was withdrawn. Four years previously her right kidney had been removed for calculous pyonephrosis. She was now experiencing violent pain in her left side. The patient was extremely obese, and a radiograph was not helpful.

The bladder was distended with lotion. The patient gave a piercing shriek, followed by a sigh of relief. A calculus about the size of a date stone was forcibly discharged with the lotion from the bladder.

The same patient was readmitted one year later. This time she had passed no urine for nearly three days. The bladder was empty. Vesical distension was of no avail. By cystoscopy, a ureteric catheter was passed freely up the left ureter, which indicated that the obstruction was near the pelvis of the kidney. Under general anæsthesia supplemented by local infiltration of procaine, the kidney was exposed in the loin. Owing to the great obesity of the patient it was necessary to resect the last rib before the organ could be displayed. A calculus was felt in the first inch of the ureter. This was pushed up into the renal pelvis by digital pressure. The renal pedicle was short and the renal pelvis mainly intrarenal. Pyelostomy was therefore impracticable. Nephrostomy was performed and the stone was removed. Owing to the friability of the œdematous kidney, sutures on either side of the tube cut out, but this difficulty was overcome and the resulting

hæmorrhage checked by inserting fresh sutures over a muscle graft taken from the sacrospinalis. Recovery. She wore a nephrostomy belt (*Fig. 819*) which was efficient. Eight and a half years later her doctor reported to me her death from bronchopneumonia. During the interval she had attended to the nephrostomy herself, and went about her household duties.

Case 2.—W. H. A., aged 43, had an attack of typical right renal colic lasting about an hour; never before had he experienced symptoms of this character. The following day he remembered that he had not passed urine since the attack, but because the pain had practically disappeared he "took no notice". So drew to a close the second, the third, and fourth days. Neither a drop of urine did he pass nor, he stated, were his bowels open. On the fifth day it dawned upon him that he should consult his doctor, who sent him to hospital as quickly as possible.

Except that the patient was mentally sluggish and his bladder was completely empty, there was nothing abnormal to be made out upon a clinical examination, but his blood-urea estimation registered no less than 253 mg. per cent. As so often happens in these cases, a plain radiograph showed no abnormality save excessive intestinal gas. Cystoscopy revealed only one ureteric orifice—the right. A ureteric catheter was passed and about 3 in. (7.5 cm.) from the ureteric orifice it met with obstruction. The catheter was partially withdrawn, and advanced once



Fig. 819.—Permanent nephrostomy. The nephrostomy tube is kept in place by a tape around the waist. (After M. L. Boyd.)



Fig. 820.—Kidd's oblique incision for exposing the ureter. Like a long gridiron incision, the main difference is that the fibres of the internal oblique are severed, not split. The peritoneum having been displayed, it is pushed medially until the ureter is reached.

more, and to my delight dark blood-stained urine commenced to drip through the catheter. For five hours dark blood-stained urine dripped steadily through the ureteric catheter. At 2 a.m. the catheter became blocked, and was removed. The next morning, as he had not passed urine, a urethral catheter was passed and 20 oz. (568 ml.) of very blood-stained urine containing clot was withdrawn. In spite of irrigations, the catheter became blocked with blood-clot; therefore it was changed, but only 5 oz. of urine was withdrawn and this was all that was registered as being excreted during the course of the day. It was considered that the patient's only chance was to operate. He was very befogged mentally, and somewhat irrational.

Right nephrostomy was contemplated, but the patient was a subject with advanced scoliosis, which reduced the space between the last rib and the iliac crest to about 3 in. (7.5 cm.); consequently it was decided to approach the right ureter through an anterior incision. Under local anaesthesia the ureter was exposed extraperitoneally through a Kidd's oblique incision (*Fig. 820*). The ureter was about the diameter of a thumb. A longitudinal incision was made into it and uriferous fluid and blood-clot were extruded. A large T-tube was fixed in place. After corrugated rubber drainage had been provided, the abdominal wall was closed about the T-tube. The cautious administration of 10 per cent dextrose solution intravenously was ordered. The blood-urea estimation on this day registered 312 mg. per cent.

Thirty-six hours later, to my dismay I found the patient in deep coma with Cheyne-Stokes respirations. His face was cyanotic and suffused. To my consternation I learned that, in spite of the fact that no urine had issued from the T-tube and that the dressings were doubtfully damp,

the intravenous drip had been continued and that the patient had received no less than 4 pt. (2.3 l.) of fluid intravenously. I then learned that the House Surgeon had gone away for the week-end without turning the case over to anyone else, and by one of those unfortunate coincidences, it was also the Sister's week-end off duty and the usual staff nurse was ill.

In view of the desperate situation, a cannula was inserted into the patient's jugular vein. Black blood issued therefrom and as it flowed into a dish, the shimmer of cholesterol could be seen on the surface. After a pint had thus been withdrawn, the patient's respirations seemed to become more quiet and his face was less suffused. Another pint was allowed to flow out while plasma was gravitated into the median basilic vein on the other side. Thus two pints of blood were removed and one pint of plasma was given.

Forty-eight hours after the venesection, urine commenced to drain through the T-tube. Therefore intravenous fluid therapy was recommenced. Within half an hour the amount of urine issuing from the tube became perceptibly greater and during the next twelve hours he passed no less than 130 oz. (3.7 l.) of urine.

Never before have I seen such a quick resurrection from a seemingly hopeless uræmic state. Twenty-four hours later the patient's mentality had cleared completely, his tongue was moist, he said he was hungry, and his blood-urea was now 84 per cent.

A week later, as the patient was passing urine per urethram, the T-tube was removed. An intravenous pyelogram showed no evidence of a functioning left kidney. Re-cystoscopy confirmed the absence of a left ureteric orifice, so this was an undoubted example of congenital absence of the left kidney and ureter. A retrograde pyelogram at this time showed an unobstructed ureter and dilated calices. Five years later he was in good health and at work. The obstructing calculus, which undoubtedly was present, was never retrieved.

Anuria due to Double Hydronephrosis.—Occasionally, bilateral obstruction to the pelvi-ureteric junction occurs.

I was called into the country to see M. G., aged 7. Five days previously her appendix had been removed for right-sided abdominal pain. The appendix, her doctor stated, was comparatively normal. Since the operation not a drop of urine had been passed. The patient, although fretful, appeared in excellent condition. She was anaesthetized and the left ureter was catheterized. Almost immediately urine dripped through the catheter in a rapid succession of drops. The right ureter was then catheterized, and although the catheter passed up the ureter well, no urine could be obtained from this side. Leaving the catheters in position, the patient was turned on to her face, and the right kidney was exposed. The pelvi-ureteric junction was obstructed by an aberrant renal vein. The pelvis of the kidney was greatly distended and below the obstruction the tip of the ureteric catheter could be felt. The vein was divided between ligatures, and the pelvi-ureteric junction was cleared of some fine fibrous strands which were compressing it. By this time the ureteric catheter had slipped down the ureter somewhat, so the operation was concluded by performing pyelostomy.

A year later the patient returned, having had an attack of pain on the left side. Excretory pyelography showed that the right kidney was functioning well, while the left showed a pelvic hydronephrosis. At operation an aberrant renal vein was found in exactly the same position as on the right side. It was divided between ligatures.

Twelve years later the patient was in perfect health.

More often anuria due to double hydronephrosis is caused by carcinoma of the cervix uteri, in which case immediate unilateral or bilateral nephrostomy is usually advised. Ureterostomy, as described and illustrated on p. 607, might prove to be a more desirable alternative. Simultaneous occlusion of both ureters by metastatic carcinomata is not very uncommon.

Anuria following Pelvic Operations, Notably Hysterectomy.—
(See p. 592).

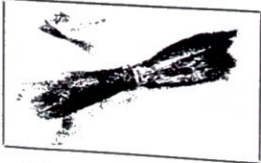


Fig. 821.—Acetylated sulphapyridine crystals resemble small wheat-sheafs. (After E. S. Margolin.)

Anuria due to Sulphonamide Crystalluria.—Owing to the comparative infrequency of the use of sulphonamides since the antibiotic era, anuria from sulphonamide crystalluria is now very uncommon. Orientals appear to be more susceptible to sulphonamide crystalluria than white races. Sulphapyridine and sulphathiazole in the presence of an acid medium are changed into acetyl salts which are insoluble or the ureters. Sulphapyridine gravel is most in evidence in the lower third of the ureter. The renal complications of sulphonamide therapy can be divided into three stages: (1) Microscopical hæmaturia; (2) Macroscopical hæmaturia, usually painful; (3) Oliguria and anuria.

Treatment.—As in the case of calculous anuria the bladder should be distended with warm saline solution, and it is desirable to repeat the procedure two or three times. Firm,

deep massage is then carried out upon each kidney. The lower end of each ureter is then massaged by way of the rectum or the vagina, preferably with the patient in the knee-elbow position. By these expedients the crystals may be dislodged sufficiently to re-establish a small flow of sludge-like urine. When external manipulative measures fail to unblock the ureters, the sooner cystoscopy is performed the better. Bladder irrigations will help to dissolve the crystals and wash them away from the trigone, and so the ureteric orifices can be seen. If it has not been left too late, ureteric catheterization is a life-saving measure in this form of anuria. Provided the catheters can be inserted, the kidney pelvis are washed out with 2.5 per cent sodium bicarbonate solution. Surgeons familiar with the use of the spiral ureteric calculus remover have used this successfully to disimpact sludge from the terminal portion of the ureter. In most instances if the surgeon fails to pass the catheters, pyelostomy must be performed.

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CHAPTER LIV

EMERGENCY OPERATIONS UPON THE KIDNEY

EXPOSURE OF THE KIDNEY BY THE LUMBAR ROUTE

Two incisions—Morris's and Mayo's—will be described: the first is in common use. I have found the second to have certain advantages, particularly in an emergency. Once the renal fascia has been reached, the steps in each operation are identical.

Morris's Incision.—

Position of the Patient is of the utmost importance. Every detail of it should be supervised by the surgeon himself. The patient is placed on his sound side, his back, at which the surgeon stands, being brought near to the edge of the table. The hip and knee of the leg next to the table are flexed fully and secured in this position either by a bandage-sling (*Fig. 822*) or by sandbags. This will counteract the tendency of the trunk to roll in either direction. The 'kidney bridge', the split in the operating table or, failing either, an air cushion or sandbag must lie directly beneath the 11th rib, so that when one of these

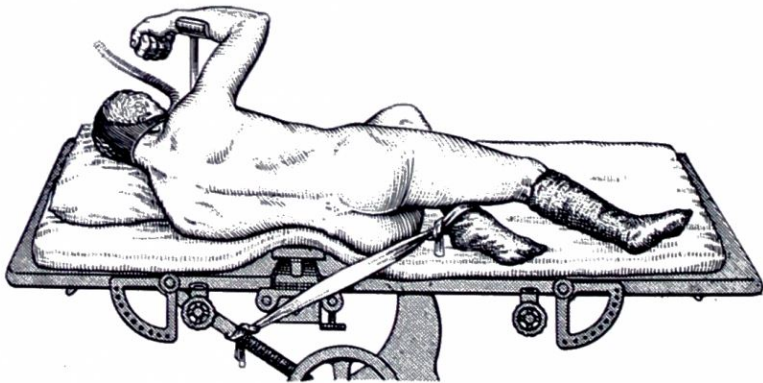


Fig. 822.—Position of patient on the operating table for exposure of the kidney by Morris's incision. (*After Eric Farquharson.*)

mechanical aids is brought into action, the space available for access to the flank is increased considerably. A support for the arm relieves pressure on the thorax, and helps to stabilize the patient in the desired position.

Technique.—Prior to making the incision, palpation of the vertebral column, the 12th rib, and the iliac crest helps to orientate the surgeon. If a radiograph of the urinary tract is available, it will reveal whether the patient has an unusually short 12th rib which is likely to be impalpable; should the 11th be mistaken for the 12th rib, the incision will be made too high, in which case almost certainly the pleura will be opened. The incision commences above the costovertebral angle: it is carried downwards and forwards parallel to and about $\frac{1}{2}$ in. (1.3 cm.) below the last rib for 10 to 12 inches (25 to 30 cm.) in the direction of the anterior superior iliac spine. Thus the incision has an upward curl at its posterior end, the better to gain access to the base of the 12th rib. The incision is deepened to display the muscles. The first layer to be encountered is, in the upper half of the wound, the latissimus dorsi, which is severed in the line of the incision; in the lower half of the wound, the external oblique, which is split in the direction of its fibres (*Fig. 823*). Bleeding vessels are ligated. The next muscular layer is that of the internal oblique, which is divided almost across its fibres in the length of the incision. Usually it is in this layer that the 12th dorsal nerve is encountered; it must be preserved carefully, and care taken that it is not clamped in the jaws of a hæmostat while picking up a bleeding vessel. It should be retracted downwards and laterally. After further blood-vessels have been ligated and retractors placed under the edges of the wound, the underlying transversus muscle will be exposed in the anterior part of the incision, while posteriorly

this layer gives place to the dorso-lumbar fascia. Both the fascia and the transversus are divided in the length of the incision. Beneath this layer lies the renal fascia (fascia of Zückerkandl), which surrounds the perirenal fat (*Fig. 824*). Further steps of the operation are described below under the heading 'Mobilization of the kidney'.

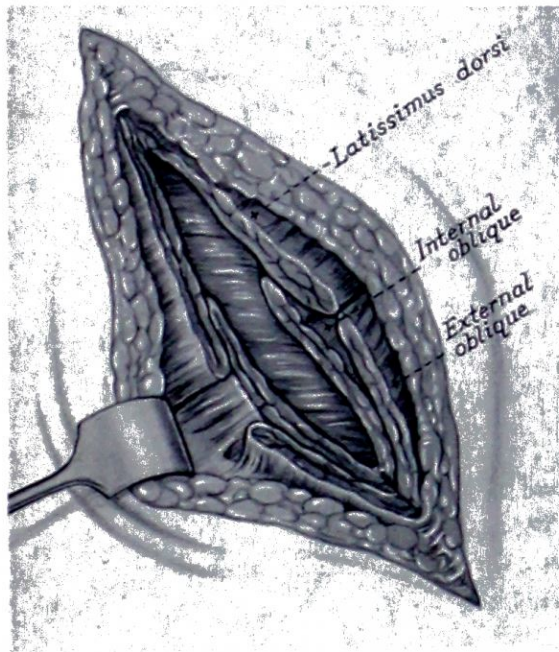


Fig. 823.—The muscles have been divided, and the transversalis fascia bulges into the wound. (*After A. I. Dodson.*)

If more room is required the tense edge of the ligamentous attachment between the last rib and the transverse process of the first lumbar vertebra can be severed. Often this results in brisk hæmorrhage from the 12th intercostal artery, which must be ligated. A firm pull on the retractor around the upper lip of the incision causes the 12th rib to

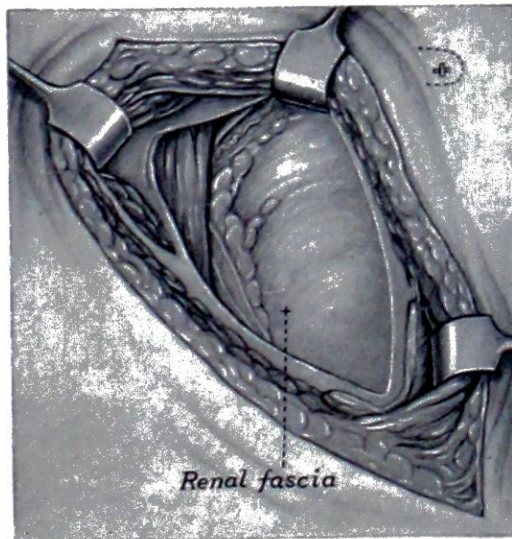


Fig. 824.—The renal fascia exposed. (*After A. I. Dodson.*)

become dislocated in a young subject; in an older subject, frequently the rib is fractured, which causes no untoward symptoms. In either event, much room is gained and the need for subperiosteal resection of the 12th rib is obviated.

Accidental opening of the pleura: Children excepted, rarely the pleura extends below the lower border of the 12th rib, but one must always keep the pleura in mind when encroaching upon the costovertebral angle. An opening in the pleura is recognized by a

sucking sound, which is comparatively faint when endotracheal anaesthesia is being employed. The opening should be occluded by the finger, and as soon as possible it should be closed by interrupted sutures. When the last suture is being inserted the anaesthetist is requested to expand the lungs. When endotracheal anaesthesia is not being employed, and a considerable amount of air has been allowed to enter the pleural cavity, it is best to insert a Jacques catheter of average size, and aspirate the air before the final suture is tied. In either event a radiograph of the thorax should be taken at the earliest opportunity, and if it reveals a significant amount of air in the pleural cavity, the air should be aspirated through a hollow needle.

Mayo's Incision.—One of several advantages of Mayo's incision is that comparatively few blood-vessels are encountered during the exposure of the kidney.

Position of Patient.—The prone position (*Fig. 825*) will be found most satisfactory. The position offers two advantages. Firstly, the kidney can be exposed rapidly. Secondly,

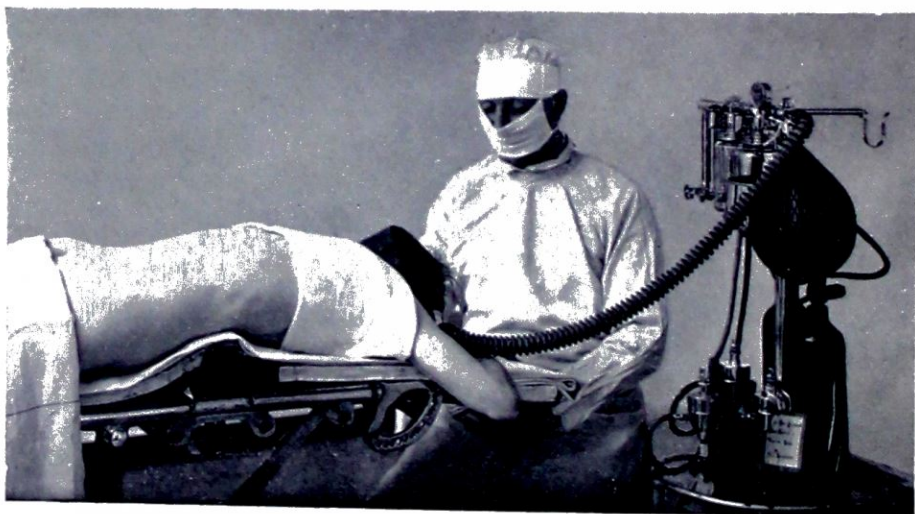


Fig. 825.—The prone position for exposing the kidney in the loin. Moderate elevation of the 'bridge' of the operating table gives adequate flexion.

the opposite side is available immediately should it be necessary to explore the contralateral organ. When the time comes for closure of the wound, the bridge of the table is lowered, or the bags are deflated.

Technique.—This incision commences over the centre of the sacrospinalis at the level of the upper border of the twelfth rib and passes directly downwards for 3 in. (7.5 cm.) where it curves outwards to form a J (*Figs. 826, 827*).

1. The sacrospinalis sheath is incised vertically, and the sacrospinalis muscle is retracted medially.

2. The deep aspect of the sacrospinalis sheath is incised vertically.

3. The quadratus lumborum is retracted medially.

4. The extraperitoneal fat and peritoneum are pushed laterally.

The renal fascia (fascia of Zückerkandl) is now exposed. Usually the 12th dorsal nerve can be found coming from beneath the upper part of the quadratus lumborum, and coursing downwards and forwards; the nerve must be preserved carefully.

The subsequent steps of the operation are described below under the heading 'Mobilization of the Kidney'.

If more room is required, ligaments uniting the 12th rib to the vertebræ are divided, and the 12th rib is pulled upwards. If still more room is needed, the 12th rib may be excised subperiosteally.

Mobilization of the Kidney.—In either of the incisions described when the renal fascia has been reached the next step is to make a short incision through this fascia. The posterior part of the incision is chosen for this purpose, the better to avoid opening the peritoneum. The incision is enlarged by inserting the two index fingers and tearing open this fascial envelope, thus exposing the perirenal fat. The fat is picked up in dissecting forceps, and by blunt dissection with a closed hæmostat, the jaws of which are opened if necessary, a portion of the renal capsule is displayed. By digital dissection the perirenal

fat is stripped from the kidney. In the course of this dissection a tight string-like structure is sometimes felt passing to the kidney in the region of the upper pole. This is probably an aberrant renal vessel, and it must be displayed to vision. Unless it proves to be an artery of considerable size, it should be divided between hæmostats and its ends ligated.

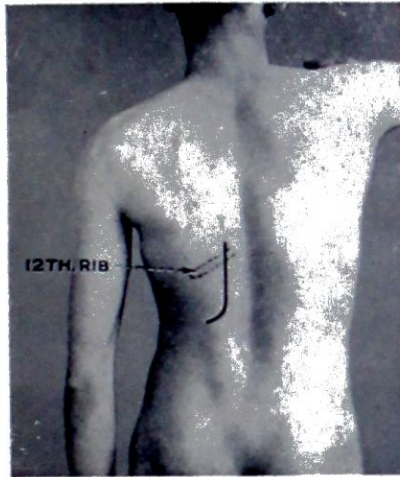


Fig. 826.—Mayo's incision for exposure of the kidney.

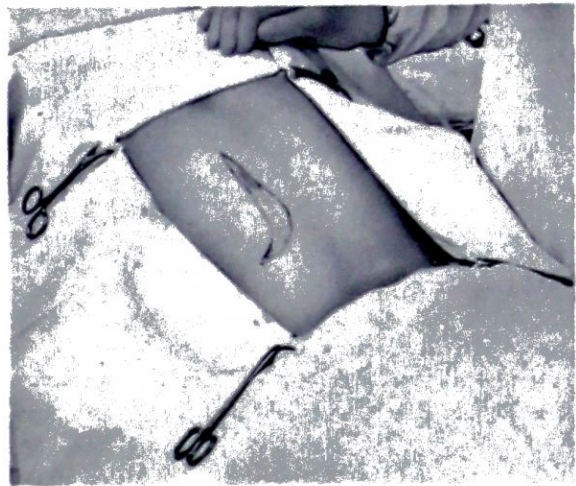


Fig. 827.—Mayo's incision. The sheath of the erector spinae is about to be incised.

Although aberrant renal vessels passing to the lower pole are much more common than the foregoing, they course parallel to, and so near, the renal pedicle that frequently they are not detected until the kidney has been delivered and its pedicle has been cleared of fat. Usually the perirenal fat can be separated from the renal capsule without difficulty. Anteriorly one must be mindful that on the right side the retroperitoneal portion of



Fig. 828.—Delivery of a kidney. The upper pole is delivered first; gauze packing is inserted into the wound to prevent this slipping back whilst the lower pole is delivered.

the duodenum overlying the inferior vena cava is in close relationship to the hilum of the kidney. Both these structures can be protected by packing the duodenum away from the field of operation. On the left side descending colon should be protected similarly.

Delivery of the Kidney (Fig. 828).—It is a great mistake to attempt to haul the organ out of the wound. The upper pole, after being freed from attachments, is brought to the surface. Gauze, still attached to a wide roll, is packed beneath the upper pole to keep it elevated, while the lower pole is delivered similarly. Always deliver the kidney one pole at a time.

The Kidney is too adherent to be mobilized in the usual manner : When serious perirenal inflammation or previous operation or operations on the kidney have resulted in adherence of the capsule to surrounding tissues, mobilization of the kidney by blunt dissection is impossible, or inadvisable. If these adhesions are capable of definition, the kidney should be separated from surrounding structures by meticulous sharp dissection, keeping close to the kidney, first posteriorly, then round the lower pole, then round the upper pole, and finally anteriorly. Should the kidney be found to be embedded in iron-like adhesions—a contingency that is not exceedingly rare—such a dissection, if possible, is dark, dangerous, and bloody. Consequently, in these circumstances, if the contralateral side is known to be healthy it is far better to decide to perform the operation of subcapsular nephrectomy (*see below*).

LUMBAR NEPHRECTOMY

Apart from irreparable rupture, the indications for nephrectomy as an emergency procedure are few. Without the advantage of having investigated the function of each kidney by refined methods, nephrectomy should seldom be even contemplated. Violent hæmaturia is sometimes an indication for fairly urgent nephrectomy, but blood transfusion has rendered it possible to delay the operation until adequate investigation has been undertaken. If it is necessary to operate at short notice upon a pyonephrosis, nephrostomy should be performed. Failure to observe this general principle has led to disaster.

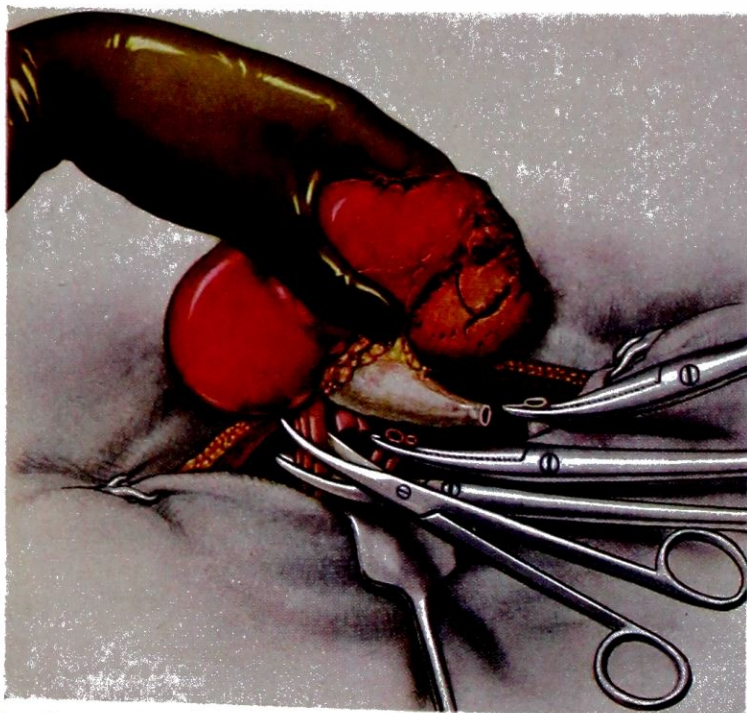


Fig. 829.—Nephrectomy. The segmental division of the renal pedicle should be noted. This is much safer than a mass ligature.

Once the kidney has been delivered, its removal in cases of rupture is simple. Working from below upwards, the individual constituents of the pedicle are clamped with ordinary long hæmostats and cut—a section at a time (*Fig. 829*). The clamps may be placed quite close to the kidney. This technique is far better than the mass ligature, and makes slipping of the renal pedicle almost impossible.

Subcapsular Nephrectomy, which greatly reduces the possibility of injury to the duodenum, colon, spleen, adrenal, or the pleura, is advised when the kidney is embedded in dense adhesions.

An incision is made through the thickened renal capsule along its convex border, and with the finger, a plane of cleavage will be found between the capsule and the parenchyma (*Fig. 830*). Separation is carried out on each surface and around the poles. After freeing the kidney as far as the hilum, the capsule is again incised, this time circularly 1 cm. from the renal hilum. This gives access to the renal pedicle, which usually can be dealt with

in an orthodox fashion. When the pedicle is short and inaccessible instead of attempting to ligate it, the hæmostats can be left attached, as described on p. 616.

When the operator is fearful that if the decapsulated kidney is cut away the hæmostats might slide off the renal pedicle, B. S. Vallett recommends, and has practised successfully, two-stage nephrectomy. The forceps are left on and the wound is left open, and packed. Six days later the necrotic kidney is excised and the forceps are removed. As a rule, the wound can be closed without drainage.

The Management of the Renal Pelvis in a Difficult Case of Nephrectomy.—The kidney having been excised, exceptionally, because of shortness of the renal pedicle, adhesions, obesity of the patient, or his poor condition, it may be considered unwise to attempt to ligate the renal pedicle. In these circumstances the hæmostats on the renal pedicle are left in situ, and provision is made to protect them. Sufficient gauze is wrapped around the blades, as well as the shafts, of the hæmostats to keep them from coming into contact with the wound, which is approximated around them. J. T. Priestley recommends that the two protruding rings of each hæmostat be tied together with strong silk to prevent the hæmostat becoming loosened accidentally. All the hæmostats

are then tied together by one encircling ligature around their shafts, just below the handles. After the wound has been dressed, a protective covering is placed over the protruding handles. If a suitably-sized firm cardboard box can be found, the bottom is removed so that the intact sides can act as a rampart when placed over the handles and secured by adhesive plaster. If no such box can be found, gauze is wound around the handles and secured by a ligature. The patient is nursed on his side; when possible, a special nurse should be in attendance. An appropriate sedative is given every four hours until the hæmostats are removed, which is commenced 72 hours after their application. The silk ligatures securing the handles and rings are cut, and the hæmostats are loosened one ratchet each. Priestley recommends an interval of 24 hours between the loosening and removal of the hæmostats. The gauze which was placed in

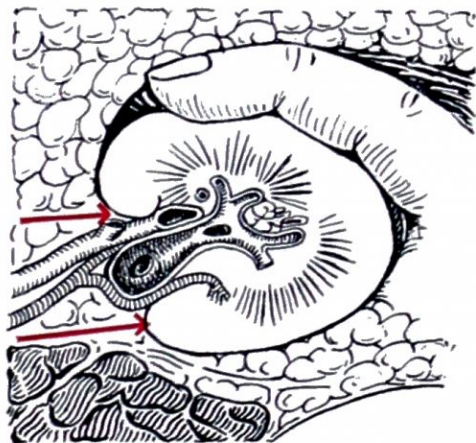


Fig. 830.—Subcapsular nephrectomy. The arrows indicate where circular division of the capsule must be made, in order that the structures comprising the pedicle can be divided. (After Eric Farquharson.)

the wound around the hæmostats is removed gradually during the next two or three days. A solution of balsam of Peru will help to soften and loosen the gauze before it is withdrawn.

Severe Hæmorrhage during Nephrectomy.—

Slipped Renal Pedicle.—Mayo has immortalized the slipped renal pedicle, which, he said, "fairly jumps into the fingers" when nimble fingers promptly follow its retraction into the depths of the wound. It would seem that a potent cause of slipping of the pedicle is the use of a single, large, and consequently clumsy, clamp.

Two measures should not be attempted: (a) To apply hæmostats blindly—this is usually unsuccessful and on the right side the duodenum may be injured; (b) To rely solely on packing.

The immediate treatment is to control the hæmorrhage by digital compression. If after the hæmorrhage has been controlled temporarily in this manner, one feels hampered for room in which to apply hæmostats accurately the incision should be enlarged by the assistant. If necessary, one, or even two, ribs should be resected. With the surgeon's fingers still compressing the bleeding point, retraction is so arranged that the fingers are seen before applying hæmostats.

When the surgeon fails to grip the bleeding pedicle, instantaneous packing and pressure of the pack against the vertebral column is fundamental. Pack follows pack in the manner about to be described, until the wound is filled. Then follows a difficult period of restraint—a wait of up to four or five minutes. Details of this and the subsequent steps will be described.

G. H. W., aged 34, was undergoing nephro-ureterectomy for a tuberculous kidney. The enormously thickened ureter had been divided between ligatures near the bladder through an anterior incision, and the lumbar stage of the operation was in progress. The kidney was a large

one—at least three times normal size. With difficulty (adhesions) the upper pole was delivered. It must be realized that the ureter having been disconnected from the bladder and mobilized, the only constituents of the pedicle still attaching the kidney were the renal vessels. Owing to adhesions, delivery of the lower pole was also difficult. As the lower pole was being firmly, but gently, lifted by the fingers beneath it, there was a sudden ‘snap’. The pyonephrosis fell and bounced on the floor. The terrifying hæmorrhagic cascade caused my left hand to obey reflexly Mayo’s instructions, but on this occasion, although the fingers grasped something, evidently it was not the entire renal pedicle. Therefore an abdominal pack was rammed as hard as possible into the depths of the wound, simultaneously letting go of what was grasped between the left finger and thumb. Keeping up compression of the pack against the vertebral column, a second pack was inserted, and pressure was applied by the left hand while the right hand was disengaged. Further packs were inserted with heavy compression, until the entire wound was filled. The patient’s condition was not good, but the anæsthetist reported that he could feel the pulse. The anæsthetist was requested to supervise the assembling of apparatus for a plasma infusion. Keeping up the compression for at least a minute, I pondered on the best course to adopt. Remembering that I had written in this book that in this predicament one must never rely upon packing, I removed the packs one by one, until the original pack alone was left. Removing this suddenly with my right hand, I was enabled to see from whence the blood was issuing, and to seize the remnants of the renal pedicle between my left forefinger and thumb. It was now a surprisingly simple matter to apply a long hæmostat accurately, and this controlled all hæmorrhage. No attempt was made to apply a ligature, as it was feared that it might cut out. The wound was quickly sutured with the handles of the hæmostat protruding. Gauze was then wrapped round the protruding part of the hæmostat, so as to immobilize it. The patient was given a plasma infusion and later blood transfusion.

On the fourth day the ratchet was loosened, and three hours later the hæmostat was removed uneventfully. The patient was seen six months later, and his condition was satisfactory.

A French surgeon, wishing to demonstrate his method of dealing with hæmorrhage from the renal pedicle, proceeded as follows: delivering the kidney into the lumbar wound, he deliberately severed the renal pedicle with a pair of scissors, without first applying either hæmostats or a ligature to the renal vessels. He immediately packed the wound tightly with abdominal packs. This accomplished, he removed his gloves and sat down and drank a cup of tea. Five minutes passed before he returned to his task. When the packs were gently removed the field remained dry long enough for him to apply with deliberation hæmostats to both the renal artery and vein. His secret of success lay in exercising restraint, and in allowing sufficient time to elapse for the torrential hæmorrhage to be reduced by sustained pressure and reflex vasospasm (Sir Reginald Watson-Jones).

Injury of the Inferior Vena Cava during Right Nephrectomy.—The inferior vena cava has no valves. Half-way to the heart it receives both renal veins. The left renal vein is longer and thicker than the right, and enters the vena cava more proximally. This knowledge is fundamental if the vena cava has to be ligated, for after right nephrectomy life can only be maintained when the ligation is distal to the entrance of the left renal vein. The mortality from tearing the inferior vena cava during nephrectomy amounts to about 50 per cent. Death usually results from exsanguination, but occasionally from air embolism. The inferior vena cava is liable to injury by avulsion of the renal vein, almost invariably the right renal vein, from the caval wall. Occasionally the accident is due to an injudicious pull on the spermatic or ovarian vein.

The best immediate treatment is direct manual compression of the vena cava below the tear; if this can be accomplished, it is better than compression applied over an abdominal pack. The lumbar incision must be enlarged upwards and downwards, so that ample exposure is obtained. The compression of the vena cava is taken over by an assistant while the surgeon examines the extent of the damage. If the tear is small, direct suture is the right course. When the tear is more extensive, suture can still be carried out if the vena cava is occluded above and below by placing thin rubber tubing around the vessel and clamping it in a hæmostat. Alternatively, ligation of the vena cava as low as possible is the only course. The results following ligation of the inferior vena cava for this accident are fair. Although series with a lower mortality have been reported, F. Papin reported 6 deaths in 15 cases, which is about what can be expected of this measure in expert hands. Surprisingly, Boeminghaus, who has performed the operation repeatedly, states that he has seen no early or late ill-effects following ligation of the inferior vena cava. This is not the experience of others (*see p. 929*).

SEVERE HÆMORRHAGE AFTER NEPHRECTOMY

If bleeding occurs some hours after nephrectomy and continues in spite of morphine and blood transfusion—if matched blood can be obtained in time—the wound must be reopened and the bleeding point sought. Often it is impossible to locate the source of the hæmorrhage, and recourse must be made to packing the wound with gauze. The portion of gauze which is first introduced may, with advantage, be absorbable gauze.

SEVERE HÆMORRHAGE AFTER NEPHROLITHOTOMY

The general principles in treatment are precisely similar to those of a severe injury to the kidney (*see p. 583*).

In my case index for June, 1922, there is the following entry: "During this month I have seen three cases of severe hæmaturia following nephrolithotomy. In all of them the condition of the patient was alarming, and did not respond to morphine. X remarked that these cases do not die." All recovered. A little more than two months later a fourth case came under my notice, and it was not until the profoundly anæmic patient died on the eighth day that I lost faith in my new-found aphorism. Two years intervened before another opportunity occurred of studying this condition.

L. F., aged 47, had left nephrolithotomy performed. By X-rays a cluster of stones in the pelvis and lower pole of the left kidney had been shown. Three large branched calculi were extracted after splitting the kidney longitudinally. Fairly profuse hæmaturia persisted until the fifth day, but on the sixth day it appeared to be clearing, and there was little to call attention to the patient until the morning of the twelfth day, when 10 oz. (0.3 l.) of almost pure blood were passed. On the three succeeding days the same thing occurred each morning, in spite of large doses of morphine. The general condition of the patient became alarming. The pulse-rate was recorded hourly, and as this showed a steady increase, on the evening of the fifteenth day, with blood transfusion proceeding, left nephrectomy was performed. The perinephric space and the interior of the kidney were full of blood-clot. Drainage. Recovery.

Fig. 831 shows the specimen. The extensive anæmic infarction on either side of the longitudinal wound is good evidence that 'post-mortem splitting' of the kidney is a poor surgical procedure. An incision radiating from the hilum, which more nearly follows the ramifications of the intrarenal vessels, is not open to this objection.

ABDOMINAL NEPHRECTOMY

The indications for abdominal nephrectomy are very limited indeed. It will be found of service in cases of intraperitoneal rupture of the kidney which are exceedingly rare, and possibly when the kidney is found to be ruptured in addition to some intraperitoneal lesion. In such conditions as intra-abdominal rupture of a hydronephrosis and torsion of the pedicle of an ectopic kidney, the abdominal route will be chosen because until the abdomen has been opened the correct diagnosis is unlikely to be established.

In torrential hæmaturia of renal origin abdominal nephrectomy may sometimes be resorted to, as was done in the following case:—

A. W., aged 50, gave the following history. Eighteen years previously she had a cyst removed from the right kidney. Four years afterwards the same kidney had been fixed. For the past three years attacks of painless hæmaturia had occurred, but during the past six weeks the bleeding had occurred daily. During the four days immediately preceding, the doctor in attendance stated that pure blood had been running away 'like a tap'. The patient was quite blanched, complained of singing in her ears, and seemed wandering in her statements. The pulse was very feeble, and all that could be found on physical examination was the scar of previous operations in the right loin. Blood transfusion was carried out the same evening. On the following morning



Fig. 831.—Kidney removed for profuse hæmaturia following nephrolithotomy by splitting the kidney—a method which should have become obsolete. Areas of infarction can be seen.

her general condition had improved somewhat, but the urine was full of blood. Under a general anæsthetic after repeated washings, cystoscopy showed a blood-clot in the orifice of the right ureter. The abdomen was opened by a right rectus incision, which was in turn converted into a Rutherford Morison's incision by a transverse cut outwards. The right kidney was ill-formed and adherent. The left kidney felt normal. Abdominal nephrectomy. Recovery. The patient was alive and well two years later. Serial sections of the kidney failed to reveal the cause of the hæmorrhage.

The reason for choosing the abdominal route in this case was the fact that the patient had had two previous operations on the kidney that was bleeding, and it was considered the scar tissue would render a lumbar exploration exceedingly difficult.

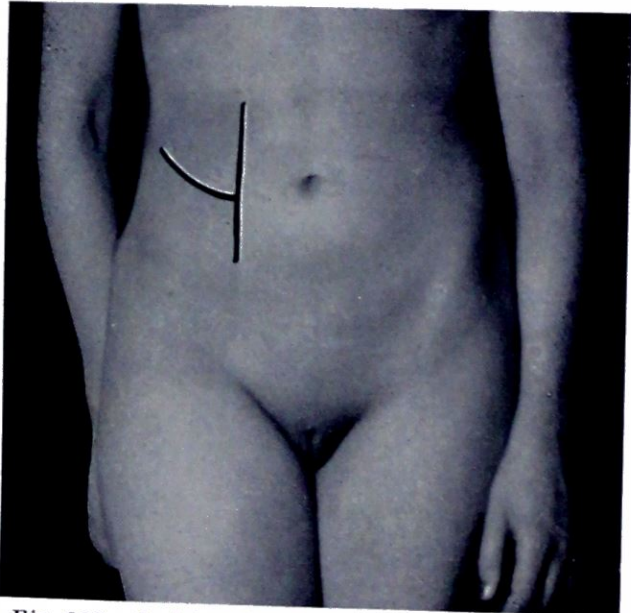


Fig. 832.—Incision for abdominal nephrectomy. If more room is required, the transverse extension is made.

An advantage of abdominal nephrectomy is that it permits examination by palpation of the opposite kidney. It is, however, a dangerous route to traverse if there is any question of the lesion being inflammatory. The operation is distinctly difficult in the presence of meteorism, or when the anæsthetic has not rendered the abdominal wall flaccid. Abdominal nephrectomy can be carried out through an incision similar to Battle's incision, though placed higher (Fig. 832). The incision must be of ample proportions, and if it is found that more room is required a transverse cut can be made towards the flank (Fig. 832). The peritoneum having been opened, the intestines are packed off carefully. The posterior layer of the peritoneum is now incised on the lateral side of the colon. It is highly important to be absolutely certain

that this incision is made on the *outer* side of the large intestine, otherwise the blood-supply to that part of the colon will be jeopardized. By gauze dissection the colon and its mesentery are mobilized towards the middle line. The kidney is now accessible. The renal pedicle is ligated in sections. After the kidney has been removed, usually it is a wise precaution to drain the perirenal space through a stab incision in the loin. The peritoneum of the posterior abdominal wall is then closed, and the anterior abdominal incision repaired in the usual manner.

Torsion of an Ectopic Kidney.—Abdominal nephrectomy has to be performed occasionally as an emergency for torsion of a mal-placed organ, of which the following is a good example.

B. N., aged 17, was admitted to hospital at 5 a.m. one autumn morning. He gave a history of a sudden onset of abdominal pain thirty-six hours previously. The pain *began* in the right side. He had vomited four times. The pulse was 104 and the temperature 99° F. (37.2° C.). There was rigidity, tenderness, and hyperæsthesia in the right iliac fossa. A diagnosis of acute appendicitis was made, but as the pain had *begun* in the right iliac fossa, it was mentally noted that this was the only unusual feature in an otherwise typical case. The urine was normal. At 8 a.m. he was anæsthetized. Under the anæsthetic a large lump could be felt in the right iliac fossa, which, it was thought, might be an appendix abscess. Gridiron incision showed a round, purple, retroperitoneal swelling about the size of a tangerine. The incision was enlarged downwards by detaching the internal oblique from the rectus sheath.

A hand was passed into the abdomen, and it was noted that the right kidney was absent from its normal position, whereas the left kidney was large and normally placed. The lump was therefore the (small) right kidney. The intestines were packed off medially, and the cæcum was mobilized a little and then packed away into the

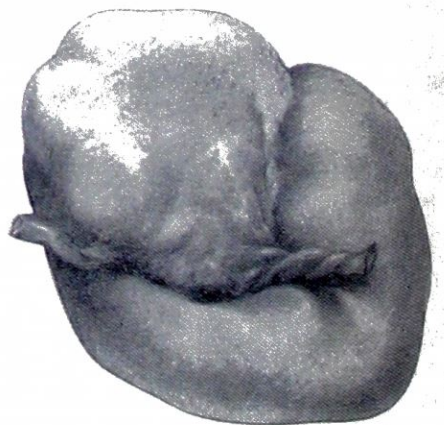


Fig. 833.—Torsion of an ectopic kidney. Drawing of a specimen removed at operation. Note the ureter on the left and the twisted renal vessels on the right.

upper part of the wound. The peritoneum was incised over the swelling, and a very deformed, rounded kidney delivered, the pelvis of which was extremely dilated (*Fig. 833*). A twist was noted in the ureter, and on turning the kidney through a complete clockwise circle the ureter straightened out and the tense pelvis discharged its contents into the bladder. The ureter was so short that there was no hope of placing the organ in the loin, so nephrectomy was performed by dividing the ureter between clamps, and likewise the renal vessels, which entered at the upper pole diametrically opposite the ureter. The peritoneum of the posterior abdominal wall was then brought together and the abdomen closed. Recovery.

NEPHROSTOMY

Nephrostomy is an excellent emergency measure in several conditions, notably :—

1. For the relief of obstructive anuria due, for example, to bilateral ureteric calculi or to a calculus occluding the ureter of an only functional kidney (*see p. 606*).
2. To divert the urinary stream in accidental ligation or severance of a ureter or ureters (*see p. 592*).
3. To drain a pyonephrosis.
4. As an accessory measure after suture of a lacerated kidney (*see p. 590*).

The exposure of the kidney is carried out in exactly the same manner as described on p. 610. Usually the incision should be a large one, because the kidney is likely to be engorged, probably in part hydronephrotic, and sometimes full of pus. Three methods of performing nephrostomy will be described, each having its special use.

Certain features are common to all methods : any type of catheter with an expanded end is likely to produce undesirable pressure on the renal parenchyma. The best drain for the interior of a kidney is a fairly large whistle-tipped catheter (*Fig. 834*). Once in



Fig. 834.—Whistle-tipped catheter.

place (its tip should lie in or near the lowest calix) the tube should be anchored to the kidney by a chromic catgut stitch, which transfixes the capsule, a small amount of parenchyma, and a segment of the diameter of the tube. While such a suture will not stand much strain, it helps to hold the catheter in the desired position. In the absence of a whistle-tipped catheter, a piece of rubber tubing can be cut similarly. Polythene tubing has an advantage in that it has less tendency to become occluded by the precipitation of crystalline material from the urine. A most essential point in the performance of nephrostomy is that the tube should run a straight course through the parietes to the interior of the kidney. The way to ensure this is, after the catheter has been inserted into the kidney and anchored to its capsule, to return the kidney to its bed, and to lower the bridge of the operating table. Only then is it possible to ascertain where the exit for the tube should lie. Often it is best to provide a special stab incision to accommodate the tube.

Before making the stab, Lane's tissue forceps are placed on the skin and muscles of the appropriate side of the incision, so that the abdominal wall can be held taut while the stab (it should be half as large again as the diameter of the catheter) is being made. In this way a perfectly straight exit for the catheter can be provided. The tube is drawn through the stab wound with a hæmostat. The lumbar incision is closed, the perirenal space being drained by corrugated rubber brought out at the inferior end of the incision. The catheter should be anchored to the skin, not with a stitch, but in the manner shown in *Fig. 987*, p. 715. There are two advantages in employing this expedient : (1) Infection of the stab wound is rendered improbable ; and (2) as there is no stitch to remove, the catheter can remain undisturbed until the time comes to change or remove it. This should be a minimum of fourteen days.

As soon as the patient has been returned to bed the catheter is connected to a collecting bottle. At all times precautions must be taken that the extra-corporeal portion of the catheter does not become kinked. It is important to keep the tube clear of blood-clot, especially during the first twelve hours after the operation, and this is done by injecting a measured quantity of saline solution down the tube at regular intervals.

Method I is indicated particularly when the kidney is obviously distended with urine or pus, and, even if it were possible, it is undesirable to deliver the kidney sufficiently for the renal pelvis to be exposed fully.

In the convex border of the kidney towards its lower pole the point of the diathermy knife, with the current switched off, is plunged through the parenchyma towards the pelvis.

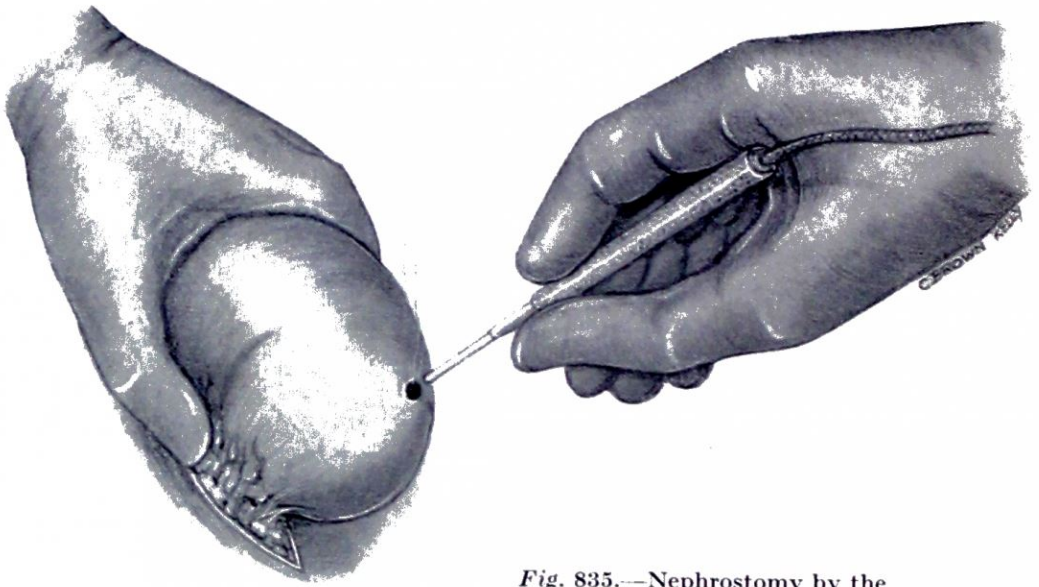


Fig. 835.—Nephrostomy by the diathermy knife.

The current, turned to 'coagulating' as opposed to 'cutting', is switched on and the knife is withdrawn slowly with a rotary movement (Fig. 835). This burns a hole cleanly through

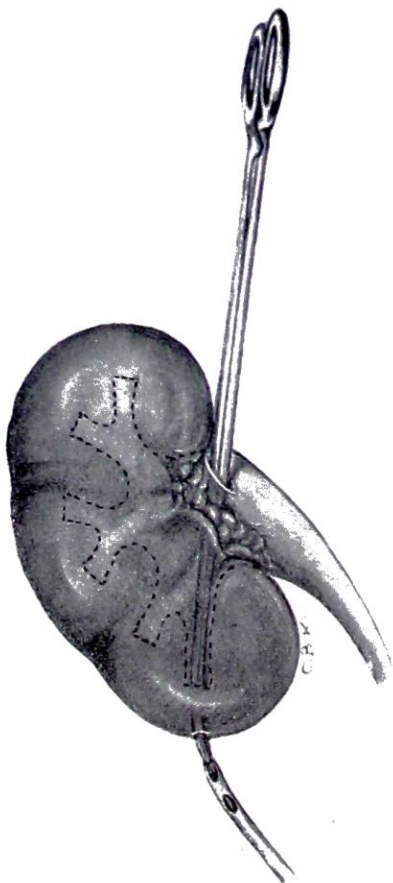


Fig. 836.—Method of performing nephrostomy with the aid of a long haemostat. (After J. T. Priestley.)

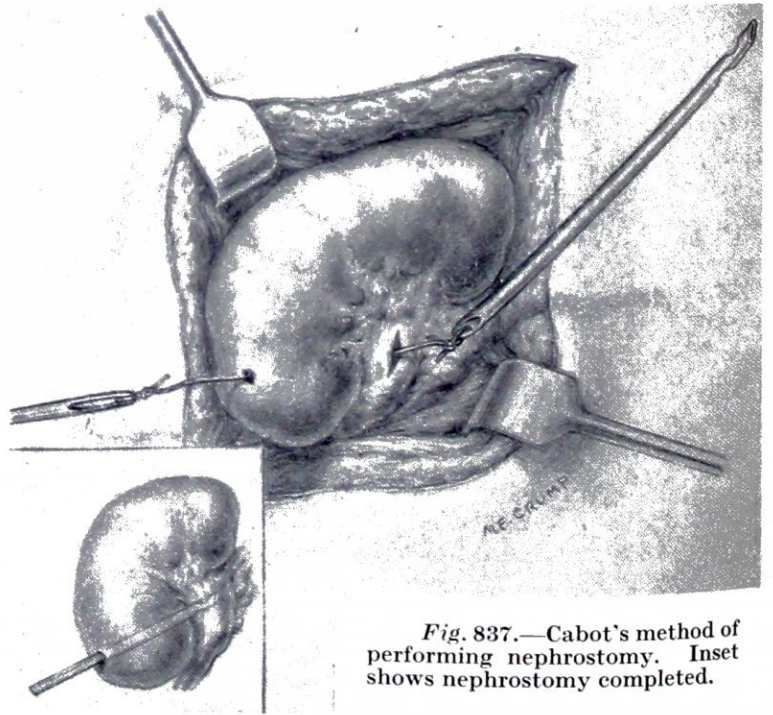


Fig. 837.—Cabot's method of performing nephrostomy. Inset shows nephrostomy completed.

the renal tissue. When it is considered that the tunnel is adequate, a Watson-Cheyne dissector is passed down it, and the probe-ended point will be felt between the finger and thumb from outside the renal pelvis. In many emergency conditions the last step is unnecessary, for once the kidney substance has been penetrated as far as the interior of a calix, there will be a gush of pent-up pus or urine. Bleeding is somewhat free, but not nearly as copious as when the kidney is incised with a scalpel. After an adequate tunnel has been cut from the surface to the caliceal system, a whistle-tipped catheter or a rubber tube of suitable size with lateral eyes is passed into the opening until its tip can be felt

to lie in the pelvis of the kidney; it is then withdrawn sufficiently to ensure that the eyes of the tube are within or near the lowermost calix. The catheter is then anchored to the kidney with a stitch (*see p. 619*). To make quite certain that the passage is unobstructed and the tube is lying correctly, a syringe full of saline solution is connected with the tube, and as the contents of the syringe are emptied the renal pelvis will be felt to balloon out. The tube is anchored to the capsule with a stitch.

In very urgent cases it is not always necessary to deliver the kidney. So long as the fingers and thumb can be made to encircle the pedicle the operation of nephrostomy by the diathermy knife can be conducted quite well within the wound. This saves time and diminishes shock.

Method 2 is usually reserved for those cases in which the kidney can be delivered easily, the renal pelvis displayed clearly, and there is no contra-indication to a somewhat more prolonged operation. On the other hand, when a diathermy machine is not available the choice is narrowed to either methods 2 or 3.

As is shown in *Fig. 836*, a small incision is made into the upper part of the renal pelvis. A long hæmostat is passed into the lowermost calix; its beak is driven through the renal parenchyma and capsule of the lower pole. The jaws of the hæmostat are opened just wide enough to grasp the tip of the catheter, which is drawn into the renal pelvis. The hæmostat is then disengaged and withdrawn, and the catheter is pulled gently so that its eyes come to lie within the lowest calix. The size of the catheter should be such that bleeding from the renal parenchyma is controlled by pressure of the catheter. If oozing occurs it can be controlled by digital compression of the renal cortex around the catheter for several minutes. The incision in the renal pelvis is closed with a few interrupted sutures.

Method 3 is valuable when the kidney and its renal pelvis cannot be delivered sufficiently to perform method 2 with ease. It is also the method to choose when the renal pelvis is mainly intra-renal (*see Fig. 839*). The eyed end of a malleable probe is passed through the convex border of the kidney near the lower pole, and it enters the caliceal system. The probe is then withdrawn slightly, and the main part of the shaft is bent so that when the probe is advanced its eye will enter the renal pelvis, where it will be felt, if not seen. A small incision is made in the renal pelvis and the eyed end of the probe is made to protrude. The remaining steps of the operation are made clear by a reference to *Fig. 837*. The distal end of the catheter is cut obliquely, and the now pointed end of the catheter is transfixed with a suture, which is tied. The other end of the suture is tied after passing it through the eye of the probe. A steady pull is made on the shaft of the probe, and, as the silk emerges, on the silk, and the catheter is drawn into the caliceal system and then through the renal parenchyma. A tiny incision through the capsule will aid the easy passage of the catheter. Once the butt end of the catheter has been drawn through the lower pole, the remaining steps of the operation do not differ from those of method 2.



Fig. 838.—When pyelostomy for acute renal infection has been performed a drainage tube is inserted down to the incision in the renal pelvis, but not into it. Free drainage of the perinephric tissues is also provided.

PYELOSTOMY (INSTEAD OF NEPHROSTOMY) IN SEVERE RENAL INFECTIONS

Mainly under local anaesthesia, but supplemented by gas and oxygen and a relaxant, the kidney is exposed. The pelvis of the kidney is cleared of fat and is opened. Nephrostomy is not a satisfactory operation when performed upon a kidney with a thick, congested cortex. In such cases a liberal incision in the long axis of the renal pelvis is recommended as a substitute. A drainage tube is not inserted into the pelvis, but free drainage is provided to the pelvis (*Fig. 838*). Only when the cortex has been attenuated by dilatation of the calices (i.e., some degree of

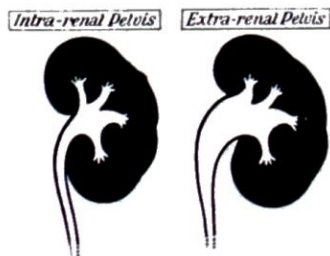


Fig. 839.—Pyelostomy is a difficult and unsatisfactory operation when the pelvis is intrarenal.

hydronephrosis is present before the infection occurs), or when the pelvis is mainly intrarenal (*Fig. 839*), is nephrostomy indicated. In cases where pyelostomy has been selected, it can,

with advantage, be combined with decapsulation. Incidentally, decapsulation will enable the parenchyma to be inspected for cortical abscesses. When the kidney is riddled with cortical abscesses and the functional integrity of the contralateral kidney has been proved, nephrectomy is often a wise procedure.

RENAL DECAPSULATION

The only indication for renal decapsulation is as an adjuvant to pyelostomy in cases of very severe pyelonephritis. The capsule is incised along the whole of the convex border.

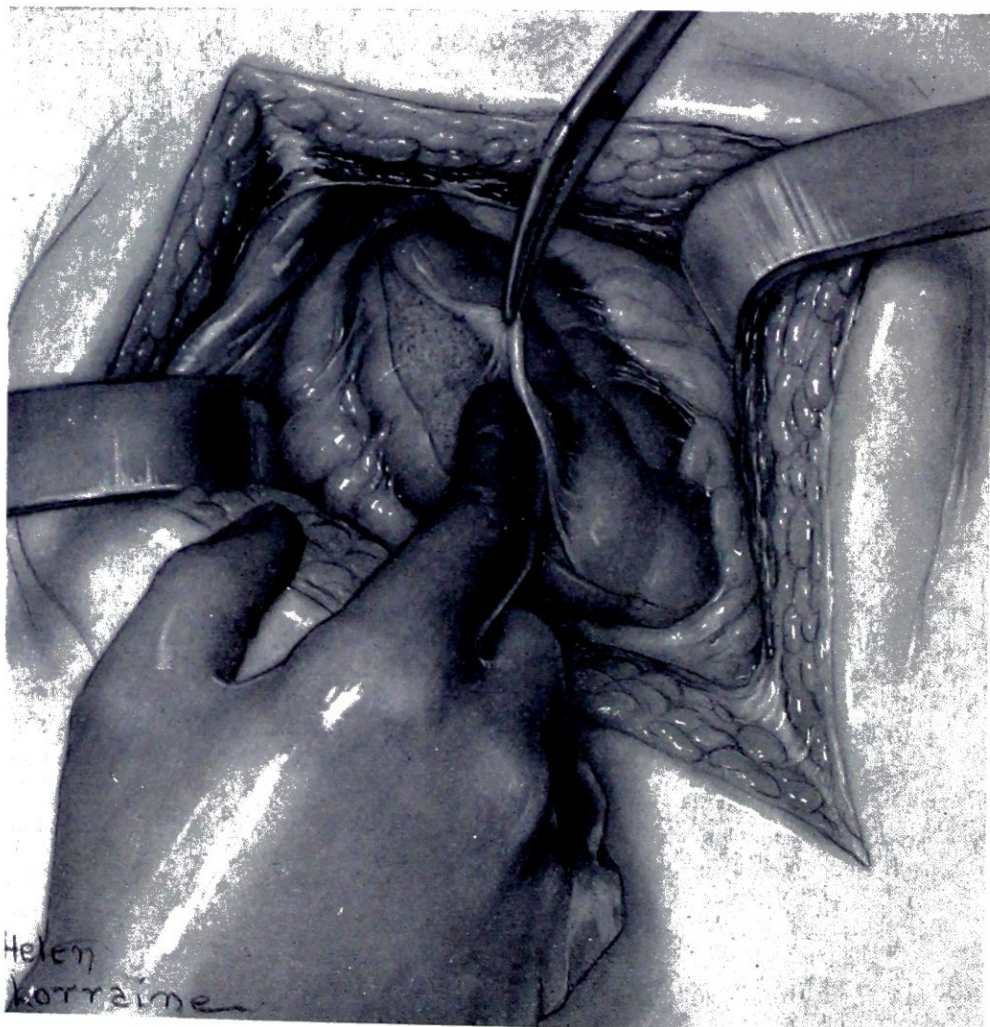


Fig. 840.—Renal decapsulation. The capsule is stripped by the finger. In urgent cases it is not necessary to deliver the kidney.

The cut edges are picked up and the capsule peeled on each side towards the hilum (Fig. 840).

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CHAPTER LV

THE BLADDER

TRAUMATIC RUPTURE OF THE BLADDER

With the increasing number of road accidents, cases of fractured pelvis complicated by rupture of the bladder have become more common. Of 1798 cases of fractured pelvis, 10 per cent had an associated rupture of the bladder. Of these, the rupture was extraperitoneal in 82 per cent and intraperitoneal in 18 per cent (Prather and Kaiser). On the other hand, owing to increased national sobriety, cases of intraperitoneal rupture of the bladder due to a blow upon the abdomen have become less frequent. This type of accident is more likely to occur in an inebriated person for two reasons: (1) The victim is off his guard, and consequently the abdominal musculature is not braced to receive the blow; (2) The bladder is likely to be full.

Partly on account of the more commodious pelvis, rupture of the bladder is decidedly less common in females than in males. In L. M. Bogart's series of 233 cases of rupture of the bladder, only 3 cases occurred in females.

The bladder of an infant and a child is mainly an abdominal organ; it does not attain its full pelvic position until the twentieth year. Therefore the chances of a rupture of the bladder being intraperitoneal are greater in a child than in an adult.

Extraperitoneal Rupture of the bladder is usually a complication of severe disruption of the pelvic architecture. Especially important are lateral crushing injuries producing separation of the symphysis pubis, fractures of the pubic rami, and/or complete fracture-dislocation of the pelvic girdle. Such injuries are liable to result in tearing of the bladder by stress upon its moorings, or exceptionally by perforation by a spicule of bone. Although a distended bladder is much more vulnerable than an empty one, a bladder containing even a little urine is not immune to extraperitoneal rupture.

Extraperitoneal rupture usually occurs on the anterolateral wall of the bladder, close to the bladder neck, thus allowing urine to extravasate into the prevesical space (cave of Retzius). The extravasated urine, admixed with blood, fills the space and infiltrates upwards to the umbilicus and laterally as far as the anterior superior iliac spines, and inferiorly to the apex of the prostate. Confined at first between the peritoneum on the one hand and the fascia transversalis on the other, the extravasated urine causes early necrosis of the intervening connective tissue; infection soon follows. Untreated, the extravasated urine can pass through the sacrosclatic notches to the buttocks, through the obturator foramina to the thighs, and via the inguinal canals to the scrotum or labiæ.

Intraperitoneal Rupture occurs through the dome or posterior surface of the bladder. The tear is usually vertical, owing to the arrangement of the muscle-bundles.

DIAGNOSIS

The symptoms of ruptured bladder are not infrequently masked by multiple injuries, shock, or inebriation. All patients with a fracture of the pelvis should be suspected of having an injury of the lower urinary tract until proved otherwise. 'Has the patient passed urine since the accident?' is a question that must be asked in every relevant case. In only 13 per cent of cases does a patient with a ruptured bladder pass urine, and when he does so almost invariably the urine is blood-stained (Gilbert and Dodson). On the other hand, case histories reveal that 37 per cent of patients with a fractured pelvis but *without* demonstrable injury to the urinary tract suffer from retention of urine, and 6 per cent with dysuria (Meredith Campbell). Furthermore, 30 per cent of such patients pass urine containing gross or microscopical quantities of blood, derived, presumably, from bruised or torn vesical mucous membrane.

Extraperitoneal Rupture.—After the initial shock has passed off, one of the first symptoms is an intense desire to micturate, but either no urine is passed, or only a few

drops of blood-stained urine with great effort. The spasms recur at intervals. Extravasation occurs into the prevesical space, causing a tender swelling above the pubes (*Fig. 841*). Patients with a fractured pelvis will complain of pain when compression or distraction is applied to the iliac crests; pressure over the pubic rami is often painful. In the male,

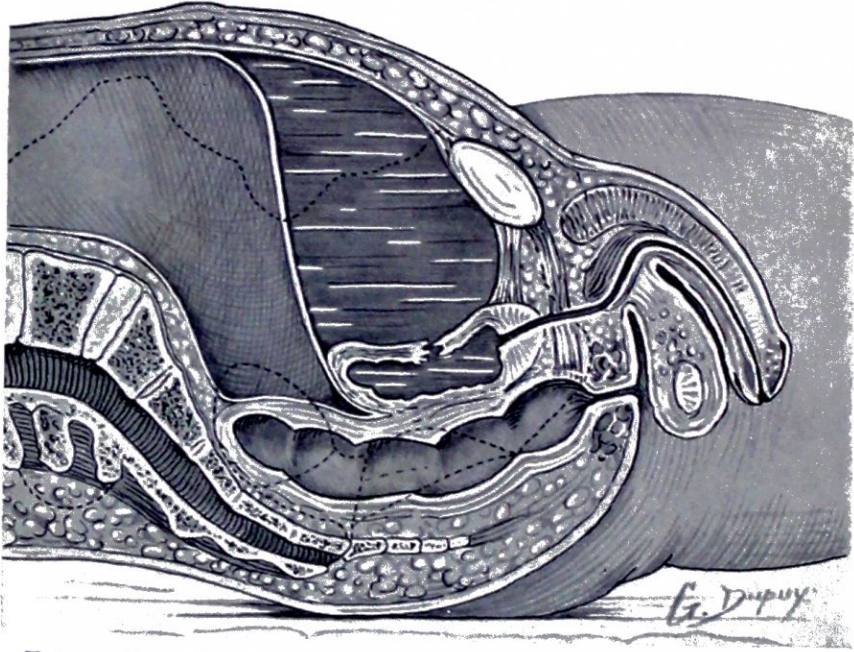


Fig. 841.—Extraperitoneal rupture of the bladder. The bladder is empty or practically so. (Cf. *Fig. 842.*)

extraperitoneal rupture of the bladder can be readily distinguished from intrapelvic rupture of the urethra by a rectal examination, for in the latter the prostate is impalpable (*see Fig. 806, p. 589*). If a patient with extravasation of urine is not seen until 24 hours after the accident, almost certainly pyrexia and toxicity will be in evidence.



Fig. 842.—Intraperitoneal rupture of the bladder.

Intraperitoneal Rupture.—There is sudden agonizing pain in the hypogastrium, often accompanied by severe shock and perhaps syncope. However, in a few minutes the shock passes off, and the pain lessens—so much so that sometimes the patient resumes his occupation—but the abdomen soon commences to distend because of paresis of intestinal coils bathed in urine (*Fig. 842*). Although there are exceptions, following the accident the patient has no desire to micturate. On examination a varying degree of abdominal

distension is present. In spite of the fact that the patient has not passed urine since the accident, there is no dullness above the pubes corresponding to a distended bladder. Usually there is tenderness in the hypogastrium. Abdominal auscultation discloses an absence of, or greatly decreased, intestinal sounds. If the amount of urine in the peritoneal cavity is considerable, shifting dullness can be elicited. Rectal examination often reveals a tender bulging in the rectovesical pouch. When the urine is sterile, symptoms and signs of peritonitis are delayed for several hours.

When a patient with intraperitoneal rupture of the bladder is not seen until 24 hours or more after the accident, signs of obvious peritonitis make the differential diagnosis from rupture of some other viscus impossible, unless, of course, the patient has passed little or no urine since the accident.

Methods of confirming the Diagnosis.—

1. *Mensuration*.—The passage of a urethral catheter, noting the amount and character of the urine that is evacuated, the introduction of 4 oz. (125 ml.) of sterile saline solution, and the attempt to recover it, has proved inconclusive so often that it should not be employed. Fallacies can arise: (a) From the tip of the catheter entering the peritoneal cavity through the rent, when it is possible for the same amount of fluid to be recovered as was injected; (b) Similar misleading information can accrue from an intraperitoneal rupture becoming sealed temporarily by a coil of small intestine, or by blood-clot; (c) Recovery of less fluid than was instilled can result from the eye of the catheter becoming blocked by blood-clot.

2. *Cystoscopy* is another method *not* to employ, for, contrary to what might be thought, even in the hands of an expert the information gained is often unreliable. When the tear is a comparatively large one the bladder cannot be distended. When the puncture is small, and blood-clot does not obscure the perforation, whether or not the tear extends through all coats of the bladder is doubtful. An absolute contra-indication to cystoscopy is when the patient has a fractured pelvis. Placing the patient in the lithotomy position is not only painful, but it is likely to increase displacement of the fracture.

3. *Retrograde Cystography* is the only reliable method of proving the integrity or otherwise of the bladder. The method should not be attempted until the patient has been treated for shock, if such is present. It is carried out at the same time that radiographs of the bony pelvis are taken. Combining excretory pyelography with retrograde cystography yields valuable additional information concerning the upper urinary tract.

Excretory urography, so valuable for visualizing the kidneys, is untrustworthy as a means of diagnosing a ruptured bladder. After the 30-min. films of the kidney have been exposed retrograde cystography is commenced, but should the blood-pressure be too low for prompt urinary excretion, i.e., below 90 mm. Hg, the excretory urography part of the examination is omitted. The opaque medium for retrograde cystography should neither be iodized oil (danger of oil embolism) nor a solution of sodium iodide (irritating and painful), but a 10 per cent solution of iodoxyl, of which there are several proprietary preparations, such as pyelosil.¹ These solutions are aseptic, non-irritating, and, if absorbed, non-toxic. The quantity needed for this examination is 150–200 ml. Strict precautions that the injection is carried out aseptically are fundamental. The penis or the vulva is cleansed thoroughly, the area draped with sterile towels, and the anterior urethra irrigated before a catheter is passed. The opaque fluid is injected slowly through the catheter into the bladder by means of a bladder syringe.

An anteroposterior view of the bladder is usually sufficient for the diagnosis of rupture, although an oblique view can be made in addition, if thought desirable. In intraperitoneal rupture the appearance of the cystogram is often characterized by coils of gas-filled small intestine occupying the basin of the pelvis delineated by the contrast medium which has escaped through the rent into the peritoneal cavity. A small extraperitoneal extravasation is sometimes obscured by the shadow of a full bladder. It is therefore advisable to empty the bladder via the catheter, and then to expose a final film.

Performed in this way, retrograde cystography leaves no doubt as to the integrity or otherwise of the bladder. By this means only can an intraperitoneal (*Fig. 843*) or extraperitoneal (*Fig. 844*) rupture of the bladder be diagnosed with irrefutable precision, and early enough to enable the operation to be undertaken with a very good prospect of success.

The question arises where this examination should be carried out. In most cases, if a portable X-ray apparatus is available, the best place to carry out the examination is in the operating theatre where asepsis can be assured. On the other hand, at the Boston

¹ Glaxo Laboratories Ltd., Greenford, Middlesex.

City Hospital the patient is placed on a Bradford's¹ frame and conveyed thus to and from the X-ray department (G. C. Prather).

When facilities for radiography are lacking one must rely on physical signs, and if there are reasons to suspect a rupture of the bladder, one should operate. To wait until the diagnosis is certain is often fatal. When the poor condition of the patient and uncertainty of diagnosis make some form of confirmatory test impelling, the following is of service: a catheter is passed after a small bowl of water has been placed between the patient's



Fig. 843.—Retrograde cystogram showing a small intraperitoneal rupture of the bladder (G. C. Prather). (By courtesy of the *Journal of the American Medical Association*.)

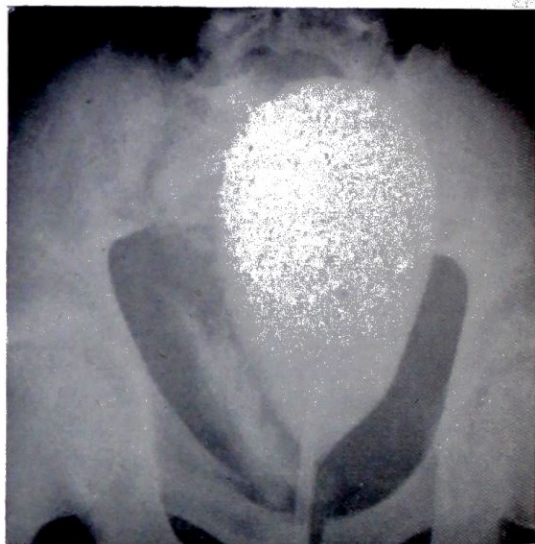


Fig. 844.—Extraperitoneal rupture of the bladder demonstrating the 'tear-drop' shape of the bladder due to its elevation by extraperitoneal extravasation of blood and urine. (J. E. Kicklighter.)

thighs. 50 ml. of air is injected into the bladder through the catheter with a syringe, and the end of the catheter is immediately pinched tightly, or clamped. The distal end of the catheter is then inserted beneath the water in the basin; the clamp is released. If a generous amount of air bubbles through the water, it is presumptive, but not conclusive, evidence that the bladder wall is intact. A possible danger of this method is air embolism.

OPERATION FOR RUPTURED BLADDER

In but few conditions is the call for operation more urgent. In cases complicated by a fractured pelvis, except for temporary immobilization, treatment of the fracture must remain in abeyance for at least four or five days after the operation. The patient must be transferred from his bed to the operating table as carefully as possible, in order not to increase shock or further displace broken bones. If a Robert Jones' abduction frame or a Bradford's frame of such a size as to fit the patient can be found, this is the best means of immobilizing the patient in his transit to the operating table, and for some hours after his recovery from the anæsthetic. If no frame is obtainable, recourse must be made to a towel across the pelvis held in place by sandbags.

Blood transfusion or infusion of a blood substitute should continue throughout the operation.

Having placed the patient, with due care, on the operating table, the area should be draped so as to give access to the whole abdomen, and the towels so arranged that, if required, a catheter can be introduced into the bladder from the external urinary meatus, which is cleansed with that possible objective in view.

The Incision is made in the middle line from just beneath the umbilicus to a finger's breadth above the symphysis pubis. It is carried through the aponeurosis, following which the recti abdominis muscles are retracted. If there is an extraperitoneal rupture, urine and blood will well up from the prevesical space. Usually suction and mopping will clear the field temporarily; if hæmorrhage is excessive, gauze packing should be inserted.

¹ Bradford's frame is a rectangular splint made from gas-piping with a canvas 'mattress' stretched between the sides. There is a division in the canvas for nursing purposes.

The anterosuperior aspect of the bladder, with its peritoneal reflection, is identified and displaced upwards by gauze dissection. At this point the peritoneal cavity should be inspected to rule out the possibility of an associated intraperitoneal injury. This is best accomplished by incising the peritoneum just above its attachment to the bladder. The opening need not be large. Rapid inspection will determine if there is free blood or urine in the peritoneal cavity. If none is found, the opening in the peritoneum is closed promptly. On the other hand, if free fluid is found the opening in the peritoneum is enlarged by continuing the incision upwards. Should there be an intraperitoneal lesion of a viscus other than the bladder, attention is directed first to appropriate measures to remedy this lesion.

INTRAPERITONEAL RUPTURE OF THE BLADDER

Having opened the peritoneum, aspirate or mop up the urine. Have the table tilted slightly downward by the head, and pack off the intestines so as to leave the pelvis clear.

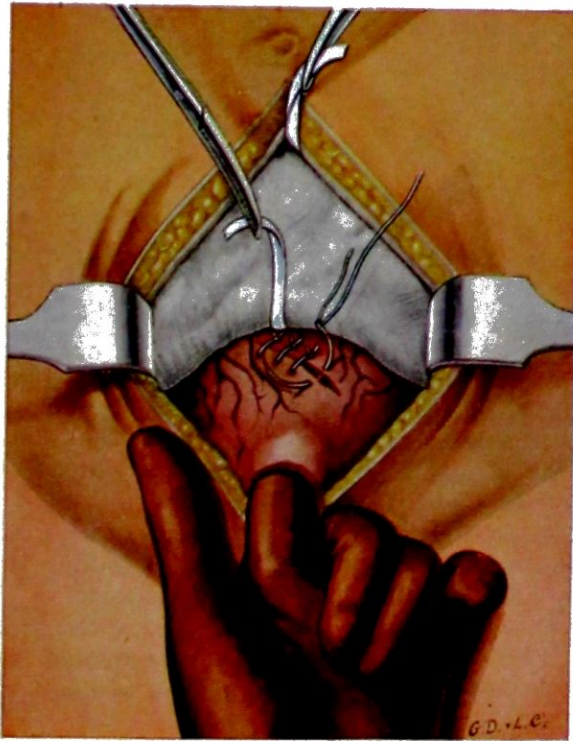


Fig. 845.—Suturing an intraperitoneal rupture of the bladder. Note the finger in the suprapubic bladder incision raising the empty bladder from the depths of the pelvis, and the abdominal pack in position.

Remember to count the packs and have their number recorded. Attention is then directed to the extraperitoneal prevesical area.

By gauze dissection strip the prevesical pad of fat (which covers the peritoneal reflection) upwards, thus opening freely the prevesical space. When the bladder is empty it is often difficult to identify. It can be recognized by the muscle-bundles in its walls and prominent veins on its surface. Should identification still prove difficult, a gum-elastic catheter passed from the external urinary meatus will simplify identification. Make an incision into the bladder as for suprapubic cystostomy (*see Fig. 849, p. 632*). Having ligated any bleeding points in the bladder wall, introduce a finger into the bladder. With the left index finger in the bladder the interior can be explored thoroughly and the rupture or ruptures usually will be found. If the rupture is on the posterior wall or in any part of the dome, with the finger in the bladder as a retractor, this portion can be brought into view. It will now be found convenient to change from the right side of the patient to the left, the better to stitch the bladder. As speedily as possible the rent should be closed with interrupted sutures of No. 1 chromic catgut penetrating deeply the bladder musculature (*Fig. 845*). It is unnecessary and a waste of time to attempt to close the rent layer by layer, or to employ any form of fancy suturing. *Of the greatest importance*

in the entire surgical procedure is the establishment of liberal suprapubic bladder drainage. Once the rent has been closed, a Marion's tube or a $\frac{3}{4}$ -in. (1.9-cm.) drainage tube¹ is passed into the suprapubic bladder incision and the bladder closed snugly around it. With such free drainage bleeding and extravasation cease, and small unsutured bladder wounds will heal. The packs are now removed from the peritoneal cavity and the table is levelled.

Unless there is frank peritonitis, after again mopping up any fluid which may be present the peritoneal cavity can be closed completely; otherwise a suprapubic peritoneal drain is left in position. It is essential to insert a generous strip of corrugated rubber to drain the prevesical space.

The abdominal wall is closed in layers. The suprapubic drainage tube and the corrugated rubber are each anchored to the skin with a stitch.

EXTRAPERITONEAL RUPTURE OF THE BLADDER

The difficulties of distinguishing between an extraperitoneal rupture of the bladder and an intrapelvic rupture of the urethra are referred to on p. 668. If the rupture is entirely extraperitoneal, it is necessary only to perform suprapubic cystostomy as

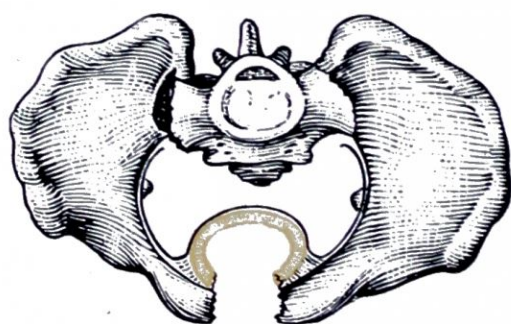


Fig. 846.—A tear of the bladder may be held apart by separation of the pubic bones. (After Sir Reginald Watson-Jones.)

described for intraperitoneal rupture of the bladder, and to drain the prevesical space freely, preferably with a Penrose drain. If the rupture happens to be on the anterior wall, the drainage tube can be inserted through the rent and the bladder closed around the tube. If it is not so conveniently placed, and by the exploring finger in the bladder the rent is found to be a large one, it may be closed by interrupted sutures applied by the transvesical method. But this is not necessary; indeed, it is to be disparaged, for with dual drainage of the bladder and the prevesical space the rent will heal, whereas if sutures are introduced, unless care is taken,

it is possible to include a ureter in a stitch.

Before completing an operation for extraperitoneal rupture an assistant should pass a catheter from the external meatus: by seeing and palpating the beak of the catheter within the bladder, we are assured that the urethra is intact.

It is possible for a tear in the bladder near the vesical outlet to be held apart by separation of the pubic bones (Fig. 846). In such cases the bladder should be dissected free from the pubic bone and the rent closed about a Marion's tube, which should emerge from the bladder as high as possible.

COMBINED INTRA- AND EXTRAPERITONEAL RUPTURE OF THE BLADDER

Although not infrequent in war wounds of the bladder, combined intra- and extraperitoneal rupture of the bladder is encountered comparatively rarely in civil practice. In these cases the operative procedure is exactly the same as for an entirely intraperitoneal lesion, except that drainage of the prevesical space is more liberal.

AFTER-TREATMENT OF RUPTURED BLADDER (ALL CASES)

Blood and parenteral fluid are administered as necessary. In cases of intraperitoneal rupture, as soon as the patient has recovered from shock he should be propped up gradually into the sitting position. Unless there are reasons to substitute another antibiotic, penicillin therapy is commenced as soon as possible, and continued for at least a week. When the patient is permitted to take fluids by mouth, a soluble sulphonamide such as sulphatriad can be given in addition.

The method *par excellence* of keeping the bladder empty, and thus ensuring that further extravasation of urine is impossible, is to employ suction (see STEDMAN'S TUBE, p. 633, or CLELAND'S SUMP DRAINAGE, p. 189). When the case is complicated by a fractured pelvis the treatment of the fracture is sometimes a problem. Immobilization by sandbags

¹ If no suction apparatus is available in the ward, the largest size de Pezzer type of catheter should be substituted. Whatever suprapubic tube is employed, it should be a large one.

is the simplest expedient, and in cases with but little displacement such immobilization is adequate until union occurs (6-8 weeks), although the application of a plaster cast (*see p. 673*) after a sufficient time has elapsed for the patient to recover from the operation (5-6 days) is preferable. In cases with wide separation of the pubic bones a pelvic sling that can be made with stout canvas and suspended by balanced weights from an overhead beam is the most effective method of maintaining apposition of the fragments. With the fracture treated in this manner, up to a week can intervene before reducing the fracture and applying a plaster cast.

When a cast is applied a large window must be cut to permit the necessary exposure of the suprapubic wound.

Prognosis.—Statistics show that when operation is performed within twelve hours the mortality is 11 per cent; when operation is delayed twenty-four hours it is 55 per cent. Without operation, as in the days of ancient Greece, it is 100 per cent.

CONTUSION OF THE BLADDER (INCOMPLETE RUPTURE)

Seven of 11 patients with contusion of the bladder reported by F. R. DeLuca et al. on admission were suffering from shock, but each of these 7 patients had either a fractured pelvis, a head injury, or a fractured extremity to account for the shock. All 11 patients passed varying amounts of blood in the urine, and all not in coma or profound shock reported pain and tenderness in the hypogastrium. However, there was no evidence of abdominal rigidity, which is usual when extravasation into the peritoneum or prevesical space has occurred. The most difficult aspect of diagnosis in these cases is to differentiate between contusions and lacerations without perforation, and ruptured bladder or intrapelvic rupture of the urethra. In cases of rupture of the bladder and intrapelvic rupture of the urethra urgent operation is imperative, while in lacerations of the bladder without perforation the treatment is strictly conservative.

Cysto-urethrography as soon as the patient has recovered sufficiently from shock is invaluable in determining or eliminating the presence of a ruptured bladder or intrapelvic rupture of the urethra.

The treatment of contusion or laceration of the mucosa of the bladder consists in strict bed rest, a high fluid intake, antibiotic therapy, and sedation. In the rare event of profuse hæmaturia an indwelling urethral catheter should be inserted for irrigation, to aid in the evacuation and prevention of clots in the bladder. When clots are troublesome, these authors have found instillations of streptokinase and streptodornase (*see p. 140*) extremely valuable.

EXTRAPERITONEAL HÆMORRHAGE IN FRACTURED PELVIS

Extraperitoneal hæmorrhage always occurs when the pelvis is fractured, and may or may not be associated with extraperitoneal rupture of the bladder or intrapelvic rupture of the urethra. The prevesical tissues contain many arteries and veins of not inconsiderable size, and when the pelvis is fractured several of these are likely to be torn. The hæmorrhage is often copious, and occasionally is severe enough to prove fatal. In a number of instances this extravasation of blood so compresses the bladder that on cystography its rounded shape is altered to that of a pear-shaped organ, well named by Prather and Kaiser the 'tear-drop' bladder (*see Fig. 844, p. 626*). When, in the course of an operation for extraperitoneal rupture of the bladder or intrapelvic rupture of the urethra, the prevesical space has been opened and blood pours out, it is seldom possible to locate the source of the hæmorrhage. Once the blood has been evacuated, usually most of the bleeding ceases, particularly after temporary packing has been inserted. From time to time hæmorrhage is brisk enough to warrant repacking the prevesical space and its lateral recesses, and retaining the packing for 48 hours.

INJURY TO THE BLADDER DURING OPERATIONS

This error is easily committed when performing *suprapubic drainage of the peritoneal cavity*. It is of course almost impossible if, as is usually the case, the left hand can be introduced through a laparotomy incision to act as a guide. But if suprapubic peritoneal drainage is being performed *per primum*, as would be the case in a collection of pus occurring some days after the appendix has been removed, the danger is a very real one. To have

the patient catheterized before he comes to the theatre is insufficient—I know this to my sorrow. The bladder must be emptied *after the patient has been anaesthetized*.

Femoral herniotomy, particularly when the low operation was in general use, proved to be a source of injury to the bladder. Before operating upon a femoral hernia, strangulated or otherwise, the bladder should be emptied by passing a catheter after the patient has been anaesthetized. This is the only way of being absolutely certain that the organ is empty.

During *hysterectomy* (particularly panhysterectomy, both abdominal and vaginal), and also during excision of the rectum, the same precautions must be taken to ensure that the bladder is empty, for this accident is liable to occur in any of these operations.

Remedying the Accident.—Wounding of the bladder during a surgical operation, recognized at the time, can be treated most successfully by closure of the bladder in two layers, and drainage of the bladder by a large urethral catheter for seven days. Penicillin and a sulphonamide should be administered for at least a week. If this accident is not recognized at the time, suprapubic cystostomy must be carried out as soon as possible after the diagnosis has been made. In necessary cases the peritoneal cavity should be drained. In order that the suprapubic drainage tube and the peritoneal drainage tube should not be in juxtaposition, it is best to bring the latter out through a stab incision

centred over the middle of one or other rectus abdominis.

Accidental Perforation of the Prostatic Cavity or the Bladder Neck during Transurethral Prostatectomy.—Produces sudden, severe pain in the epigastrium or lower part of the thorax. The pain sometimes radiates to the shoulder-joint, usually to the left. These symptoms, of course, are only manifest if the patient is under spinal anaesthesia. If the accident is recognized immediately, it can be treated by drainage of the bladder by a large urethral catheter, and the administration of antibiotics (H. R. Kenyon). Should an interval of hours or longer elapse before this complication

(*Fig. 847*) is recognized, suprapubic drainage of the bladder and drainage of the prevesical space is essential. When sogginess

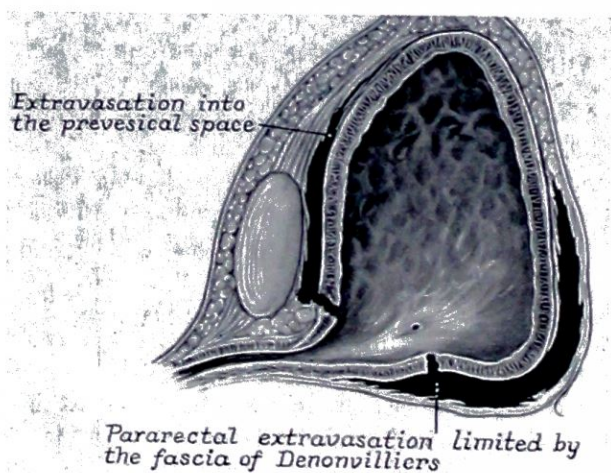


Fig. 847. — Extravasation of urine following perforation of the prostatic capsule during transurethral prostatectomy. (After Kenneth Walker.)

can be felt per rectum, or there are other reasons to believe that the perforation is posterior, drainage of the pararectal tissues via the perineum (*see p. 540*) is imperative.

Perforation of the bladder can also occur as the result of destruction by cystodiathermy of a neoplasm of the bladder; it is more likely to happen as the result of the use of a cutting loop (resectoscope) than a plain electrode.

Other Causes of Rupture of the Bladder.—(1) After forcible irrigation or catheterization of a pathological bladder; (2) During litholapaxy; (3) As a complication of difficult labour—spontaneous rupture of the bladder during the puerperium has been reported after normal delivery and from perforation of an infected diverticulum of the bladder; (4) Extravasation of urine through the intact bladder wall has occurred following irrigation of the bladder with a solution of hyaluronidase with a view to removing phosphatic encrustations. Finally the female bladder has been ruptured from the patient falling in a squatting position on to a projecting object. The rupture occurred through the anterior vaginal wall (A. H. C. Walker).

ACUTE CYSTITIS

Theoretically it might reasonably be assumed that to drain an acutely inflamed bladder would give it rest and relieve the patient of the agonies of strangury. *Cystostomy in acute cystitis is absolutely contra-indicated*. Its dangers are manifold. They include a spread of the infection, e.g., ascending pyelonephritis, virulent cellulitis commencing in the prevesical space, and anuria. It is wise to refrain from even passing a catheter during the early stages of acute cystitis and to rely entirely upon conservative treatment. A mid-stream specimen of urine is secured to determine the sensitivity of the infecting organism or organisms to antibiotics and sulphonamides. In the meantime the best practice is: (a) To place the patient on a high fluid intake; (b) Order a fluid

intake and output chart; (c) Render the urine alkaline by suitable doses of sodium citrate (*see* p. 575). Minims 30 (2 ml.) of tinct. hyoscyami every three hours helps to relieve pain; (d) Pending the bacteriological report, administer a broad-spectrum antibiotic.

After the ultra-acute stage is passed, i.e., in a matter of thirty-six hours, it is permissible to pass a catheter. This serves as an opportunity:—

1. To obtain a specimen of bladder urine for further bacteriological examination.
2. To ascertain if there is any residual urine (in acute cystitis the bladder is usually tonically contracted, hence the futility of suprapubic cystostomy).
3. To irrigate the bladder very gently with warm saline solution under low pressure.
4. To leave in the bladder 4 oz. (125 ml.) of sterile liquid paraffin, for its soothing effect.

The last measure is particularly valuable; some of the paraffin is retained in the bladder for upwards of three days, and there is no contra-indication to further instillations.

When the acute symptoms have abated and the urinary output is adequate, excretory urography may help to elucidate the cause of the cystitis.

SUPRAPUBIC CYSTOSTOMY

Catastrophic catheterization predisposes to shock and anuria. The danger of emptying suddenly a full bladder was known to our forefathers. The unavoidable abruptness with which the bladder is emptied by the operation of ordinary suprapubic cystostomy puts catastrophic catheterization into the shade. No doubt exists in my mind that to open the bladder suddenly is extremely dangerous.

On Christmas Eve, 1921, I was asked to perform suprapubic cystostomy upon a man who had been admitted the previous night with acute retention. His retention, due to an enlarged prostate, had been relieved soon after admission by the passage of a bi-coudé catheter. It was also pointed out that the morrow was Christmas Day, with its arduous calls upon resident staff. Suprapubic cystostomy was duly performed, the bladder being considerably distended at the time, and the urine gushed forth. This was the last urine that the man passed. For four days he had complete anuria which failed to respond to the remedies then in vogue. He died in coma on the fifth day. At the necropsy a benign enlargement of the prostate was found, but the kidneys showed no gross abnormality.

It is improbable that this disaster would have occurred had suprapubic catheterization (*see* p. 642) been substituted for ordinary suprapubic cystostomy, for with the former the outflow of urine can be controlled. *Open suprapubic cystostomy is therefore contra-indicated in acute retention of urine, and especially in acute retention with overflow.* The only exception to this rule is in cases of acute retention due to an enlarged prostate when the blood-urea estimation proves to be within normal limits and the operator is prepared to undertake immediate prostatectomy.

Indications.—The indications for open suprapubic cystostomy as an emergency should be limited to the following:—

1. As a means of treating extraperitoneal rupture of the bladder.
2. As an integral part of the treatment of intraperitoneal rupture of the bladder.
3. As the preliminary step in the treatment of complete rupture of the urethra.
4. For the evacuation of blood-clot. This should be reserved for those cases where diligent washing through a catheter has failed to evacuate all the blood-clot.
5. For the removal of foreign bodies that cannot be extracted by an operating cystoscope.

The Operation.—A catheter is passed and the bladder is distended with an antiseptic solution such as acriflavine 1–10,000.

The incision, about 2–2½ in. (5.0–6.3 cm.) in length, is made in the middle line immediately above the pubis. The rectus sheath is opened near the middle line, and the fibres of the rectus muscle are split and separated with the handle of the scalpel (*Fig. 848*). Retractors are inserted, and the index finger of the left hand dives deeply into the

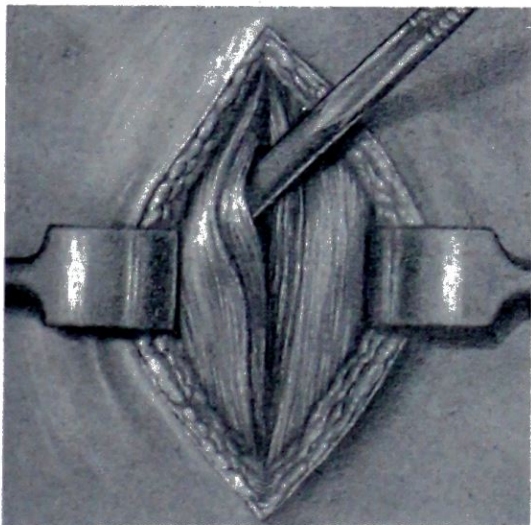


Fig. 848.—Suprapubic cystostomy. The fibres of the rectus are separated with the handle of the scalpel.

prevesical space (cave of Retzius), behind the symphysis pubis. The fat pad and cellular tissues are hooked upwards. A little dissection with the handle of the scalpel renders this upward reflection possible. This step is the most important in the operation. Using this technique the peritoneum is never seen, and is protected until the bladder is opened. The bladder can be recognized by its muscle-fibres and the veins coursing over its surface. Still keeping the forefinger hooked in the upper angle of the wound, the bladder is caught in a pair of Lane's tissue forceps; a fairly substantial bite is necessary in order to prevent tearing out. A second tissue forceps is applied a little to the left of the first and is given to the assistant to hold; tension is applied, and a scalpel, with its cutting edge towards the symphysis, is plunged into the bladder between these forceps (*Fig. 849*). On removing the scalpel the finger is inserted into the bladder, and the organ explored. If a mechanical sucker is available, the escaping lotion can be aspirated as it gushes forth. A Thomson-Walker tray is a good alternative method of collecting the escaping fluid.

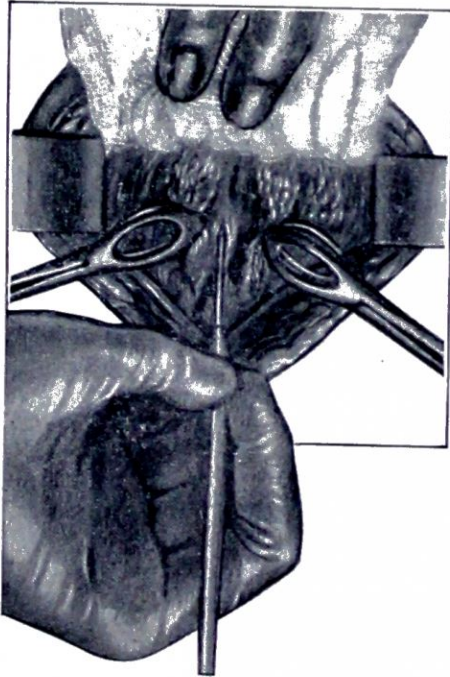


Fig. 849.—Suprapubic cystostomy. The bladder is picked up at two points by Lane's tissue forceps. Between these a scalpel is passed into the bladder. The blade of the knife is directed towards the pubis and the opening into the bladder enlarged in a downward direction only; alternatively a transverse incision can be employed. Note the gauze swab protecting the peritoneum.

The edges of the bladder are then secured with a hæmostat on each side, and the Lane's forceps are removed. When the bladder has been emptied a mushroom-headed catheter (*Fig. 850*) is introduced, stretched on a long hæmostat (*Fig. 851*). The bladder is now closed about the tube, so as to make a water-tight junction. The ends of the

Walker tray is a good alternative method of collecting the escaping fluid.

The ends of the

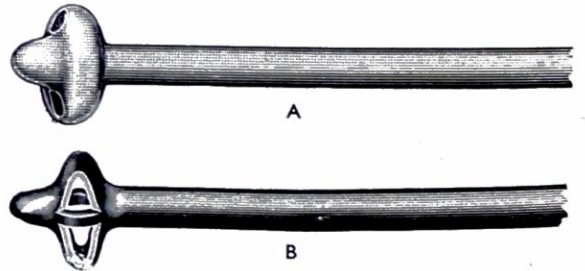


Fig. 850.—A, De Pezzer catheter. B, Malecot catheter.

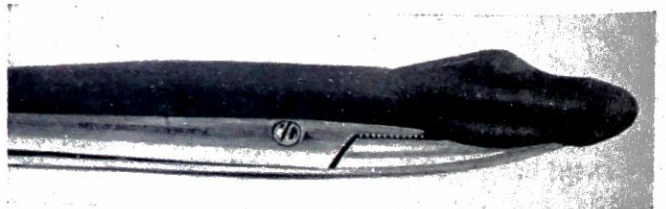


Fig. 851.—Method of stretching a de Pezzer catheter with a hæmostat.

uppermost suture are left long and brought through the rectus sheath on each side to be tied later: this is the means of preventing the collapsed bladder sinking into the depths of the wound. The shaft of the catheter is brought out of the extreme upper end of the wound, to avoid adherence of the bladder to the symphysis pubis. The rectus sheath is approximated with interrupted sutures except at the extreme lower end, where a corrugated rubber drain is placed; always drain the prevesical space. The operation is afterwards brought to a completion by closing the skin and anchoring the tubes with suitable skin stitches.

A stitch should always anchor the catheter to the skin. This little precaution will prevent the annoying complication of the semiconscious patient pulling out his catheter.

After-treatment.—If a mushroom-headed catheter has been employed, it must be connected to a closed-system drainage bottle (see p. 641). If bladder irrigations are considered necessary, a solution of 1:2000 bradosol is advised, but if the infection appears to be responding to antibiotic therapy, it is better to omit the irrigations which, of necessity, break the closed system of drainage temporarily. Should drainage be required for a lengthy period it will be unnecessary to change the catheter at

least for several weeks. The old catheter is removed by a sudden, sharp pull, and the new one, stretched on its special introducer (*Fig. 852*), is insinuated down the track, which by this time is well lined with granulation tissue.



Fig. 852.—De Pezzer catheter stretched on its special introducer ready for inserting into the bladder.

SUPRAPUBIC CYSTOSTOMY WITH SUCTION DRAINAGE

Another method of maintaining drainage of a suprapubic cystostomy wound is by suction. This is a splendid principle; urine is aspirated as soon as it enters the bladder—the antithesis of suprapubic boxes, where there must always be a stagnant pool which

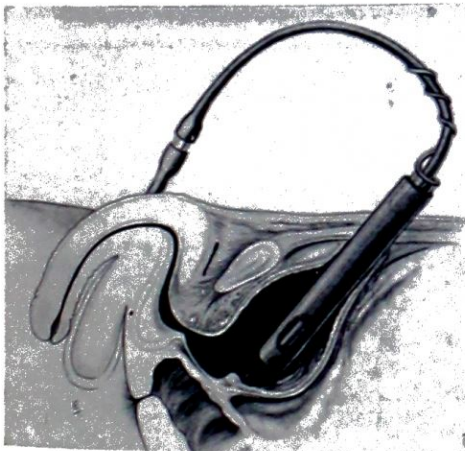


Fig. 853.—Stedman's tube. The Stedman fitting enables a rubber catheter to be retained within Marion's tube.

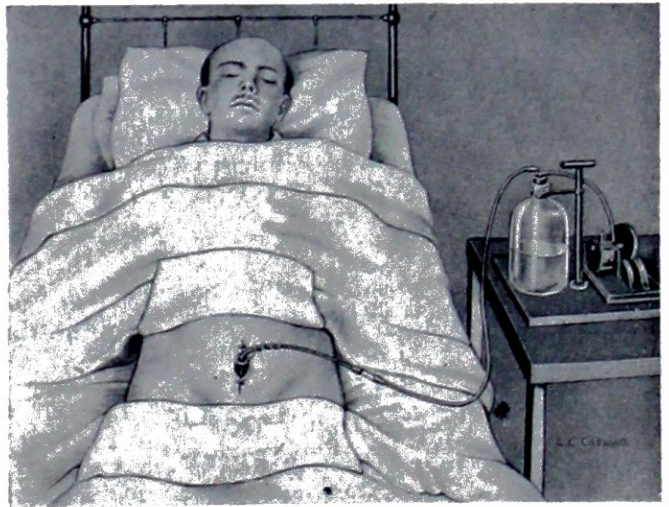


Fig. 854.—Suction drainage, using a Stedman's tube. Note the division in the bedclothes, which are protected by sterile towels. The area is covered with a towel supported by a bed-cage.

invites infection. Stedman's tube consists of a Marion's tube with an ingenious fitting to hold a rubber catheter within it (*Fig. 853*). The catheter is connected to a suction apparatus. Alternatively Cleland's sump drain (*see Fig. 242*, p. 189) can be employed. A most important nursing detail is that the wound is left completely uncovered by making a division in the bedclothes. A sterile towel above and below protect the hypogastrium from the bedclothes. Every detail of this simple and efficient method is shown in *Fig. 854*, and unless the wound is cared for in this way, the method will not give satisfaction. If a bed-cage is placed across the patient's lower abdomen the exposed area can be covered with a towel.

BLADDER WASHES

There are a number of bladder washes available. Bradosol 1-2000 is a good routine solution to employ, the most usual alternative being 1-10,000 silver nitrate. An exception is made in cases of persistent alkaline cystitis, when a 1 per cent solution of phosphoric acid is used on alternate days.

FOREIGN BODIES IN THE BLADDER

The removal of foreign bodies from the bladder by cystoscopic manœuvres is beyond the scope of this work. Usually the object has been in the bladder for weeks or longer



Fig. 855.—A hair fastener in the bladder.

(Fig. 855) before giving rise to symptoms, and the accompanying cystitis makes suprapubic cystostomy the only method which should be employed. After removing the foreign body the bladder is drained with a Malecot catheter.

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CHAPTER LVI

RETENTION OF URINE

THE relief of acute retention of urine by catheterization is too often looked upon as a trivial matter, insufficient attention being directed to asepsis and technique. Actually it is a matter of the highest importance, and can be made an interesting study, not beneath the dignity of the most fastidious.

In undertaking the treatment of acute retention the three fundamental objectives are: (1) To prevent infection; (2) To avoid laceration of the urethra; (3) To obviate the necessity for repeated catheterization.

If repeated catheterization could be carried out with care and due observance of asepsis it would do little harm. It is because sooner or later a time arrives when the patient becomes distended at an inconvenient moment that an element of risk creeps in.



Fig. 856.—Foley's catheter. (C. R. Bard, Inc., New Jersey.)



Fig. 857.—Tiemann's catheter.



Fig. 858.—A coudé catheter.



Fig. 859.—A bicoudé catheter.



Fig. 860.—An olivary-tipped gum-elastic catheter.

Catheters.—If it can be passed, the ideal catheter with which to relieve retention of urine in either sex is a Foley's (Fig. 856), which can be retained so easily to permit the bladder to be emptied slowly and for as long after that has been achieved as is deemed necessary. Often it is impossible to pass a balloon-ended catheter in cases of organic obstruction, and for that reason, in a male, Tiemann's catheter (Fig. 857) offers many advantages. It is made of firm rubber, withstands repeated boiling, and, being angulated, it is suitable for prostatic obstruction. Its olivary end also enables a urethral stricture of moderate calibre to be negotiated frequently. A coudé (Fig. 858) or bicoudé (Fig. 859) catheter can sometimes be passed in cases of prostatic obstruction when a Tiemann's fails. If, in an emergency, a suitable gum-elastic instrument cannot be obtained and a rubber catheter will not pass the obstruction, a large silver catheter can be tried. Olivary-tipped gum-elastic catheters (Fig. 860) are especially valuable in cases of urethral stricture.

Methods of negotiating a fine stricture of the urethra are described on p. 675.

Choosing a Catheter of Suitable Size.—The narrowest part of the urethra is the external urinary meatus; therefore, unless there is good reason to suspect that the urethra is strictured, it is usual to choose a catheter with a diameter a little less than that of the meatus. In this connexion the scale of calibration of catheters (*Fig. 861*) will prove most useful. The French scale¹ is used widely.

ENGLISH	FRENCH	ENGLISH	FRENCH	ENGLISH	FRENCH
3.....●.....	8	7.....●.....	14	11.....●.....	20
4.....●.....	{9 10	8.....●.....	{15 16	12.....●.....	{21 22
5.....●.....	11	9.....●.....	17	13.....●.....	23
6.....●.....	{12 13	10.....●.....	{18 19	14.....●.....	{24 25

Fig. 861.—A guide to the calibration of catheters.

Sterilization.—All modern catheters can be sterilized by boiling. It should be appreciated that gum-elastic catheters are boilable, and with due care they can withstand repeated boiling. The catheter should be plunged for two minutes into water already boiling; it must be removed carefully by its wide end, and dropped into sterile cold water or cold weak antiseptic lotion before use. Plastic and nylon catheters withstand boiling without special precautions, but they are inferior to gum-elastic, for gum-elastic is never too soft or too rigid. If, however, the catheter is to be retained, a plastic catheter is said to be less irritating to the urethral mucous membrane than gum-elastic, and this is definitely so in the case of low-grade red rubber.

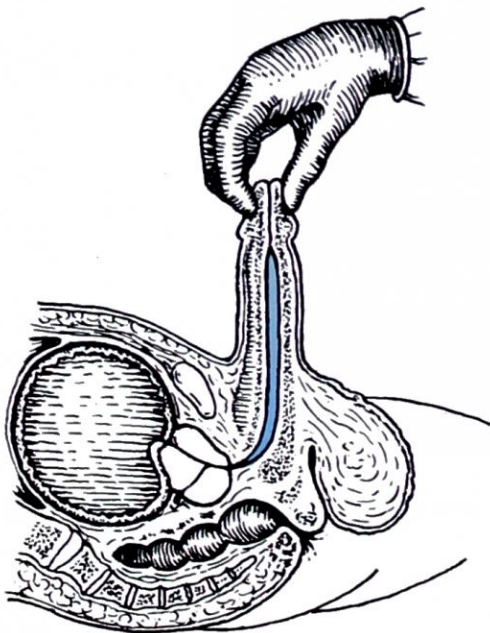


Fig. 863.—Anterior urethra distended with local anæsthetic solution, which is then massaged and milked posteriorly.

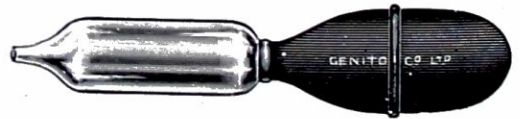


Fig. 862.—A urethral syringe.

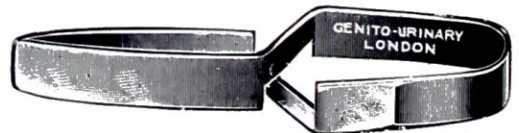


Fig. 864.—A penile clamp.

Aseptic Catheterization.—By taking a little trouble, catheterization can be performed aseptically and painlessly. Each of the selected catheters is inserted into a half-length of Penrose tubing (Paul's small rubber tubing will do). The catheters thus ensheathed are placed in a dish of water, and so manipulated that there is no air inside the catheters the dish are tipped into a sterilizer and boiled for five minutes. During this time the operator scrubs his hands.

The penis is grasped with a swab moist with boric lotion or weak flavine solution. The prepuce is retracted and the glans cleansed thoroughly with another moist swab. A sterile towel is placed over the thighs and beneath the penis. The anterior urethra should be irrigated in every case. This can be performed readily with a syringe filled with the same weak antiseptic used for cleansing the glans. A urethral syringe (*Fig. 862*), an inexpensive

¹ The French scale is commonly known as Charrière's scale, so called after Joseph Charrière (1803–1876), a Paris surgical instrument maker.

item, should be looked upon as a necessary part of the equipment. In its absence a Record syringe will suffice.

Anæsthetizing the Urethra.—There are a number of suitable and safe solutions for this purpose. Amongst the best are 4 per cent procaine, 1–1500 percaïne, and 2 per cent decicain. Admittedly, in the case of acute retention, the anæsthesia will only extend to the seat of the obstruction, but even this is a distinct asset. One-eighth or one-quarter ounce (4–8 ml.) of the solution should remain in the urethra for five minutes (*Fig. 863*). A penile clamp (*Fig. 864*), another useful piece of equipment, obviates the necessity for holding the lips of the meatus together during this period.

Introduction of the Catheter.—Aseptic lubricating jelly is squeezed into the urethra from a tube. The penis is kept stretched vertically, and the catheter, within the Penrose tube, is passed into the meatus. The Penrose tubing is thin enough to feel the catheter. Still keeping the penis stretched vertically, the catheter is passed onwards, observing the watchword for all urethral instrumentation—*non vis sed arte*. At no time during its passage is the catheter uncovered.

In the female catheterization is performed usually by a nurse. The vulva must be cleansed with pieces of cotton-wool wrung out in an antiseptic, being wiped in an upward direction. It is most desirable that the urethra be washed out, and above all the use of a sterile lubricant should be insisted upon. Frequently these precautions are omitted.

Antibiotic and Chemotherapy.—Whenever catheterization is undertaken a urinary antiseptic should be given. In the case of a single catheterization, sulphatriad is usually sufficient, but in a susceptible bad-risk case the surgeon will probably think it wise to give an antibiotic of his choice as well. These precautionary measures reach their zenith of importance when the catheter is left in situ, and a good combination in this instance is sulphatriad and achromycin. For dosages see pp. 575, 576.

THE INDWELLING CATHETER

The Prevention of Urethritis.—In cases where an indwelling catheter is to be employed, the prevention of urethritis is to a great extent a matter of thoughtful care. Naturally such infection is more likely to supervene in the male with 10 in. (25 cm.) of urethra than in the female, with a urethra one-tenth as long. In nearly all cases infection commences in the anterior urethra, and it is with the object of washing out any organisms that have invaded the urethra, through which no urine has passed for hours, that the anterior urethra

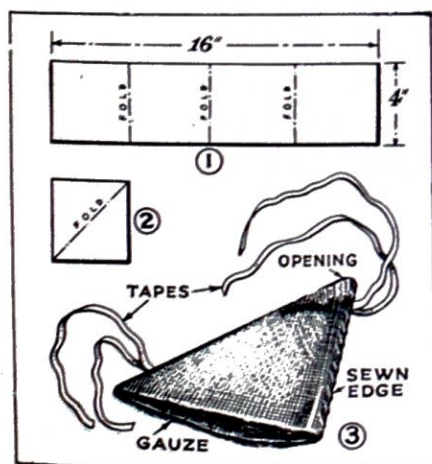


Fig. 865.—An antiseptic penile jacket is made easily from gauze and tape.

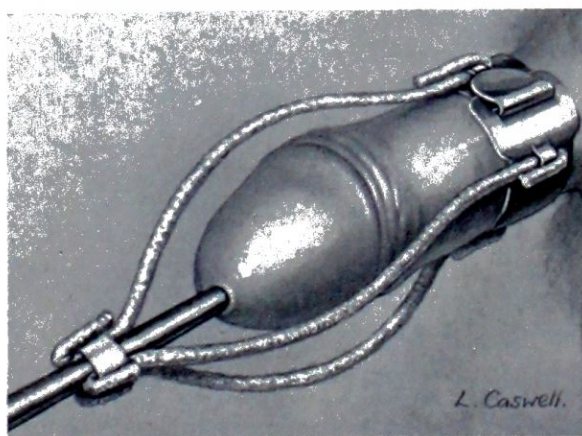


Fig. 866.—A method of tying in a urethral catheter, using pipe-cleaners. The penile jacket is not shown.

is irrigated with a mild antiseptic solution before catheterization is attempted. Next one must consider the means of retaining the catheter. Any method that compresses the distal end of the penis on to the catheter should be condemned utterly, for this prevents urethral secretions from escaping through the meatus alongside the catheter. The ideal method in this respect is drainage by means of a Foley's catheter, for if it is no larger than 20 French, and the patient is an adult, urethral secretions can escape unhindered.

An Antiseptic Penile Jacket can be made quite easily with gauze and tape (*Fig. 865*). It is boiled before use and wrung out in flavine solution. It is applied in all cases in which

a catheter is to be retained. By this means infection alongside the catheter—a potent source of urethritis—is prevented.

There are a large number of methods by which a non-balloon ended catheter can be retained in the urethra. One of those which can be applied over the penile jacket should be chosen.

The Pipe-cleaner Method (Fig. 866).—After the catheter has been passed, four pipe-cleaners are fastened around the base of the penis with 1-in. (2.5 cm.) flexible adhesive strapping. The four ends are then brought to the catheter and fixed there with a narrow strip of adhesive plaster, in such a way that each pipe-cleaner has a definite bow, and

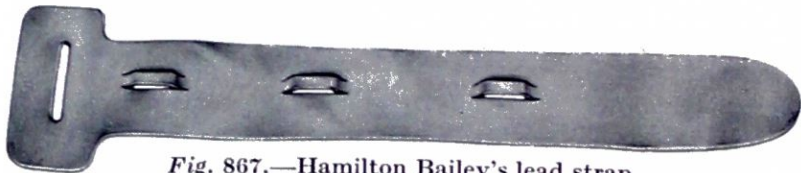


Fig. 867.—Hamilton Bailey's lead strap.

stands well away from the glans penis. The ends at the base of the penis are then bent back or cut off. It is important to apply the band of strapping loosely around the penis to avoid constriction and œdema.

Instead of employing flexible adhesive plaster at the base of the penis, a lead strap (Fig. 867), which holds three pipe-cleaners, will be found most practical and comfortable for the patient.

DECOMPRESSING THE OVERDISTENDED BLADDER

Once a catheter has been introduced into an overdistended bladder it is advisable to allow the urine to escape slowly, and the more distended the bladder, the slower should be the rate of emptying. Such is the view of the majority of surgeons who have interested themselves in this important subject.

A minority believe that slow decompression is unnecessary. They attribute the suppression of urine that sometimes follows sudden emptying of the bladder, not to reflex



Fig. 868.—This pattern of intravenous drip chamber gives very accurate control of the outflow of urine.

anuria following catastrophic catheterization, but to infection: the rapidity with which anuria sometimes follows sudden emptying of the bladder (see p. 631) would seem to put this explanation out of court. C. Wells states that slow decompression is an ideal, rather than an accomplishment. This certainly is untrue if the technique about to be described is followed. Indeed, no good reason has been put forward why this additional safeguard should not be practised.

Decompression of the bladder by means of an intravenous drip chamber (Fig. 868) is the method of choice. Its simple principles

can be employed even in remote districts, asepsis is assured, and the rate of emptying the bladder is controlled with mathematical precision.

Into the mouth of the catheter is inserted a nozzle (Fig. 869). An ordinary glass nozzle serves the purpose, but the silver right-angled connexion (Fig. 870) has many advantages. In order to support the penis connected to the apparatus, a piece of broad adhesive plaster is applied to the thighs so as to form a sling between them. Upon this rests the penis. The free end of the nozzle is then connected to the tubing of the intravenous saline dripper.

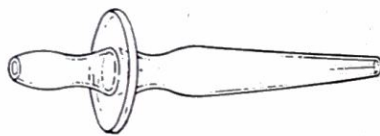


Fig. 869.—An ordinary glass nozzle can be used to connect the catheter with the rubber tubing.



Fig. 870.—Silver connecting link for use between catheter and tubing¹ prevents kinking and ensures a water-tight junction.

¹ Made by Kipling, 3 Gloucester Way, London, E.C.1.

The screw clamp of the dripper is set to allow forty to sixty drops per minute to escape (Fig. 871). If the retention is of long standing the rate of emptying is somewhat slower.



Fig. 871.—Decompression of the bladder, using the dripper of an intravenous saline apparatus.

Recompression.—If by some mischance the bladder has been decompressed too rapidly, it is logical to refill the bladder partially with normal saline solution, and to start decompression anew.

POST-OPERATIVE RETENTION OF URINE

The reason why a patient having undergone an operation is unable to pass urine is sometimes apparent; at others it is indeterminable. Naturally, when the patient is an elderly male, prostatic obstruction, hitherto latent, is suspected, but there is no means of confirming the suspicion unless a soft-rubber catheter is arrested in the prostatic urethra.

Some patients have a bashful bladder: this type of individual hesitates to ask for a urinal, and is unable to micturate in the presence of another person. Many cannot urinate while lying or sitting in bed. Another common cause of post-operative retention of urine, and one that is not often thought of, is sedation. When a patient is given sufficient morphine or other drug to relieve post-operative pain, frequently the desire to micturate is suppressed until the bladder is overdistended. Should the patient be spare, a swelling in the hypogastrium can be seen, felt, and percussed. On the other hand, if the patient is obese or the abdomen is bandaged, especially with flexible adhesive plaster, not infrequently post-operative retention of urine is overlooked for the following reason: the bladder being very full, the patient passes small quantities of urine frequently, just sufficient to prevent dribbling overflow. It is in such cases that if these small amounts have been charted it will be apparent that the urinary output is much lower than it should be, and even if the patient is obese, careful percussion of the hypogastrium will reveal an overfull bladder.

Pain on attempting to micturate is yet another frequent cause of retention of urine after lower laparotomy, herniorrhaphy, and anal operations. Retention of urine following an operation for prolapsed intervertebral disk, or particularly after laminectomy, can be ascribed to trauma of the spinal cord. After operation upon the pelvic viscera, particularly excision of the rectum and total hysterectomy, retention of urine is so common that it is usual to forestall it by inserting a self-retaining catheter at the conclusion of the operation. In a quarter of cases of excision of the rectum the retention lasts more than two weeks (P. C. Watson).

While outstanding examples have been given, the list is by no means exhausted. Indeed, retention of urine can be encountered after an operation on any part of the body; for instance, it is quite common after an operation for cataract.

Treatment.—It can be stated categorically that parasympathetic stimulating drugs should be avoided.¹ Too often they are valueless, but their particular danger is that of

¹ Provided the patient has not undergone an abdominal operation, carbachol (Moryl), $\frac{1}{2}$ –1 ml., is permissible, but in view of the dangers of its promiscuous use by house surgeons, it is safest to forbid parasympathetic stimulants in cases of post-operative retention of urine, altogether.

necessity they stimulate the intestinal musculature, and on that account, by their action on the unaffected upper reaches of the intestine as opposed to that affected by paresis below, are liable to precipitate paralytic ileus.

Methods of relieving post-operative retention of urine vary with the probable cause, whether or not overdistension has been allowed to occur, and whether or not infection of the urine is present or has supervened. The measures recommended are set out in the form of a surgical crescendo :—

1. *Simple Expedients are tried.*—

a. The male patient is given a warmed bed-bottle; the female patient is sat upon a bed-pan. The bed should be screened and the patient left undisturbed for at least ten minutes.

b. In cases of lower laparotomy or herniorrhaphy a firm binder against which the patient can push is well worth trying.

c. If there is no contra-indication, let a male patient dangle his legs over the side of the bed while he attempts to empty the bladder.

d. With the surgeon or his deputy's signed permission only (the case history sheet should be marked 'up P.R.N.') a male patient is allowed to stand supported, and a female patient is permitted to sit on a commode.

2. *Catheterization is undertaken* with a catheter no larger than 15 French, and preferably one of the Foley type. In order to minimize the risk of infection, besides the precautions set out already, it is a good practice to instil 1 oz. (30 ml.) of a 1 per cent solution of mercurochrome or a 1-500 solution of silver nitrate into the emptied bladder. If less than 15 oz. (450 ml.) of urine are withdrawn, it is probable that catheterization will not be required again, so the catheter is removed.

3. *Indications for an Indwelling Catheter.*—Post-operative, like all other varieties of retention of urine, if not diagnosed and relieved early, allows the bladder to become overdistended and paresis of its musculature ensues. Consequently, if the catheter is removed after the bladder has been emptied one must be cognizant of the fact that further attacks of overdistension will occur more easily and with less pain. Therefore when the bladder contains more than 15 oz., so probable is it that recatheterization will be required, that it is advisable to retain the catheter. The end of the catheter is clamped (a screw clamp is better than a spigot) and wrapped in sterile dry gauze. Every two hours the clamp is loosened, and the urine evacuated is collected. The end of the catheter is wiped with alcohol, reclamped, and rewrapped in gauze. The amount of urine retrieved is measured and charted. Sometimes, especially if the patient is receiving intravenous fluid therapy, he will ask for the catheter to be unclamped more frequently. If such requests are repeated, and the quantity recovered is 12 oz. or less, it can be assumed with some degree of confidence that spontaneous micturition will be re-established if the catheter is withdrawn.

Although some trouble from the nursing standpoint, this method of managing post-operative retention pays handsome dividends: uninfected urine remains uninfected, and the catheter is not retained one day longer than is necessary. When the method is not employed, and the catheter is connected to a collecting bottle, adjudicating when the catheter shall be removed is guess-work. The alternative is to connect the catheter with the apparatus about to be described.

CLOSED SYSTEM OF CATHETER DRAINAGE

Regardless of whether urine issuing from a catheter is draining the bladder via the male or the female urethra, or through a suprapubic or perineal system, or through a ureterostomy, pyelostomy, or nephrostomy, it should never be allowed to drain into an open-mouthed receptacle. The incidence of ascending infection is nearly halved (W. Goldie) by connecting the catheter to sterile tubing conducted to a sterile collecting bottle, and employing irrigations only if clot retention demands them. Changing a full receptacle for an empty one then becomes the principal cause of failure of the system, which is minimized by bringing a sterilized empty receptacle and placing it in close proximity to the full one, thereby effecting the change-over expeditiously. If infection occurs in spite of these precautions, *Esch. coli* is the commonest infecting organism, and a high proportion of strains are streptomycin-resistant.

Ogier Ward's collecting bottle can be improvised easily. As seen in Fig. 872, air entering the bottle through the inlet passes through gauze containing lightly packed formalin tablets. The litre flask contains 4 oz. (115 ml.) of 10 per cent formalin solution.



Fig. 872.—Method of managing an indwelling catheter in the female. The antiseptic drainage bottle is suitable for suprapubic and urethral drainage in either sex. (After Ogier Ward.)

The K.C.H.¹ drainage apparatus, which was designed for use after prostatectomy, provides a closed antiseptic system of bladder drainage from the time of operation onwards, that gives warning if the catheter becomes blocked.

The apparatus (Fig. 873) consists of a large jar (A) with a small one (B) fixed within its metal lid. The lid is provided with a rubber washer, and makes an airtight fit on the large jar. In the base of the small jar is a hole $\frac{1}{2}$ in. (1.3 cm.) in diameter which is closed by a rubber washer on the end of a spring-loaded plunger (c). After connecting the autoclaved apparatus to the catheter with sterile tubing, urine (admixed with blood) drips into the small jar, the contents of which is released at intervals of half an hour by the nurse pressing the plunger. Should the catheter become blocked, pressing the plunger will yield no result, and the nurse reports the matter forthwith; if, on the other hand, the small

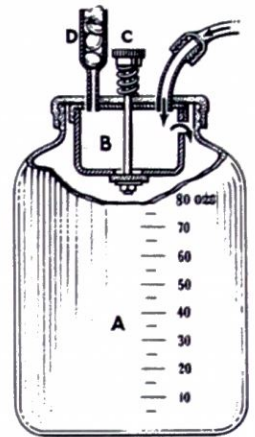


Fig. 873.—King's College Hospital closed-system urine collecting apparatus.

jar becomes filled to capacity before the plunger is pressed, urine in excess of its capacity will overflow through a hole in its side into the larger jar. Thus, once it is assumed that the urine is no longer heavily blood-stained, and the catheter is draining satisfactorily, the plunger need not be operated.

The air-vent (D) is filled loosely with formaldehyde tablets: 4 oz. (115 ml.) of 10 per cent formaldehyde solution is placed in the large jar prior to use. The capacity of this large jar is 80 oz. (2.27 l.), consequently changing the full jar for a fresh one (a spare jar is provided) is a relatively infrequent procedure. The jars are marked in ounces, which permits the nurse to record the urinary output accurately with a minimum of trouble. After emptying, the jar not in use is cleansed thoroughly and filled with a 1-2000 solution of hibitane,² to sterilize it.

CATHETER URETHRITIS, PROBABLE OR ESTABLISHED

When a urethral catheter has to remain in situ for five days or more, even if special precautions to prevent it have been taken, some degree of urethritis is likely to supervene. Consequently, should the catheter become blocked, or should the catheter come out, or should a purulent urethral discharge be observed, and it is considered improbable that the patient will pass urine naturally, it is most unwise to attempt to re-drain the bladder by a urethral catheter.

To change a catheter in the presence of urethritis entails a grave risk of carrying the infection from the anterior urethra to the deep urethra and to the bladder, and from thence to other parts of the urogenital system (Fig. 874). Consequently, rather than replace a catheter through an infected urethra, it is wiser to perform suprapubic catheterization of the bladder (see p. 642) or, alternatively, if this is undesirable because of an operation wound in the lower abdomen, perineal urethrostomy (see p. 647) should be substituted.

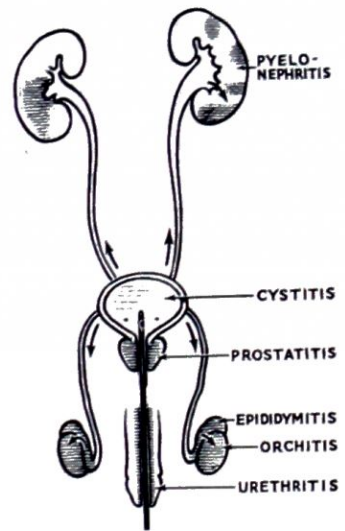


Fig. 874.—Complications are especially liable to follow changing a urethral catheter in the presence of urethritis. (After C. G. Scorer.)

¹ King's College Hospital. The apparatus is made by Charles F. Thackray Ltd., Leeds.

² Hibtane-(bis-*p*-chlorophenyldiguanido-hexane acetate). Imperial Chemical (Pharmaceuticals) Ltd., Wilmslow, Manchester.

RETENTION OF URINE DUE TO ORGANIC OBSTRUCTION

Prostatic obstruction is by far the most frequent cause of retention of urine. In 87 per cent of cases such obstruction is due to adenomatous enlargement of the gland; in 10 per cent of cases it is the result of prostatic carcinoma, while in about 3 per cent the cause is fibrous contracture of the prostate.

When the retention arises in hospital, where the patient is undergoing treatment for another condition, probably catheterization is the best course. In endeavouring to pass a catheter when the obstruction is due to enlargement of the prostate, the difficult point to pass is where the middle lobe commences, i.e., about half-way along the prostatic urethra. The double bend of a bicoudé catheter helps to surmount this obstacle. At times the left index finger inserted into the rectum may help to lever the tip of the catheter into the bladder. It should be noted that the pressure must be exerted, not on the lateral lobes, but over the apex of the prostate (*Fig. 875*).

In the common event of the patient being admitted because of retention of urine due to an enlarged prostate, provided the general condition is satisfactory, the time-honoured $\frac{1}{4}$ gr. (0.016 G.) of morphine and a hot bath can be tried; in a small proportion of cases the retention is relieved naturally in the bath.

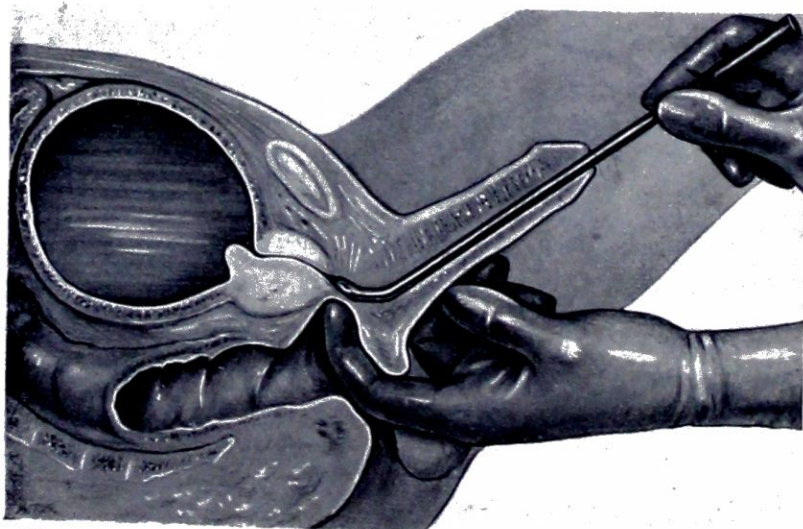


Fig. 875.—A finger in the rectum aiding the passage of the catheter in a difficult case of prostatic obstruction.

Immediate Prostatectomy.—Some urologists consider that the correct treatment of acute and acute-on-chronic retention of urine due to prostatic obstruction is immediate prostatectomy. This presupposes that the surgeon is a practised prostatectomist and that he has available throughout the 24 hours radiological services for excretory pyelography and laboratory facilities to prove that the patient's renal function is adequate. The majority of surgeons do not

subscribe to this view because: (a) a very high percentage of patients admitted with acute retention of urine are clinically unfit for an immediate major operation; (b) this course leaves no time to meditate as to which type of operation (retropubic, suprapubic enucleation, endoscopic resection) is best suited to the particular case; and (c) it must be remembered that in at least 13 per cent of cases of prostatic obstruction the lesion is not an adenomatous hypertrophy (*see above*).

Avoidance of Urethral Catheterization.—There is a growing body of the profession who consider that it is wiser to avoid urethral catheterization in these cases because: (a) it may be impossible to pass a urethral catheter; (b) catheterization sometimes causes considerable hæmorrhage from the engorged prostate; (c) a tied-in urethral catheter entails strict confinement to bed; (d) above all, if the catheter must be retained for more than a few days there is always the danger of infection, which so often proves disastrous. The alternatives to urethral catheterization are suprapubic catheterization, which is very popular, and perineal urethrostomy, the advantages of which should be better known.

SUPRAPUBIC CATHETERIZATION

While the main indication for this procedure is prostatic obstruction, it can be employed in cases of overdilatation of the bladder from other causes. The only contra-indications are when the patient has had recent hæmaturia (*see CLOT RETENTION*, p. 649), when there is a recent wound or a scar near the middle line of the lower abdomen, and when the abdominal wall is infected.

Again it is emphasized that ordinary suprapubic cystotomy, which allows the urine to gush forth, must be avoided rigorously.

The aim is to introduce a mushroom-ended catheter into the bladder without spilling even a drachm of urine. There are several ways of achieving this end.

Technique 1.—The essential armamentarium is a No. 28 reinforced Malecot catheter. The bladder perforator shown in *Fig. 878* is inexpensive, and a most useful instrument to possess. If the special perforator is not available, the Malecot catheter can be stretched over a narrow-bladed scalpel (*Fig. 876*). This is not so satisfactory, and requires some deftness, but in cases of necessity it serves its purpose. When this makeshift is employed there is inevitable leakage about the catheter, which is undesirable.

One per cent procaine is injected into the skin in the middle line, from the symphysis to 1 in. (2.5 cm.) below the umbilicus. A skin incision is made and towels are clipped to the wound edges. The rectus sheath on either side is infiltrated within the limits of the incision, great care being taken not to prick the underlying distended bladder. The linea alba is then incised. The cellular tissue and fat in front of the distended bladder are hooked up with the fingers, and the bladder wall, with tortuous veins coursing over it, is seen clearly (*Fig. 877*). All is in readiness for the introduction of the catheter. The bladder perforator is armed with a No. 28 reinforced Malecot catheter which is stretched on the perforator as shown in *Fig. 878* (*inset*). The actual introduction is performed in the twinkling of an eye, with a short, sharp stab (*Fig. 878*). The introducer is disengaged while the end of the catheter is pinched, prior to clipping



Fig. 876.—A narrow-bladed scalpel can be used as a bladder perforator in the absence of a special instrument.

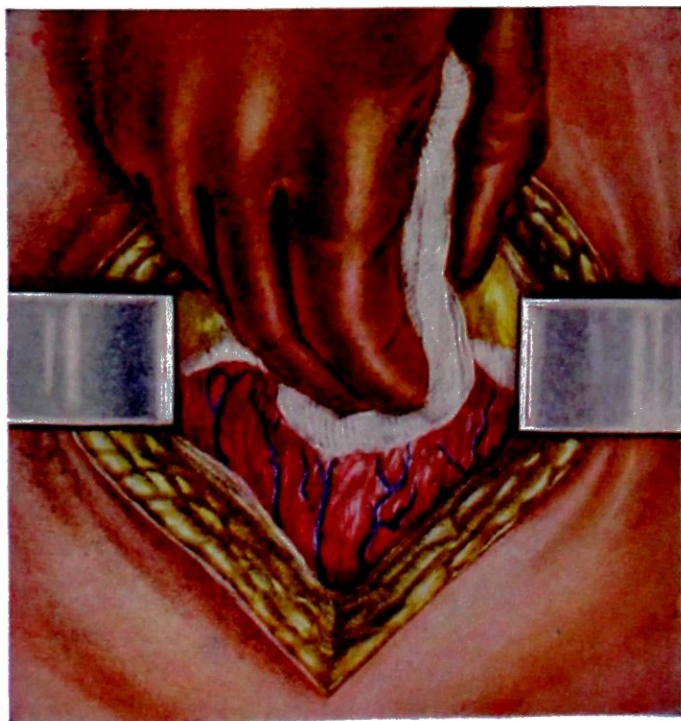


Fig. 877.—Suprapubic cystotomy. The suprapubic fat pad is reflected upwards by gauze dissection. The peritoneum is thus protected; in most cases it is not even seen. Note the vessels coursing over the bladder musculature, a spectacle that enables the operator to recognize the bladder immediately, and permits him to avoid these vessels when the bladder is punctured.

it with a hæmostat. A few drops only of urine escape around the puncture. It is essential to push the mushroom-head of the catheter well into the bladder, otherwise it is liable to be extruded when the distended bladder contracts (*Fig. 879*). The catheter is brought out through the abdominal incision as high up as is practicable. This little precaution will aid considerably when the time comes for the prostate to be removed, either retropublically or suprapublically.

Drainage of the prevesical space is provided, using a strip of corrugated rubber. The abdominal wall is approximated and the skin is closed with silkworm-gut sutures, not

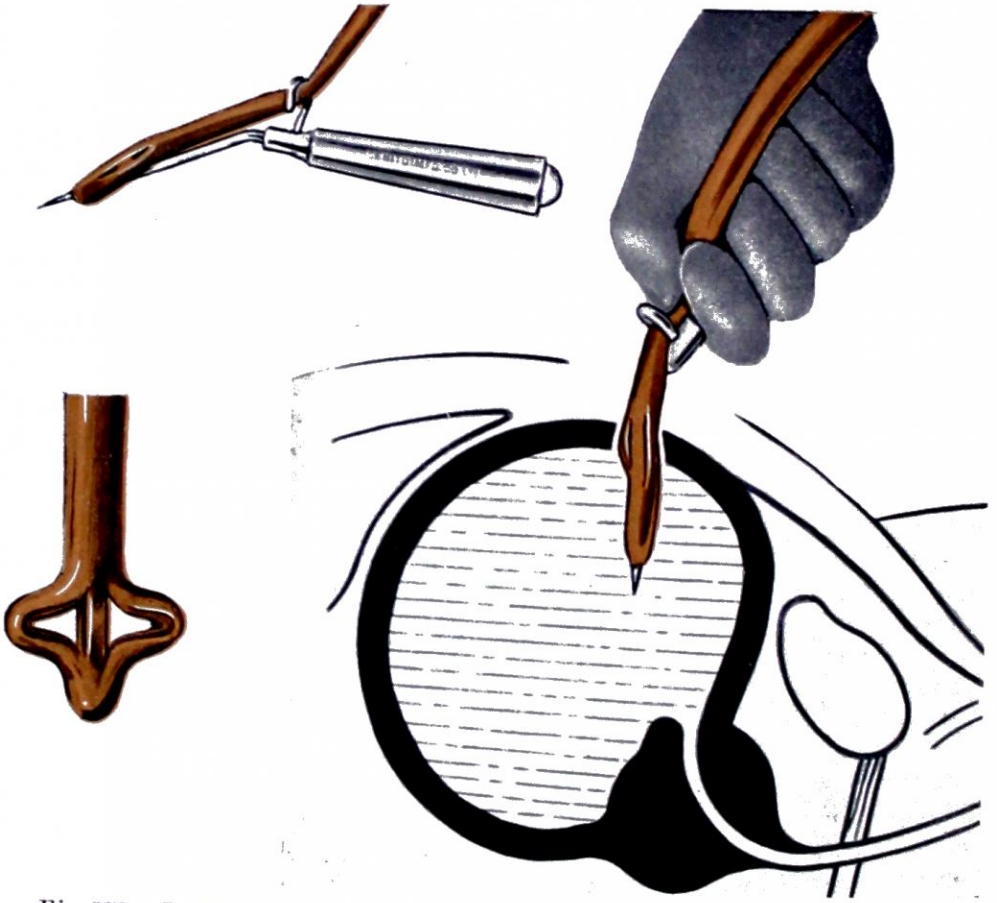


Fig. 878.—Introducing a suprapubic catheter into the exposed over-full bladder by means of the bladder perforator.

forgetting to anchor the catheter with one of these. In order to minimize displacement, the anchoring of the catheter to the skin is reinforced by a narrow strip of adhesive plaster

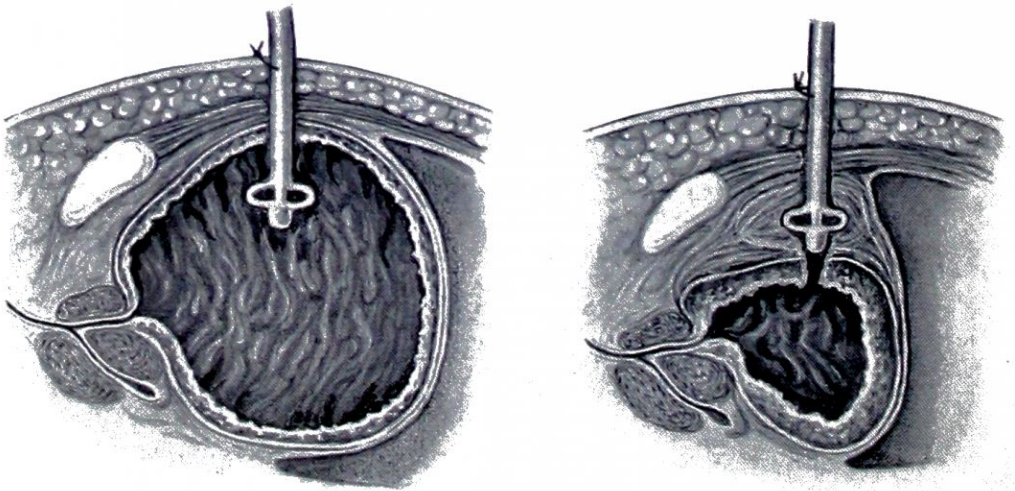


Fig. 879.—Unless the expanded end of the catheter is pushed well into the bladder it will be dragged out as the bladder contracts, for the catheter is fixed to the skin by a stitch.

entwined around the catheter, and fixed firmly to the skin. Alternatively a St. Peter's Hospital suprapubic catheter shield (*see Fig. 882*, p. 645) can be employed to retain the catheter. The suprapubic catheter is then connected to the intravenous dripper by a glass connexion (*Fig. 880*).

Technique 2.—The suprapubic catheter is inserted into the bladder through a small incision made 1 in. (2.5 cm.) below the level at which the anterior surface of the bladder curves upwards and backwards to form the dome. This site is ascertained by careful palpation, after muscular relaxation has been enhanced by the administration of a suitable dose of morphine. The incision is between $\frac{1}{4}$ and $\frac{1}{2}$ in. in length, and the strong fibres of

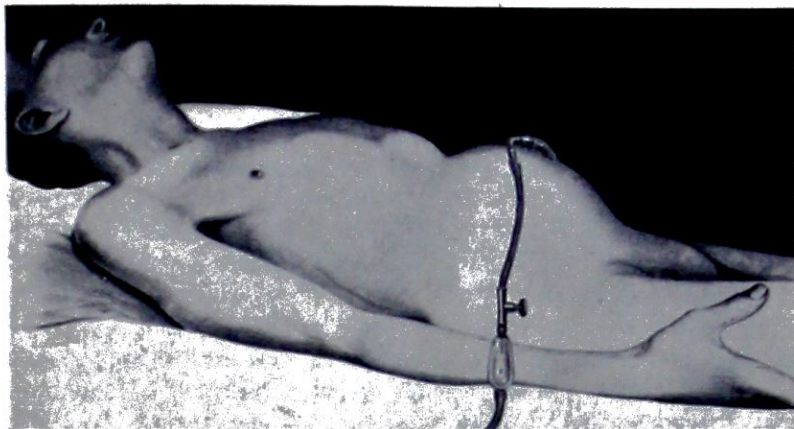


Fig. 880.—Decompression of the bladder after the insertion of a suprapubic catheter.

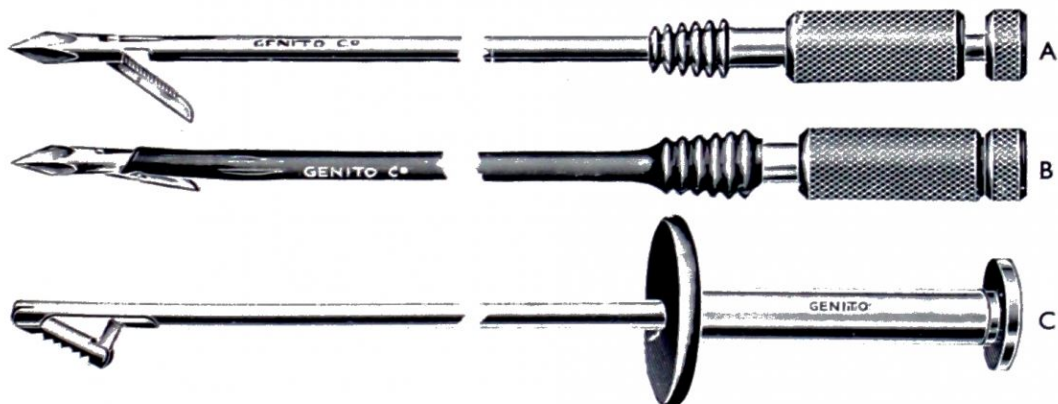


Fig. 881.—A, The suprapubic catheter introducer; B, The catheter stretched on the introducer; C, The advancer (E. W. Riches).

the linea alba are severed in the length of the incision. The puncture of the bladder can be made with a trocar and cannula of suitable dimensions to accommodate a stretched Malecot catheter. With a trocar and cannula a good deal of spill while introducing the catheter is inevitable, and the operation can be performed better, and more expeditiously, with a special instrument designed for the purpose, such as that of Riches, Lane, or Anscombe. Riches's instrument is the best known and the least complicated of these; it will therefore be described. After the special catheter has been mounted on the introducer (Fig. 881 A, B), it is passed through the incision in the linea alba until its sharp point touches the surface of the bladder. The patient is warned that he will experience momentary pain, and the instrument is passed into the bladder with a short, sharp thrust. The introducer is removed and the advancer (Fig. 881 C) is passed down the lumen of the catheter and its expanding end is opened. By its agency the catheter is carried into the depths of the bladder so that the tip lies near the trigone. This important step being accomplished, the advancer is removed. A stitch is used to secure the catheter to the skin, and the anchorage is reinforced with a strip of adhesive plaster. Alternatively a St. Peter's Hospital suprapubic catheter shield (Fig. 882) can be



Fig. 882.—St. Peter's Hospital pattern suprapubic catheter shield.

employed. This obviates the necessity for placing a skin stitch through the catheter. The shield is drawn down the lubricated catheter in the same way as a cuff for a jejunostomy catheter (*see p. 525*), full precautions being taken not to pull the catheter out of the bladder during the manipulation. The shield is kept in place by strips of adhesive plaster.

Dangers.—While eminently satisfactory in most cases, a possible danger of the method is wounding the peritoneum. In a careful study of a large series of cases, Scorer has been able to demonstrate that in a small percentage of cases the catheter track passes through the opposed layers of the lowest fold of the peritoneum without harm. However, if the junction is not watertight it is possible for peritonitis to develop from this undesirable happening. Hæmorrhage is another possible danger; one cannot choose an avascular

portion of the bladder through which to introduce the catheter, as is possible in Technique 1.

Suprapubic Puncture with a Hollow Needle.—Suprapubic puncture (*Fig. 883*) is a useful method of relieving acute retention when catheterization has failed and the circumstances are extenuating. If the circumstances remain extenuating, and a catheter still cannot be passed, as in the case cited below, the puncture may be repeated. Repeated

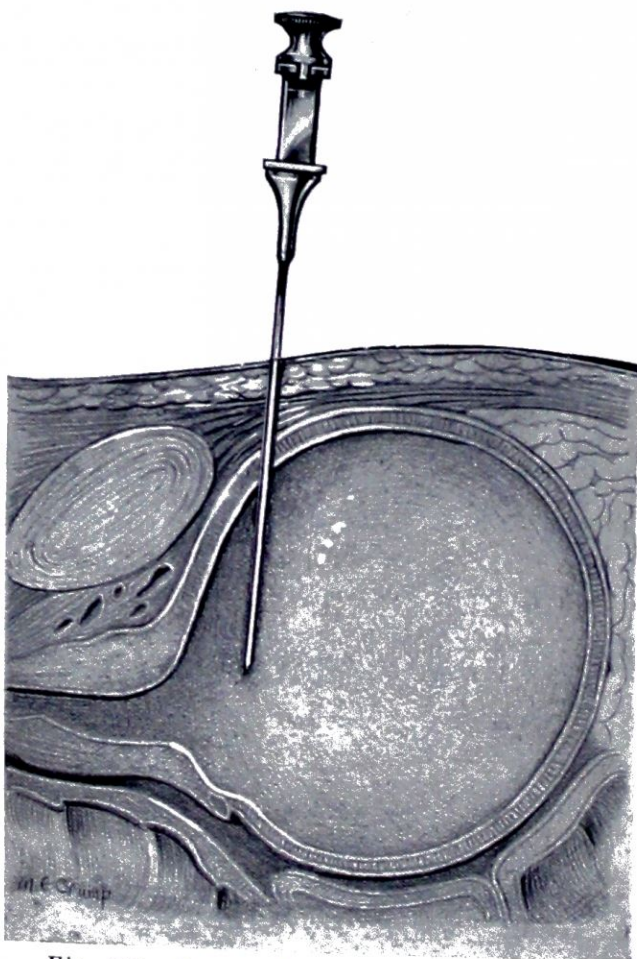


Fig. 883.—Suprapubic puncture with a lumbar puncture needle. The needle is inserted very near the top of the symphysis pubis.

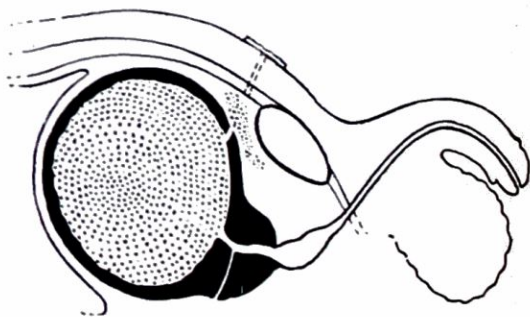


Fig. 884.—Suprapubic puncture has been performed and the bladder has been allowed to refill to the point of tension. Leakage is taking place through the vesical puncture into the cave of Retzius.

ated during the same night upon two cases of cellulitis of the abdominal wall due to this cause. One case occurred within the hospital, whilst the other was admitted from an outlying country district. It is obvious that the smaller the puncture hole the less likely is this leakage to occur; therefore the finest lumbar puncture needle obtainable is recommended for the operation.

The following experience shows the inestimable value of suprapubic puncture:—

Whilst employed as surgeon on a small gun-boat during the first world war, I was summoned in the middle of the night to an officer's cabin. The case was one of acute retention from stricture, and the bladder extended half-way to the umbilicus. Morphine, gr. $\frac{1}{4}$ (0.016 G.), and hot flannels to the hypogastrium produced no relief. There was a very small selection of instruments aboard, and none could be made to pass the stricture. The pubes were therefore shaved and suprapubic puncture performed with a lumbar puncture needle. The next morning catheterization was again attempted, but the stricture was impassable. The retention was relieved three times by suprapubic puncture before the patient could be got ashore to hospital. No extravasation took place. The patient recovered after internal urethrotomy.

PERINEAL URETHROSTOMY

Perineal urethrostomy is an alternative to suprapubic catheterization, and is particularly valuable in young males and debilitated old men. This operation opens the urethra where the lumen is widest, and consequently a comparatively large catheter can be introduced with room to spare; the free drainage alongside the catheter explains the low incidence of epididymo-orchitis that accompanies the operation, when compared with that of an indwelling catheter lying along the whole length of the urethra.

The catheter emerges at a site not readily accessible to the prowling hand of a difficult patient. Should this small wound become infected, the drainage is so excellent that complications are negligible. Leakage alongside the catheter is most uncommon. Whether the patient is ambulant or bed-ridden, drainage is downwards from the lowest point of the bladder. Changing the catheter can be carried out without the slightest difficulty. Transurethral resection of the prostate can be performed via the urethrostomy opening, which allows the use of a larger resectoscope than would be admitted by the anterior urethra. The development of a fistula or a stricture at the site of the urethrostomy is unusual, but if the catheter has to be retained for many weeks a fistula does result because of epithelialization of the walls of the opening. In the few cases where operative closure of the urethrostomy is necessary, it is easier to perform than closure of a suprapubic fistula.

Technique.—Perineal urethrostomy is performed easily under caudal anæsthesia. The patient should be placed in a rather exaggerated lithotomy position, with the thighs well flexed at the hip-joints. After cleansing the external genitalia and the perineum, the area is draped in the usual way. A metal sound of medium size is passed into the urethra so that its tip enters the posterior urethra, and the curve presents in the perineum. The scrotum is held out of the way in the manner described on p. 676. The assistant maintains the sound in this position, and the surgeon grasps the curve of the instrument firmly between the forefinger and the thumb of the left hand, about midway between the base of the scrotum and the anus. An incision 1 in. (2.5 cm.) long is made directly on to the sound, so as to expose the metal clearly. If grasping pressure on the sound is maintained, bleeding is minimized. The edges of the urethra are caught in tissue forceps, the sound is withdrawn, and a suitable catheter is introduced between the tissue forceps and passed into the bladder. If a Foley's catheter is chosen, the bag is distended with water by the assistant, while hæmorrhage is arrested. Bleeding, which is profuse because the incision traverses the cavernous tissue surrounding the urethra, is effectively and rapidly controlled by the insertion of a continuous suture of No. 1 plain catgut. This suture is so passed as to approximate the cut edges of the bulbo-spongiosus muscle to those of the urethral mucous membrane, traversing such corpus spongiosum that lies between them. The catheter should emerge from the urethra at the anal end of the wound. The skin and fat are approximated loosely by a single stitch; it is well to leave the wound partially open for free drainage. It is always advisable to secure the catheter to the skin with a suitable stitch, even when a Foley's catheter is employed, for the bag may break within the first few days. After four days a track is formed, and the reinsertion of a catheter presents no difficulty. A dry dressing is applied to the perineum.

If considered advisable, bilateral ligation of the vasa can be carried out.

Wounds in the perineum are notorious for becoming moist and odorous, but nevertheless are famous for freedom from toxic reaction and eventual good healing. In the unusual event of the wound becoming unduly purulent, Sitz baths are recommended if the patient is sufficiently ambulant; if not, then hot fomentations are applied. Bladder wash-outs are ordered only if the urine is infected. The catheter should be changed at intervals from two to four weeks, depending upon the amount of urinary salt deposited within its lumen. Encrustation is detected easily by rolling the catheter between the finger and thumb. Encrustation occurs particularly when the urine is alkaline, and can be counteracted by acidifying the urine or by giving the patient acid bladder washes.

RETENTION WITH OVERFLOW

The necessity for controlled decompression of the bladder reaches its zenith in cases of retention with overflow. The organ has been distended for weeks or months, and to empty it suddenly contravenes general principles and common sense. It is remarkable how these patients, with their bladders distended above the umbilicus and with a blood-urea

of perhaps 250 mg. per cent, often walk about with comparative unconcern, and it is difficult to convince the patient and his friends of the seriousness of the condition. To have had more than twenty-five consecutive cases of retention with overflow recover (several of them of the type depicted in *Fig. 885*) indicates something more than a



Fig. 885.—One of the cases of retention with overflow referred to in the text just prior to the insertion of a suprapubic catheter.

coincidence, because before adopting the method about to be described the mortality was very high. In this condition there is no need for undue haste in commencing decompression of the over-distended bladder.

Treatment.—The bladder is decompressed very slowly by means of a saline dripper. To this end the upper limit of the bladder is marked upon the abdominal wall, and the aim is to lower the dome of the bladder not more than 2 in. (5 cm.) per day. What is probably an important consideration is that each patient is catheterized (either per urethram or more usually suprapubically) in the operating theatre, where asepsis can be assured. In cases where a urethral catheter has been employed, the penile jacket undoubtedly helps to prevent infection. Soon after decompression has started, the slow administration of continuous 5 per cent dextrose solution is commenced. The outflow of urine is set at, say, fifty drops; the inflow of dextrose solution regulated to, say, forty drops per minute. It is, of course, essential that the rules concerning the administration of all intravenous solutions are observed. An accurate balance-sheet of intake and output is of vital importance. With this treatment it is astonishing to observe the blood-urea fall as much as 100 mg. per cent in twenty-four to thirty-six hours.

RETENTION DUE TO A URETHRAL STRICTURE

One of the results of the early and efficient treatment of gonorrhœa by antibiotic therapy is that retention of urine due to a urethral stricture is becoming much less frequent. When it is found that a Tiemann's catheter is arrested in the bulb of the urethra (the most frequent site of urethral stricture) or in the penile urethra, an olivary-ended catheter of suitable calibre, as tested by trial, sometimes can be inserted. A Phillips catheter (*Fig. 886*) is a very good instrument in cases

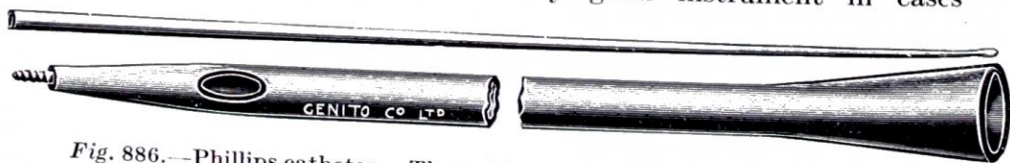


Fig. 886.—Phillips catheter. The guide is inserted through the stricture, after which the catheter is screwed on to the guide.

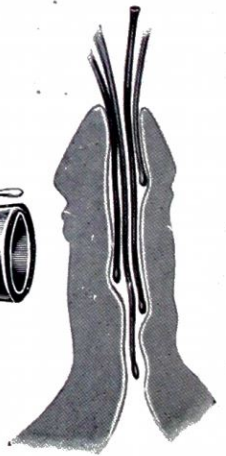


Fig. 887.—The faggot method of passing bougies.

of stricture, and one with which it is impossible to lacerate the urethra. When such an instrument has not been at hand I have often used a fine gum-elastic bougie, passed, if necessary, by the faggot method (*Fig. 887*). This answers the purpose admirably, for urine trickles slowly alongside the instrument and lo! our very objective—namely, slow decompression of the bladder—is accomplished.

To retain the bougie in place a piece of cotton is tied tightly around it, and the long ends are bound to the penis by adhesive plaster.

RETENTION DUE TO IMPACTED URETHRAL CALCULUS

Retention of urine due to this cause is uncommon. The retention may be partial or complete, but the pain accompanying the condition is intense. Palpation of the urethra usually reveals the site of the impaction, which is not infrequently behind a urethral stricture or narrow external urinary meatus.

The stone is impacted in the fossa navicularis.—The treatment is simple and precise. Perform meatotomy (see p. 681), and the stone will be passed when the patient micturates.

The stone is impacted in the penile urethra.—When the obstruction is partial, Bivona's device is occasionally effective. Local anæsthetic is injected and sufficient time is allowed for it to take effect. The patient passes urine, and suddenly interrupts the stream by compressing the end of the penis. The urethra is thereby dilated, and the stone may be swept onwards.

When this course is impracticable (a child) or is ineffective, so agonizing is the pain that the most practical method of procedure is first to administer a low spinal anæsthetic in the case of an adult or a general anæsthetic when the patient is a child. Possibly this in itself may be effective, and, as soon as anæsthesia has been produced, the stone may be extruded at the head of a jet of urine. Under anæsthesia there is no difficulty in making out the exact location of an impacted urethral stone by palpation. The important thing is to ascertain whether or no there is a urethral stricture. If the operator is skilled in its use, the urethroscope will decide this question. If there is the slightest doubt, it is safer to presume that a stricture is present, and to remove the stone through a longitudinal incision in the floor of the urethra.

The stone is impacted in the posterior urethra.—Again an anæsthetic should be given. An attempt is made to pass a catheter. Occasionally the stone can be pushed backwards into the bladder, whence it can be removed at the time, or later, by crushing or by performing suprapubic cystotomy. If, as is more usually the case, gentle catheterization fails to dislodge the stone, the best expedient is to relieve the retention by suprapubic catheterization, and to extract the stone at a later date, as was done in the following case :—

G. H., aged 29, was admitted with acute retention. Catheterization had been attempted, and he was bleeding from the meatus. Per rectum a stony mass could be felt in the region of the prostate. The retention was relieved by decompressing the bladder with a catheter introduced suprapubically. Later a radiograph (*Fig. 888*) showed a large calculus in the prostatic urethra. Fourteen days later, the stone was removed via the bladder after incising the internal urinary meatus. It was found that a No. 8 French bougie could be passed through a stricture of the bulbous urethra. The suprapubic wound healed, and the patient was advised to attend regularly for dilatation of the stricture.



Fig. 888.—Large stone impacted in the prostatic urethra.

CLOT RETENTION

Blood-clot in the bladder sometimes causes acute retention of urine. I have seen several cases follow nephrolithotomy and have also encountered an unusual example in a middle-aged woman, where later, on cystoscopy, the hæmorrhage was found to be coming from a Hunner's ulcer of the bladder. Curiously, although the hæmaturia is often severe, clot retention seldom occurs in connexion with papillomata and malignant growths of the urinary tract. The passage of a catheter will often relieve the retention, and repeated washings with a warm solution of 4 per cent sodium citrate through a catheter of wide bore sometimes remove the clot : more effective is to evacuate the clot via the sheath of a cystoscope, through which suction can be applied. Alternatively, a Bigelow's evacuator can be employed.

Blood-clot in the bladder is certain to become infected.

If the source of the bleeding is known, and it is estimated that there is a considerable amount of clot in the bladder, it is best to evacuate the clots by suprapubic cystostomy. This avoids decomposition of the blood and the attendant dangers of purulent cystitis.

RETENTION DUE TO ACUTE URETHRITIS OR PROSTATITIS

If the retention is unrelieved by morphine and a hot bath, even to attempt to pass a urethral catheter is to contravene surgical principles. Suprapubic catheterization should be performed.

RETENTION OF URINE IN THE FEMALE

This is comparatively rare.

Incarcerated Retroverted Gravid Uterus is the most important cause of sudden inability to empty the bladder. The incarceration occurs about the fourteenth week of pregnancy, and is caused by the fundus of the enlarging uterus becoming entrapped beneath the sacral promontory of an unusually concave sacrum. Retention from this cause is more serious than a corresponding overdistension of the bladder caused, for instance, by an enlarged prostate, for the distension arises so suddenly that the bladder has no opportunity to accommodate itself to its greatly increased burden by muscular hypertrophy. Consequently hæmorrhage from, and sometimes necrosis of, the vesical mucous membrane is liable to occur. Should infection follow, the result is always serious, and perforation of the bladder is not unknown.

Diagnosis.—It should be known that the usual complaint is not of inability to pass urine, but of abdominal pain and increased frequency or dribbling due to overflow. The diagnosis should spring to mind when a large cystic swelling arising out of the pelvis is discovered, and vaginal examination reveals a high cervix pointing forwards. If the patient has not volunteered the information that she is pregnant, her menstrual history must be questioned closely. Even if the swelling is mistaken for a twisted ovarian cyst, surely one would think the diagnosis would always become apparent when the patient was catheterized in the anæsthetic room, but not so. Chassar Moir has heard of a case where the abdomen was opened, the bladder wounded, urine gushed forth, and death resulted.

Treatment.—The correct treatment is to pass a self-retaining catheter—the urethra is unusually long in these cases—and after emptying the bladder, to clip the catheter and strap it to the thigh as high as possible; then proceed to evacuate the bladder contents at least every two hours. As soon as she is comfortable the patient is instructed to lie on her side or, better, in a semi-prone position, and often the uterus rectifies itself. When this does not occur, 24 hours later, with the patient in the knee-elbow position, gentle pressure should be exerted on the body of the uterus as near to the fundus as possible, by a finger inserted into the rectum. If digital reposition is unsuccessful, a large ring pessary should be inserted. Often the constant pressure of the ring causes disimpaction of the fundus from beneath the sacral promontory. In most exceptional instances laparotomy must be performed to disimpact the uterus held in the retroverted position by adhesions.

An Impacted Uterine Fibroid, usually cervical in origin, can cause retention of urine (see p. 560).

An Ovarian Cyst impacted in the Pelvis, or Pelvic Hæmatocele are rare causes of acute retention of urine.

Childbirth is a very common cause of retention of urine, and is one that is frequently overlooked, the associated pain being ascribed to after-pains, and the distended bladder being mistaken for subinvolution of the uterus. The retention is due to bruising of the bladder neck, and is probably a temporary neuromuscular derangement, rather than a mechanical obstruction due to œdema. A self-retaining catheter should be inserted, and the bladder emptied in the manner described above. The catheter should be retained for at least 48 hours.

Hysteria is often cited as a cause of urinary retention in the female. It is probably very uncommon, and every other cause must be eliminated before this diagnosis is assumed.

ACUTE RETENTION OF URINE DUE TO DRUGS OTHER THAN SEDATIVES

A number of the newer drugs are prone to induce or precipitate retention of urine. Methantheline banthine bromide, used to decrease secretion and motility in peptic ulcer, is very likely to produce retention of urine in patients with prostatic enlargement. Anti-histamine drugs, antihypertensive drugs, anticholinergic drugs (belladonna; probanthine),

and isonicotinic acid hydrazine compounds (chemotherapeutic agents for tuberculosis) have all been responsible for producing acute retention, and the surgeon should be cognizant of 'drug retention'.

RETENTION OF URINE FOLLOWING INJURY OF THE SPINAL CORD¹

Physiology.—The maintenance of the postural tone of the bladder is a function of the intramural nerve plexus, and is not influenced directly by extravascular nerve lesions. Contrary to traditional teaching, the bladder does not become atonic after a complete lesion of the spinal cord unless overdistension is allowed to occur.

Micturition is a spinal reflex action, mediated by the third and fourth sacral segments and controlled by descending inhibitory impulses (*Fig. 889*). For practical purposes the sympathetic innervation may be ignored, apart from the sensation of overdistension that it conveys; these impulses reach the cord at a level as high as the sixth thoracic segment.

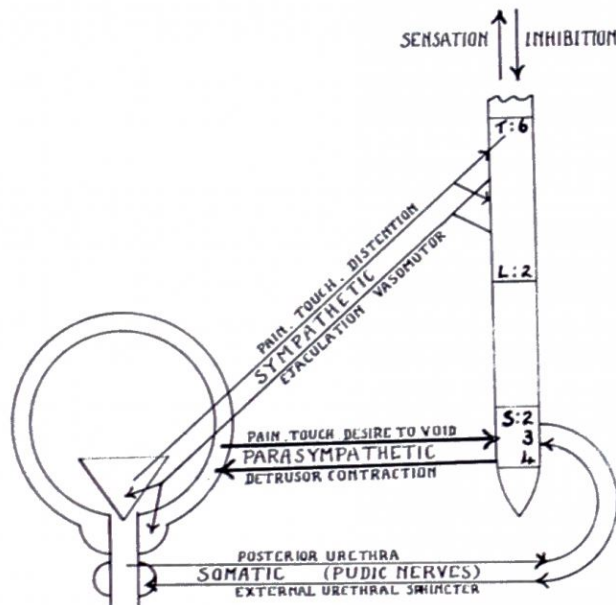


Fig. 889.—The mechanism of nervous control of the bladder.

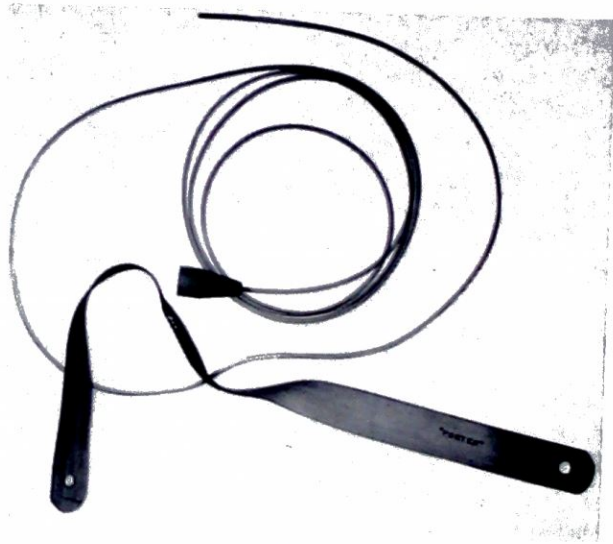
Conus or Cauda Equina Injuries.—In lesions of the terminal conus or cauda equina involving the third and fourth sacral segments or roots, emptying contractions of the bladder are abolished, but the external urethral sphincter is also paralysed; however, the abdominal muscles retain their power, so that the stage is set for expression of urine by abdominal straining or manual compression. A short period of retention is usual, lasting until such time as the patient is able to master the technique required. Sympathetic sensation usually enables the patient to judge when his bladder becomes full, and efficient emptying with complete continence can often be achieved.

The onset of retention in such a case is a surgical emergency from the urological point of view at least. If the damage is incomplete and remediable (as in the case of a prolapsed intervertebral disk), surgical decompression of the lesion performed within a few hours will probably relieve a bladder paralysis, which would otherwise be permanent.

Injuries above the Sacral Segments.—In injuries above the third and fourth sacral segments of the cord, there is a period of retention of urine (which may last for many months) associated with that abolition of distal reflexes known as spinal shock. Uncontrolled spinal reflex emptying ultimately returns provided the bladder remains healthy and the general condition of the patient good. Imperfect voluntary control is often established in an incomplete lesion, and sometimes in cases of partial recovery after a complete lesion.

¹ Written by N. O. K. Gibbon, Ch.M. Liverp., F.R.C.S. Eng. et Edin.; Assistant Surgeon, Walton Hospital, Liverpool.

Management.—In the case of acute injury to the cord or cauda equina, the bladder becomes distended until it overflows. Pain is rare, except in partial lesions, and the distension does not necessarily interfere with the subsequent development of efficient emptying by reflex contraction or expression. The overflowing urine can be collected easily in the male, so preventing soaking of the bed and maceration of the skin. Only in the female paraplegic is early vesical drainage imperative. There are many male cases on record in which non-intervention has been followed by satisfactory bladder emptying,



A



B



C

Fig. 890.—A, The Gibbon catheter ; B, Catheter in place in the male ; C, Catheter in place in the female.

the urine having remained sterile throughout. I mention this in order to emphasize that unless aseptic drainage can be guaranteed, it may be wiser to abstain from any instrumentation. In cauda equina lesions, sometimes from the very commencement of the retention, the urine can be expressed by gentle manipulation of the bladder aided, perhaps, by a finger in the rectum.

It is currently accepted, however, that prolonged vesical overdistension is liable to damage the detrusor, and that drainage should be instituted as soon as conditions permit of this being done aseptically. It should often be possible to wait until the patient has been transferred to a spinal injury centre. Judicious use of suprapubic aspiration is helpful in the female and in patients suffering pain.

An indwelling urethral catheter is satisfactory for routine use, provided the catheter used is non-irritant and of small calibre. A latex rubber catheter of the Foley type, of a size not greater than 14 F., is recommended. With the use of such a catheter (or of a finer polyvinyl catheter (Fig. 890) which is employed at the Liverpool Regional Spinal Injuries Centre), urethritis is minimized, and there is seldom need for suprapubic drainage. If this is required, however, the suprapubic catheter should be introduced with an instrument such as that devised by E. W. Riches (see p. 645).

In all cases the catheter should be connected by sterile tubing to a sterile bottle, the system being closed, apart from an air vent in the stopper of the bottle. A rubber catheter should be changed once or twice a week, opportunity being taken to irrigate the urethra. A daily bladder wash-out is advisable when mucus or phosphatic debris is detected in the urine; 1-2000 bradosol is employed for routine irrigations, and 0.5 per cent acetic acid when there is evidence of phosphatic encrustation of the bladder or the catheter. The irrigation is best accomplished by the skilful use of a bladder syringe, otherwise an irrigating reservoir is connected by a Y tube to the closed drainage system and released intermittently.

A high fluid intake should be insisted upon, and a urinary antiseptic is administered prophylactically. A safe urinary antiseptic to employ is urolucosil,¹ 250 mg. six-hourly, as there is little risk of crystalluria, even when it is given for many weeks.

Intermittent Catheterization has been revived successfully at the National Spinal Injuries Centre at Stoke Mandeville. With the intermittent method serious complications can be avoided only by the unremitting attention of skilled personnel. The method is fraught with danger in inexperienced hands, as pyelonephritis soon follows if an infected bladder is allowed to become overdistended.

The management of the paraplegic bladder in the later stages is not within the province of this book. Suffice it to say that it is a difficult exercise in applied physiology, and a rigorous test of surgical judgment and technique. As such, it lies properly within the sphere of the specialized staff attached to a Spinal Injuries Centre, and should not be embarked upon by anyone who lacks the necessary experience.

¹ William R. Warner & Co. Ltd., Power Road, London, W. 4.

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CHAPTER LVII

THE PROSTATE AND SEMINAL VESICLES

Hæmorrhage after Prostatectomy.—During the first 24 hours after retropubic prostatectomy with closure of the bladder or transurethral resection, stoppage of the flow of (blood-stained) urine due to a small clot occluding the urethral catheter is not unusual. This must be cleared by alternately introducing 1 oz. (30 ml.) of flavine solution and sucking it out with a well-fitting piston-type bladder syringe. Care must be taken not to introduce air into the bladder. If these irrigations are carried out soon after the catheter becomes blocked, the clot can not only be dislodged but evacuated.

The incidence of severe hæmorrhage is low after operations which allow bleeding points to be ligated: reactionary hæmorrhage is highest after the Freyer operation, while secondary hæmorrhage (due to separation of slough) is more likely to occur after transurethral resection with the diathermy loop. Should severe hæmorrhage recur at intervals of several days after adenomatous tissue has been enucleated, the possibility that a piece of adenomatous tissue has been left behind must receive careful consideration.

Reactionary Hæmorrhage.—When, following prostatectomy, hæmorrhage is greater than would be expected, the following measures are imperative:—

1. A quarter of a grain (16 mg.) of morphine is given at once.
2. The pulse-rate and blood-pressure are recorded at two-hourly intervals on a special chart.

3. Blood transfusion is commenced as soon as matched blood has been procured.

4. Because of the danger of supervention of infection, prophylactic antibiotic therapy is administered. If the urine proved sterile on previous examination, penicillin is given. In other circumstances an antibiotic suited to the bacteriological findings will be chosen.

5. Bladder irrigation is all-important. The bladder is irrigated with not more than 3 oz. (90 ml.) at a time of 1–10,000 silver nitrate solution. It is a moot point whether these bladder washes should be given hot (the temperature of the solution in the receptacle must never exceed 110° F. (43° C.)): it is a time-honoured belief that the heat of the fluid helps to stay the hæmorrhage. Nevertheless, it can be argued reasonably that the heat provokes vasodilatation, thereby favouring hæmorrhage. For this reason, lotion at blood heat is recommended.

The irrigations are repeated, and the empty syringe is used to apply suction, which aids in the evacuation of small clots. If the presence of larger clots in the bladder is suspected a warm solution of 4 per cent sodium citrate is valuable in breaking up very recent clot. When, apparently, all clot has been evacuated, irrigation with silver nitrate solution is recommenced.

Foley's Hæmostatic Bag Catheter (see Fig. 856, p. 635). If the catheter inserted at the time of the operation was not a Foley's, and the above measures have failed to stay

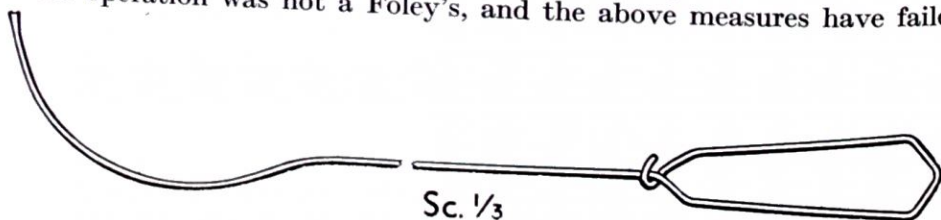


Fig. 891.—Introducer for a Foley's catheter.

the hæmorrhage, or a blocked catheter cannot be unblocked, the original catheter should be removed and a Foley's catheter substituted.¹ The best type of bag catheter for this purpose is one with a special irrigating channel as well as an inflation limb, but any type

¹ In some cases, particularly after retropubic prostatectomy, it is impossible to insert a Foley's catheter. When this contingency arises the patient should be taken to the operating theatre and if, with further irrigations and evacuation of clot through another type of catheter, the hæmorrhage cannot be controlled satisfactorily, the prostatic cavity should be packed.

of Foley's catheter is better than none. If the unstiffened Foley's catheter cannot be passed into the bladder it must be inserted while stretched on an introducer (*Fig. 891*).

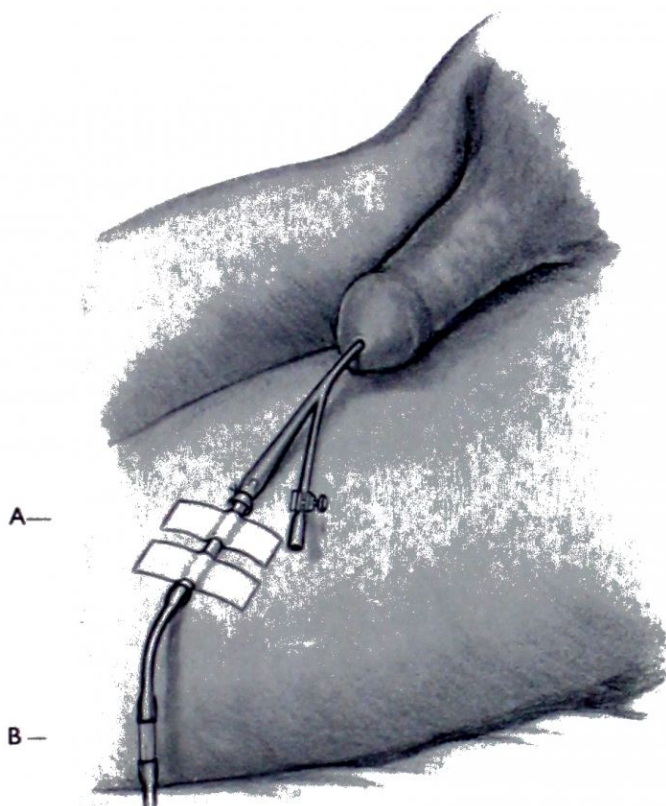


Fig. 892.—Traction on the catheter is maintained by the glass connexion (A) being fixed to the thigh with strapping. By disconnecting the rubber tube at B, irrigations can be carried out without disturbing the bag in the prostatic cavity. If the catheter is fixed as shown, the patient can flex the knee without releasing the tension on the catheter.

Before inserting the Foley's catheter, procure a glass syringe that will fit the inflation limb of the catheter tightly, and, with water, fill the bag to capacity, without overstretching it. Allow the water to run into a measuring glass, and note the amount. Pass the sterilized catheter into the bladder and fill the bag with the measured amount of water stained deeply with methylene blue. Apply a screw clamp tightly below the expanded end of the inflation tube, or tie a tight ligature around it in the manner shown in *Fig. 918*, p. 672. The methylene blue is to aid early recognition of a burst bag—not a very unusual happening. The next, and most important, step is to apply traction to the catheter so that the distended bag is withdrawn into, and kept within, the prostatic cavity.

Requirements.—Two glass connexions that will fit the catheter, a piece of rubber tubing 4 in. (10 cm.) long that will fit the connexions, and a long piece of similar tubing leading to a drainage bottle are assembled as shown in *Fig. 892*.

Maintaining Traction.—While the catheter is being pulled gently, an assistant fixes the proximal glass connexion (A) to the thigh with two strips of adhesive tape, thus achieving tension without obstructing the outflow. To permit intermittent irrigation of the bladder without disturbing the bag in the prostatic cavity (*Fig. 893*) the glass connexion



Fig. 893.—Foley's bag catheter in the prostatic cavity. Traction on the catheter causes sufficient compression on the walls of the cavity to stop moderate hæmorrhage.

(B in *Fig. 892*) is disconnected from the short rubber tube. As a rule these expedients control hæmorrhage from the prostatic cavity.

Renewed Hæmorrhage.—Should serious renewed bleeding occur, it is best to transfer the patient to the operating theatre where, especially at night, in the good light it is less difficult to ascertain if the bleeding is progressive or not.

If the Foley's Catheter is, or becomes, blocked with Clot.—Usually it is necessary to remove the catheter, for the walls of a Foley's catheter are insufficiently rigid to permit

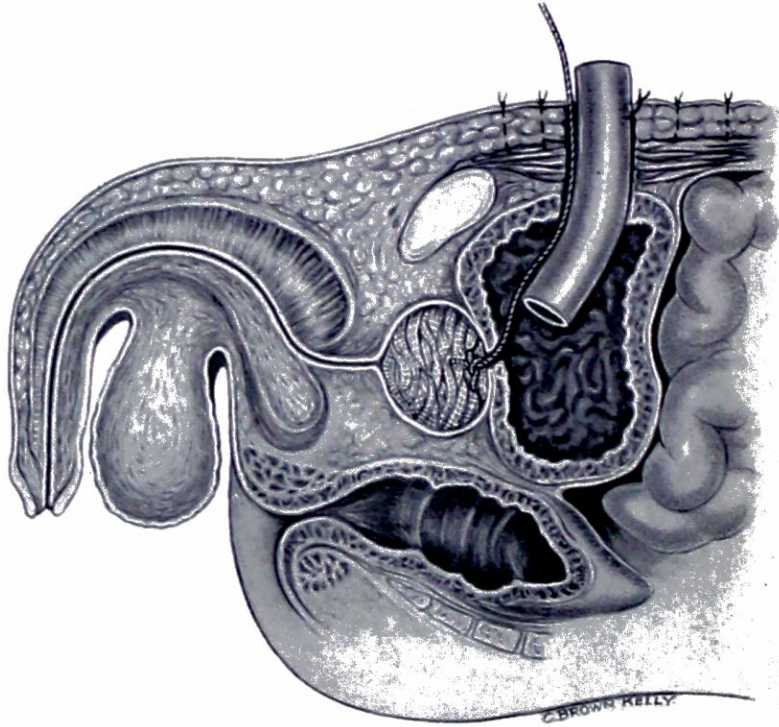


Fig. 894.—The packing of the prostatic cavity completed.

piston suction with a bladder syringe. Having removed the catheter, insert any type of more rigid catheter with a large eye, and attempt to remove clots by irrigation and suction. In this connexion attention is drawn to the inestimable value of passing the cannula of a bladder evacuator, such as Bigelow's, and evacuating clot in the same way as a fragmented vesical calculus is removed after litholapaxy. If, after either of these procedures, the hæmorrhage seems to have stopped, it may be good judgment to reinsert a Foley's catheter, inflate the bag, apply traction, and irrigate the bladder for a quarter of an hour. Should irrigations be returned tolerably clear, the patient is returned to bed.

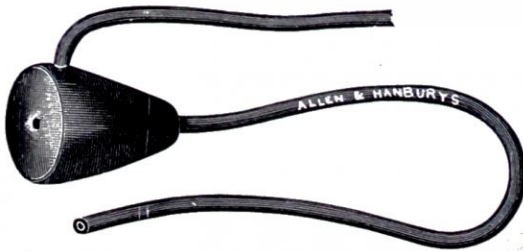


Fig. 895.—Pilcher's bag. The inflating limb is brought out of the suprapubic incision.

When the bleeding proves to be progressive, more radical steps must be taken.

Packing the Prostatic Cavity.—The patient is anaesthetized. Suprapubic cystostomy is performed, or the suprapubic bladder incision is reopened, as the case may be. Blood-clot is evacuated and the bladder is irrigated. The

prostatic cavity is packed at first with a small quantity of oxycel absorbable gauze and then with 1 in. (2.5 cm.) ribbon gauze, to the end of which is tied a piece of silk, to aid removal of the packing (*Fig. 894*). The bladder is closed around a large drainage tube, and when the patient is back in bed the bladder is kept empty by sump drainage (*see p. 189*).

Alternatively, Pilcher's bag (*Fig. 895*) can be inserted, and the bag distended with water. This bag being made of stout rubber, it is possible to exert considerable traction without fear of the bag bursting. Traction is effected by tying a piece of silk to the end of the tubing, carrying the silk over the rail of the bed, and attaching a 3 oz. (90 G.) weight to it. While the bag is in position all the bladder urine is evacuated by suprapubic sump drainage.

The packing or the bag is removed four or five days later.

SPECIAL CONSIDERATIONS

Excessive Bleeding through the Prevesical Drain after Retropubic Prostatectomy.—

When excessive hæmorrhage occurs after retropubic prostatectomy the bleeding often takes place not into the bladder, but into the prevesical space, and from thence it manifests itself through the tube draining that space. In these circumstances the wound should be reopened, and if the bleeding is seen coming from the capsular suture line, the bleeding area is under-run with one or more sutures. Alternatively, resort can be made to packing the prevesical space, but this is less desirable.

Bleeding after Transurethral Resection of the Prostate occurring within 48 hours of the operation usually can be checked by traction on the Foley's catheter and frequent irrigation of the bladder. When these measures fail, the patient should be taken to the operating theatre, and after evacuation of clots the bleeding points are visualized with the resectoscope, and coagulated. Rarely is suprapubic cystostomy and packing of the prostatic bed necessary.

Secondary Hæmorrhage due to Sloughing is relatively common after transurethral resection of the prostate, especially if a large hypertrophy has been resected. Hæmorrhage usually occurs during the second post-operative week, when the patient is becoming convalescent. If the bleeding is comparatively slight, often it can be controlled by emptying the bladder with a catheter, withdrawing clots by suction after small irrigations, and leaving in a Foley's catheter to which traction is applied. When the hæmorrhage is more severe and is not controlled by these measures, the patient should be taken to the operating theatre and anæsthetized. Sometimes it is possible to coagulate the bleeding points through a resectoscope. Should this prove impracticable, suprapubic cystostomy must be performed and the prostatic cavity packed.

Blood-clot in the Bladder.—When, after a hæmorrhage, the urine remains discoloured pink for several days, it is of course possible that slight hæmorrhage is continuing. Another possibility is that there is blood-clot in the bladder, and the urine becomes discoloured by contact with the clot. The best course in these circumstances is to assume that both possibilities are present. The first is cared for by keeping traction on a Foley's bag; the second is the more menacing, for blood-clot in the bladder will certainly become infected and putrefy, no matter what concentration of antibiotic is present in the urine: antibiotics cannot penetrate lifeless clot. Irrigation of the bladder with a solution containing 100,000 units of streptokinase and 25,000 units of streptodornase (*see* p. 140) every 4–6 hours greatly helps to dissolve clot. The Foley's bag, pressed against the vesical neck, will prevent these enzymes coming into contact with the clot occluding the mouths of blood-vessels in the prostatic bed, where such enzymic action might cause renewed hæmorrhage.

Recurrent Hæmorrhage, by which is meant that bleeding recommences after everyone concerned is certain that it has ceased, is often due to a fragment of enucleable prostate remaining in the prostatic bed. I have encountered a case in which bleeding recurred no less than five times, and was treated by the methods described. On the fifth occasion, under gas and oxygen anæsthesia, a small piece of prostatic tissue was found and removed, and a Pilcher's bag was inserted. With further blood transfusions, the patient recovered.

RUPTURE OF THE PROSTATE

Because of its sheltered position, rupture of the prostate is exceedingly uncommon.

An effeminate man, aged 26, was admitted with severe rectal and perineal pain and slight hæmaturia. He stated that six hours previously he had been to a party, and one of the guests was 'very rough with him'. No abnormality was detected on physical examination until a rectal examination was made. The anus was patulous, and where the prostate should lie there was a large cystic, tender swelling.

Operation. A perineal incision was made, and by sharp and blunt dissection it was deepened upwards and backwards to the region of the prostate. Suddenly there was a gush of about $\frac{1}{2}$ pt. (140 ml.) of blood, and in the blood there was a piece of the prostate. The wound was closed with drainage. No complication ensued.

ACUTE PROSTATITIS

It is difficult, if not impossible, to separate infections of the prostate gland from those of the seminal vesicles; indeed, in 80 per cent of cases the condition is, in fact, an acute prostato-seminal vesiculitis. The infection is sometimes hæmatogenous; more often it is retrograde.

Diagnosis.—As a rule there is considerable elevation of temperature, and the patient feels ill. A persistent aching in the perineum, accompanied by pain on defæcation, is the characteristic local symptom. When the infection follows urethritis, including catheter urethritis (see p. 641), the diagnosis presents no difficulty, and in all instances it becomes unmistakable when an enlarged, acutely tender, hot prostate is felt on rectal examination. In no circumstances whatsoever must the prostate be massaged in the attempt to obtain a specimen of purulent fluid for bacteriological examination. A two- or three-glass test should be performed, and clear, followed by cloudy, urine is extremely suggestive. The specimen should be sent for bacteriological examination. Especially when the infection appears to be blood-borne, it is advisable to send a specimen of blood for culture.

Treatment.—The patient should be kept strictly in bed. The urine is rendered alkaline with a citrate mixture (see p. 575), to which Tinct. hyoscyami is added. After an enema has been given, suppositories of morphine and ichthyol are often soothing. Hot Sitz baths are helpful. While awaiting the bacteriological report on the urine, penicillin and streptomycin, or aureomycin, can be given. At the present time the bacteria most often responsible for acute prostatitis are *Esch. coli*, a staphylococcus that is not infrequently penicillin-resistant, and an antibiotic-resistant gonococcus. Especially if specific antibiotic therapy can be given, the prognosis is excellent. Occasionally the main infecting organism is proteus or *Pseudomonas aeruginosa*, which are resistant to the more usual antibiotics. The organism cultured from the urine is not necessarily the one causing the prostatitis; therefore, if one antibiotic fails to control the infection another (e.g., neomycin) must be substituted, always being mindful that the usual cause of failure of conservative treatment is the development of a prostatic abscess.

When the acute symptoms have abated for a week, the prostate and seminal vesicles should be massaged, and the resulting specimen examined bacteriologically. In necessary cases the treatment for chronic prostatitis must be commenced and continued until all signs of infection have disappeared.

PROSTATIC ABSCESS

As would be expected, since the advent of sulphonamides and antibiotics, the incidence of prostatic abscess has declined steeply, with the result that in recent years there has been a liability to overlook the condition until retention of urine has supervened. Prostatic abscess can occur at any time during adult life, and contrary to days gone by, when most prostatic abscesses (resulting from gonorrhœal prostatitis) were seen in young men, a rather high proportion of these patients are elderly.

At the present time the organisms most often responsible for a prostatic abscess are *Esch. coli* or a penicillin-resistant staphylococcus.

Diagnosis.—The differentiation between acute non-suppurative prostatitis and prostatic abscess can be very difficult. Urgency, increased frequency, and dysuria are the most usual symptoms in both conditions. Typically, the advent of a prostatic abscess is heralded by a steeper rise of temperature than was registered during the stage of prostatitis, and rigors are not unusual—but the early administration of an antibiotic often disguises these leading symptoms. Severe, unremitting perineal and rectal pain, occasionally associated with tenesmus, should direct the clinician's thoughts to the probability of prostatic abscess. Too often the nature of the pain, and particularly its localization, leads to confusion with pararectal suppuration. A digital examination of the prostate will obviate this mistake, for the gland will be found to be enlarged, often asymmetrically, hot, and extremely tender. If an area of softening can be felt in the prostate, the diagnosis is certain. Nevertheless, what is extremely important to know is that a tense, exquisitely tender enlargement of the prostate is liable to disguise the presence of an abscess, because no area of softening can be elicited. In these circumstances on no account should fluctuation be awaited.

Untreated, if a prostatic abscess does not burst into the urethra, it frequently does so into the perirectal tissues or the perineum. Rupture into the rectum is a calamity, for so often a rectovesical fistula results, and such a fistula is most difficult to close.

A brief period of illness does not rule out the possibility of prostatic abscess; in L. Persky's series many patients had had symptoms for less than a week. Especial attention is directed to the frequency with which diabetic patients with prostatitis

develop a prostatic abscess which, if not drained early, is liable seriously to endanger the patient's life. In all suspected cases culture of the urine and the blood should be undertaken when possible.

Treatment.—The continued administration of antibiotics in the presence of a prostatic abscess is useless. As soon as the diagnosis has been made, the abscess should be drained without delay. It is true that if a catheter is passed to relieve acute retention of urine, sometimes the abscess is ruptured into the prostatic urethra, with amelioration of symptoms. However, such drainage is insufficient in the majority of cases, intractable chronic prostatitis follows, and the development of a further abscess is not unusual.

Operation.—Of several methods of draining the abscess, the following will be found to be the most satisfactory, and it does not require special instruments such as a prostatic tractor. The anaesthetized patient is placed in the exaggerated lithotomy position, and an incision $1\frac{1}{2}$ in. (4 cm.) in length is made 1 in. (2.5 cm.) in front of the anus (*Fig. 896*) on to a metal bougie introduced from the external meatus. The urethra having been opened, the bougie is removed. Haemostasis is effected as described in the section on perineal urethrostomy (*see p. 647*). A finger is introduced through the incision into the prostatic urethra, and then through the posterior urethral wall into the abscess cavity. If this is found to consist of several pockets, intervening septa should be broken down. The finger is withdrawn, and a rubber catheter—preferably a Foley's—is passed into the bladder, through the wound, and anchored to one side of the posterior end of the skin incision. The anterior part of the wound is approximated loosely, and a dry dressing is applied.

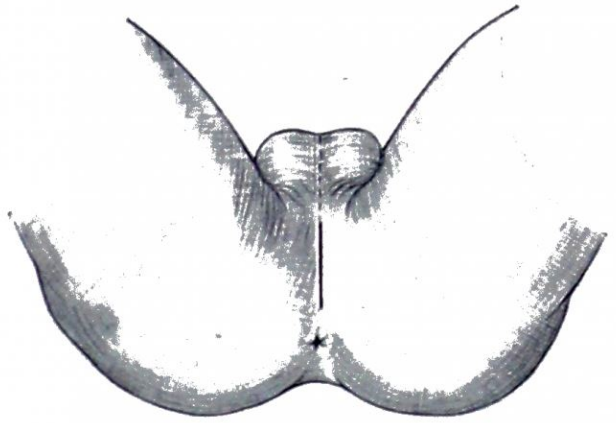


Fig. 896.—Incision for opening a prostatic abscess.

After-treatment.—The catheter should be left in for six or seven days. Drainage of the abscess is followed by immediate relief of pain and early subsidence of the accompanying pyrexia, extracapsular contiguous extension of the suppurative process is prevented, and chronicity is minimized.

The patient should be observed for some months, with a view to treating chronic prostatitis, if such persists.

ABSCESS OF A SEMINAL VESICLE

While infection and suppuration of the seminal vesicles is common, abscess formation is rare. A few cases of bilateral abscesses have been reported, but as a rule the condition is unilateral.



Fig. 897.—Incision for draining an abscess of the left seminal vesicle.

Diagnosis.—In addition to the usual signs of prostatitis, pain is sometimes referred to the small of the back, the suprapubic region, and down the inner side of the thighs. It is possible for a large abscess of a seminal vesicle to be present without constitutional symptoms, especially if the patient has been treated by antibiotics. On rectal examination the vesicle is found to be greatly enlarged, tender, and hot. On no account must an attempt be made to evacuate the contents of the abscess down the common ejaculatory duct by pressure on the vesicle.

Operation.—The patient is placed in the exaggerated lithotomy position. An incision is made over the medial part of the ischio-rectal fossa as shown in *Fig. 897*. By blunt dissection the incision is deepened until the fusiform swelling is felt unmistakably. A long haemostat is then thrust into the abscess cavity, and its jaws are opened, liberating the pent-up accumulation of purulent fluid. The wound is closed lightly around a drainage tube passed into the abscess cavity.

ACUTE COWPERITIS

The bulbo-urethral glands of Cowper, situated between the layers of the triangular ligament, are from time to time the seat of acute inflammation, which is often mistaken for prostatitis or seminal vesiculitis. When abscess formation follows, too often the very existence of these glands is not thought of, and the diagnosis of ischio-rectal or periurethral abscess is made. The chief symptom of Cowperitis is pain in the perineum; the pain is not so severe as that of acute prostatitis, and it is not referred to the rectum. Tenderness on one or other side of the midline of the perineum anteriorly is very suggestive. On rectal examination the prostate and vesicles are likely to be affected. Still retaining

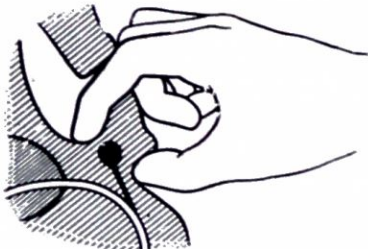


Fig. 898.—Method of palpating Cowper's glands.

the finger in the rectum, each Cowper's gland is palpated by placing the thumb first on one side, and then on the other, of the median raphe of the perineum (Fig. 898). If the inflammation does not subside with rest in bed, Sitz baths, and antibiotic therapy, and the swelling is enlarging, drainage is necessary.

A retired major, aged 62, had great pain and swelling in the perineum two weeks before admission. He was given sulphanilamide therapy. The pain, though less severe, continued, and the swelling enlarged. On examination there was a very large perineal abscess to the left of the middle line. A diagnosis of abscess of Cowper's gland was made.

The skin overlying the abscess was excised, and the lining membrane of the cavity, which was the size of a goose's egg, was abraded with gauze. The wound was packed with gauze soaked in flavine. The wound healed well. Culture of the pus disclosed *Staphylococcus albus* and a diphtheroid bacillus.

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CHAPTER LVIII

THE URETHRA

RUPTURE OF THE URETHRA¹

Rupture of the urethra is one of the most serious accidents, and unless your skill can prevent the development of a stricture, you are presiding at the opening of a lifelong tragedy. (Rutherford Morison.)

Every rupture of the urethra, even the slightest, is a potential stricture. (Boeckel.)

RUPTURE OF THE BULBOUS URETHRA

THE triad of signs and symptoms of a ruptured bulbous urethra is: (1) Urethral hæmorrhage; (2) A perineal hæmatoma; and (3) Retention of urine. To these may be added a fourth—pain.

Urethral hæmorrhage (Fig. 899) is certainly good evidence that the mucosa is involved, but its profusion is no guide to the severity of the rupture. I saw a patient who, three



Fig. 899.—Complete rupture of the bulb of the urethra. Blood is trickling from the meatus. The patient had fallen astride a few hours before the photograph was taken.

days previously, had stepped on to the lid of a pavement coal-hole which was not securely in place, with the result that one leg went down into the cellar whilst the perineum bore the brunt of the fall. For three days severe urethral hæmorrhage had continued, and owing to this the patient was profoundly anæmic, yet an exploring catheter slipped readily into the bladder.

Perineal hæmatoma (Fig. 900) is always in evidence, but its size is no guide to the extent of the mucosal tear. It is quite clear that the bulb of the corpus spongiosum may be severely damaged and its ensheathing envelope broken whilst the mucous membrane remains unharmed.

Retention of urine is due to a reflex spasm of the compressor urethræ. Proof of this is afforded by the fact that the bladder is sometimes emptied as soon as the patient is anæsthetized fully. This spasm of the compressor prevents extravasation for many hours (see Fig. 906).

If the bulbous urethra has been ruptured, it is most necessary to know whether the rupture is complete or incomplete. Yet it must be realized that there is no absolute

¹ This accident, other than as an obstetrical complication, is almost unknown in the female.

necessity to obtain this information immediately. The practice of passing or attempting to pass a catheter with only ordinary precautions, and the mild infection of the lacerated tissues which ensues thereby, account for many traumatic urethral strictures.



Fig. 900.—Rupture of the bulb of the corpus spongiosum with extravasation of the blood into the scrotum. In spite of the magnitude of the hæmatoma, the rupture of the urethra was incomplete.

and wash out the anterior urethra several times. Introduce a lubricated soft rubber catheter through the meatus and pass it down the urethra. If the catheter passes without difficulty into the bladder, obviously the lesion is incomplete. Distend the bladder with lotion and permit it to run out into a receptacle before removing the catheter.

If the tip of the catheter is arrested in the bulb and bleeding is provoked, there is a complete rupture.

In either case wash out the urethra once more before proceeding further. At this stage a general anæsthetic is administered.

Incomplete Rupture.—Perform suprapubic cystostomy (see p. 631). A small de Pezzer type of catheter is used to drain the bladder: small, because when it is removed the cystostomy wound will close more quickly.

Complete Rupture.—As in the above instance, the first step is to perform suprapubic cystostomy under local anæsthesia. The bladder having been opened, a Lister's sound is introduced down the internal urinary meatus. A liberal supply of gauze is wrapped round the sound, and this forms an excellent protection to the wound during subsequent manœuvres. (*Fig. 901.*) A towel is then placed over the gauze and the bougie, leaving the handle free for an assistant to hold. The patient is now moved into the lithotomy position.¹ Two Lane's tissue forceps are clipped upon the scrotum. By passing a long loop of bandage through the handles, the anæsthetist at the head of the table can retract the scrotum upwards. A very important



Fig. 901.—A bougie has been passed into the internal urinary meatus. The handle is held by an assistant, whilst a plentiful supply of gauze wrapped around the shank protects the suprapubic wound during the perineal stage of the operation.

¹ If Lloyd-Davies's stirrups are available it is possible to place the patient in a position that will obviate the necessity of changing the position during the operation.

detail is to have the perineum shaved and the skin disinfected thoroughly. It is quite impracticable to have this attended to at an earlier stage of the proceedings. All this time an assistant has been holding the Lister's sound in the posterior end of the urethra. A gum-elastic bougie is now passed from the external meatus to the site of the rupture and the assistant holds this bougie in position also. Towels are draped around the area. An incision is made in the middle line of the perineum from the base of the scrotum to within $\frac{3}{4}$ in. (1.8 cm.) of the anus. Blood and blood-clot are removed, and spurting vessels are ligated. The incision is deepened until the urethra is opened.

Both ends of the urethra are at once accessible. The assistant is requested to remove the gum-elastic bougie and to withdraw the metal bougie until its tip is conveniently out of the field of operation. The roof of the urethra is sutured by interrupted catgut stitches

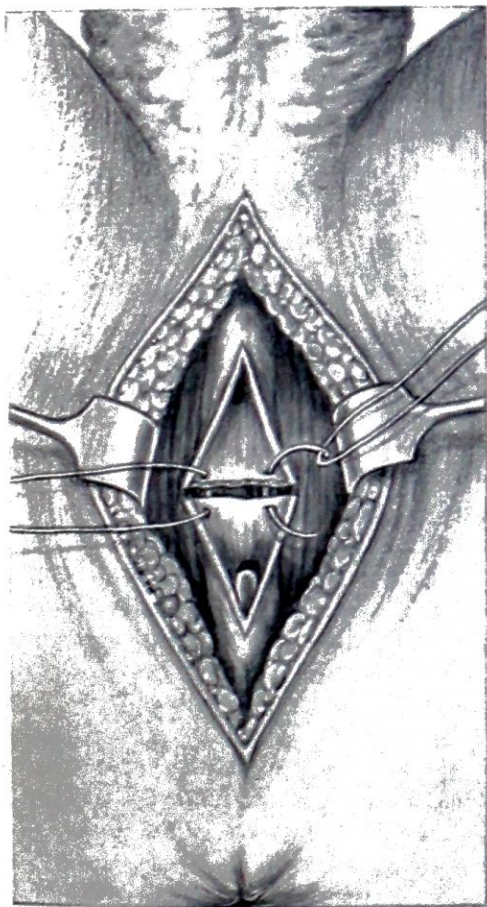


Fig. 902.—Suturing of the roof of a completely ruptured bulbous urethra. Note the tip of the metal bougie in the proximal end of the exposed urethra.

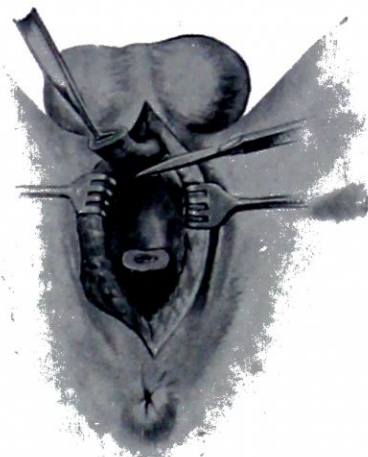


Fig. 903.—Mobilizing the anterior end of the corpus spongiosum. (After G. Marion.)



Fig. 904.—Irrigation of the perineal wound with penicillin solution through a Higginson's syringe.

(*Fig. 902*), and, in order to avoid these cutting out, a firm grip of the corpus spongiosum as well as the mucous membrane should be taken. After the suturing has been completed—two or three sutures suffice—the perineal wound is packed lightly with ribbon gauze soaked in acriflavine solution. Dressings having been applied, the patient is taken down from the lithotomy position. Attention is now directed to the suprapubic incision. The bladder is closed about a medium-sized Malecot catheter.

Occasionally, owing to their wide separation, it will be found impossible to bring the divided ends of the urethra into apposition by the method detailed. This obstacle can be surmounted by mobilization of the anterior end of the corpus spongiosum (*Fig. 903*), an expedient that permits the divided ends of the roof of the urethra to be united without tension.

After-treatment.—The suprapubic catheter is connected to a closed-system drainage bottle (p. 640). The proximity of the perineal wound to the anus makes some infection almost inevitable, and special precautions are needed to ensure healthy granulation, which

means so much in the prevention of stricture formation. To this end the bowels should be kept confined for the first four or five days. The administration of penicillin is continued, and sulphadimidine or sulphatriad is given by mouth. The perineal wound should be irrigated twice daily with a mild antiseptic solution (e.g., acriflavine 1-10,000) by means of a Higginson's syringe (*Fig. 904*), which has been found a trustworthy method. Irrigation should be commenced when the packing is removed 24 hours after operation and continued for a fortnight.

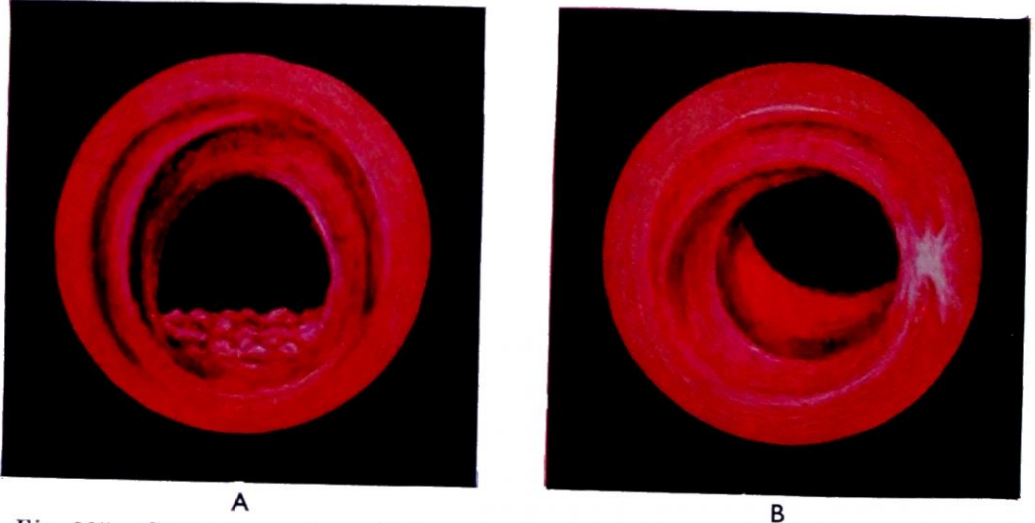


Fig. 905.—Complete rupture of the bulbus urethra treated by suture of the roof. A, Urethroscopic appearance during the sixth week after operation. B, Three months later. An irregular scar is seen on the floor. A 17/19 bougie passes with ease.

Not until the twelfth or fourteenth day is it necessary to commence instrumentation. Before this is undertaken, the meatus should be cleansed and the urethra irrigated with a weak antiseptic solution. One well-lubricated Lister's sound is introduced, exercising the 'rule of the bougie'—*non vis sed arte*—to its fullest degree.

Great stress must be laid upon the necessity for urethroscopic control (*Fig. 905*) in the after-treatment of cases of ruptured urethra. Only by repeated use of the urethroscope and post-operative urethrography (*see Fig. 920*) can the extent of the urethral scarring be determined. While the intervals between urethral dilatations can be extended gradually, it is essential that a bougie be passed occasionally. In many instances, eventually months can elapse between attendances, but it is most advisable for every patient who has sustained a complete rupture of the urethra to attend for occasional urethral dilatation for the remainder of his life.

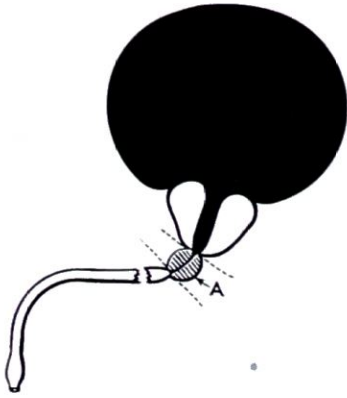


Fig. 906.—In rupture of the bulbus urethra reflex spasm of the compressor urethrae (A) prevents extravasation of urine for several hours.

Complete Rupture with Extravasation (*Fig. 906*).—*The sutureless operation* is without doubt the operation when extravasation has occurred, for suturing is technically impossible in the presence of infection or extravasation. If it is attempted under these conditions, the sutures simply cut out and add still further to the destruction and loss of tissues. A course of penicillin and streptomycin is commenced pre-operatively.

Technique.—Preliminary suprapubic cystostomy and retrograde bouginage are carried out as described previously. The patient is placed in the lithotomy position, and perineal

section is performed. A catheter, a Foley's catheter for preference, is passed from the external urinary meatus into the perineal wound, and from thence is threaded along the posterior urethra guided by the retrograde bougie, which is withdrawn slowly by the assistant as the catheter is advanced. The tip of the catheter is made to protrude through the suprapubic wound. By transfixion, a length of strong silk is attached to the catheter just below the terminal eye. The silk is left protruding from the suprapubic wound, so that in due course the catheter can be changed by the railroad method.

While the gap between the ends of the urethra may be considerable when the patient is in the lithotomy position, yet when the legs are extended probably the ends of the urethra

will be in contact. Once the catheter is in place, if it is not a Foley's catheter, it should be tied in by one of the approved methods. Suprapubic drainage of the bladder should be effected by a large drainage tube so that the bladder can be kept empty by suction drainage, and the prevesical space should be drained adequately. Incisions are made into the infiltrated tissues as necessity demands.

After-treatment.—Being of latex rubber, if a Foley's catheter has been inserted, it need not be changed. In other circumstances the urethral catheter should be changed at the end of a week. The after-treatment of the perineal wound is similar to that described on p. 677. The incisions leading into the extravasated area should be dressed with sterile gauze if non-infected, or, if infected, by the method described in the section dealing with extravasation following peri-urethral abscess (*see* p. 677). In cases of extravasation of urine it is advisable to administer streptomycin in addition to penicillin and sulphatriad.

The suprapubic tube is removed at the end of 14 days. The urethral catheter is removed finally when the suprapubic and perineal wounds have healed. Further details concerning extravasation of urine are given on p. 674.

INTRAPELVIC RUPTURE OF THE URETHRA

Intrapelvic rupture of the urethra is a more serious condition than the foregoing. The mortality is higher, and the immediate diagnosis more difficult. The lesion is almost always an accompaniment of a fractured pelvis, and shock is often pronounced.

In addition to a fractured pelvis, about half the patients will be found to have

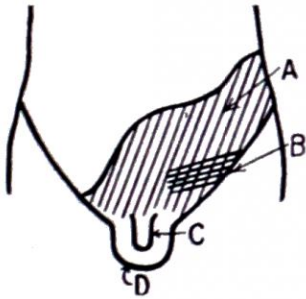


Fig. 907.—Physical signs recorded in a case of intrapelvic rupture of the urethra complicating a fractured pelvis. A, Deep-seated swelling (tender); B, Superficial bruising; C, Blood from meatus; D, Perineum nil. There was grating on compressing the iliac crests.

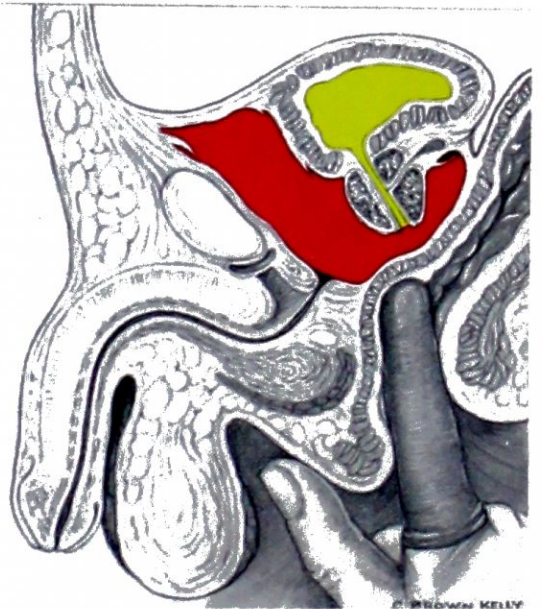


Fig. 908.—Intrapelvic rupture of the urethra. The prostate cannot be felt in its normal position.

sustained one or more other fractures. V. J. O'Connor found that the thigh or leg, one or more ribs, the skull, and a vertebra, in that order of frequency, are the bones most frequently broken. Nor does this complete the list of major concomitant lesions. One must always be alive to the possibility of, and take precautions to exclude, an additional intra-peritoneal lesion.

Diagnosis.—Signs of a fractured pelvis are usually, but not always, evident; on this account, preliminary radiography is most desirable. The patient has not passed urine since the accident, and the escape of blood via the meatus is a common occurrence. On examining the abdomen tenderness above the pubes in a conscious patient is always present. As a rule, a swelling can be felt in the hypogastrium. Extravasation into the pelvic fascia occurs early, and, curiously, it usually proceeds more on one side than on the other (*Fig. 907*). In this variety of rupture of the urethra there is no perineal swelling, but ecchymoses may be present.

Differential Diagnosis.—When the rounded dome of the bladder can be palpated distinctly from the rest of the swelling (the extravasation) intrapelvic rupture of the urethra is probable. If, on rectal examination, the prostate cannot be felt, but where the prostate should be there is an indefinite doughy swelling (blood and urine) (*Fig. 908*), or if the prostate is felt, but is displaced upwards, and on exerting increased pressure upon

it, it eludes the examining finger, then the diagnosis of a complete intrapelvic rupture of the urethra is certain (Vermooten's sign). Unfortunately this sign is not present regularly. In its absence it is desirable to confirm the diagnosis by cysto-urethrography.

Cysto-urethrography will enable intrapelvic rupture of the urethra or extraperitoneal rupture of the bladder to be distinguished from lesions not requiring an immediate operation. The technique of cysto-urography is the same as that described on p. 625, but instead of the medium being introduced through a urethral catheter, the injection is undertaken with a urethral syringe applied to the external urinary meatus, and films are exposed while the medium is still being injected. In this way the urethra will be visualized.

In intrapelvic rupture of the urethra the typical cystographic finding is a 'rising sun burst' shadow, representing extravasation below an intact bladder containing urine.

The Urethral Lesion.—Intrapelvic rupture of the urethra occurs frequently at the apex of the prostate—in other words, the prostatic urethra is severed from the membranous portion. In addition, the puboprostatic ligaments are torn. The loss of these ligaments, aided no doubt by the pressure of the extravasated products in the prevesical space, causes the neck of the bladder, with the prostate, to become displaced backwards (*Fig. 909*). Urine does not escape immediately because of the tone of the internal sphincter of the bladder.

While suprapubic cystostomy and drainage of the prevesical space commonly saves the life of the patient, it is essential to go further, and make provision for restoration of the continuity of the urethra before it is too late. It is the backward displacement of the bladder neck that accounts for the poor results of remote restoration of continuity of the canal; and if it is not rectified at the initial operation we are bound to meet with the following depressing aftermath:—

A patient presents himself with a suprapubic fistula. The sinus is unhealthy and discharging purulent urine. He may have been fitted with a permanent suprapubic belt, but the reason for his appearance is that the fistula has closed down and will not admit the catheter. An examination of the perineum reveals an old scar, and there is a history of a fractured pelvis, rupture of the urethra, suprapubic drainage, and drainage of the prevesical space. At a later date (usually when the fracture has united) an attempt—or more often several attempts—has been made to restore the continuity of the urethra, but without success. Continually wet and smelling of urine, subject to

recurrent attacks of cystitis and pyelitis, these cases are poignant examples of what Rutherford Morison refers to so aptly as "lifelong tragedies".

These tragedies *can* be obviated, but only by correcting the backward displacement of the neck of the bladder before it becomes anchored in its abnormal position.

When intrapelvic rupture of the urethra has occurred, seldom can a catheter be passed into the bladder; it is therefore impossible to divide these cases into incomplete and complete ruptures. There is, however, little doubt that in many the continuity of the urethra is not broken completely (D. S. Poole-Wilson).

Armamentarium.—For the correction of the backward displacement of the bladder neck and the prostate, some form of catheter of the Foley type, which permits extension being applied to the neck of the bladder via the catheter, is essential.

1. Foley's balloon-ended catheter is generally employed (*Fig. 910*).
2. Pilcher's bag (*Fig. 911*) is also excellent. Its strength is an advantage.
3. Improvisation: When neither (1) nor (2) is available, or the catheter or bag is too large to permit its use in a child, a soft-rubber catheter, after it has been passed in the way presently to be described, can be rendered suitable in the following way: the eyed end of the catheter is brought out of the suprapubic wound. Rubber dam¹ (lengths can be cut from a rubber glove) $\frac{3}{4}$ in. (1.8 cm.) wide is wound around the shaft of the catheter above the eyes, until there is a substantial collar. The collar is made fast by transfixion

¹ Penrose rubber tubing, or small Paul's rubber tubing, is ideal for this purpose.

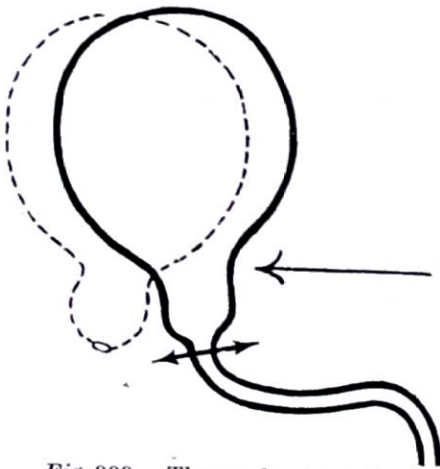


Fig. 909.—The mechanism of backward displacement of the bladder. The urethra having been severed near the apex of the prostate, and the puboprostatic ligaments having been torn, the pressure (arrow) of the extravasated products in the prevesical space causes the neck of the bladder to be displaced backwards.

with a silk ligature passed on a straight cutting needle. The ligature is then tied firmly, first on one side and then on the other, thus binding the collar. It must be removed by pulling it head first through the cystostomy wound (Constantian and Felton).

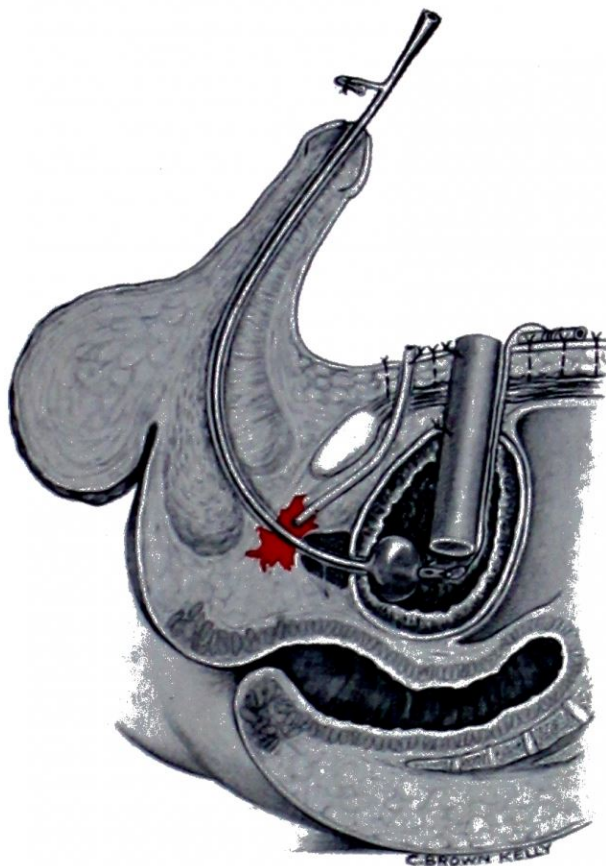


Fig. 910.—Foley's catheter in place in a case of intrapelvic rupture of the urethra. Extension has not yet been applied to the catheter.

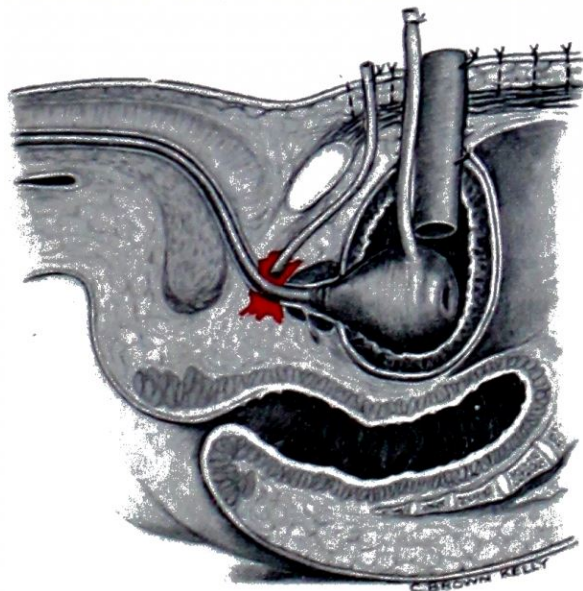


Fig. 911.—The use of Pileher's bag in intrapelvic rupture of the urethra. Extension has not yet been applied.

In addition to the special catheter, Lister's sounds will be required. Before commencing the operation, select two of these sounds that should be commensurate with the size of the patient's urethra (13/15 and 14/16 for an adult). Have in readiness a long piece of rubber tubing that fits really tightly when milked on to the beak of the smaller of the two sounds.

OPERATION FOR INTRAPELVIC RUPTURE OF THE URETHRA

The importance of temporary immobilization of the fractured pelvis during the patient's transit to and from the operating theatre and thereafter has been discussed in connexion with rupture of the bladder on p. 626. Blood transfusion or infusion of a blood substitute throughout the operation is essential.

When the facilities for cysto-urethrography are lacking, and there is any doubt about the diagnosis, instrumentation of the urethra should be undertaken in the operating

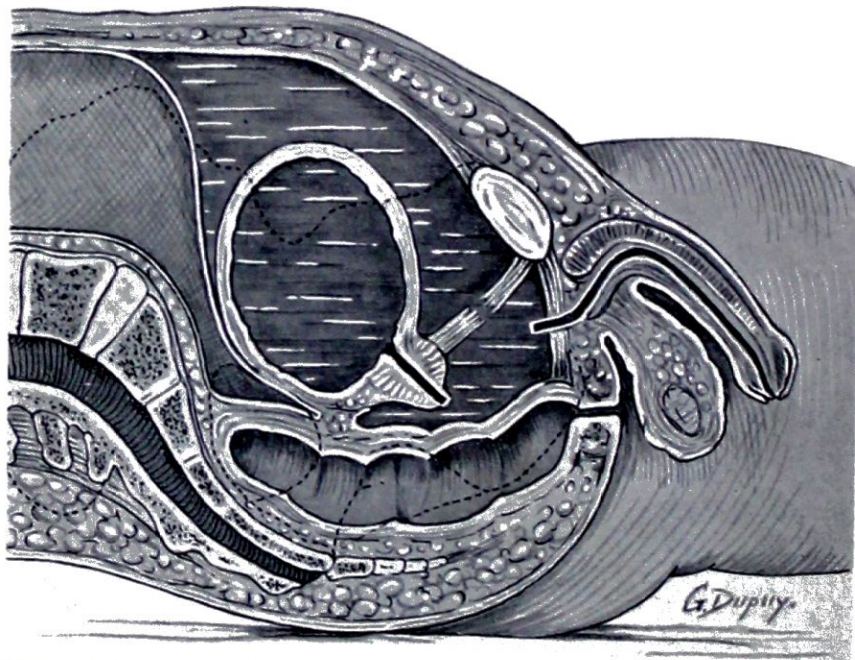


Fig. 912.—Intrapelvic rupture of the urethra. The puboprostatic ligaments are torn, and the bladder, which may be moderately distended, becomes displaced backwards. (Cf. *Fig. 913.*)

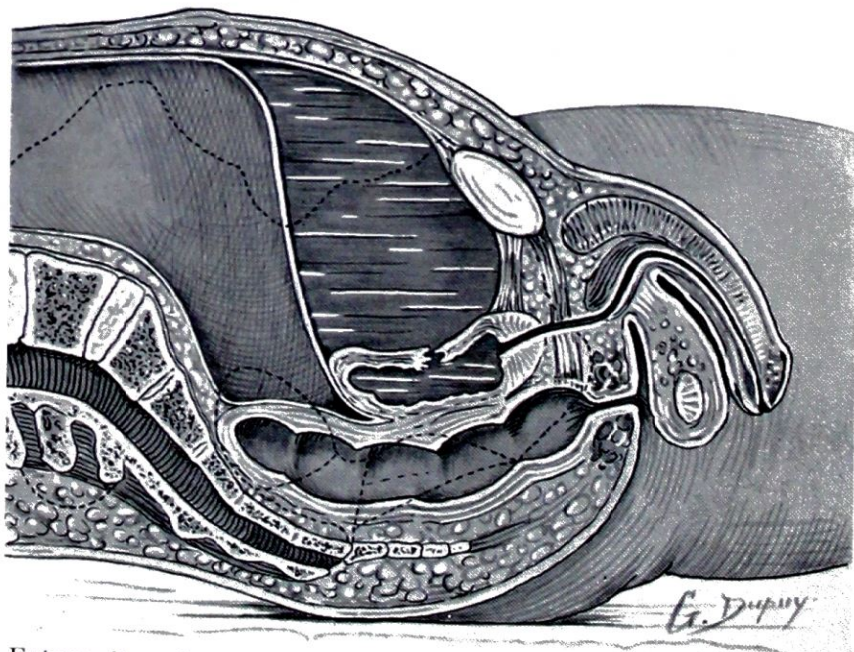


Fig. 913.—Extraperitoneal rupture of the bladder. The bladder is empty or practically so. (Cf. *Fig. 912.*)

theatre. The surgeon must be watchful lest the passage of a catheter into the prevesical space, and the withdrawal of a few ounces of blood-stained urine from this situation, be mistaken for an entry into the bladder. This is a trap into which many have fallen.

The method of draping the towels, the site of the incision, and the directions for inspecting the interior of the peritoneal cavity are exactly the same as those described on p. 626 for ruptured bladder. Blood and urine are aspirated or mopped from the prevesical space; even

then, amidst the blood-stained effusion, it may not be easy to determine the exact site of the lesion. The guiding rule is : if the bladder is even moderately distended, the lesion must be situated below the internal vesical sphincter. Thus the diagnosis of rupture of the urethra is confirmed (*Figs. 912, 913*). When, as is often the case, hæmorrhage from the depths of the pelvis is profuse, packing should be inserted while other matters receive consideration.

Before opening the bladder the bony pelvis should be manipulated into the best possible position. An assistant exerting traction on the lower extremities may facilitate this procedure.

Occasionally elevation and internal fixation of the fragments of the pubic bones are necessary to avoid further trauma to the soft parts post-operatively.

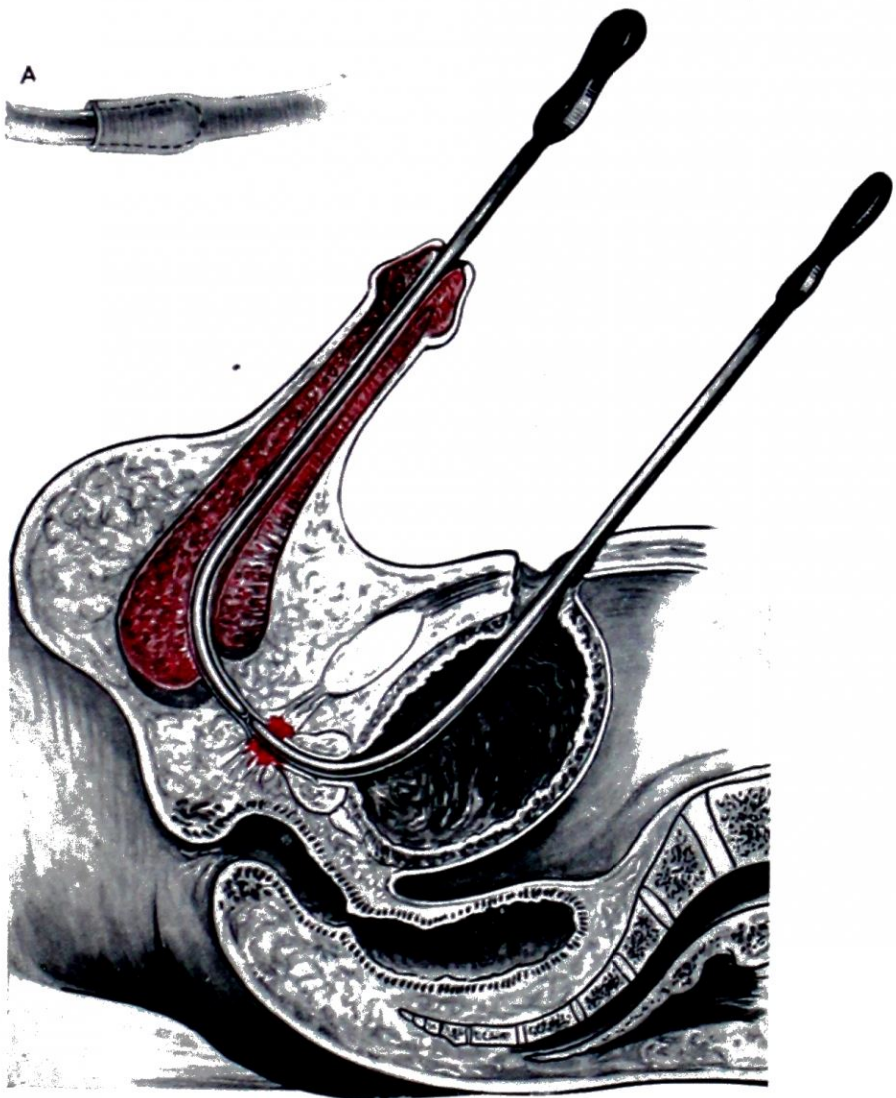


Fig. 914.—Complete intrapelvic rupture of the urethra. The two Lister's sounds are manipulated until their beaks are indisputably in contact. The instrument on the left is then guided by its fellow into the bladder and the tear in the membranous urethra is bridged. A, Method of attaching the rubber tube to the beak of a Lister's sound.

Suprapubic Cystostomy is performed. Unlike extraperitoneal rupture of the bladder, identification of the bladder in intrapelvic rupture of the urethra seldom presents any difficulty, because of the urine it contains.

Methods of negotiating the Breach of Continuity of the Urethra.—

Method I.—If the left index finger is passed through the internal urinary meatus into the prostatic urethra, not infrequently it is possible to guide the beak of a Lister's sound which has been passed down the anterior urethra, into the bladder. The long rubber tube referred to already is milked on to the beak of the sound, which is slowly withdrawn from the external urinary meatus, and in this way the rubber tube is drawn past the rupture along the whole course of the urethra.

Method 2.—The larger Lister's sound is inserted into the internal urinary meatus and passed along the prostatic urethra to the seat of rupture. The smaller Lister's sound is passed through the external urinary meatus, along the urethra, until it comes into contact with the tip of the first. The two sounds, one in each hand, are manipulated gently until their beaks lie in contact with one another, end to end (*Fig. 914*). By withdrawing the first bougie and advancing the second, keeping the beaks in contact, it is possible to guide the second bougie past the seat of the rupture and into the bladder; no force must be used. The first sound is removed; the second is made to protrude through the suprapubic opening. A rubber tube is attached to the beak, as described in Method 1, and by withdrawing the sound through the external urinary meatus, the tube is laid along the whole course of the urethra (Banks's method).

Method 3. Pass a Lister's sound through the internal urinary meatus, and make its beak emerge through the severed upper end of the urethra into the prevesical space. Thread one end of the rubber tube on to the tip of the sound, and withdraw the sound, thus carrying the tube into the bladder and out of the suprapubic wound. Clip the tube

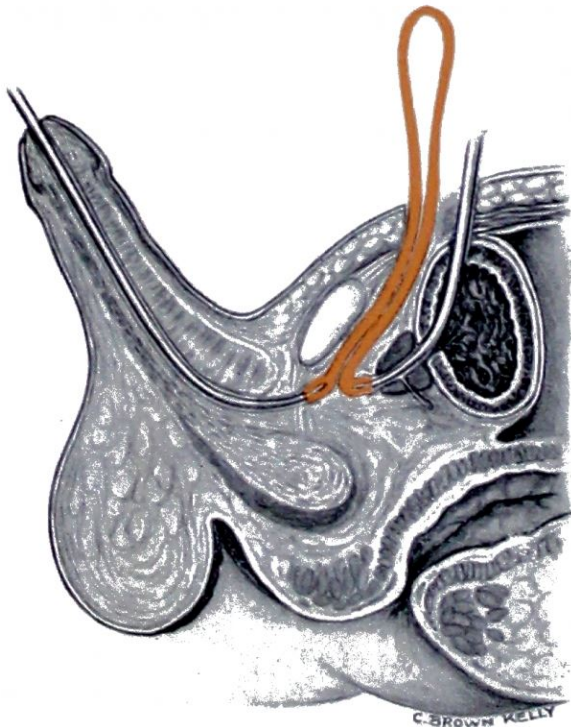


Fig. 915.—Method of negotiating the gap by threading each end of a rubber tube on to a Lister's sound.

in a hæmostat, and disconnect the sound. Insert the same sound into the external urinary meatus, and make its beak appear in the prevesical space. Thread the other end of the tube on to its tip (*Fig. 915*), and withdraw the sound, thus bringing the tube along the whole course of the urethra. If there is difficulty in threading the tube on to the sound passed from below, tilting the patient into steep Trendelenburg's position facilitates this step.

The third method is only necessary when both the first and second methods prove unsuccessful.

Inserting a Foley's Catheter.—To the suprapubic end of the rubber tube attach a long piece of strong silk, by means of a needle and a knot. By pulling on the rubber tube from the external urinary meatus, the silk is made to traverse the whole course of the urethra. The silk is cut just above the knot, and the rubber tube is discarded. The Foley's catheter is taken, and a tight ligature is tied just beyond the eyes; in this instance the

catheter is *to be regarded as a splint, and should not be used for drainage*. The free end of the long piece of silk is threaded on to a needle which transfixes the Foley's catheter near its tip, enabling the silk to be tied to the catheter. By pulling on the end of the silk emerging from the suprapubic wound, the Foley's catheter is made to traverse the whole length of the urethra, and its balloon enters the bladder. After the bag has been moderately distended with water the side tube is folded on itself and ligated securely (*see Fig. 918*). The length of silk attached to the tip of the catheter is left protruding from the suprapubic wound to permit changing the catheter by the railroad method. It is convenient to wind the excess of silk around a stout piece of rubber tubing or a sterile wooden tongue spatula, and to secure it with a single knot.

The introduction of a Pileher's bag is similar, but it is drawn into the urethra from above, by attaching the silk to the proximal extremity of the tube.

In cases where the general condition is poor, the operation can be concluded at this stage in the manner described below. However, the incidence of infection¹ is reduced, anatomical reposition is more perfect, and the complication of a burst bag is almost eliminated, by the addition of one more step before closing the wound.

¹ When a bag catheter alone is employed, infection is favoured (a) by possible pressure necrosis from prolonged weight extension on the catheter; (b) the necessarily comparatively long sojourn of an indwelling catheter when reliance is placed on the catheter alone.

Reposition of the Prostate in an Anatomically Correct Position by Sutures (L. A. Orkin).—

Two long sutures of heavy silk are passed through the substance of the prostate on either side of the middle line, towards its apex with a fully curved needle on a holder. The curved needle having been removed, each of the four ends of these sutures is threaded on straight cutting needles (Fig. 916). An assistant removes the towel covering the scrotum, flexes and abducts the right knee, elevates the scrotum, and sterilizes the skin of the perineum. With the vesical neck and the prostate under direct vision, the surgeon passes the sutures below the symphysis pubis to emerge in pairs lateral to the middle line of the perineum. The assistant catches each needle in a hæmostat as it appears, and pulls the suture through. While the surgeon holds the displaced prostate in the anatomically correct position, each of the two stay sutures is tied over a small rubber tube by the assistant. The knot is tied just tight enough to maintain perfectly correct anatomical alignment, and no tighter. The perineum is then covered by a dry dressing. This accomplished, the assistant extends the leg, and the sterile towels are replaced.

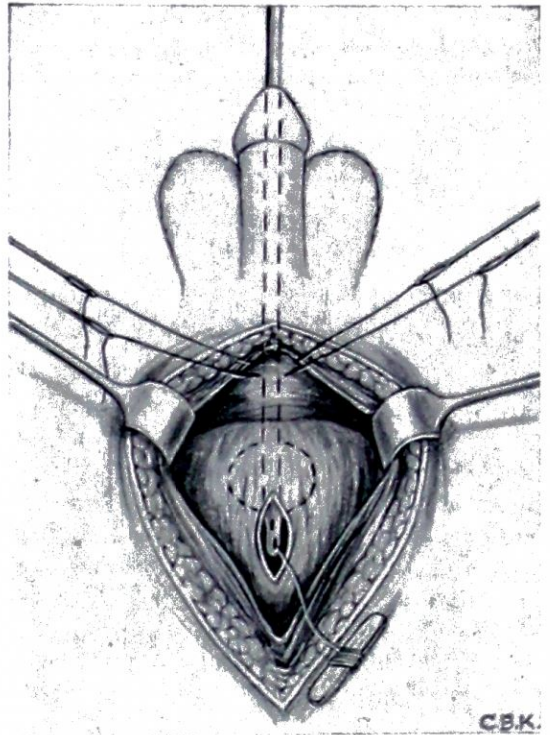


Fig. 916.—Traction sutures are placed in the prostate prior to passing each pair through the triangular ligament to the perineum where they are tied. (After L. A. Orkin.)

Concluding the Operation.—The opening in the bladder is closed around a large drainage tube, which will be used for sump drainage (see p. 189). Two Penrose drains are inserted into the prevesical space, one on either side of the middle line (Fig. 917). The abdominal wall is closed in the usual manner, and all tubes are anchored to the skin.

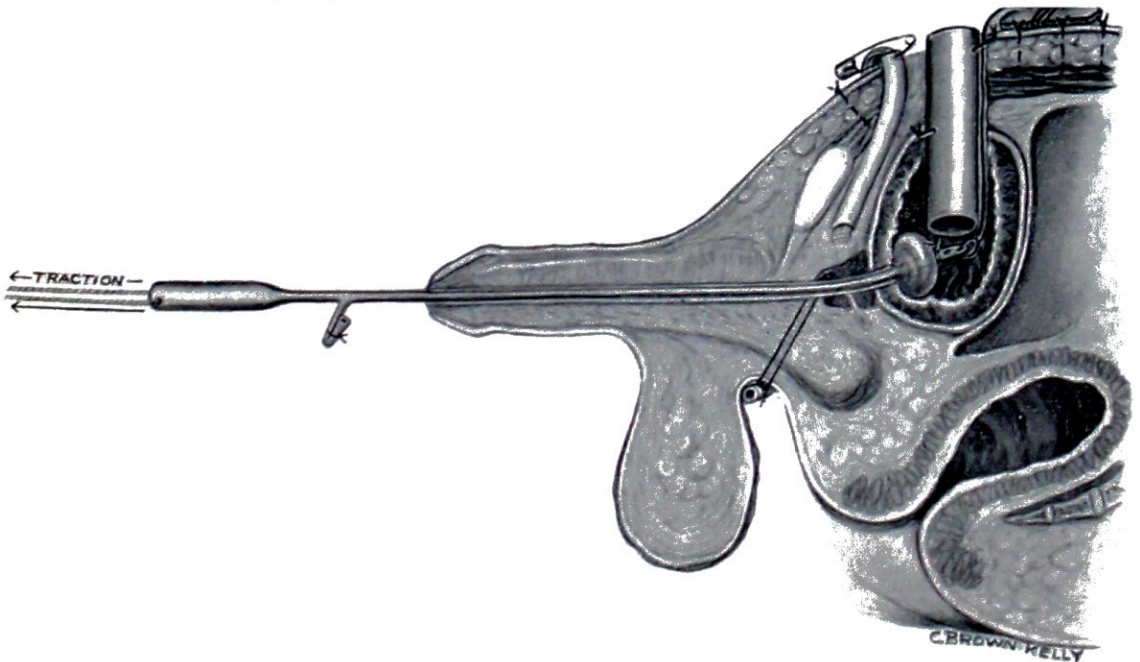


Fig. 917.—Operation for intrapelvic rupture of the urethra, including suture of the apex of the prostate to the perineum, completed. (After L. A. Orkin.)

Effecting Extension via the Catheter when Anchoring Sutures have been employed.—Much lighter extension is required than in the case of a sutureless operation. By the mediation of a silk suture passed with a needle through both lateral walls of the expanded

end of a Foley's catheter (*Fig. 918*), sufficient traction can be maintained by attaching the silk to the leg in the following way; one long end is laid on the skin of the outer side of the leg below the knee. A crêpe bandage is then wound around the leg below the patella. Thus one end of the suture is below the bandage and one outside it. The ends are then tied together, so as to exert moderate tension on the catheter with the leg extended. The reason for applying the traction to the outer side of the leg below the knee is to enable the patient to flex the knee without releasing the traction.



Fig. 918.—Passing the stitch for extension through the distal end of a Foley's catheter.

tension must be applied and maintained with great care. If it has not been carried out in the operating theatre, the distal end of the catheter is transfixed with a very long piece of strong silk—long enough to allow the ends to pass over the bed-rail at the foot of the bed for about 12 in. (30 cm.). A spigot is placed in the open end of the catheter to prevent urine draining by this route. The silk traction cords are passed over a pulley which has been attached either to the bed-rail or, if a special pulley of this type is not available, over an ordinary pulley screwed to a board which is placed at the foot of the bed. Satisfactory traction is exerted by 2 lb. for three days and 1 lb. thereafter for fourteen days. Bed-cages must be so arranged as to prevent the bedclothes touching the cords.

(b) *Keeping urine away from the seat of the rupture:* The suprapubic drainage tube is connected to a suction apparatus, Stedman's fitting (*see p. 189*) being most satisfactory for this purpose. The foot of the bed is raised on 12-in. (30-cm.) blocks. Both these

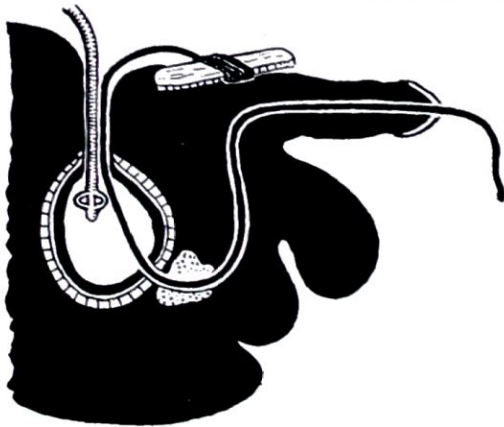


Fig. 919.—Method of retaining a length of silk along the whole course of the urethra for use in early bouginage. (After L. A. Orkin.)



Fig. 920.—Cysto-urethrogram after operation for intrapelvic rupture of the urethra. Armed with this radiographic evidence, the catheter was not replaced.

expedients aim at keeping urine away from the severed ends of the urethra. Both can be dispensed with on or about the 12th day. When the suprapubic tube is removed, a Malecot catheter is substituted.

(c) *Antibiotic and urinary therapeutics:* Is commenced as early as possible. Penicillin 500,000 units and streptomycin 0.5 G. are administered 12-hourly, and should be continued for 10 days, unless the result of culture of the urine (which should be undertaken at regular intervals) dictates otherwise. The urine is kept alkaline with a mixture of sodium citrate containing tinct. hyoscyami, as directed on p. 575.

(d) *How long should the urethral catheter be retained?* To leave it in for 4–6 weeks, as is sometimes recommended, must provoke urethritis and fibrosis. Far better is it to remove the catheter at the end of 10–12 days, but in so doing to leave the attached silk (which is soaked in penicillin solution just prior to being unwound) along the whole course of the urethra, emerging at the external urinary meatus at one end and through the suprapubic wound at the other (*Fig. 919*). Urethrography is carried out (*Fig. 920*). Should extravasation of the medium occur, a catheter is replaced. If no extravasation is demonstrated, the catheter is

left out, but it is advisable for the silk to remain in situ until the suprapubic wound has almost healed. The silk is used for periodic bouginage by the railroad method.

In one case where the indwelling silk guide was not employed, J. H. Powers found that he could not replace the catheter. He therefore introduced a cystoscope into the suprapubic wound, and by its aid was enabled to pass a ureteral catheter through the internal urinary meatus and thence along the whole urethra.



Fig. 921.—Fractured left pubic ramus with gross displacement—a type of injury that is almost certainly associated with intrapelvic rupture of the urethra.

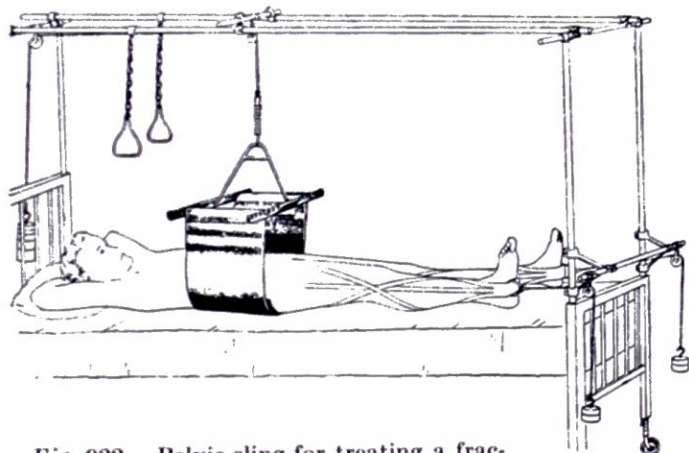


Fig. 922.—Pelvic sling for treating a fractured pelvis (London Splint Co.).

Orthopædic Management.—Many of the more remote disabilities of fractured pelvis complicated by intrapelvic rupture of the urethra, including urethral stricture, are due to deformity of the pelvis, or excessive callus formation.

Fractures of the pelvic ring with minimum displacement can be treated by bed rest between sandbags for 6–8 weeks. However, in the more common types of fractures of the pelvis associated with injuries of the lower urinary tract in which there is separation of the symphysis pubis or fracture of the pubic ramus (Fig. 921) or rami, it is highly important to effect or maintain reduction. The two halves of a separated symphysis can be brought together by a sling around the pelvic girdle (Fig. 922), supported by weights over an over-



Fig. 923.—Osteitis pubis following fracture of the pelvis. Typical X-ray appearance in this condition. (After C. P. Mathé.)

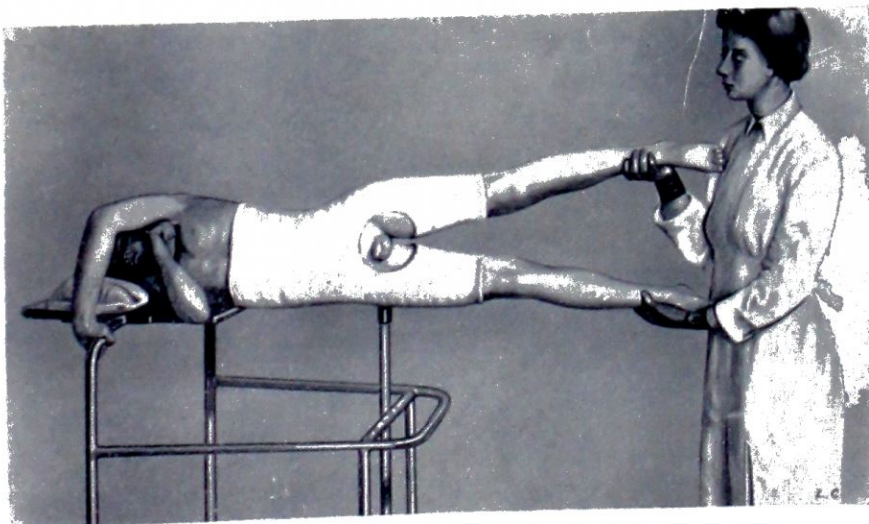


Fig. 924.—Applying a double hip spica in the lateral position. The patient is lying upon the relatively uninjured side. (After Sir Reginald Watson-Jones.)

head beam. If this expedient is used as the sole method of treatment, as opposed to a temporary expedient, the patient is

liable to be left with a narrow heart-shaped pelvis, which causes even more disability than when the pelvis is too wide. When asymmetry of the pelvis is present with shortening, then skeletal or skin traction should be applied to the shortened leg. After several days, as soon as the patient's general condition permits, Sir Reginald Watson-Jones advises that a double hip spica plaster be applied. This is the best method of immobilizing the fracture; it allows the patient to be turned, thus avoiding bed-sores, and minimizes the complication of osteitis pubis (Fig. 923). The plaster should be applied with the patient in the lateral position (Fig. 924). Although an advantage, an orthopædic table is not

essential for the application of the plaster. There is no difficulty in accommodating the suprapubic cystostomy wound. The margins of a fairly generous window are packed with petroleum-jelly gauze. The same remarks apply to a perineal wound, if such be present, especially if the plaster is put on with the thighs abducted fairly widely.

Treatment of Osteitis Pubis.—The pain is relieved within 36 hours, and resolution hastened by the administration of cortisone by mouth, 50 mg. twice daily for two days, and then 25 mg. for sixteen days, so that in all 1 G. of cortisone is given.

EXTRAVASATION OF URINE

Extravasation of urine may be deep or superficial.

Deep extravasation is that which occurs above the pelvic diaphragm as a result of intrapelvic rupture of the urethra and extraperitoneal rupture or perforation of the bladder. By liberal drainage of the prevesical space the condition is cared for adequately, the bladder being kept empty by continuous suprapubic suction. If pocketing occurs posteriorly, which is unusual, perineal drainage of the pararectal tissues must be undertaken (*see p. 540*).

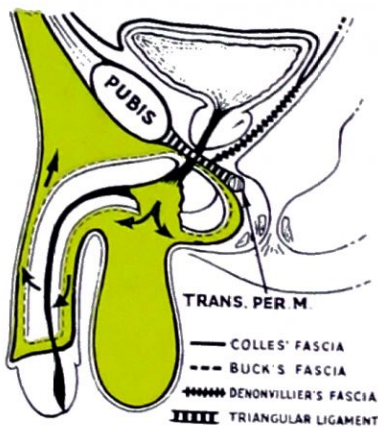


Fig. 925.—The fascial planes concerned in superficial extravasation of urine. (*After Wesson.*)

Superficial extravasation will occur into the substance of the penis if Camper's fascia is intact. When, as is more usual, Camper's (syn. Buck's) fascia is torn or eroded, diffusion occurs superficial to this fascia, but beneath Colles' fascia, to distend the perineum to the midperineal point, the scrotum, and the penis. Unrelieved, the extravasation or the cellulitis that accompanies it passes up the abdominal wall beneath Scarpa's fascia, which is continuous with Colles' fascia (*Fig. 925*).

In over 80 per cent of cases superficial extravasation arises as a complication of peri-urethral abscess, which in turn is the result of a urethral stricture. Smith and Pinton, analysing 150 examples of superficial extravasation of urine occurring at the Baltimore City Hospitals, found that traumatic rupture of the bulbous urethra accounted for only 5 per cent of the cases. The passage of instruments such as sounds, catheters, and cystoscopes was the cause in 18 per cent, while the remainder were due to peri-urethral abscess.

In non-infected cases of superficial extravasation it is only necessary to make adequate incisions and release the urine imprisoned beneath Colles' fascia. Several authorities state that the incisions in the scrotum should be deep enough to lay bare the testes and spermatic cords: Finestone has shown by injection experiments that the deeper structures of the scrotum are not involved; consequently it suffices to make a long incision through the superficial fascia only on each side of the median raphe.

A far more difficult problem is the treatment of peri-urethral abscess with extravasation, which is relatively common. A better understanding of the principles of surgical anatomy, together with the use of antibiotic therapy, has done much to reduce the mortality.

PERI-URETHRAL ABSCESS WITH EXTRAVASATION

When the urethra has given way behind a stricture and urine has become diffused into the cellular texture, very prompt and vigorous measures are necessary. Delay is fatal. (Sir Benjamin Brodie.)

A peri-urethral abscess which gives rise to extravasation is usually connected with the bulbous portion of the urethra. Arguments as to whether it is urine which is forced beneath the fascial planes or whether the phenomenon is not rather a subfascial cellulitis need not detain us. It is, however, necessary to grasp certain fundamental points concerning the surgical pathology of the condition.

1. Incision of a peri-urethral abscess does not usually open the urethra and drain the bladder, for reasons shown in *Fig. 926*.

2. By the time the peri-urethral abscess has advanced sufficiently to invade the superficial perineal tissues it must have traversed the bulb of the corpus spongiosum. In doing so, it is highly probable that infiltration beneath Camper's fascia has resulted in thrombophlebitis of some portion of the extremely vascular corpus spongiosum or corpora

cavernosa. Here lies the explanation of Sir Benjamin Brodie's aphorism, "a black patch on the penis is a harbinger of death".

3. A constant observation of surgeons who have devoted attention to the subject is that it is not those patients with a peri-urethral abscess resulting from an impassable stricture who develop extravasation, but rather the ones with a passable stricture who continue to pass urine. E. O. Finestone explains this paradox by suggesting that the extravasation is due to the contractions of the bulbocavernosus which occur with each act of voiding. For this reason the urinary stream must be diverted at the earliest possible moment.

OPERATIVE TREATMENT

To drain the bladder suprapubically is inadvisable: of necessity the cystostomy incision traverses the infected superficial planes, and incurs the danger of deep pelvic cellulitis. The following is the best method of procedure:—

A low spinal anæsthetic suffices unless the extravasation has extended above the pubes, when, in addition, a short general anæsthetic is required while incisions are being made into these superficial planes.

After washing out the urethra, an attempt is made to pass a bougie. The urethra in the region of the stricture is intensely inflamed if not gangrenous, and therefore extreme gentleness must be exercised. It is usually possible to insert a small French bougie through the stricture. I do not remember having failed to pass the stricture in this condition, although in a few instances it has been necessary to resort to the faggot method (*Fig. 927*).

The introduction of a bougie simplifies the subsequent stages of the operation.

If the bougie has been passed, it should be fixed in position. A good method of fixing the bougie is to clip a hæmostat on to its extremity to prevent it passing in, and to tie a turn of bandage moderately tightly around the penis behind the corona to prevent it slipping out.

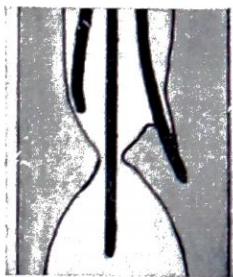


Fig. 927.—Faggot method of passing bougies.

A Bougie has failed to pass through the Stricture.—*Cock's operation* should be performed (*see p. 677*).

A Bougie has been passed (which will be found possible in the majority of cases).—The patient is placed in the lithotomy position. Two Lane's tissue forceps are clipped upon the infiltrated scrotum. By passing a loop of bandage through the handles of these forceps the anæsthetist, or a nurse at the head of the table, can retract the scrotum upwards, leaving the operator with an unobstructed view of the perineum. Towels having been arranged, an incision is made from the base of the scrotum to within half an inch of the anal verge, keeping strictly to the middle line. The tissues being extensively infiltrated, it is usual to find that one has to proceed to a depth of $\frac{3}{4}$ in. (1.8 cm.) or more before the abscess is reached.

Urine and pus then escape, usually under considerable pressure. A finger is now passed into the wound, and the bougie within the urethra (*Fig. 928*) sought by palpation. Retractors are placed in either side of the wound, and the urethra is inspected. The floor of the urethra is incised and the edges are retracted. The left index finger is passed into the dilated urethra, with the pulp against the bougie; the finger is guided into the bladder. A large polythene or gum-elastic coude catheter is now passed through the incision along the index finger into the bladder, and secured to one side of the wound with a stitch (*Fig. 929*). Alternatively a Foley's catheter can be employed for this purpose. If the bladder is very distended (as a rule it is not) the usual precautions for decompressing it must be taken.

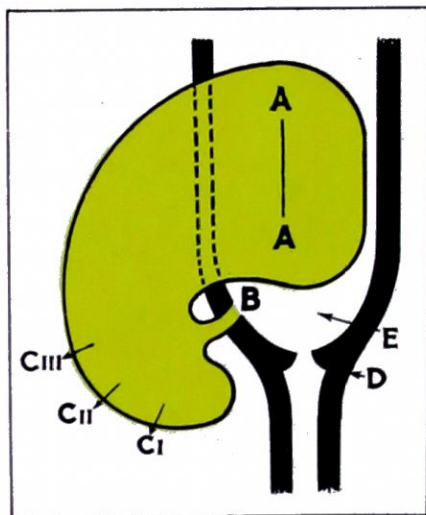


Fig. 926.—An incision into a peri-urethral abscess does not usually open the urethra and drain the bladder. A-A is an incision into the peri-urethral abscess which communicates with the urethra through a small lateral orifice (B) behind the stricture. C I, C II, C III, is that part of the abscess wall which has given way, and through which urine and pus are extravasating. D, Stricture; E, Dilated urethra.

Drainage of the Infiltrated Area.—A long incision on each side of the median raphe of the scrotum. For reasons set out above, these incisions should pass no deeper than beneath the superficial fascia. The incisions into the infiltrated area of the abdomen

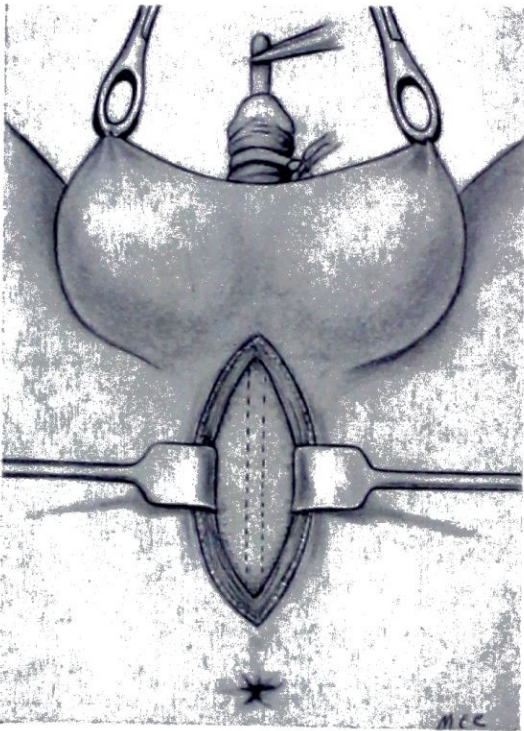


Fig. 928.—Peri-urethral abscess with extravasation. The perineal stage of the operation. Note the method of maintaining the bougie in position. A hæmostat prevents it going in too far, whilst a turn of bandage tied behind the glans prevents its coming out. Lane's tissue forceps are acting as scrotal retractors.



Fig. 929.—A towel clip is used to pierce the catheter. To endeavour to pass a needle and thread through a gum-elastic catheter without this preliminary step entails a great deal of trouble.

(*Fig. 930*) should be bowed and extend beyond the infiltrated area for a short way into the normal tissue. If this is not done, infiltration often continues.

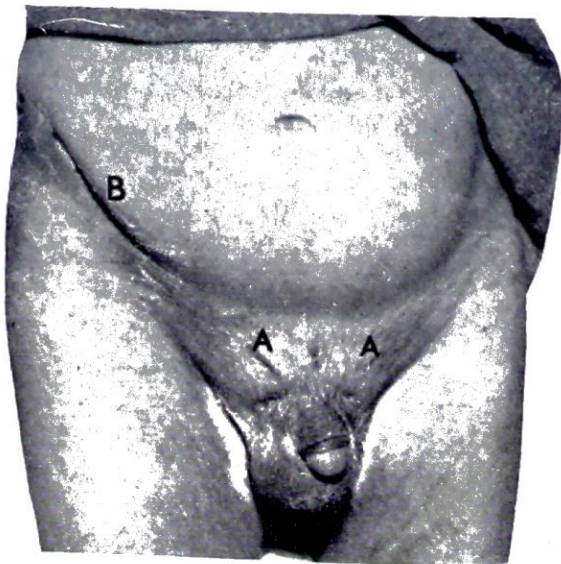


Fig. 930.—Patient convalescent from peri-urethral abscess with extravasation. A, B, Incisions into the infiltrated tissues.

At the conclusion of the operation the drip infusion of dextrose-saline is commenced cautiously. This is an important



Fig. 931.—Sloughing of the overlying skin after extravasation of urine. Involved area treated by skin-grafting during convalescence. (*G. Y. Char.*)

part of the treatment of the case, for, as pointed out already, considerable depression of the renal function is part and parcel of that clinical entity—peri-urethral abscess with extravasation.

Immediate After-treatment.—There is no doubt that anaerobic organisms are largely responsible for the spreading of cellulitis in these cases. Because streptomycin is contra-indicated in patients with poor renal function, a broad spectrum antibiotic is administered until a report on the sensitivity of the infecting organisms is to hand when, if necessary, substitutions can be made. Sulphonamide therapy should not be given until it is quite certain that the urinary output is adequate. As oxygen is inimical to gas-forming organisms, a good method is to place Carrel's tubes into the incisions and irrigate them with hydrogen peroxide, followed by a weak antiseptic solution. Several observers have found peroxide of zinc most effective. The powder is sterilized, and afterwards made into a cream with sterile water; it is applied liberally.

Local Complications.—

Residual abscess is frequently seen in the flank just above the anterior superior iliac spine. Under gas anaesthesia the abscess should be opened freely.

Sloughing of a large area of skin sometimes occurs (*Fig. 931*). Skin-grafts will probably be needed eventually.

More Remote After-treatment.—When the infection has subsided, which is usually in about 3–4 weeks, the treatment of the perineal fistula should receive attention.

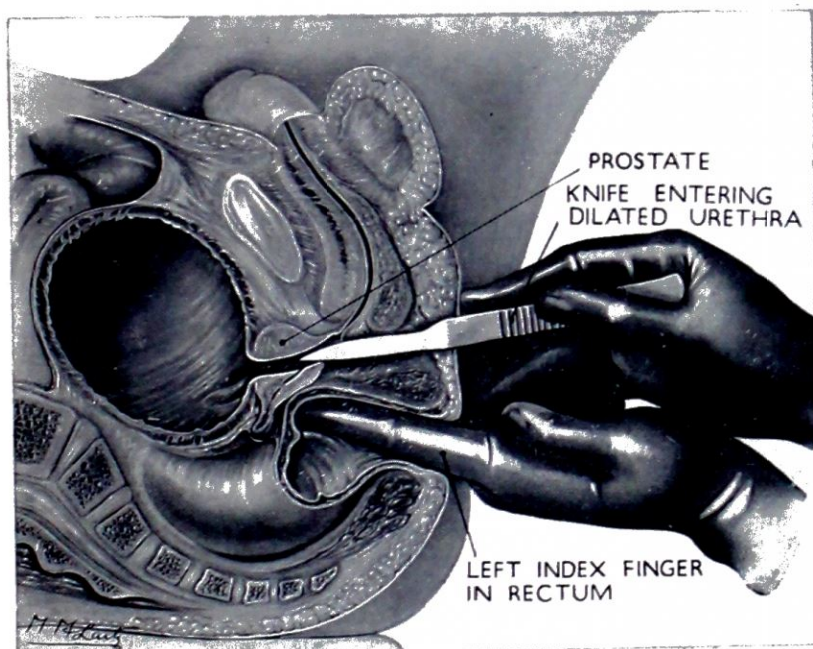


Fig. 932.—Cock's operation. The finger in the rectum rests on the apex of the prostate and acts as a guide.



Fig. 933.—Teale's probe-pointed gorget.

Sometimes it is possible to dilate the stricture with bougies; at others, when the stricture is a tight one, internal urethrotomy with the insertion of an indwelling catheter is an effective method of dealing with the stricture and hastening closure of the wound.

The patient should not be discharged until the fistula has closed. Arrangements must be made for the stricture to be dilated regularly.

Cock's Operation is an external urethrotomy that opens the urethra behind the stricture and without a guide. It is indicated in those cases of peri-urethral abscess and extravasation in which a bougie cannot be passed. These cases are very few and far between.

Technique.—Lithotomy position. It is of the utmost importance that the body and the pelvis should be straight so that the median line may be accurately preserved. The left index finger is introduced into the rectum and the tip of the finger is lodged at the apex of the prostate (*Fig. 932*). The knife (Cock used a double-edged knife) is plunged steadily but boldly into the middle line of the perineum and carried on towards the tip of the left forefinger. The point of the knife enters the dilated urethra just in front of the apex of the prostate. When it is certain that the knife has penetrated the urethra, the instrument is withdrawn, but the left forefinger remains in position. Teale's probe-pointed gorget (*Fig. 933*) is passed into the wound, and, guided by the

left forefinger, enters the urethra and is passed onwards into the bladder. A large coude catheter is slid along the director, which is then removed, and the catheter, having been cut short, is secured to one side of the wound with a stitch.

The after-treatment is as detailed above.

FOREIGN BODIES IN THE URETHRA

In the male, foreign bodies are usually introduced into the urethra with the object of relieving acute retention. More often than not the foreign body fails to give the desired relief, and we have to perform the dual service of retrieving the object and relieving the retention. In locating the foreign body a radiograph is often valuable (*Fig. 934*). Urethroscopy should be performed whenever possible. By this means the foreign body, if in the anterior urethra, can be seen. Many, if not most, foreign bodies can be extracted in the following way. The sheath of the urethroscope is left in situ, and a pair of alligator forceps seizes the foreign body (*Figs. 935, 936*). The sheath, the forceps, and the foreign body are then removed *en bloc* (*Fig. 937*).



Fig. 934.—Hairpin in bulbous and membranous urethra inserted by a patient to relieve acute retention. Removed via a urethroscope sheath.

himself with a hairpin, he went downstairs and proceeded to attempt to get relief. A few hours later he was admitted to hospital with the bladder extending almost to the umbilicus and the hairpin lost within the depths of the urethra. Morphine, gr. $\frac{1}{4}$ (0.016 G.), and a hot bath relieved the retention. After urethroscopy the hairpin was caught with alligator forceps through the sheath of the urethroscope. The forceps, sheath, and hairpin were then extracted together.

B. G., aged 48, had been drinking heavily one Saturday night, and on getting home found that he was unable to pass urine. Towards morning the pain became intolerable, so, having armed



Fig. 935.—Foreign body in urethra. Urethral forceps are introduced through the sheath of a urethroscope.

Irregular foreign bodies, or those of long standing which have become encrusted with phosphates, are best dealt with by opening the inferior wall of the urethra at the site of the obstruction. After the extraction has been effected, the concomitant infection renders it necessary to leave the lips of the wound open widely.

In the absence of a urethroscope, pins and needles in the anterior urethra may be extracted by angulating the penis in such a way as to make the sharp point of the foreign body protrude through the floor of the urethra. In the case of a needle, once the point

has protruded it may be extracted immediately ; but a pin, on account of its head, must be manipulated so that the head points towards the meatus (*Fig. 938*).

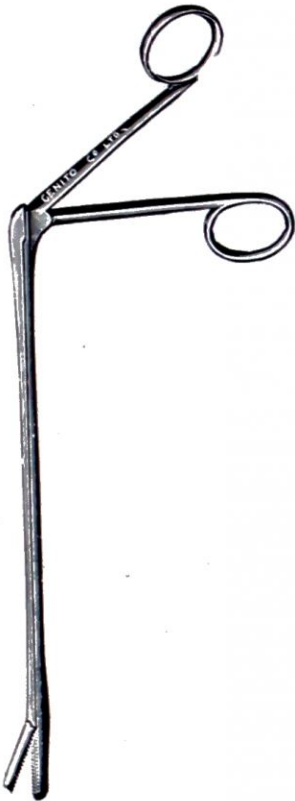


Fig. 936.—Alligator forceps.

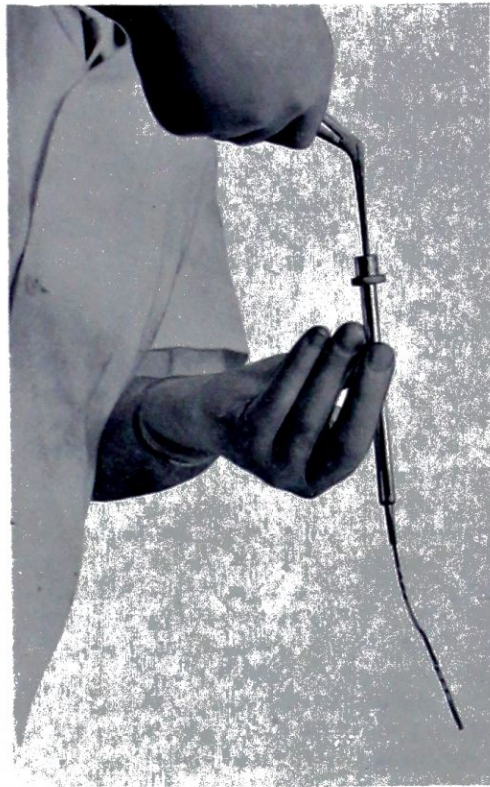


Fig. 937.—Sheath of the urethroscope, forceps, and foreign body (a hairpin) removed *en bloc*.

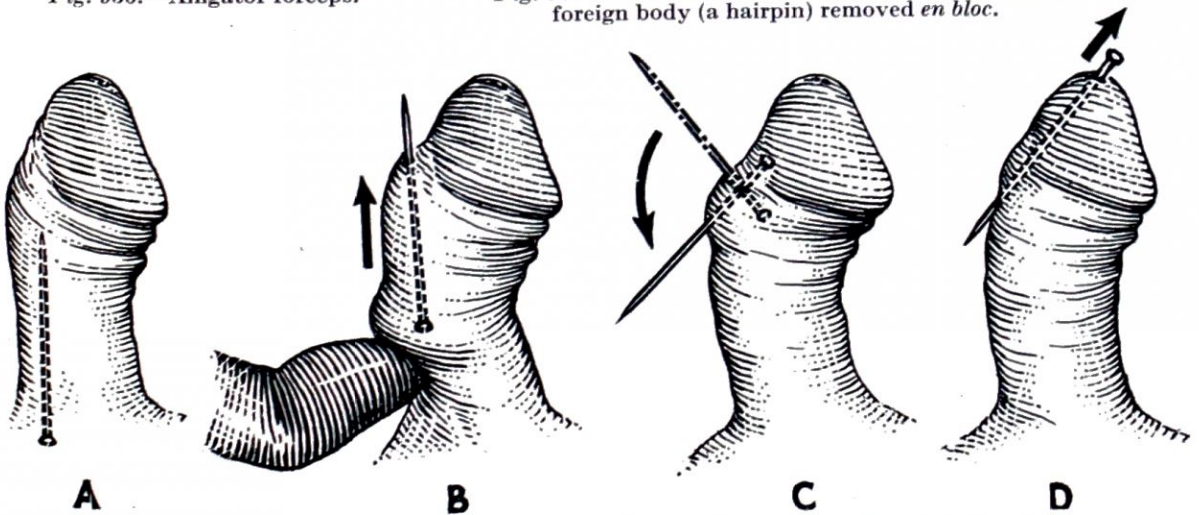


Fig. 938.—Method of removing a pin from the urethra. (*After Meredith Campbell.*)



Fig. 939.—Wheelhouse's staff.

External Urethrotomy.—The indications for external urethrotomy as such will be confined to the removal of foreign bodies and urethral calculi when other methods have failed. As the other methods which have been detailed are almost always successful, the indications for external urethrotomy are necessarily limited.

Technique.—Lithotomy position. Wheelhouse's staff (*Fig. 939*) is passed to the point of obstruction and then rotated, so that the groove lies towards the floor of the urethra. Cutting on to the groove, the urethra is opened and the obstructing agent is removed.

Wheelhouse's operation is now seldom employed for the relief of acute retention of urine due to an impassable urethral stricture. These now infrequent cases are better treated by suprapubic catheterization, followed at a later date, when the function of the kidneys has been shown to be satisfactory, by internal urethrotomy.

CONTROL OF HÆMORRHAGE FROM THE URETHRA

Severe Hæmorrhage from a Urethral Chancre.—In the solitary example of this condition that has come under my notice, a catheter was passed and the penis firmly bandaged. The method proved effective.

Hæmorrhage after Internal Urethrotomy.—Although this operation is not now performed frequently, the results are usually most satisfactory. Being a blind operation, post-operative hæmorrhage is its chief danger.

I have lost two patients from this complication, and I feel that both could have been saved if I had understood the complication better. In the first case the hæmorrhage started on the day after operation; it was checked by tying in a catheter. Evidently some of the blood had passed backwards into the bladder, for clots were evacuated when the bladder was washed out. For some days dark, blood-stained urine was passed, but on every occasion the wash-out was soon returned clear. Infection supervened, and the patient died of pyelonephritis. Here was a mistake. Suprapubic cystostomy or perineal urethrostomy should have been performed as soon as the bleeding was recognized. Not only would this measure have prevented urine passing over the lacerated tissues, but, what is even more important, all the blood-clot could have been evacuated from the bladder instead of allowing some of it to remain and putrefy, which undoubtedly was the cause of death.

The second patient had a large hæmorrhage on the tenth day. It was checked by tying in a catheter. As he had a suprapubic cystostomy I thought all was well. Four days later a second hæmorrhage occurred. After a blood transfusion perineal section was performed and a fair-sized calculus was discovered in the dilated urethra behind the stricture. There was some ulceration around the area which harboured the stone, and it was concluded that this was the bleeding point. The wound was packed. One week later he had a further severe hæmorrhage; again transfusion and packing were employed. These events were repeated. Eventually he went downhill in spite of transfusion.

As a result of this experience I think late hæmorrhage after internal urethrotomy should be treated by (1) diversion of the flow of urine, and (2) extending a perineal section right through the stricture or strictures and packing the interior with gauze moistened with snake venom or thrombin topical. Blood transfusion will, of course, be given as required.

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CHAPTER LIX

THE PENIS

Meatotomy.—This is a satisfactory little operation and is not practised frequently enough. Pin-hole meatus and atresia meati are the indications *par excellence* for this measure, but there are many cases in which the meatus is small enough to prevent the introduction of a catheter of satisfactory calibre or a urethroscope. A urethral calculus sometimes can be extracted after the meatus has been enlarged.

Technique.—The frænum and the glans immediately beneath the meatus are infiltrated with 1 per cent procaine (*Fig. 940 A*). A narrow-bladed scalpel is passed into the meatus, with its cutting edge downwards, and with one sharp cut the meatus is enlarged, preferably a little to one side of the middle line, the better to avoid the frænal artery (*Fig. 940 B*). Sutures are unnecessary. Unless a sound of suitable calibre is passed into the meatus daily for about a week, the atresia is liable to recur. For at least four weeks following this the patient should attend for dilatation.

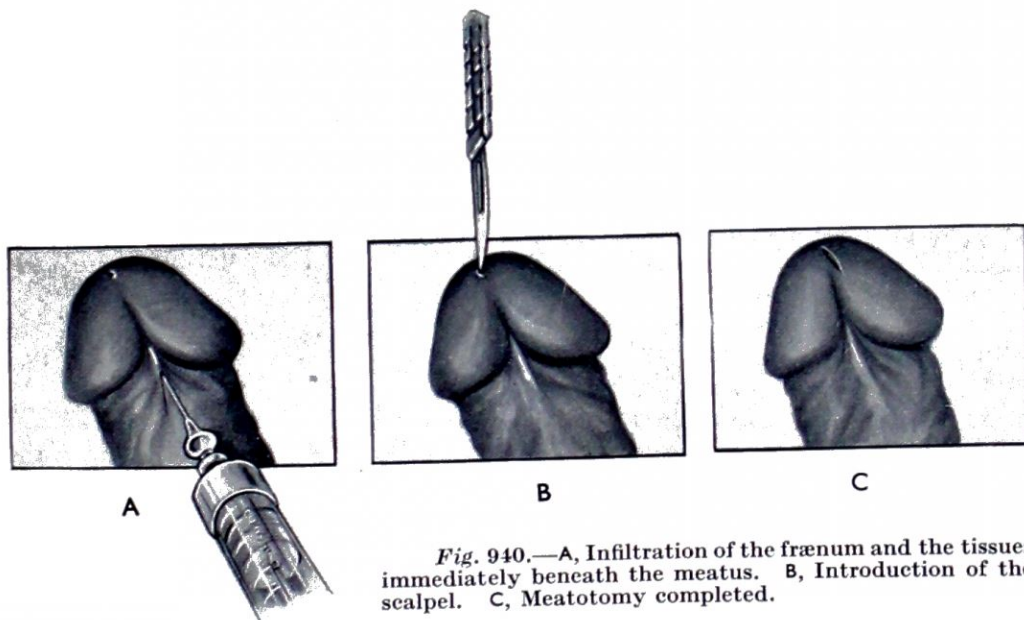


Fig. 940.—A, Infiltration of the frænum and the tissues immediately beneath the meatus. B, Introduction of the scalpel. C, Meatotomy completed.

Complications after Circumcision.—

A troublesome complication after circumcision in the adult is *post-operative priapism*. Bromides, of course, are helpful in allaying erection; more beneficial, however, are 5-mg. doses of stilbæstrol. In addition, an intelligent patient should be provided with an ethyl chloride spray, which he can apply to the organ as the need arises. If the following dressing is applied after circumcision priapism does not occur, or at least is greatly minimized. The dressing consists of a narrow viscopaste bandage. A well-lubricated glass rod is placed in the urethra while the bandage is applied (*Fig. 941*). Sufficient of the ends of the bandage are left at the base of the penis to allow these ends to be strapped by adhesive plaster to the pubis. This will ensure that the bandage does not slip. The entire penis being bound up, the glass rod is removed. At the end of ten days the dressing is slit up with scissors and discarded.

Hæmorrhage after circumcision usually occurs from the region of the frænum. The three-in-one frænal stitch minimizes this untoward occurrence (*Fig. 942*). Further, it can be used to stop post-operative bleeding in this area. When bleeding is coming from any part of the cut surface, an interrupted stitch or two will usually control the hæmorrhage, especially when ribbon gauze soaked in tinct. benzoin. co. is wrapped around the region

of the corona. When persistent bleeding occurs after circumcision, hæmophilia should be suspected, and measures taken forthwith to supply the deficient factor (*see p. 68*).

Retraction of the skin covering the penis, leaving the shaft bare, is not unknown, particularly after the operation where no sutures are used. The condition is remedied by placing appropriate stitches after cleansing carefully the exposed area.

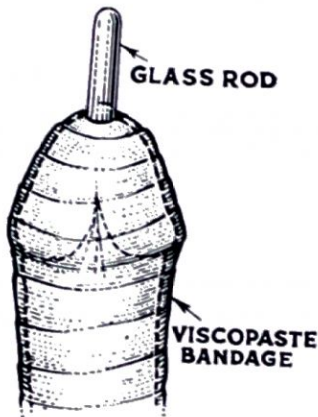


Fig. 941.—Technique of the dressing.



Fig. 942.—The three-in-one frænal stitch.

Local Anæsthesia of the Penis.—Although it sounds dangerous, ideal anæsthesia of the whole of the penis can be obtained by injecting 2 per cent procaine into the base of each corpus cavernosum (Fig. 943). Using a No. 23 gauge needle, 10 ml. (170 min.) is injected. A cardinal injunction is that the needle having been introduced into the corpus, if blood is aspirated, the injection must not be made at that point. It is unusual for blood to be aspirated. On occasions this form of anæsthesia is useful in cases of irreducible paraphimosis.



Fig. 943.—Cross-section of the penis, showing sites of injection with local anæsthetic. (*After Magid and Culp.*)

Paraphimosis.—

Treatment with Hyaluronidase: In early cases, i.e., under 6 hours' duration, 150 T.R. units dissolved in 1 ml. of normal saline solution is injected and dispersed into the œdematous ring at 3 and 9 o'clock positions. In about 2 minutes the œdema takes on a pitting quality; at the end of 12 minutes the swelling of both the ring and the frænum has disappeared. The prepuce can be restored to its original position by manipulation (Fig. 944). To avoid repetition, circumcision should be performed later.

Irreducible Paraphimosis.—In my experience the classical operation, which consists of 'nicking' the constricting band in several places and forcible reduction with the thumbs—



Fig. 944.—A method of reducing a paraphimosis.

usually performed under a general anæsthetic—is not effective after about 24 hours. Moreover, forcible reduction, if not immediately successful, causes much bruising; furthermore, after the nicking and battering the penis has received, it is not unusual for infection to supervene.

For these reasons the surgeon is advised to proceed as follows: under local anæsthesia the constricting band is incised (*Fig. 945*) and then the narrow cuff of skin which forms that band is excised (*Fig. 946*). This leaves an œdematous collar attached to the corona. When the œdema has been reduced by circular compression with a constricting length of gauze, the collar will be seen to consist of the mucous membrane just behind the corona. On the other side of the gap left by the excision of the band is skin, a further cuff of which is excised according to judgment, before uniting skin to mucous membrane, as in circumcision.

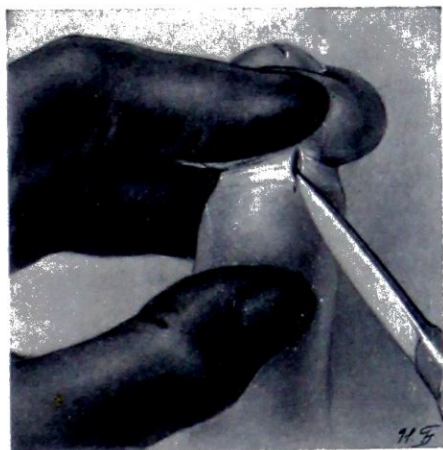


Fig. 945.—Paraphimosis. Nicking the constricting band.

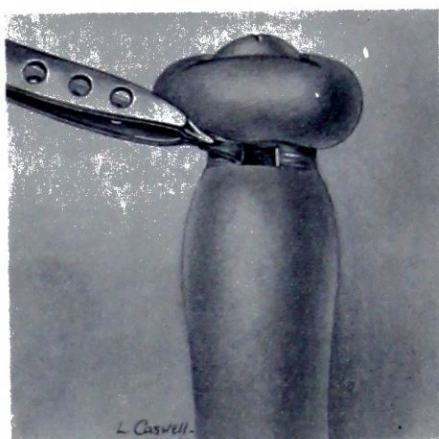


Fig. 946.—Paraphimosis. Excising the constricting band.

Fracture of the Penis.—Fracture of the erect penis is a rare but definite accident. In cases in which it has been noted there are usually evidences of old-standing periurethral fibrosis. Some patients have alleged that they heard a snap at the time of the accident. In Central Africa the condition is well known, for women have learned that an effective method of preventing rape is to take a firm hold of the penis and sharply bend it backwards towards the anus. (J. Smibert.) The organ suddenly becomes flaccid, and excruciating pain is followed by great swelling from the extravasated blood.

The condition should be treated by immediate operation. Through a suitable incision clots are turned out and the corpora cavernosa repaired with sutures. When the corpus spongiosum is the seat of the rupture, in addition to repairing this structure, the torn urethra must be united carefully.

De la Cour and Stephens recorded a case of rupture of the corpus cavernosum that occurred during coitus. The subcutaneous tissue of the penis and the whole of the scrotum were discoloured with extravasated blood. At operation the tunica albuginea of the left corpus cavernosum was found torn. After removing blood-clot, the fascia of the penis was united and the wound closed. Unimpaired function of the organ resulted. In W. Halloran's case it was the corpus spongiosum which was torn. A man aged 56 noticed sudden pain during coitus. Soon afterwards the penis became swollen, cold, and œdematous distal to an angulation. There were subcutaneous hæmorrhages, and bleeding occurred from the meatus. Halloran made an incision and after removing blood-clot repaired the torn urethra and corpus spongiosum with sutures.

Strangulation of the Penis by Rings.—After a ring has been placed upon the penis, venous engorgement follows and strangulation ensues. In early cases aspiration of the corpora cavernosa with a needle and syringe may assist removal by lessening vascular engorgement. When the ring has been on for some time and is firmly embedded, the aid of a locksmith must be sought.

V. Vermooton describes a case where the offending ring was of thick cast iron and could only be dealt with by an electrically driven circular saw. The saw was applied at two diametrically opposite points: on one side the ring was cut half-way through; on

the other the machine was stopped when it had almost traversed the whole thickness of the iron. The ring was finally severed with a cold chisel and a hammer. Guillot, confronted by a baker with a gold wedding ring firmly impacted upon the penis, used the ingenious method of dissolving the gold in a mercury bath.

Simple homely methods are sometimes useful. When newly appointed as a casualty officer, I was confronted by an excited individual who demanded that a friend in a cab outside should see the doctor alone. Draped in a long cloak, the friend was duly led behind the examining screen. The cloak having been removed, the cause of the excitement was evident, for the patient's penis was impacted in a stone hot-water bottle that he supported with his hands. A wet towel having been placed over the receptacle, release was effected by the blow of a hammer.

Avulsion of the Skin of the Penis and/or the Scrotum.—Traumatic avulsion of the skin of the penis and the scrotum is encountered with increasing frequency. Entanglement of clothing in rotating machinery accounts for the majority of these injuries. A varying amount of the skin of the penis is avulsed, but in most cases the shaft of the penis is uninjured. Partial or complete avulsion of the scrotum may occur in addition, or alone: usually the partially or completely denuded testes are remarkably free from damage.

When any part of the skin remains attached, or even if the completely detached skin is available, it is worth while replacing the skin of the penis, for it frequently survives. On the other hand detached scrotal skin should not be replaced as such a step is almost doomed to failure because it is impossible to maintain sufficient pressure on the area. Replacement of penile skin is carried out as soon as treatment for shock has been commenced.

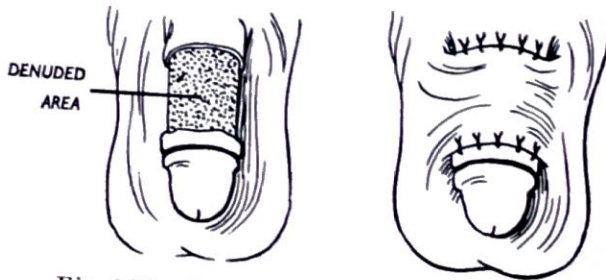


Fig. 947.—Covering the denuded shaft of the penis by burying it in a scrotal tunnel. (After Goodwin and Thelen.)

All other procedures must be postponed until the patient has recovered from shock. The first steps of the operation are débridement of non-viable tags and hæmostasis.

Covering the Denuded Penis.—

a. The most satisfactory method for one not particularly familiar with skin-grafting is to bury the shaft of the penis in the scrotum (Fig. 947), with subsequent surgical release at a propitious time.

b. If a dermatome is available, a split-thickness graft large enough to cover the penile shaft completely and allow for contraction is cut from a relatively hairless area. The cuff of foreskin, which is often left intact, is removed, and only a small rim of mucosa about the corona is preserved. The graft having been applied, a dressing that will maintain even pressure is mechanic's waste, over which is bound a viscopaste bandage. Skin-grafting is obligatory when the scrotum has also been torn away.

Covering the Testes.—Sometimes the remnants of the scrotum are sufficient to allow a scrotal bag to be fashioned, particularly if undercutting of the junction of the scrotum with the skin of the thighs is performed. If this measure is not feasible, or inadvisable because of the patient's poor general condition, oblique incisions are made in the thighs to accommodate each testis and its spermatic cord; or better, if time permits, is to undermine the skin of the upper thigh adjacent to the perineum on both sides, and to swing the testes laterally to a subcutaneous position for temporary housing. Plastic procedures, to construct a new scrotum, can be considered later, remembering that a scrotum constructed of non-scrotal skin cannot function as a thermo-regulating mechanism.

Wounds of the Penis.—Unless the blood-supply to the penis is manifestly inadequate—a rare event—amputation should rarely, if ever, be performed in the first instance. When the urethra is involved, which is usual, suprapubic cystostomy is necessary. In an early case, after débridement of the wound, the skin should be sutured or, in the case of an infected wound, petroleum-jelly gauze is used to pack lightly the defect. The organ should then be bandaged, and splinted in an upright position. There is nothing lost by conservatism; the wound usually heals readily. Often a badly mutilated organ, as well as the urethra, can be reconstituted later by plastic surgery.

Acute Balanitis is, more correctly speaking, an acute balano-posthitis, for there is inflammation of the opposing surfaces of the glans penis and prepuce. The occasional

presence of glycosuria makes it imperative to test the urine for sugar in every case. Three varieties are recognized, all of which are favoured by phimosis :—

Purulent : When the prepuce cannot be retracted, and particularly if it has been torn at coitus, a chronic balano-posthitis is liable to become acute and painful. The prepuce is red and swollen, and pus exudes from beneath it. Bacteriological examination of the pus is essential, and it usually reveals a highly mixed infection ; much less frequently a pure culture of one organism. Cases of diphtheria of the glans have been reported. Even with bacteriological assistance it is impossible to exclude a Hunterian chancre or urethritis behind a prepuce that cannot be retracted.

Erosive (syn. fourth disease) is due to Vincent's organisms (spirilla and fusiform bacilli) probably transmitted by infected saliva. The surface of the glans and post-coronal sulcus, together with the under surface of the prepuce, become eroded in small areas that appear white. In the more severe lesions these erosions are succeeded by ulcers with reddened borders and a yellowish-white base, in which event constitutional symptoms will be evident.

Gangrenous (syn. phagedæna) : In virulent forms of the above and in cases secondary to chancroid, where free drainage is not provided, occasionally the prepuce becomes black and gangrenous, and the patient becomes acutely ill with general malaise and a high fever. Acute retention of urine sometimes complicates the situation. Gangrene of the skin of the penis, especially the under surface of the base of the shaft, is liable to complicate Fournier's gangrene (see p. 696), while a black patch on the penile skin is seen occasionally in superficial extravasation of urine, especially that complicating peri-urethral abscess (see p. 674).

Treatment.—Early treatment consists in giving systemic antibiotic therapy, and while awaiting the bacteriological report penicillin, together with an antibiotic with a wide range of activity, cannot be bettered. The preputial sac should be irrigated freely with saline solution, delivered with a Higginson's syringe to which is attached a Eustachian catheter instead of the usual nozzle. This is followed by an instillation of penicillin solution. Sometimes this treatment is followed by such improvement that resolution can be anticipated. Circumcision should follow in due course. Should conservative measures not improve matters within 24 hours, no time should be lost in excising a broad V from the dorsum of the prepuce under general anæsthesia. H. B. Taylor, after an immense experience of infected phimosis in China, is emphatic that immediate circumcision (under antibiotic cover) gives better and quicker results than a dorsal slit.

When gangrene has supervened the whole of the prepuce and gangrenous skin covering the penis should be removed with a diathermy knife. Eventually a healthy granulating surface presents, and this can be covered by a skin-graft (see p. 677). If the glans sloughs, severe secondary hæmorrhage is probable, and to avoid this, partial amputation of the penis in cases where the base is comparatively healthy, or removal of the sloughing area with a cautery, becomes necessary. Finally, remember the likelihood of urethral stenosis following the suppuration, and prevent this by passing bougies regularly.

Penile Peri-urethral Abscess.—The abscess arises in an infected follicle of Littre, as a complication of acute (rarely chronic) urethritis. A tender induration can be felt on the under surface of the penis. Left to nature, the abscess frequently bursts externally, and a urinary fistula may result. Early incision per urethram, supplemented by penicillin, is the best method of abruptly terminating these untoward possibilities. The help of an aero-urethroscope is desirable ; but if the abscess is near the meatus, as it usually is, it may be dealt with by inserting a tenotome down the urethra.

Persistent Painful Priapism.—Many cases of persistent painful priapism are due to thrombosis of the deep pelvic veins. Priapism is a recognized complication of leukæmia—particularly of myeloid leukæmia : at the preliminary examination do not forget to examine the spleen for enlargement. It also occurs as a complication of sickle-celled anæmia, which occurs only in those of negro race, or their descendants. Whether the cause of the priapism is neurological or vascular, if erection has persisted for two days thrombosis exists in the corpora cavernosa, and this thrombosis is sufficient to sustain the erection. In such cases the use of sedatives, narcotics, cooling lotions, and rectal diathermy are absolutely useless ; curare-like drugs and diethylstilbæstrol may be helpful in the early stages. If a low spinal anæsthetic is given, and the priapism persists, it proves that the condition is due to intravascular clotting.

Aspiration should be undertaken. Very occasionally it is permanently successful. A point on the skin of the penis about midway down the organ is anaesthetized and the underlying fascia is injected with local anaesthetic, also. An aspirating needle of large size, fitted to a syringe, is plunged into the corpus cavernosum (*Fig. 948*). On withdrawing the piston, dark blood is evacuated. The needle is passed more deeply, and the corpus cavernosum of the opposite side is aspirated. When aspiration has been effected, flaccidity occurs. A 10 per cent solution of heparin in normal saline is then injected, and the priapism reappears. Aspiration and injection are repeated several times, in order to wash out the spongy meshwork, and the organ is left in a flaccid condition.

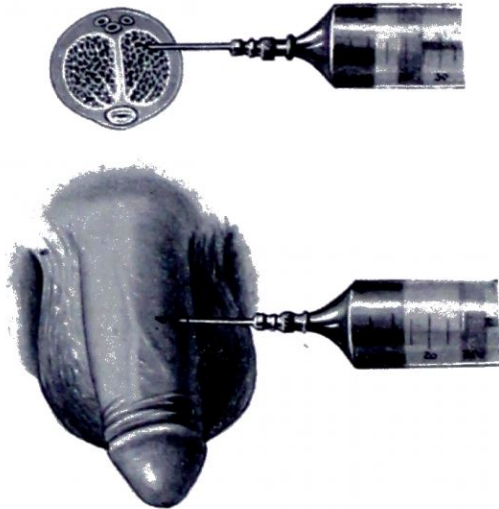


Fig. 948.—Deflating the corpora cavernosa by aspiration.

Systemic anticoagulant therapy (see p. 927) can also be tried, but if this does not register some success in 48 hours, it should be abandoned in favour of operation, allowing sufficient time for the particular anticoagulant employed to be wholly or partially neutralized by its specific antidote.

Ligation of the dorsal arteries, in addition to evacuating blood and clots by incising the corpora cavernosa, has been advocated. I carried out this measure in one case; gangrene of the penis (*Fig. 949*) set in, and amputation of the penis had to be performed (*Fig. 950*). The patient has remained in good health for many years.



Fig. 949.—Commencing gangrene following incision of a corpus cavernosum with suture combined with ligation of the dorsal arteries.



Fig. 950.—The penis amputated, showing gangrene. Suprapubic cystostomy was performed because of persistent retention of urine.

Lowsley's operation appears to be the best that has been described. Under antibiotic cover, and after having cleansed the operative area thoroughly, the corpora cavernosa are exposed through a perineal incision. Each corpus cavernosum is incised, freeing black blood and clots. Two catheters (Nos. 10 and 14) are passed into each corpus cavernosum, a pathway having been made for them with sinus forceps. The smaller catheter is for irrigation and the larger to evacuate dissolved clot. Constant bilateral drip irrigation with a solution of 1,000 ml. of saline solution, 100 mg. of heparin, and 200,000 units of crystalline penicillin is continued for six days. The catheters are then removed.

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CHAPTER LX

THE TESTES AND SCROTUM

TORSION OF THE TESTIS

TORSION of the testis, called perhaps more accurately torsion of the spermatic cord, is said to occur relatively frequently in an imperfectly descended testis. It has been my experience that it is the fully descended testis which is somewhat more often affected. The factors that favour torsion are illustrated in *Fig. 951*, and it is clear that torsion occurs seldom, if ever, in a normal testis. Torsion of the *body* of the testis can occur, the twisting taking place between the body of the testis and the epididymis (Underhill). If complete torsion persists for 3-4 hours, infarction is inevitable, consequently it is but rarely that detorsion results in salvage of the testis. Patients with recurrent torsion sometimes learn successfully to perform detorsion upon themselves, but as a rule gradual atrophy of the testis ensues.

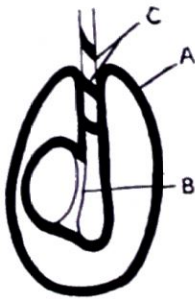


Fig. 951.—Diagrammatic representation of the predisposing causes of torsion of the spermatic cord. A, Complete and high investment of the testis, epididymis, and cord by the tunica vaginalis; B, Testis and its adnexa hang like the clapper of a bell; C, The cremaster muscle, which is attached spirally, will readily cause rotation of the clapper when the muscle contracts vigorously. (After M. Muschat.)

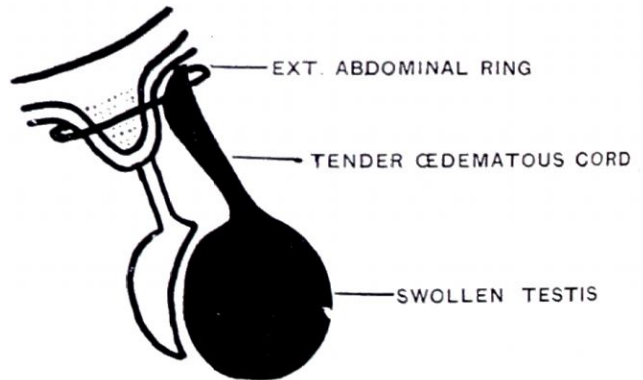


Fig. 952.—Explanation of how a small strangulated hernia may cause testicular symptoms by pressure on the cord.

Torsion of the Fully Descended Testis.—The scrotal contents on the affected side are retracted upwards by torsion of the cord itself and by cremasteric spasm. Elevation of the scrotum intensifies the pain (Prehn's sign), whereas in epididymo-orchitis such elevation brings relief; however, this sign is not infallible.

Torsion of the testis can be a dangerous diagnosis if it conveys the (erroneous) suggestion of a condition that does not require immediate operation. A case that I have in mind was diagnosed as torsion of the testis on account of the engorged, tender cord, the swollen testis, and the small secondary hydrocele; but when operation was performed some six hours later a gangrenous Richter's hernia was found in the inguinal canal. This had pressed upon the cord at the external abdominal ring and accounted for the testicular symptoms (*Fig. 952*).

Sometimes when the patient is not seen until six or more hours have elapsed and gangrene of the testis has set in, an erroneous diagnosis of acute epididymo-orchitis is apt to be made, for the scrotum becomes slightly inflamed and the temperature registers about 99° F. *Fig. 953* illustrates a case in point. If the patient presenting these symptoms is a boy, and recent mumps is excluded, it is far more likely that the symptoms are due to torsion of the testis or one of its appendages (*see below*), for acute epididymo-orchitis at this time of life is, apart from mumps, exceedingly rare. The frequency with which epididymo-orchitis is mistaken for torsion of the testis is revealed by the fact that each and all of seven consecutive cases of torsion of a fully descended testis that I was called upon to see had been diagnosed and treated as acute epididymo-orchitis for periods varying from 24 hours to 10 days.

When the diagnosis of torsion is tolerably certain and the patient is seen within an hour of the onset of the attack, manipulation can be attempted.

R. E. Smith's Case :—

A schoolboy at Rugby was awakened at 5.30 a.m. with excruciating pain referred to a point one-third along a line joining the anterior superior iliac spine to the umbilicus. At 6.45 a.m. he was writhing in agony. The right testicle was the size of a hen's egg, and moderately tender. On rotating his testicle 180° from his left to right he volunteered the statement, "That's better", but it required a further 180° before complete relief was obtained. He was left to hold the testicle in position for an hour. Three hours later the testicle was normal in size.

R. Burkitt advises that the testis be rocked gently, to see which way the torsion has occurred, before rotation is attempted.

Even in early cases, when untwisting is unquestionably successful, operation within 24 hours should be advised, in order to fix the testis and prevent a further attack.

In later cases, or when manipulation is not quickly and entirely satisfactory, the testis should be exposed through an inguinal incision with as little delay as possible. The skin should be prepared with aqueous metaphen or some other non-spirit-containing antiseptic, e.g., cetavlon; spirit causes unnecessary stinging pain and irritates the skin of the scrotum. The operation can be conducted readily under a local anæsthetic, especially if a preliminary dose of morphine has been given, or a general anæsthetic can be employed. The testis is delivered through the wound. If, on untwisting the cord, there are any signs of a return of the circulation, an attempt should be made to preserve the organ and to fix it by sutures in an anatomically correct position (*see below*). Experience teaches us that in the majority of instances when untwisting has been performed after the sixth hour atrophy of the testis ensues, although it takes several months to become manifest. Therefore, if the testis appears blue-black and lifeless, the best course is to ligate the cord securely and remove the useless organ.

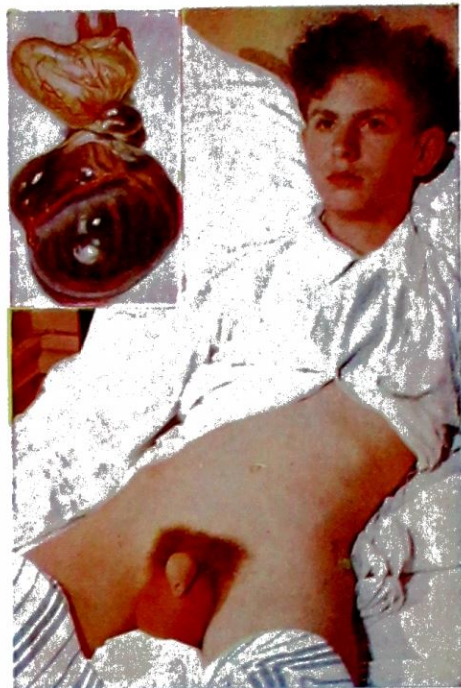


Fig. 953.—Torsion of the testis. The inflamed, acutely tender right testis and scrotum simulate acute epididymo-orchitis exactly.

B. G., aged 15, had orchietomy performed for torsion of the right testicle fifteen hours after the onset of symptoms. On the fourteenth day after the operation, whilst defæcating, he was seized with severe pain in the left testicle. Operation was carried out within four hours. The testicle was untwisted and found to be viable, and it was fixed in the manner shown in *Figs. 955, 956*. Seen three years later the patient's remaining testicle appeared normal, secondary sexual characteristics had developed, and he had been passed as medically fit for service in the Royal Air Force.

Torsion of the Testis in the Newborn.—If direct trauma during delivery can be excluded, a hard swelling of one testis discovered at birth, or soon afterwards, is almost certainly due to torsion. Sometimes the blue discoloration of the testis can be perceived through the infant's thin scrotal skin.

The neonate is no exception to the rule that operation should be undertaken as soon as arrangements can be made.

Torsion of the Imperfectly Descended Testis.—It is often difficult, if not impossible, to distinguish this condition from a strangulated inguinal hernia. True, the corresponding side of the scrotum is empty and the possibility of the testis as a cause of the painful tender lump in the inguinal region springs to our minds. Notwithstanding, the lump in question often turns out to be a strangulated hernia, for is not a hernia a fairly regular accompaniment of a maldescended testis? There should be no hesitation in exploring the swelling promptly.

B. A., aged 14, for some years had a lump in his right groin. For three days it had been larger and painful, and he had vomited two or three times. On examination there

was a large irreducible right inguinal hernia. The testicle on the left side was absent, and the patient had hypospadias. The hernial sac was opened and was found to contain a testis black in colour. The cord was twisted three times. This was untwisted, but there appeared to be no life in the testis. Orchiectomy (*Fig. 954*). Herniotomy. Recovery.



Fig. 954.—Torsion of an imperfectly descended testis removed in the case of B. A. quoted in the text.

EMERGENCY OPERATIONS FOR TORSION OF THE TESTIS

Either an incision the same as that used for inguinal herniotomy, or a vertical incision traversing the upper two-thirds of the scrotum can be employed.

Untwisting and Anchoring the Testis.—When untwisting of a viable organ has been possible, the testicle should be fixed by sutures in the manner shown in *Figs. 955, 956*, in order to prevent recurrence. It may be argued logically that if the anatomical anomaly which allows a testicle to twist is present on one side, the same condition is likely to be found on the contralateral side. Wherefore, in every case of torsion of the testis and especially if a patient has lost a testicle through torsion, exploration of the contralateral side and, if the 'clapper of a bell' abnormality is found, fixation is advised: this can be under-

taken at some convenient time after reasonable convalescence, but it should not be long delayed.

Orchiectomy as an emergency measure should be performed rarely; so often the testis can be saved. The principal indication for urgent removal of the testicle is torsion when untwisting cannot be effected satisfactorily, or when gangrene has set in.

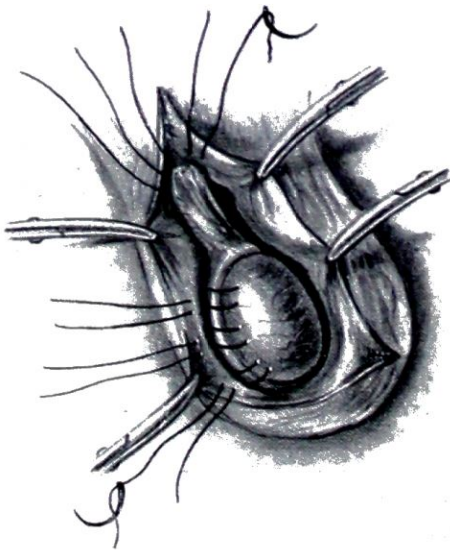


Fig. 955

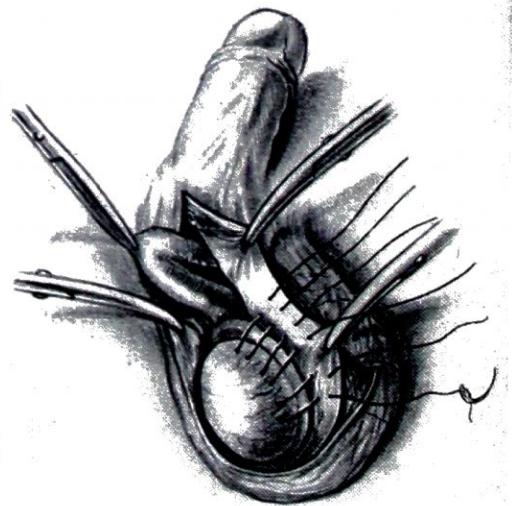


Fig. 956

Figs. 955, 956.—Mode of anchoring the testis with sutures to prevent recurrence of torsion. The left-hand figure shows lateral mattress sutures, the right-hand medial mattress sutures to the septum dartos. The sutures are passed in each case through the tunica albuginea. Fine silk or thread is perhaps the best material to employ in order to make the anchorage permanent.

Technique.—The testis having been delivered, the cord is isolated and crushed at a point conveniently distant from the external inguinal ring. The cord is then transfixed and ligated. To err on the side of safety, it is a good practice to employ two ligatures, one applied a quarter of an inch distant from the other. When the ligatures are securely in place, the cord is severed and the testicle removed.

Post-operative Slipped Ligature.—The spermatic cord is a very vascular structure which retracts readily; insecure ligation of it can prove a most unpleasant complication. M. F. Campbell reported a case where fifteen minutes after an operation for varicocele the patient's dressings were found soaked in blood. The wound was re-opened promptly, but the bleeding stump had retracted so far that it was necessary to incise the muscles of the lateral abdominal wall and retract them widely before the proximal venous stump could be retrieved.

TORSION OF AN APPENDAGE OF THE TESTIS

Vestigial structures related to the testis and epididymis—namely, the hydatids of Morgagni, the paradidymis or organ of Giralde's, and the vasa aberrantia—are liable to undergo axial rotation. The commonest of these structures to twist is the pedunculated hydatid (*Fig. 957*). Torsion of an appendage of the testis is essentially a lesion occurring before, or at, puberty. No doubt many cases have escaped recognition and have been looked upon as examples of epididymo-orchitis of unknown origin. Apart from the orchitis of mumps, acute epididymo-orchitis is of the utmost rarity in young boys, whereas torsion of the appendages of the testis cannot be exceedingly unusual, for I operated upon 14 cases of this condition in 10 years. Therefore, if a boy gives a history that one side of the scrotum has become swollen following a sudden attack of pain, torsion of an appendage of the testis should at once spring to mind as the diagnosis. Treated expectantly, the affection runs a rather painful course, accompanied often by pyrexia, but resolution occurs eventually in all cases. Immediate operation with ligation of the pedicle and amputation of the twisted appendage terminates the symptoms abruptly.



Fig. 957.—Torsion of the pedunculated hydatid of Morgagni. (After Foshee.)

RUPTURE OF THE TESTIS

Even when the damage is severe, repair is possible, as is well shown by the following case:—

A. G., aged 23, whilst playing football was kicked in the scrotum. He continued to play for a short while. Six hours later a large scrotal hæmatoma had developed. The testis was exposed, and after blood and blood-clot had been swabbed away, the body of the testis was found to be split cleanly, as if cut with a knife. The testis was repaired with catgut sutures, the wound closed, and a firm scrotal bandage applied. Recovery was uneventful, and when the patient was seen six months later, palpation of the testicle revealed an organ indistinguishable from normal.

Fourteen similar cases have been reported; in only three instances did the accident produce severe shock.

Avulsion of the Scrotum.—(See AVULSION OF THE SKIN OF THE PENIS AND SCROTUM, p. 684.)

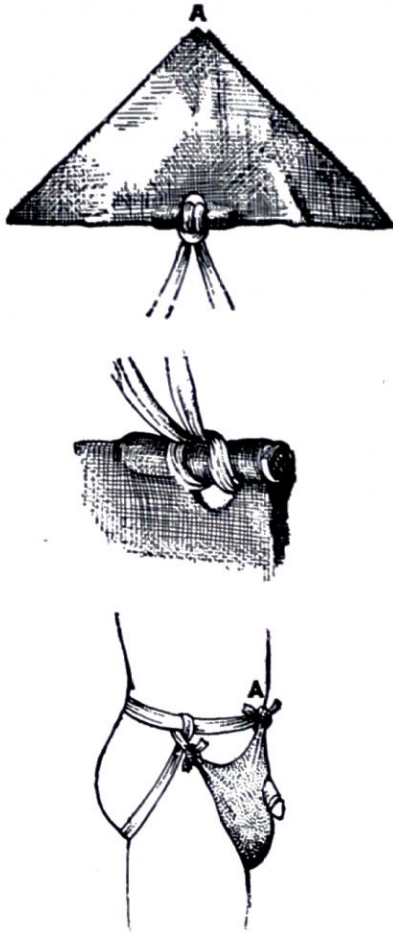
RECENT HÆMATOCELE

Recent hæmatocele is usually the result of injury of a small vessel during tapping or aspiration of a hydrocele. Prompt refilling of the sac with considerable pain and tenderness, and poor or absent transillumination, leaves no doubt as to the diagnosis. The treatment should be urgent operation, with evacuation of blood, followed by hydrocelectomy. If this course is not followed, after a prolonged period of rest accompanied in the early stages by pain, an old clotted hæmatocele will almost certainly result.

Acute hæmorrhage into a previously normal tunica vaginalis can result from a blow on the testis. The treatment should be similar to the above, for the reasons given, and also because without exploration it is impossible to tell whether or not the testicle is ruptured.

In cases such as these the testis can be exposed through a long vertical scrotal incision under local anæsthesia, and can be delivered without pain if the cord is infiltrated with 1 per cent procaine just outside the external inguinal ring. Great attention is paid to hæmostasis, for if the slightest oozing occurs a scrotal hæmatoma develops; for this reason, the insertion of a drainage tube in a dependent portion of the scrotum is most necessary. The tube can be removed after 24 hours.

Whether drainage is considered necessary or not, after all operations upon the testis, scrotum, and inguinal canal, in order to minimize dead space it is a good practice to support the scrotum by Nitschke's scrotal bandage (*Fig. 958*). A square of surgical gauze, measuring 18 in. \times 18 in., is folded diagonally. A small roll of gauze, about 3 in. long and $\frac{1}{2}$ in. thick, is placed in the centre between the layers of the preceding fold. Just above the roll a small hole is made with a pair of blunt-ended scissors. A piece of 2 $\frac{1}{2}$ -in. bandage, 16 in. long, is folded in the middle; the folded end is pushed through the opening made in the gauze and looped through. Another piece of bandage is tied round the patient's waist and the scrotal bandage is applied firmly, so as to elevate the scrotum. The ends are fixed as shown in the figure. Then two ends of the gauze are tied to the waist-band, after which a hole is made in the gauze to accommodate the penis. This easily made scrotal support will be found extremely useful.



Post-operative Scrotal Hæmatoma.—*Hyaluronidase Treatment.*—In early cases, when the blood can be presumed to be unclotted, after cleansing the scrotum, aspiration can be attempted. Whether or not this is successful a solution composed of 300 T.R. units of hyaluronidase dissolved in 30 ml. of saline solution with 5 ml. of 1 per cent procaine and 300,000 units of aqueous crystalline penicillin can be injected into the scrotum, after which pressure is applied to the scrotum by means of a tight Nitschke's bandage. In a number of cases, within 24 hours the scrotal distension has diminished greatly.

Drainage.—On the other hand, when the hæmatoma is a large one and probably of more than 24 hours' standing,



Fig. 958.—Nitschke's scrotal bandage.

after local anæsthetic has been injected into a dependent part of the scrotum, a small incision is made with a narrow-bladed scalpel. Clots are expressed; one stitch is sufficient to close the skin incision. A dry dressing is applied, and the scrotum is elevated and compressed by a scrotal bandage. Systemic antibiotic therapy is given.

This course obviates the long wait necessary for absorption of blood-clot to take place and the risk of infection is greatly diminished.

ACUTE EPIDIDYMO-ORCHITIS

Although clinically the inflammation sometimes appears to be confined to the epididymis or, less frequently, to the body of the testis, usually in acute cases both these structures are involved. In a high percentage of cases the infection is secondary to infection of the corresponding seminal vesicle, which in turn is infected from the prostatic urethra. Probably such infection travels along the lumen of the vas, although it is possible that it occurs via the lymphatics that accompany the vas. Infections can be blood-borne, examples being the orchitis of mumps, acute epidemic epididymo-orchitis (both virus infections), while bacterial metastatic epididymo-orchitis can occur in any severe infection, for instance in meningococcal septicæmia and pneumococcal pneumonia.

Acute epididymo-orchitis has become less common, due (1) to division of the vasa and ligation of their distal ends prior to prostatectomy; (2) to antibiotic therapy, particularly after operations on the urethra (including catheterization); (3) to the frequent employment of Foley's catheter in cases where an indwelling catheter is required—this eliminates the necessity for constriction of the penis by adhesive plaster, and consequent retention of exudate within the lumen of the urethra; (4) to the steep decline in gonococcal epididymitis, due to early antibiotic treatment.

Seeking the Cause.—An endeavour should be made to determine the cause of the infection and the organism responsible. If a specimen of urethral discharge can be obtained for bacteriological examination by milking the anterior urethra, well and good, but on no account should the prostate and vesicles be massaged for this purpose in the acute stage. In every case a suitable specimen of urine should be submitted for bacteriological investigation.

Often the cause, or the probable cause, is apparent. In a smaller number the reason for the epididymo-orchitis is not unfolded by the history or a clinical examination, consequently the following résumé of the less frequent causes of acute epididymo-orchitis is likely to be of service.

Subacute Tuberculous Epididymitis.—In cases where the vas is thickened and there is little response to the usual treatment, the possibility of the infection being due to tuberculosis of the epididymis, which is not rare, must receive due consideration.

Epididymitis complicating Non-specific Urethritis is more frequent than it is in gonorrhœa, and unless correct antibiotic treatment is given early, suppuration is usual. This form of infection responds best to low doses of erythromycin, 100 mg. four times a day, or to terramycin, 250 mg. every four hours.

Epididymo-orchitis due to the Virus of Lymphogranuloma Venereum.—The infection is frequently bilateral, and is often followed by abscess formation (W. E. Coutts). The diagnosis presents little difficulty because of the massive inguinal adenitis, but confirmation by the Frei intradermal test is required. Treatment with a broad-spectrum antibiotic is necessary for a month, therefore every precaution to prevent overdose must be taken.

Epididymo-orchitis due to Brucellosis (undulant, abortus, and Malta fevers).—Acute epididymo-orchitis is sometimes the first sign of these diseases. Malaise and general systemic symptoms are in evidence. The diagnosis can be clarified by appropriate agglutination and skin tests, and cultures of the urine and the blood. The most effective treatment is by a combination of streptomycin and aureomycin.

Orchitis of Mumps without Parotitis occurs from time to time, especially in infants. That the orchitis is due to mumps can be confirmed by a serological complement-fixation test. When the differential diagnosis between orchitis of mumps, torsion of the testis, or torsion of an appendage of the testis cannot be determined there and then, the scrotal contents should be explored without delay.

Traumatic Epididymo-orchitis.—When, as is often the case, the patient attributes epididymo-orchitis to a strain at work, the surgeon is almost certain to become involved in the resulting litigation. If a blow on the testis or an undue strain, e.g., lifting a heavy weight, can be proved, compensation is often allowed. When there is no direct injury it can be argued that an undue strain forces urine from a full bladder down the vas into the epididymis. The degree of inflammation that results depends upon whether or not the urine is infected, or whether or not there is a latent infection in the prostate or seminal vesicles. Even when there is no evidence of such pre-existing infection, there are some who are prepared to state that sterile urine forced down the vas can give rise to epididymitis. When the trauma was slight, it is right and proper for the surgeon to take the stand that the alleged accident could not have caused the epididymo-orchitis, but merely drew attention to an already existing inflammatory process that rendered the scrotal contents more sensitive than usual.

Treatment.—

General treatment: In the majority of cases of epididymo-orchitis due to a descending infection, the organisms responsible are staphylococci, *Esch. coli*, and streptococci. In view of the high percentage of *Esch. coli* infections, empirical antibiotic therapy should include either streptomycin, aureomycin, or terramycin, as well as penicillin.

Analgesics.—In severe cases morphine will be required, but as a rule suitable doses of pethidine suffice.

Local treatment: The patient should be confined to bed with the inflamed organ and its fellow supported on a bridge of adhesive plaster (*Fig. 959*). The inflamed testis rests



Fig. 959.—A splint for the testicles. Broad adhesive plaster is employed to make the sling.

on a nest of cotton-wool, which for the sake of clarity is not shown in the illustration. A bed-cage is placed across the pelvis. When, by transillumination, a secondary hydrocele is clearly apparent, much relief will be afforded by aspiration of the fluid. If necessary, aspiration can be repeated.

Operative treatment: Provided rest and antibiotic treatment control the inflammation, no question of operation arises. On the other hand, in cases where it seems likely that suppuration will occur, comparatively early operation, say on the third day of the attack, spares the patient unnecessary suffering, recurrence, chronicity, and possibly sterility. In cases where it is known

that the infection will not respond to antibiotics (e.g., mumps), or when torsion of the testis cannot be ruled out, an exploratory operation should be undertaken soon after admission.

The following method of decompressing the epididymis gives excellent results. Shaving is deferred until the patient is anaesthetized, for the parts are so tender. The skin is disinfected as described on p. 689.

Technique.—The organ is explored through a lateral incision of the scrotum.

TURNER'S METHOD OF DECOMPRESSION OF THE EPIDIDYMIS



Fig. 960.—An incision is made into the coverings of the testicle in order to expose the whole of the epididymis and the coverings of the vas.



Fig. 961.—The coverings are peeled away, exposing the intensely inflamed epididymis, which is incised.

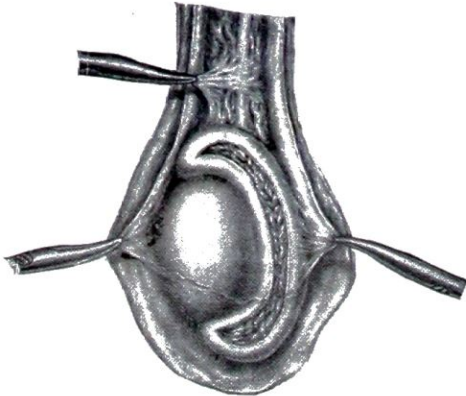


Fig. 962.—The commencement of the vas is freed and its lumen catheterized.

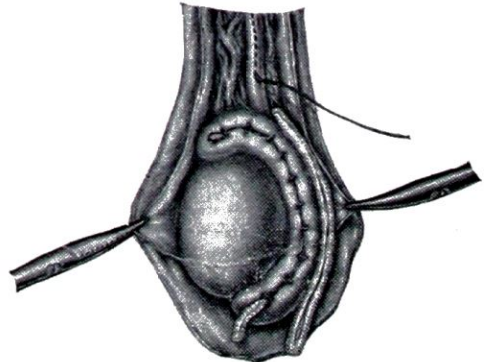


Fig. 963.—A strand of nylon suture is placed in the lumen of the vas to drain pus therein. The epididymis and its coverings are drained as shown.

Step 1 (Fig. 960).—An incision is made through the coverings of the testicle, freeing the epididymis from adhesions and allowing the commencement of the spermatic cord to be identified (*Fig. 961*). The vas is separated from the other constituents of the cord and a hollow needle inserted into its lumen. Using the needle as a cannula the vas is catheterized with a strand of silkworm gut. If the vas is patent and no pus exudes, its sheath is closed with a catgut suture. *If pus is present*, the silkworm gut suture is left in place and brought out through the skin at the upper angle of the wound.

Step 2.—When a secondary hydrocele is present it is incised.

Step 3.—An incision is made over the entire epididymis (*Fig. 962*), which is separated from its sheath by blunt dissection. The epididymis is probed systematically with a sharp instrument in search of an abscess. A piece of soft rubber drain is inserted and the sheath united over the drain (*Fig. 963*). The wound is closed and the drains removed upon the third or fourth day.

The immediate relief of pain which follows decompression of the epididymis and the subsequent rapid convalescence is gratifying.

Orchitis of Mumps.—No known antibiotic has any effect on the virus of mumps. Diethylstilbœstrol in doses of 3–5 mg. daily sometimes diminishes the pain and pyrexia. In severe cases convalescent serum is said to be efficacious. In view of the regularity with which atrophy follows this variety of acute testicular inflammation, there is little doubt that decapsulation of the epididymis should be performed more often than it is.

To be regularly effective the operation must be performed early, i.e., within forty-eight hours of the onset. The tunica vaginalis is exposed through a short scrotal incision, the tunica opened, and the epididymis decapsulated. When the body of the testis feels stony hard and is covered with petechial hæmorrhage, a short incision is made through the tunica albuginea, to relieve tension. The scrotum is drained with corrugated rubber, and is supported on an adhesive plaster sling. The operation relieves pain immediately, reduces fever, and prevents atrophy. In 4 cases of this condition upon which I have operated, the epididymis was mainly involved and was plum-coloured.

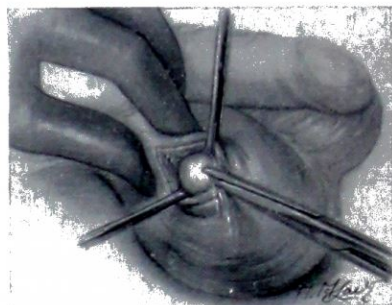


Fig. 964.—Orchitis of mumps. Early incision of the tunica vaginalis only, and drainage, brings about immediate amelioration of symptoms and prevents testicular atrophy. (After N. Nixon and D. B. Lewis.)

In a large experience of epididymo-orchitis of mumps in soldiers, D. B. Lewis found that by suitably infiltrating the scrotum with local anæsthetic, making a small incision over the involved testis, incising the tunica vaginalis, allowing hydrocele fluid to escape (*Fig. 964*), and closing the incision around a small drainage tube resulted in immediate alleviation of pain with cessation of pyrexia within forty-eight hours.

To strengthen the hand of the surgeon who advises operation for the orchitis of mumps, it is recorded that of 19 men attending an infertility clinic, all of whom had had orchitis of mumps, 11 were aspermatic (Ballew and Masters).

ACUTE FUNICULITIS

Subacute funiculitis is endemic in many tropical countries. Occasionally the condition takes on true epidemic characteristics. However, the acute form, with rapid suppuration and frequently death (if drainage is not instituted), is now almost unknown.

Essentially the lesion is a streptococcal cellulitis of the spermatic cord, with secondary thrombophlebitis of the pampiniform plexus. The clot affects the veins right up to the internal inguinal ring, and often extends farther along the testicular vein. Occasionally the clot invades the inferior vena cava, when pulmonary embolism is liable to occur.

Subacute endemic funiculitis is characterized by pain in the testis and isolated clots, which can be felt as tender nodules in the pampiniform plexus. These nodules are clearly separable from the vas deferens, which, however, is often thickened. It is the non-attachment of the nodules to the vas that makes the condition easily distinguishable from subacute tuberculous epididymitis.

When an isolated clot is situated abutting the posterior border of the body of the testis, the diagnosis can be difficult, and exploration is justifiable to rule out malignant testis. If a clotted vein is clearly visualized, unwarranted orchietomy can be avoided.

With rest in bed, support of the testis, and antibiotic therapy, resolution can be expected in nearly all cases of subacute funiculitis. Occasionally the thrombosis results in late atrophy of the testis.

IDIOPATHIC GANGRENE OF THE SCROTUM

(*Fournier's Gangrene*)

Idiopathic gangrene of the scrotum comes on with dramatic suddenness, the first symptom—severe pain in the scrotum—even awakening the patient from sleep. The disease is more usual in middle life, but has been reported at all ages; occasionally a similar lesion occurs on a labium majus. Almost invariably the patient was in good health up to the time of the visitation. Within a few hours œdema appears; the scrotum



Fig. 965.—Idiopathic gangrene of the scrotum. With appropriate incisions combined with systemic penicillin therapy, the infection was soon controlled. Showing the two areas where the scrotum had sloughed, leaving the testicles exposed; this photograph was taken when these areas had commenced to granulate.

becomes tense, reddened and, at a time varying from 12 hours to several days, gangrene sets in. The gangrene involves part or whole of the scrotum, and occasionally the under surface of the penis: if uncontrolled, the infection spreads along the plane beneath Colles' fascia, as in extravasation from the bulbous urethra.

Peri-urethral abscess with extravasation is ruled out by the absence of dysuria and the lack of any induration in the perineum. Notable is the extraordinary rapidity and severity of the local inflammation combined with but moderate constitutional symptoms: this should, and often does, give ample time, with present-day methods of treatment, to prevent fatal complications. The bacteriology of this remarkable disease shows an overwhelming preponderance of infections by hæmolytic streptococci. The cause of the scrotal gangrene is still a matter for speculation. It seems probable that the infection is blood-borne; once within the scrotal subcutaneous tissues the streptococci produce a violent inflammation that results in obliterative endarteritis of the arterioles supplying the overlying skin. It is the suddenness of the onset that strongly suggests a vascular disaster of infective origin.

Treatment.—In some cases penicillin in full doses has proved beneficial; however, the causative organism, a hæmolytic streptococcus which sometimes can be grown aerobically, is, like the hæmolytic streptococcus that causes progressive gangrene of the

abdominal wall (*see p. 178*), more sensitive to bacitracin than to any other antibiotic. Therefore, if it is available, pending the opportunity to submit pus to the bacteriologist and while awaiting his findings, systemic bacitracin 400 units per kilo of body-weight, repeated at 6-hourly intervals, is the antibiotic of choice.

Unless the case is a very early one, and this treatment produces improvement within 6-8 hours, the scrotum should be incised (*Fig. 965*). If gangrene has commenced, O. T. Mansfield recommends wide excision of all sloughing areas, which saves time, rids the patient of scrotal tissue that is doomed, and stops the spread of gangrene. The excision should pass through, but not beyond, the area of erythema, thus usually preserving sufficient skin to cover the testes in due course. Excision provides the freest possible drainage. Although the testes are often denuded to their tunicae albuginea, they remain undamaged. As to local treatment, the newest and probably the best is a solution of bacitracin, 500 units per ml., applied on gauze. Streptokinase and streptodornase (*see p. 140*) have also given good results. When the inflammation has died down completely, and the patient's general condition is entirely satisfactory, secondary suture should be undertaken. In most cases the freshened edges of the elastic scrotal skin can be brought together over the testes. Exceptionally, a plastic procedure will be required. Because epithelialization was not progressing satisfactorily, J. F. Thomes implanted the testes into the thighs on the nineteenth day. He advises this procedure in like cases in men over 55 where fertility is not of prime importance.

Prognosis.—During the past ten years the mortality has fallen from over 30 per cent to under 10 per cent.

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