

CHAPTER XXXI

URINARY SYMPTOMS. INVESTIGATION OF THE
URINARY TRACT. ANURIA

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URINARY SYMPTOMS

THREE symptoms, a veritable triple alliance, accompany most urinary affections. They are pain, increased frequency, and hæmaturia.

Pain associated with affections of the urinary tract embraces :

Renal pain is usually a dull ache situated mainly in the costo-vertebral angle, but also in the upper and outer quadrant of the abdomen.

Ureteric pain is the well-known colic¹ passing from the loin to the groin.

Vesical pain varies from slight suprapubic discomfort to strangury, which is agonising pain referred to the external urinary meatus, accompanied by an intense desire to micturate, but resulting in the expulsion (by straining) of only a few drops of blood-stained urine.

Prostatic and seminal vesicular pain is deep-seated in the rectum; it is often referred to the perineum, but sometimes the suprapubic region or to one or both iliac fossæ, or to one or both the sacro-iliac joints.

Urethral pain is scalding, and occurs during micturition.

Increased Frequency.—The patient states that micturition is frequent. Of greater significance is the number of times he has to rise at night to empty his bladder. In the clinical history the record of such an enquiry

is usually entered thus $\frac{D}{N} = \frac{?}{3}$.

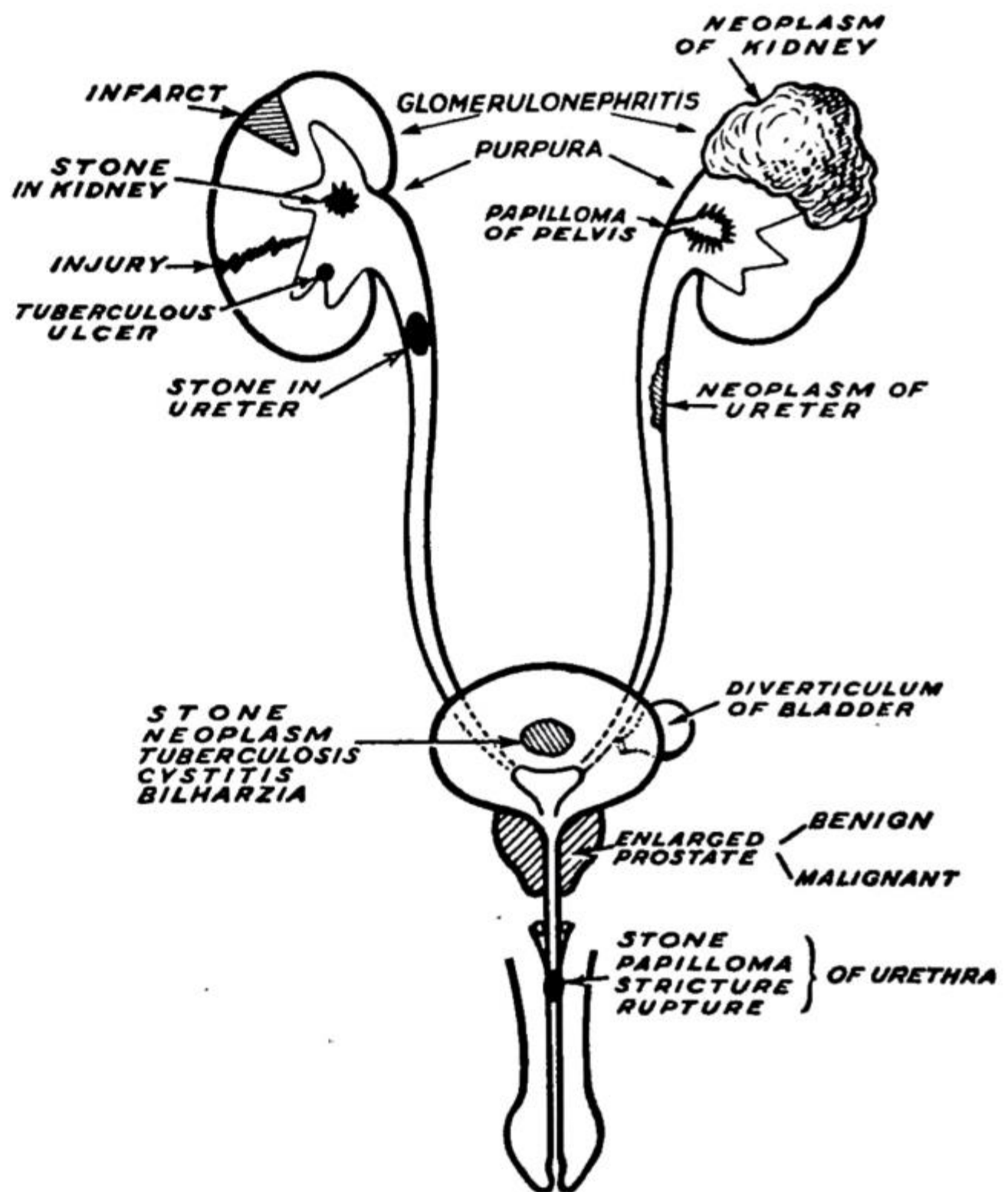


FIG. 949.—The more common causes of hæmaturia.

¹ Renal colic is a term that is deeply rooted. Pain passing from loin to groin should be called ureteric colic, for obviously that is more accurate.

Hæmaturia.—Blood in the urine, however transient, is a symptom that must never be passed by lightly. Painless hæmaturia is so often a herald of new-growth in some part of the urinary tract that a complete urinary investigation should be started at once, and the patient must not be discharged until the cause has been found. When hæmaturia is painful, the patient demands relief, and the task of persuading him to undergo a thorough examination is less difficult. The causes of hæmaturia are manifold. The more common ones are depicted diagrammatically in fig. 949, and these conditions will receive appropriate attention in the text that follows.

INVESTIGATION OF THE URINARY ORGANS

The urine is examined chemically and bacteriologically. For the former a twenty-four-hour specimen is collected under normal conditions. For the latter a mid-stream or catheter specimen must be collected. Both in the female and the male a mid-stream specimen of urine is much to be preferred (absolute freedom from contaminants). With a normal fluid intake, the amount of urine excreted by the kidneys is 50 ounces (1.5 litres) every twenty-four hours, and the average specific gravity of the urine varies from 1.018 to 1.020.

Tests of Renal Function.—Because of the large reserve of renal tissue considerable structural damage can occur before measurable functional damage becomes apparent. Kidney function can be impaired in three principal ways: the renal plasma-flow may be reduced, the glomeruli damaged, or the function of the tubules impaired. In essential hypertension the chief fault lies in the renal plasma-flow. In glomerulonephritis the main effect is reduction in the glomerular filtration rate, while in pyelonephritis the brunt falls on tubular function. In back pressure due to obstruction of urinary out-flow all become impaired.

Range of Specific Gravity.—The power of the kidneys to concentrate and dilute urine is a good test of their functional integrity. Fluid is withheld for twelve hours overnight. The specific gravity of the first two morning specimens should reach 1.020; a specific gravity of 1.025 in a urine free of protein indicates good renal function. Two pints (1.2 litres) of water are given by mouth. Within four hours the specific gravity should reach as low as 1.002. A fixed specific gravity of 1.010 under these varying circumstances is good presumptive evidence of impaired function of the distal renal tubules.

The blood urea (or non-protein nitrogen) is normally between 20 and 40 mg. per 100 ml. of blood. A reading above 40 mg. is suspicious, and one more than 50 mg. is indicative that the kidney function is impaired.

Urea Concentration Test.—All fluid is withheld for twelve hours. After emptying the bladder the patient receives 15 grammes of urea dissolved in 100 ml. of water. Urea is a diuretic, and the excess of urea in the circulating blood should be eliminated in a few hours if the kidneys are healthy. If the urine contains 2 to 2.5 per cent. of urea during the second and third hours after the intake, renal function may be regarded as satisfactory. If there is under 2 per cent., there is deficient functional activity of the renal tissue. The total output of urea per hour should be more than 1.5 gm.; this is of more importance than the percentage (J. Swift Joly). If the blood urea is high, the test is not reliable. Urea concentration is a measure of tubular function.

The Urea Clearance Test (Van Slyke).—The test depends on the amount of urine passed in a definite time, usually one hour, its urea content, and on an average

John Swift Joly, 1876-1943. Surgeon, St. Peter's Hospital, London.

Donald Dexter van Slyke, Contemporary. Biochemist, Brookhaven National Laboratory, Upton, New York.

blood urea. Without preliminary fluid restriction the bladder is emptied completely (by a catheter, if necessary) and this urine is discarded. The patient is instructed to drink a glass of water. The bladder is emptied again after one, and after two hours; when the first hourly specimen of urine has been obtained, a sample of blood is taken for a blood urea. The mean of the two clearances, which should agree within 10 per cent., is taken. The average normal amount of blood cleared of urea in one minute is either 54 or 75 ml., depending on whether the flow of urine is less or greater than 2 ml. per minute; these are termed *standard* and *maximum* clearances respectively. The normal range of urea clearance is from 70 to 120 per cent. of the average normal amount. The urea-clearance test is accepted generally as a test of glomerular filtration-rate.

The Phenolsulphonphthalein Test.—One ml. of phenolsulphonphthalein (containing 6 mg. of the dye) is injected intravenously. During each half-hour of the test the patient is requested to drink 200 ml. of water. The urine is examined one and two hours after the injection. The average amount of dye normally present in the first specimen is 40 to 60 per cent.; the second specimen is 20 to 25 per cent. Therefore the total excreted in two hours should be 60 to 85 per cent. An impaired phenolsulphonphthalein test indicates impaired function of the proximal renal tubules.

Before a patient undergoes a major operation on the urinary tract the minimum tests of adequate renal function that should be satisfied are: (1) A blood-urea estimation which is a crude indication of glomerular function. (2) A phenolsulphonphthalein test which is a fair estimate of the activity of the proximal renal tubules and a specific gravity test which signifies adequacy of function of the distal renal tubules (W. W. Scott).

Excretory (syn. Intravenous; Descending) Pyelography.—The preparation now employed for this purpose is diodone (BP)¹ which contains about 50 per cent. of iodine that renders it relatively radio-opaque. It is supplied in 20-ml. ampoules of a sterile solution (adult dose).

Contraindications.—When renal function is poor. (If in doubt, renal function tests should be carried out.) Idiosyncrasy to iodine, thyrotoxicosis, grave anæmia, hepatic insufficiency, and acute infections of the kidneys are also contraindications to excretory pyelography.

Tests for Sensitivity:

Ocular Test.—One drop of the contrast medium is instilled into a conjunctival sac. If in ten minutes erythema is produced, the test is positive.

Subcutaneous Test.—0.1 ml. is injected subcutaneously. If erythema and induration develop promptly, the test is positive.

If untoward signs develop during the injection, stop the injection at once. Give oxygen for anoxia, a pressor drug for low blood pressure, dextrose-saline solution for shock which is to be followed by dextran if needed. Important antidotal drugs in the treatment of acute sensitivity reactions are (a) anthisan, 100 mg. intravenously or (b) hydrocortisone, 100 mg. intravenously.

Preparation.—A mild vegetable aperient is given on two evenings preceding the examination. For 8 hours before the injection the intake of fluids is restricted. No fluid is given on the morning of the examination, and the patient is instructed to empty the bladder just before the injection.

Technique.—The contents of an ampoule, warmed to blood heat, is injected into a suitable vein, usually of an arm, with the patient recumbent, the rate of injection being not greater than 10 ml. per minute. None of the

¹ The best-known proprietary preparations of diodone are Perabrodil (Bayer Products), Pyelosil 35 (Glaxo Laboratories), Pylumbrin (Boots Ltd.), Uridone (May & Baker), and Diodrast (Winthrop-Stearns, U.S.A.).

William Wallace Scott, Contemporary. Urologist-in-Charge, The Johns Hopkins Hospital, Baltimore, U.S.A. Alexander von Lichtenberg, 1880-1949. Professor of Urology, Berlin, announced the discovery of uroselectan (the first successful medium for excretory pyelography) in 1929.

solution must be permitted to escape into the tissues around the vein, for it is very irritating. Even a small quantity injected outside the vein causes



FIG. 950.—Normal excretory pyelograph.

painful inflammation lasting for days, and may result in local necrosis. If the kidneys are functioning normally, the medium appears simultaneously in the calyces and pelves of both kidneys in an X-ray film taken two minutes later. As a routine, films are exposed at 5, 10, 15, and 25 minutes. Compression applied to the abdomen by a strap enhances the clarity of the pyelographs. The concentration reaches its maximum in 15 to 30 minutes (fig. 950). After the 25-minute prone film has been taken, another film in the erect position is valuable: (a) to demonstrate the mobility of the kidneys, (b) to visualise the ureters. Normally visible excretion is completed in one to one and a half hours. The

later radiographs show the bladder filled with the medium. In order to display the termination of the ureters the patient should micturate immediately before the final radiograph. The amount of residual urine in the bladder, if any, can also be demonstrated in this way. When the renal pelves and calyces fail to empty within the normal limits, further radiographs are taken at half-hourly intervals.

Subcutaneous Pyelography.—When the calibre of the veins prohibits the intravenous route, subcutaneous pyelography can be employed. For subcutaneous administration a 35 per cent. solution of diodone is diluted with sterile water to give a concentration of 15 per cent. In order to aid absorption, 1,000 units of hyaluronidase is injected in two equal portions into the subcutaneous tissue above each scapula. The diluted contrast medium is then injected into the same sites, and radiological exposures are made after thirty minutes.

INSTRUMENTAL EXAMINATION OF THE URINARY ORGANS

Anæsthesia.—For instrumental examination of the urinary organs local anæsthesia of the urethra must be efficient.

In the Female.—The vulva is washed with soap and water followed by swabbing with a mild antiseptic solution. The labia minora are held apart and a swab stick with the cotton-wool soaked in 10 per cent. cocaine solution is inserted into the urethra and left there for five minutes. The anæsthesia so produced allows instrumentation almost without discomfort.

In the Male.—If the prepuce is present, it is retracted and all smegma is removed by washing with soap and water followed by swabbing with a mild antiseptic solution. For the circumcised swabbing is sufficient.

Cocaine in the male is dangerous, absorption via the deep and prostatic urethra into the circulation sometimes causing collapse and even death. A cocaine substitute in a lubricating jelly is best. In decreasing order of efficacy there are xylocaine 2 per cent., nupercaine 0.5 per cent., and procaine 5 per cent. One of these jellies is squeezed into the urethra, about 20 ml. being employed. It is retained in the urethra for five minutes by placing penile clamps on the glans.

Bouginage is described in Chapter xxxv.

Catheterisation is described on p. 795.

Cystoscopy.—By cystoscopy, the interior of the bladder is inspected and the ureteric orifices observed. If 7 ml. of a 0.4 per cent. solution (adult dose) of indigo-carmin are injected intra-

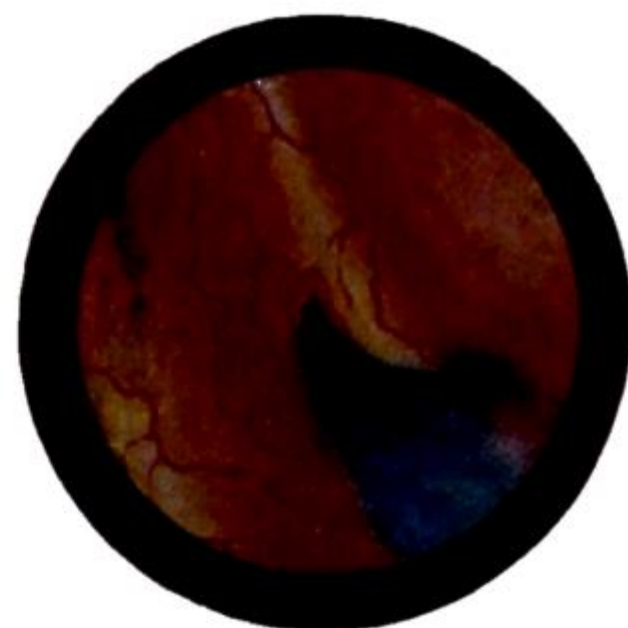


FIG. 951.—Discharge of indigo-carmin down a right normal ureter. Cystoscopic appearance.



FIG. 952.—A ureteric catheter about to enter the left ureteric orifice. Cystoscopic view.

can be watched (fig. 951); normally it should appear within four or five minutes. Delay of excretion of the dye on one side is indicative of unilateral

urinary obstruction or disease, while delay on both sides suggests bilateral renal impairment. By employing a catheterising cystoscope, ureteric catheters can be passed up each ureter (fig. 952), and specimens of urine collected

from each kidney (fig. 953). Such specimens are examined chemically and bacteriologically, and much information is obtained thereby.

Retrograde (*syn. instrumental*) **pyelography** is employed when a clearer definition than that afforded by excretory pyelography is required, e.g. suspected renal neoplasm or early tuberculosis. The ureters are cathe-



FIG. 953.—Specimens of urine being collected after ureteric catheterisation. The test-tubes are capped with rubber finger-stalls.

terised, and the patient is conveyed to the radiological table. A plain radiograph is taken and developed before injecting the medium in order to ensure that the ureteric catheters are not too advanced. A sterile 12½ per cent. solution of sodium iodide can be used, but for even better definition pyelectan retrograde (Glaxo Labs.), which is a 20 per cent. solution of iodoxyl, can be employed and has the advantage of being entirely non-irritating. A pyelograph syringe which fits any ureteric catheter is filled with 10 ml. of the solution, and the injection is made up the catheter slowly. If pain is complained of, the injection is stopped. A radiograph is then taken (fig. 954). Should a large hydronephrosis be present, more medium will be required to obtain clear definition. By this method it is possible to inject the pelves of both kidneys at the

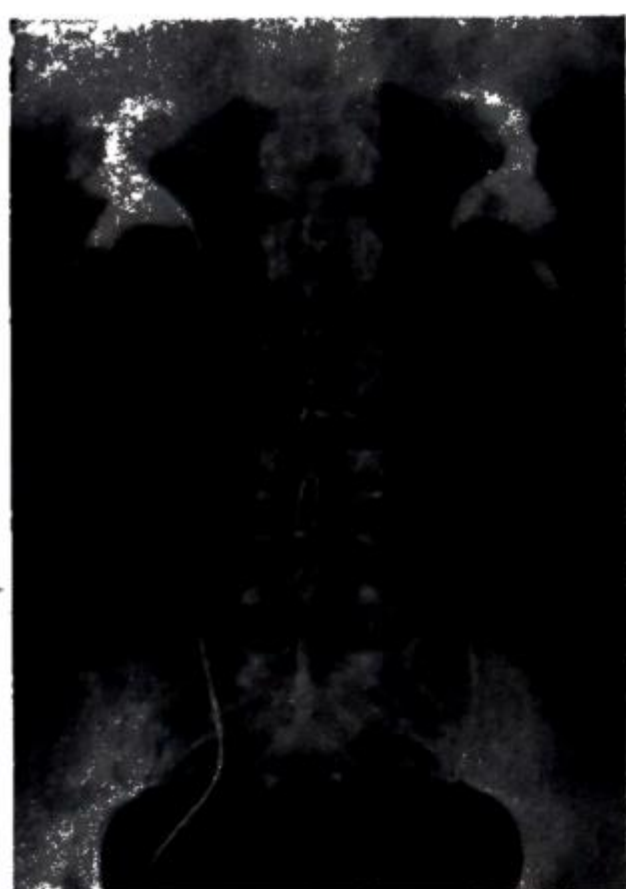


FIG. 954.—Normal retrograde pyelogram. The definition is much clearer, consequently this procedure is invaluable in confirming doubtful abnormalities visualised by the excretory method.

In 1877, Max Nitze, Professor of Urology, Berlin, in conjunction with Beneche, an Optician of Vienna, produced the first cystoscope.

same sitting, but in cases of poor renal function it is advisable to make each examination independently. In either event, after the X-ray exposure has been made, as much of the medium as possible is aspirated from the renal pelvis.

Cystography: (a) *Excretory*.—The cystographs which accompany the later films of excretory pyelography usually are not sufficiently dense to give a clear delineation of pathological conditions in the bladder.

(b) *Retrograde* is employed principally to confirm the presence and dimensions of a vesical diverticulum. A rubber catheter is passed and the urine in the bladder is evacuated. If a diverticulum is suspected, the patient lies on his face so as to favour drainage of urine from the diverticulum. A plain radiograph is taken to exclude a calculus in the diverticulum. The bladder is then filled with medium until the patient feels a desire to micturate. An excellent contrast medium for cystography is a 25 per cent. solution of iodoxyl (B.P.). A radiograph is taken with the bladder full, and again after the bladder has been emptied. If there is a diverticulum present, it will remain full of medium after the medium has left the main cavity (see p. 809). The extent of a very large neoplasm of the bladder can sometimes be demonstrated better by cystography than by cystoscopy.

Urethroscopy: (a) *Anterior urethroscopy* is employed when the presence of a urethral stricture (see fig. 949, p. 711) or strictures is suspected, or in cases of chronic urethritis, in order to exclude or confirm the presence of an infected urethral crypt or a granuloma (a 'soft' stricture). Anterior urethroscopy is conducted under air inflation of the urethra.

(b) *Posterior urethroscopy* permits inspection of the prostatic and membranous urethræ. Posterior urethroscopy is carried out under intermittent dilatation of the urethra with boric or oxycyanide solution. By posterior urethroscopy the internal urinary meatus can be seen as a crescentic fold forming the floor of the urethra. When the sphincter is relaxed, as it is in cases of congenital nocturnal incontinence, the whole periphery of the bladder

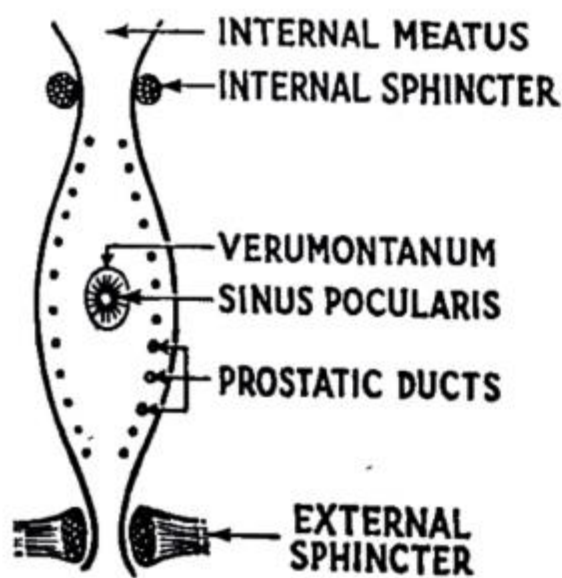


FIG. 955.—Structures on the floor of the posterior urethra. (After J. C. Ainsworth-Davis.)

neck is visible. When the prostate is enlarged, it can be seen as bulging of the floor and lateral walls of the urethra in the vicinity of the internal urinary meatus. The most notable normal spectacle of posterior urethroscopy is the verumontanum, which



FIG. 956.—Inflamed swollen verumontanum seen through a posterior urethroscope.

presents as an eminence on the floor of the prostatic urethra. On the summit of this projection is the sinus pocularis (fig. 955). Into the sinus pocularis open the ejaculatory ducts, the orifices of which can be seen but rarely. The verumontanum is reddened and enlarged in cases of chronic vesiculitis (fig. 956). In cases of chronic prostatitis, one

or more of the numerous prostatic ducts which normally are difficult to visualise may be seen exuding pus.

Urethrography is employed extensively for diagnostic purposes in Scandinavian countries. Urethrography (fig. 957) is especially valuable for gaining information concerning the length of a urethral stricture, of dilatation or diverticulum formation above a stricture, or of failure of the medium to pass a stricture. It also reveals dilated prostatic ducts in chronic prostatitis and especially in tuberculous prostatitis. It is valuable for determining the presence of contraction of the bladder neck. The one contra-indication to its use is the presence of urethral hæmorrhage. The medium employed must be chosen with great care, for should there be a breach in the continuity of the lining membrane of the urethra the medium will enter the circulation.



FIG. 957.—Normal urethrograph.

Lipiodol brings with it the danger of oil embolus and this medium never should be employed. Even worse is to inject barium emulsion: at least two deaths have occurred from its use in cases of ruptured urethra.

The medium must therefore be harmless should some of it enter the circulation, and the injection must not be rapid or forceful. Perabrodil (80 per cent.) complies with these stipulations seeing that it can be injected intravenously. For general purposes the most satisfactory medium is umbradil viscous V. This is a jelly that is squeezed from a tube into the butt end of a urethral syringe. It is injected easily and contains the local anæsthetic xylocaine. The in-

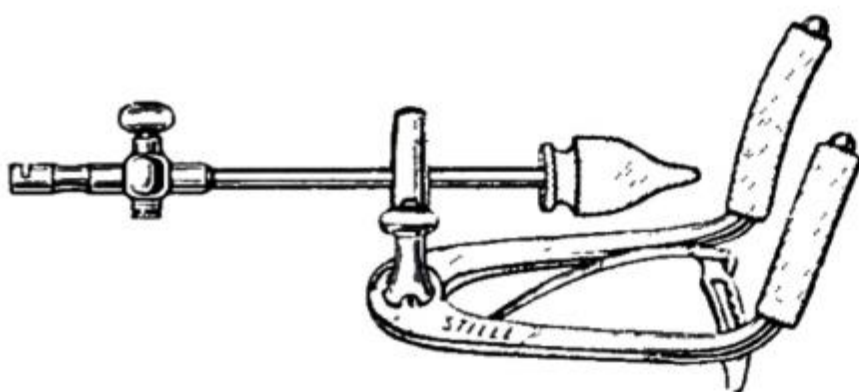


FIG. 958.—Knutsson's apparatus for urethrography.

jection is made most satisfactorily by employing Knutsson's apparatus (fig. 958) which has a penile clamp attached.

RENAL ANGIOGRAPHY

Renal angiography rarely provides information unobtainable by retrograde pyelography. To be enabled to visualise the renal arterial architecture is of diagnostic value in the following conditions, the value decreasing in the order enumerated:

1. Aneurism of the renal artery.
2. Renal hypertension—unilateral ischæmia suspected.
3. Renal tuberculosis—partial nephrectomy contemplated.
4. Renal neoplasm.
5. Renal cyst.

There are two methods of performing renal angiography.

(a) **Translumbar aortography** is carried out under general anæsthesia. A hollow needle is passed into the abdominal aorta just below the renal arteries, the contrast medium is injected and four films are taken in rapid succession. To minimise accidents a small quantity of medium is injected and a film taken to ensure that the needle is below the level of the renal arteries.

(b) **Retrograde Arteriography.**—A special needle is used. The needle is passed into the femoral artery. The stilette is removed. The 'leader' with a supple tip is passed into the artery and the needle is removed. The artery is compressed to avoid bleeding and polythene tubing is threaded on to the leader and so guided through the skin and arterial punctures into the artery. The polythene tube is

advanced to the desired level, a small quantity of medium being injected to render it opaque to X-rays. The medium is then injected.

In either method not more than 15 ml. of urografin (60 per cent.), one of the least toxic media, should be injected. If these stipulations are adhered to, accidents are minimised. The dangers of the procedure are (a) tubular necrosis of the kidneys, (b) paraplegia, often temporary, probably due to contrast medium entering the vessels of the spinal cord.

Operation should not be performed for at least one week after renal angiography.

Perirenal insufflation of oxygen to delineate a renal or adrenal swelling is described on p. 255.

ANURIA (*syn.* SUPPRESSION OF URINE)

Oliguria should be defined as an excretion of less than 300 ml. (11 ounces) of urine in twenty-four hours. Anuria is an absence of excretion for twelve hours.

The most helpful classification of anuria is into pre-renal, renal, and post-renal. Although suppression of urine is commonly and conveniently referred to as anuria, except in post-renal (obstruction) cases the suppression is seldom absolutely complete.

PRE-RENAL ANURIA

The blood pressure in the glomeruli is normally about 90 mm. of mercury ; when the systolic blood pressure falls below 70 mm., filtration from glomeruli ceases. If the glomeruli are diseased, a higher pressure (up to 100 mm. of mercury) 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.

Treatment.—Blood transfusion in the case of hæmorrhage, the treatment of shock (see p. 14) if that be the cause of the fall in the blood pressure, or in cases of dehydration the administration of dextrose-saline solution intravenously often restores urinary excretion. If hypotension is long maintained, damage to the renal epithelium results, and the condition passes on to one of renal anuria.

Reflex Anuria.—Suppression of renal function occasionally follows instrumental procedures on the renal tract or the sudden relief of acute-on-chronic or chronic retention of urine. It can arise in a healthy kidney when the contralateral ureter becomes acutely obstructed, as by a calculus ; and rarely it follows certain gynæcological and obstetric operations in which the urinary tract has not been involved. The most serviceable explanation of this perplexing phenomenon is that the condition is one of pre-renal anuria brought about by reflex vasoconstriction of the afferent glomerular arterioles or over-production of pituitary antidiuretic hormone. It must be mentioned that in a few instances of suppression of urine following ureteric catheterisation re-cystoscopy has revealed bulbous œdema of the ureteric orifices. In these instances the anuria has been post-renal and due, it is believed, to an idiosyncrasy to formalin used in sterilising the catheters and failure to wash them effectively before use.

RENAL ANURIA

Renal anuria results from damage to, or destruction of, the renal epithelium (fig. 959). The principal causes met with in surgical and gynæcological practice are :

1. Severe shock (hypotension) lasting two hours or more.

2. Incompatible blood transfusion (see below).

3. Ultra-acute pyelonephritis, especially that occurring with retention of bladder urine.

4. The crush syndrome (see p. 17).

5. Concealed accidental hæmorrhage and abortion.

6. Certain poisons. The main ones of surgical importance are (a) media used for aortography, (b) the toxin of eclampsia.

7. Acute pancreatitis.

8. Congenital cystic kidneys.

9. Advanced bilateral renal tuberculosis.

Owing to destruction of renal epithelium, the last two, of necessity, eventually prove fatal.

When renal anuria is reversible and it is treated correctly the condition is divided into three phases :

1. The oliguric phase.

2. The phase of diuresis.

3. The phase of recovery.

Clinical Features.—The average duration of the oliguric phase is ten to twelve days. Anorexia is an early symptom which is followed by hiccough. Within four or five days copious effortless vomiting is usual. Abdominal distension is seldom absent. Untreated, or treated incorrectly, the blood urea

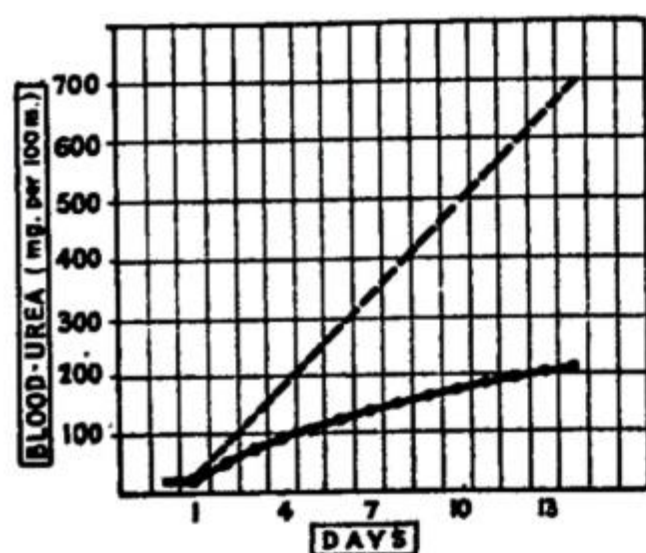


FIG. 960. — Dotted line : rise of blood urea in untreated anuria. Solid line : same when treated by fluid limitation and protein-free diet. (After G. M. Bull.)

mounts by 20 to 30 mg. daily (fig. 960). The systolic blood pressure tends to be moderately elevated—200 mm. Hg. after two or three days.

Still untreated, or treated incorrectly, about the sixth day increasing drowsiness, thirst, a dry skin, and a dry brown tongue are characteristic findings. The respiratory and pulse-rates become slower and irregular, and Cheyne-Stokes' respirations are often in evidence. The final stages are usually characterised by muttering delirium followed by coma.

Before commencing treatment of a comparatively early case, should doubt exist as to the cause, post-renal anuria must be eliminated by

ureteric catheterisation and plain radiography.

Treatment.—Special Emergency Measure.—In cases of incompatible blood transfusion renal damage can sometimes be prevented by provoking copious diuresis within an hour of the reaction. To this end $\frac{1}{2}$ litre of

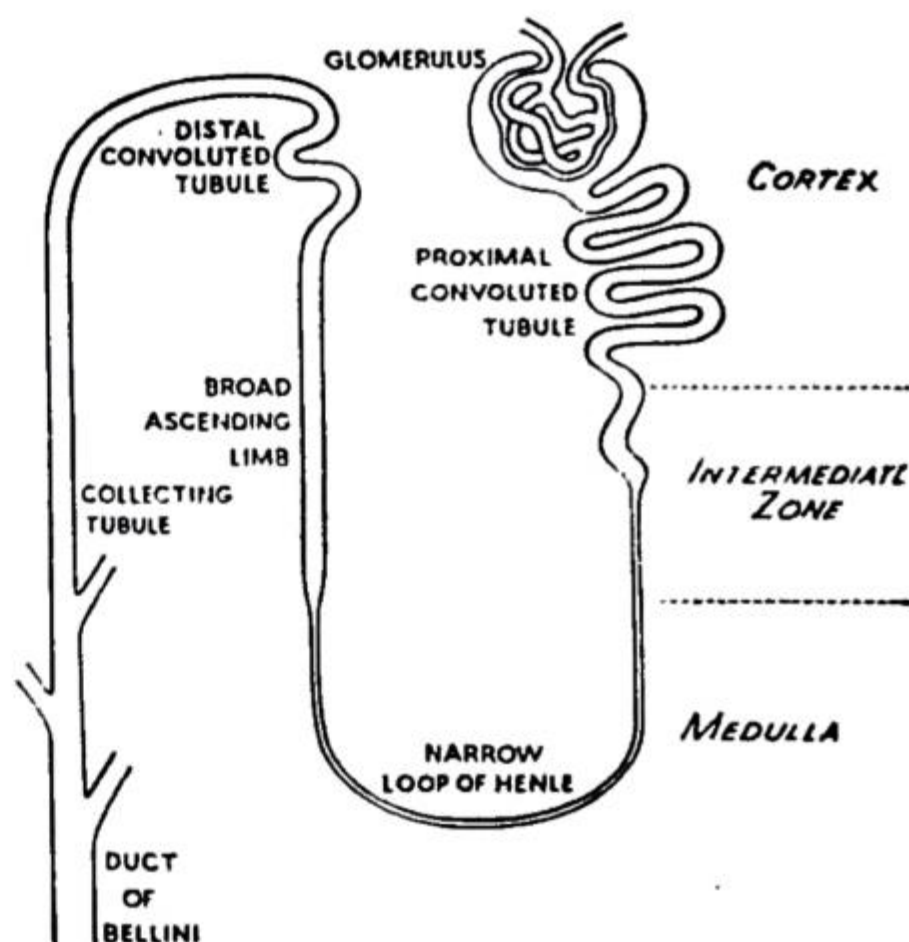


FIG. 959.—Necrosis of the proximal convoluted tubule produces immediate anuria of the nephron. (After H. L. Sheehan.)

Lorenzo Bellini, 1643–1704. Professor of Anatomy, Pisa.
Friedrich Gustav Jacob Henle, 1809–1885. Professor of Anatomy at, successively, Zürich Heidelberg and Göttingen.
John Cheyne, 1777–1836. Physician-General to the Forces in Ireland.
William Stokes, 1804–1878. Regius Professor of Medicine, Dublin.

isotonic (4.285 per cent.) sodium sulphate¹ is gravitated into a vein. If within a quarter of an hour the patient passes some urine, a further $\frac{1}{2}$ litre is administered. When there is no response, the hollow needle is withdrawn and all fluids are restricted forthwith.

In all other varieties of renal anuria the essence of what *not* to do is to force fluids. Contrary to former beliefs, the most important substances in the genesis of uræmia are not urea and other organic end-products of nitrogen metabolism but water and electrolytes.

Another reprehensible practice is to prescribe *potassium* citrate for a patient on the threshold of suppression of urine; it has caused many deaths from hyperpotassæmia.

Principles in Treatment.—The three essentials upon which to concentrate are :

1. *Water Balance.*—If a patient with renal anuria receives less than 2,000 ml. of fluid per diem, death within fourteen days is unusual, and recovery is frequent. On the other hand, should such patients receive 3,500 ml. or more per diem, 75 per cent. die with signs of water overload during life, and evidence of pulmonary (and of cerebral) œdema at necropsy. In the absence of vomiting the elimination of water by an anuric patient is limited to extra-renal routes, i.e. lungs, skin, and fæces. In a temperate climate this loss is 600 to 1,000 ml. per day. As it is estimated that there is a daily production of 400 ml. of water from the oxidation of body fat and proteins, the daily fluid intake of an anuric patient must be limited to 500 ml. plus an amount equal to that of the water vomited or recovered by gastric aspiration.

Additions must be made for diarrhœa and excessive sweating: regarding the latter an extra 200 ml. is allowed for each degree of the patient's temperature above 100° F. (37.8° C.). When the weather is exceedingly hot the allowance is increased, but even in these circumstances the allowance should rarely exceed 1,000 ml. per twenty-four hours.

Bedside evaluation—thirst, moisture of the tongue and the skin—are excellent guides of adequate hydration.

2. *Electrolytic Balance.*—In the absence of diarrhœa and vomiting, the only effective channel for excretion of electrolytes is by the kidneys. Consequently, in anuria the administration of electrolytes often leads to gross disturbances of electrolytic balance; in particular, hyperpotassæmia is liable to cause sudden death from cardiac arrest. *Therefore the patient should not receive any electrolytes until diuresis recommences.*

3. *Nitrogen Metabolism.*—The end-products of protein katabolism, other than urea, are possibly toxic. Furthermore, by the breakdown of both exogenous and endogenous protein, potassium is liberated. For these reasons it is essential to prohibit protein intake altogether and to reduce endogenous nitrogen metabolism as much as possible. A high carbohydrate intake depresses endogenous nitrogen metabolism.

¹ Alternatively, the new diuretic mannitol, 50–100 G. intravenously as a 25 per cent. solution, has much to recommend it. The U.S. N.F. preparation is put up in ampoules containing 12.5 G. in 50 ml. (a 25 per cent. solution).

The Protein-free, Mineral-free, Strictly-limited-fluid Régime.—The object is to provide 2,000 calories per day, and at the same time to limit fluid intake as detailed above. This is a diet upon which the patient can subsist without discomfort for periods up to three weeks (G. M. Bull). According to circumstances, the régime can be varied :

(a) When the patient can take fluid by mouth without vomiting or undue nausea, a daily intake of 500 ml. of 40 per cent. lactose, given in small frequent amounts, is likely to be acceptable because the solution tastes less sweet than dextrose.

(b) When the patient is anorexic, nauseated, and prone to vomit, a plastic gastric tube is passed transnasally and the 500 ml. of 40 per cent. dextrose or lactose is gravitated by the drip method. A plastic gastric tube is chosen because its relative stiffness makes it less likely to be expelled if the patient vomits. As far as possible vomitus must be collected and measured, for obviously it is highly important to supplement the loss with precision. To stop the drip for two to four hours at a time helps some patients to retain the solution.

Alternatively, 50 to 100 ml. of doubly centrifuged cream¹ is added to the dextrose solution. This enables the solution to be tolerated by some patients who otherwise would eject it.

(c) When the patient is unable to retain the fluid gravitated into the stomach, or toxæmia or a head injury (anuria is not uncommon in cases of head injury) makes him stuporous and therefore liable to inhale vomitus, there is but one alternative—to give the 40 per cent. dextrose solution intravenously.

At present it is popular to give this clot-provoking solution into the inferior or superior vena cava by a polythene tube passed from the saphenous or cubital vein respectively.

In order to discourage thrombosis, heparin (1,000 units per 500 ml.) is added to the infusion. Even so post-mortem examination has shown intravenous clotting in a high percentage of cases. For this reason the intravenous route should be employed only in cases of absolute necessity. Some advise passing the polythene tube but a few inches into a peripheral vein and to change the vein if clotting occurs. By gravitating the fluid in this way it is believed that the menace of pulmonary embolism is lessened.

Vitamins.—Irrespective as to whether the alimentary or the intravenous route is employed, the daily vitamin intake should be identical with that of a patient subsisting wholly on parenteral feeding (see pages 71 to 73).

Prevention of Infection.—Anuric patients become infected easily, therefore all who come in contact with the patient should be gowned and masked. Penicillin, 1 mega unit per twenty-four hours, can safely be given but all other antibiotics are cumulative even when given in greatly reduced doses. Erythromycin 1 G. daily is the least harmful.

Watching for Hyperpotassæmia.—Serial electrocardiographs are a better check to the development of this complication than reliance on plasma potassium determinations.

Diuretic Phase.—In reversible lesions, usually about the eighth day, the

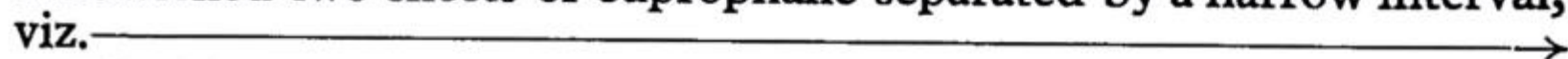
¹ Peanut oil recommended in previous editions of this book is more nauseating and diarrhoea-provoking than doubly centrifuged cream.

epithelium of the lower nephrons regenerates sufficiently to prevent resorption of the glomerular filtrate, and a little urine is passed. This is a most hopeful sign, and given correct management and previously healthy kidneys (Causes 1 to 7) an increasing twenty-four-hourly output during the subsequent week is usual. When diuresis commences, an amount of water equal to the output of urine for the previous twenty-four hours is added to the daily allowance. More difficult is to estimate an appropriate allowance of electrolytes, for the restitution of renal electrolyte-regulating function returns slowly. Only when renal excretion reaches 1 litre per day does the blood-urea level commence to fall. Once diuresis exceeds 1 litre in twenty-four hours, the intragastric tube is removed and the patient is fed on a high calorie, low-protein diet containing an adequate daily amount of mineral salts.

Other methods of treatment in special circumstances :

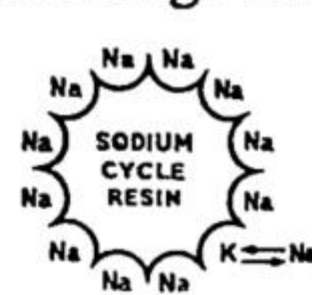
1. **Exchange Transfusion.**—The principal indication is in the initial phase of anuria following incompatible blood transfusion, the object being to remove free hæmoglobin, hæmolytic toxins, and damaged erythrocytes.

2. **The Artificial Kidney.**—The chief indication is mounting hyperpotassæmia. The principle of the artificial kidney is that of dialysis across a membrane which is permeable to crystalloids and not to colloids with the patient's blood on one side of the membrane and a saline bath on the other; excessive crystalloids will leave the blood and enter the bath, which is constantly flowing.

The modern machine consists of tiers of grooved rubber plates between which are sandwiched two sheets of cuprophane separated by a narrow interval, viz. 

The blood is pumped from the inferior vena cava through the space between the cuprophane sheets while saline solution is pumped in the opposite direction through the rubber tunnels and thence to waste or analysis. The purified blood is returned to the patient through an antecubital vein.

The artificial kidney requires a trained team of six to operate the machine, so as a consequence it is available only in a comparatively few centres. It is therefore necessary to describe other methods of ridding the patient of excessive electrolytes, particularly potassium.

Ion Exchange Resins.—If the patient does not vomit, then exchange ion resins in the sodium phase have been used successfully to withdraw potassium ions into the intestine in exchange for sodium ions. 

Five G., dissolved in the patient's allowance of dextrose solution, is given eight times a day. The resins are of no avail given *per rectum*.

Peritoneal Dialysis.—This method has been used with limited success. The simplest method and the one least likely to give rise to peritonitis is to insert a polythene tube into the peritoneal cavity by means of a trocar and cannula. Into the peritoneal cavity is gravitated moderately slowly a hypertonic solution (20 per cent. dextrose solution with 6 G. sodium chloride per litre added). The fluid is retained by clipping the tube for two hours and the process continued for up to forty-eight hours. Thus the peritoneum can be made to act as a dialysing membrane.

Willem J. Kolff, *Contemporary*. Member of Staff, Research Division, Cleveland Clinic Foundation, Cleveland, Ohio, U.S.A. Formerly Physician, Kampen, Holland. First described the clinical use of an artificial kidney.

POST-RENAL (*syn.* OBSTRUCTIVE) ANURIA

Calculous anuria arises in one of the following ways :

1. A calculus becomes impacted in the ureter of the only functioning kidney, the other kidney being congenitally absent, previously removed, or destroyed by disease.

2. Both ureters become obstructed by stones.

3. A calculus blocks one ureter, and the contralateral organ, seldom completely normal, also ceases to function (see reflex anuria, p. 718).

In two-thirds of cases the obstruction lies at the uretero-pelvic junction or in the upper third of the ureter.

Clinical Features.—Usually the patient is a man between forty and sixty years of age with a long history of urinary lithiasis, but in 20 per cent. of cases calculous anuria arises without previous symptoms.

Onset.—Typically an attack of renal colic precedes the anuria, the onset of which is sudden. In a few cases there is little, if any, pain, and the anuria is preceded by several days of increasing oliguria. The latter variety is usually due to a superimposition of pyelonephritis on kidneys (or a sole existing kidney) that have been functioning poorly on account of partial calculous obstruction.

Stage of tolerance usually lasts from three to six days. Exceptionally it is prolonged to as much as twelve days. The patient feels comparatively well and may continue his work for a few days. During this time the blood urea mounts steadily, and as it does so headache, sleeplessness, constipation, and lassitude supervene. By the end of this stage the blood urea is very high, often over 200 mg. per cent.

Stage of uræmia follows, and is characterised by the same clinical features described in late renal anuria.

Diagnosis and Treatment.—Retention of urine is excluded by the passage of a urethral catheter. In anuria the bladder will be found to be empty, or it contains but a few ounces of blood-stained urine. If rigidity is present in one loin, the corresponding kidney is the one likely to be the last obstructed. A large palpable kidney is probably functionless and the seat of a hydronephrosis or pyonephrosis ; a recently obstructed kidney is never grossly enlarged. A plain X-ray film occasionally reveals the obstructing calculus. More often, because the obstructing calculus is small (it is seldom larger than an orange pip) and the film is obscured by intestinal gas shadows, the obstructing calculus is not visualised at this stage. Sometimes a large branched renal calculus is displayed on the non-functioning side. Cystoscopy should be carried out as soon as possible. Occasionally a stone is seen wedged in a ureteric orifice (fig. 961). If the necessary instruments are available, ureteral meatotomy (see p. 757) or the passage of a stone

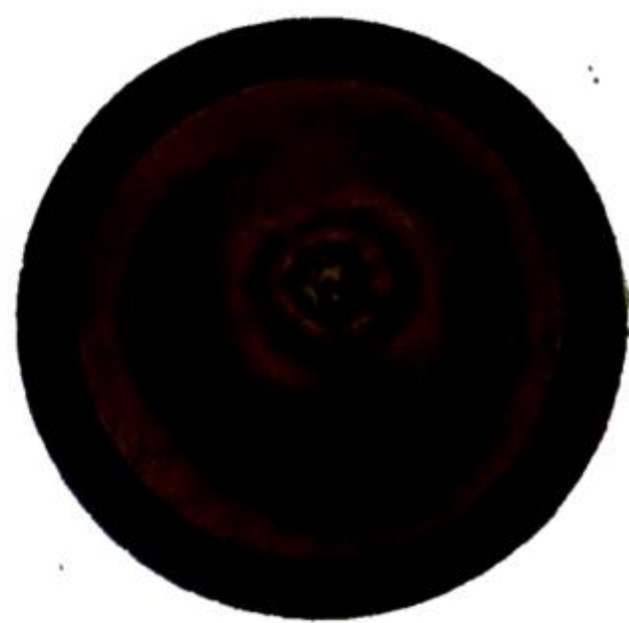


FIG. 961.—Stone impacted in the ureteric orifice as seen through the cystoscope.

dislodger (see p. 757) may result in disimpaction of the calculus. If the stone cannot be extricated or a ureteric catheter passed beyond it, nephrostomy should be performed. Usually the ureteric orifices are normal. In the not uncommon anomaly of congenitally absent kidney (1 in 1,400), one ureter alone is present. An attempt is made to pass an olivary-ended catheter into the renal pelvis on the side believed to be obstructed. If the catheter can be manipulated beyond the stone, dark urine drips from the catheter. Failing this, a large stiff ureteric catheter may cause a stone at the uretero-pelvic junction to be displaced into the renal pelvis. The contralateral side is catheterised also; occasionally in cases belonging to groups 2 and 3 urine drips from both catheters. In the event of successful catheterisation, usually unilateral, the cystoscope having been removed, the ureteric catheter is strapped to the corresponding thigh, and as long as it drains it is left in position, during which time the patient receives a urinary antiseptic (see p. 762). As soon as the blood urea approaches normal limits, further X-ray examinations are carried out, and with the decrease of gaseous shadows the stone may be visualised. If it is still not seen, provided the blood urea has fallen to within normal limits, excretory pyelography is permissible and will enable the stone to be delineated, after which the catheter is removed. If it is not expelled spontaneously within twenty-four hours after removal of the catheter, pyelolithotomy or ureterolithotomy, according to the position of the stone, is carried out.

Not infrequently during the first or second day of successful ureteral catheterisation the catheter becomes blocked, and must be removed. Removal of the catheter in these circumstances may result in (a) renewal of the anuria; (b) continuance of the passage of urine; (c) occasionally in the spontaneous expulsion of the stone.

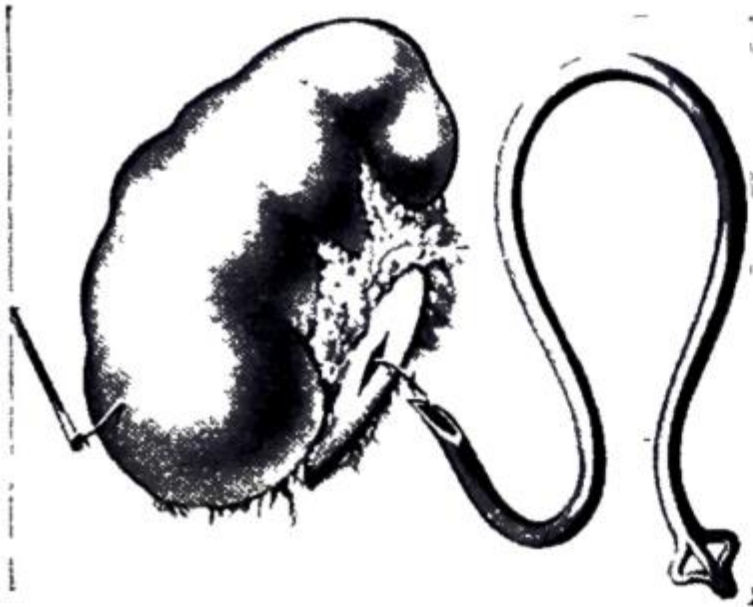


FIG. 962.—Cabot's method of performing nephrostomy.

When a ureteric catheter fails to relieve the obstruction, or the catheter becomes blocked and after its removal excretion of urine again ceases, nephrostomy (fig. 962) or pyelostomy is undertaken. When the obstructing stone is readily accessible, it may be removed at the same time.

If the kidney explored is found to be hopelessly diseased, nephrostomy must be performed upon the other side.

When the obstruction has been relieved, either by ureteric catheterisation or operation, until diuresis is established, the general treatment is similar to that described on p. 720. In cases where nephrostomy has been necessary, preparations should be made for blood transfusion, for sometimes the hæmorrhage from the incised œdematous kidney is excessive.

Anuria due to Sulphonamide Crystalluria.—Sulphapyridine, sulphadiazine, and occasionally sulphathiazole in the presence of an acid medium are changed into acetyl salts which are insoluble. These crystals (fig. 963) are deposited in the kidney tubules and ureters.

The condition is now infrequent, and occurs mainly in patients with partial obstruction to the kidneys, and in those who have become dehydrated from excessive sweating or vomiting.

Treatment.—When a patient undergoing sulphonamide therapy develops renal colic and oliguria, the drug should be withheld and the high fluid intake further increased. Should anuria supervene, firm deep massage is carried out on each ureter, from above downwards. The lower ends of the ureters are then massaged per rectum. If this is not followed by the passage of urine, there should be no delay in performing cystoscopy and attempting to catheterise the ureters. Provided the

FIG. 963.—Acetylated sulphapyridine crystals resemble small wheat sheaves.



catheters can be inserted, the kidney pelves are washed out with 2.5 per cent. sodium bicarbonate solution. The crystalline mass can, on occasions, be dislodged with a spiral stone dislodger (see p. 757). As an alternative means to cystoscopic manoeuvres, many favourable results have followed splanchnic block anaesthesia. When none of the above measures is successful, unilateral or bilateral pyelostomy must be performed.

Anuria due to Accidental Ligation of the Ureters.—This is a hazard of hysterectomy. Bilateral pyelostomy should be performed in the first instance. Only when the patient is out of immediate danger should an operation to reconstruct or implant the ureters be performed (see p. 739).

Anuria due to Involvement of both Ureters in a Neoplastic Process, e.g. Carcinoma of the Cervix.—Nothing can be done in these cases, except transplantation of ureters into the bowel or bilateral nephrostomy.

CHAPTER XXXII

THE KIDNEYS AND URETERS

HAMILTON BAILEY

Embryology.—In human embryos the metanephros, or permanent kidney, appears as a bud from the lower end of the mesonephric (Wolffian) duct. This bud grows backwards and upwards behind the peritoneum to the lumbar region (fig. 964). The stalk of the bud forms the ureter and its dilated extremity the kidney pelvis. Not infrequently the bud is duplicated or the stalk becomes bifurcated, giving rise to congenital anomalies which will be discussed. Commencing with an embryo of six weeks and continuing to a foetus of five months, O. F. Kampmeier showed histologically that outgrowths of the primitive renal pelvis divide repeatedly to form collecting tubules. Each division is spoken of as a generation of collecting tubules, e.g. 1st generation, 2nd generation, etc. Each collecting tubule is capped by mesoblast, which is the anlage of the glomerulus and the convoluted tubule. The first three or four generations are not permanent, but persist only for a short period as cystic structures. Normally they degenerate and disappear. It is the persistence of these provisional structures

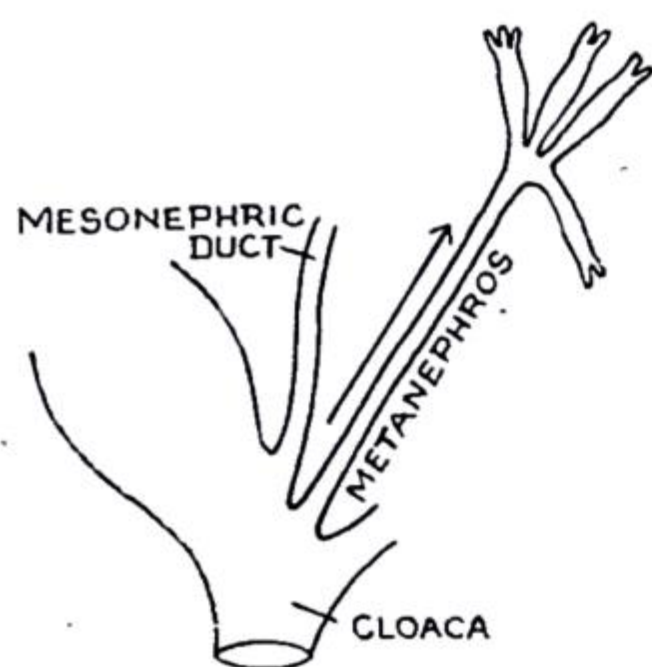


FIG. 964.—The metanephros.

that gives rise to the cysts of congenital cystic kidneys. If one cyst only fails to degenerate, a solitary cyst of the kidney results.

The foetal kidney is at first lobulated, but in the human organ the lobules become welded together by the growth of a new cortex beneath the capsule. In some mammals, e.g. oxen and bears, foetal lobulation is retained throughout life.

In early embryonic life the renal pelves face anteriorly. As the kidneys ascend, they also rotate so that by the time they reach their destination the renal pelves lie medially with their calyces directed laterally.

Surgical Anatomy.—The parenchyma of each kidney is drained by seven pairs of calyces, three in the upper and two each in the middle and lower segments (fig. 965). Each of the three segments represents an anatomical and physiological unit with its own blood supply. In view of the increased indications for partial nephrectomy, a knowledge of this arrangement is fundamental (Carl Semb).

Surgical Physiology.—Ciné-pyelography indicates that there are sphincters at the junction of the minor and major calyces, and at the pelvi-ureteric junction. Each segment of the calyceal system fills before its contents is passed into the next chamber. Should this mechanism be under nervous control (and some believe that it is) it would prove a sound argument in favour of renal pedicle sympathectomy for the rectification of non-mechanical hydronephrosis.



FIG. 965.—The three divisions of the kidney render resection (partial nephrectomy) of the upper or lower division a practical proposition. (After Carl Semb.)

CONGENITAL ABNORMALITIES

(a) Of the Kidney

Absence of One Kidney.—Sometimes pyelography reveals only one functioning kidney, and at cystoscopy only one ureteric orifice is present ;

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Otto Frederic Kampmeier, Contemporary. Emeritus Professor of Anatomy, University of Illinois, U.S.A.
Carl Boye Semb, Contemporary. Chief Surgeon, Ullevål Sykehus, Oslo, Norway.*

at others a ureter and pelvis are present on the non-functioning side, but renal parenchyma is almost or entirely absent. In either of these circumstances the functioning kidney is hypertrophied. An absent or congenital atrophic kidney is present in 1 : 1,000 individuals.

Renal ectopia also occurs once in 1,000 cases. The kidney is arrested in some part of its normal ascent, usually at the brim of the pelvis. As a rule the kidney of the opposite side is present and in its normal position. The left kidney is ectopic far more often than the right, the reason for this being obscure.

When an ectopic kidney becomes inflamed, the tender lump to which it gives rise frequently causes supreme difficulty in diagnosis; for instance, when right sided it is liable to be mistaken for an appendix abscess.

Congenital solitary pelvic kidney is a rare sub-variety of this anomaly.

Horse-shoe Kidney.—The most median subdivisions of the primary metanephric bud of each side fuse and the kidneys fail to ascend completely. The adrenal glands, being developed separately, are in their normal positions beneath the diaphragm.

The abnormality, which occurs once in every 1,000 necropsies, is more common in the male, the ratio being 8 : 3. In the majority of cases the bridge joining the lower poles lies in front of the fourth lumbar vertebra. Fusion occurs very early, when the embryo is but thirty to forty days old, at which time the two masses of mesoblasts destined to form the kidneys lie very close together. Exceptionally, it is the upper poles of a horse-shoe kidney that are fused.

Clinical Features.—Horse-shoe kidneys are notoriously prone to become diseased, largely because the ureters are angulated as they pass over the fused isthmus (fig. 966). This

produces urinary stasis; consequently simple infection, tuberculosis, and calculus formation are

common complications. Although a fixed mass below the umbilicus may suggest a horse-shoe kidney, the final diagnosis is established by pyelographic data. A most characteristic finding is that the lowest calyx on each side is reversed in position (i.e. directed towards the vertebral column). Sometimes most, or all, of the calyces are reversed (fig. 967). In a large percentage of cases the ureters curve like a flower vase. While horse-shoe kidney is not a contraindication to pregnancy, a high per-

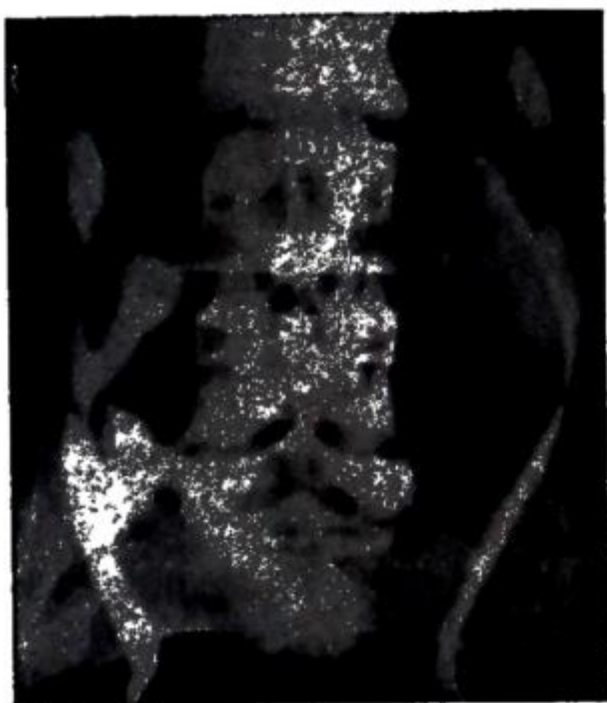


FIG. 967.—Pyelogram of a horse-shoe kidney. The calyces are directed towards the spinal column. (Mr. A. Jacobs, Glasgow.)

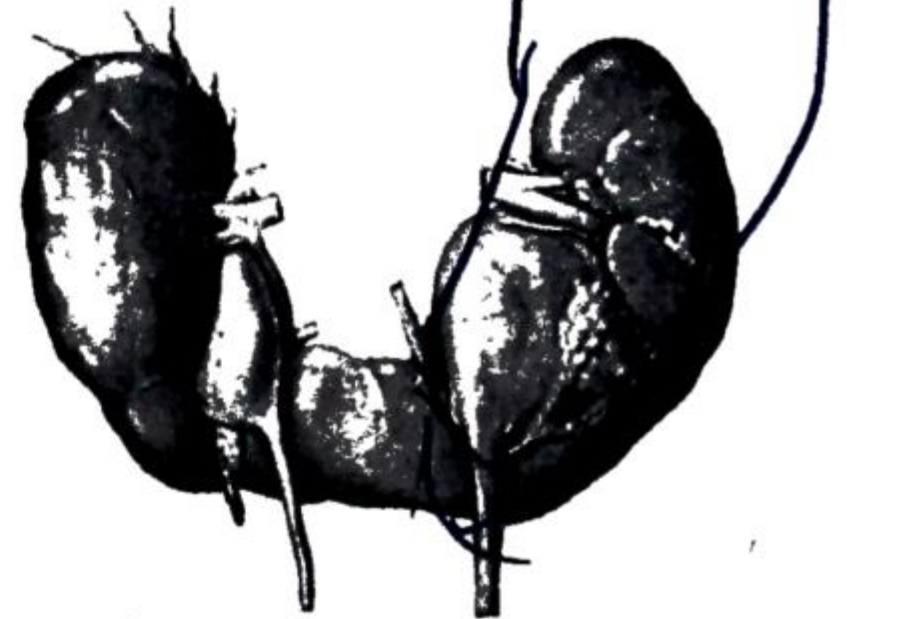


FIG. 966.—Horse-shoe kidney. Note the ureters passing in front of the fused lower poles.

centage of complications must be expected, some of which will entail induction of labour.

Treatment.—In cases giving rise to pain, or when chronic simple infection is present, division of the isthmus, followed by nephropexy of each half of the organ, is usually curative. The operation is conducted extraperitoneally, for some leakage from the divided isthmus is to be expected.

It is prudent to defer operating on the contralateral side for three weeks. When one half of a horse-shoe kidney is irreparably diseased, e.g. the seat of tuberculosis or neoplasm, heminephrectomy should be performed provided the remaining half has adequate function.

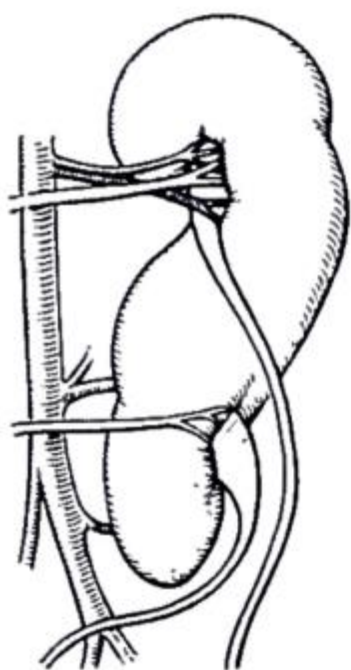


FIG. 968.—Unilateral S-shaped fusion of the kidneys.

Unilateral fusion (*syn.* crossed dystrophia) is rare. Both kidneys are situated in one loin. One kidney, carrying its own blood-vessels and with the ureter opening into the bladder in a normal position, crosses the middle line, and its upper pole fuses with the lower pole of the normally placed kidney. In this instance both kidney pelvises are situated one above the other medial to the renal parenchyma (unilateral long kidney). In some cases the pelvis of the crossed kidney faces laterally (unilateral S-shaped kidney (fig. 968)).

Congenital Cystic Kidneys (*syn.* Polycystic Kidneys).—In 18 per cent. the condition is associated with congenital cystic liver; occasionally the pancreas is affected similarly. The disease is hereditary and can be transmitted by either parent.

Pathology.—The organs may become enlarged enormously. While the usual contour of a kidney is preserved, the surface presents an appearance which can be likened to a bunch of grapes. On section the renal parenchyma is riddled with cysts of varying sizes (fig. 969), some containing clear fluid, others thick brown material, and still others coagulated blood.

Clinical Features.—In the Foetus.—The kidneys may be so large as to obstruct labour. A quarter of the cases are stillborn or die shortly after birth.

In the Infant.—The bilateral swellings of congenital cystic kidney must be distinguished from those of bilateral Wilms's tumour (p. 777). In cases of congenital cystic kidneys presenting during this period, renal rickets often develops a few years before the final uræmia.

Between the ages of three and thirty, cases of congenital cystic kidneys are encountered but rarely.

In the Adult.—The condition is slightly more common in women than in men. There are six clinical types:

(a) *Insidious.*—The large knobby kidneys when discovered in the course of a routine examination can hardly be mistaken. Sometimes congenital cystic kidneys are revealed only at laparotomy for some other condition.



FIG. 969.—A congenital cystic kidney removed on account of profuse hæmaturia.

Patients with congenital cystic kidneys pass abundant urine of low specific gravity (1.010 or less) containing a slight trace of albumin but neither casts nor cells. On cystoscopy there is often considerable delay in the excretion of indigo-carmin, even in cases with a normal or only slightly elevated blood urea.

(b) *Pain* is due either to the weight of the organ dragging upon its pedicle or to tension within the cysts. Often the pain is a dull ache in the loin; sometimes it takes the form of renal colic, when a calculus, which is not rare in this condition, should be suspected.

(c) *Hæmaturia*.—In about 25 per cent. of cases, as a result of over-distension, one of the cysts ruptures into the renal pelvis and causes hæmaturia. Usually moderate hæmaturia lasts for a few days, and recurs at varying intervals; sometimes it is profuse.

(d) *Infection*.—The most common complication of congenital cystic kidneys in adult life is pyelonephritis.

(e) *Unilateral Renal Swelling*.—One kidney contains larger cysts than the other, and gives rise to physical signs similar to those of a renal new-growth.

(f) *Hypertension*.—About 75 per cent. of patients with congenital cystic kidneys above the age of twenty years have also arterial hypertension. Why some escape this complication is not clear. Possibly the high blood pressure is due to a separate genetic factor frequently linked with congenital cystic kidneys.

(g) *Renal Insufficiency*.—The patient presents himself on account of anorexia, headache, and indefinite gastric symptoms associated with a high blood urea, or the first symptoms may be drowsiness and perhaps vomiting. Signs of uræmia often commence suddenly during middle life; only one-quarter of all patients with this condition survive the age of fifty-five years.

Pyelography.—Excretory pyelography is the best means of confirming the diagnosis in the majority of instances. When the concentration of dye is insufficient to cast a clear shadow, retrograde pyelography is necessary, in which case only one side should be injected, the other being deferred for a week lest uræmia be induced thereby. The shadows of the kidneys are enlarged in all directions. The renal pelvis is elongated and may be compressed. The calyces are also elongated and narrowed like the legs of a spider.

Aortography.—The cysts can be demonstrated by the resulting arteriography, but as this procedure is not without risk, it should not be resorted to lightly.

Treatment :

(a) *Expectant*.—Routinely the patient should drink a large quantity of water, have a low-protein diet, and take iron to prevent anæmia. Infection, which is common, should be treated by an appropriate drug, but streptomycin must never be given to anyone with congenital cystic kidneys, for patients with this condition are very prone to sustain vestibular destruction (J. G. Yates-Bell).

(b) *Operative*.—By relieving pressure on the remaining renal parenchyma, Rovsing's operation, if performed early, often permits the kidneys to function

more readily and even to regenerate. Thus, in many instances, life is prolonged five years or more.

Rovsing's Operation.—One kidney and then the other is exposed. The cysts are incised with a narrow-bladed scalpel, first on the convex border, then on the posterior surface and, finally, as the kidney becomes more manageable in size the peritoneum is peeled away and the anterior surface is dealt with similarly.

So improved by bilateral Rovsing's operation was one of our patients who was admitted in a state of uræmia, that two and a half years later he was serving in the Life Guards! Notwithstanding, Rovsing's operation should be performed, not as a last resort on a moribund patient, but *early* in the course of the disease, i.e. soon after the condition is recognised.

Solitary Renal Cyst (*syn.* Simple Renal Cyst).—While the term 'solitary' serves to distinguish the condition from congenital cystic disease of the kidneys, it must be admitted that not infrequently one or two similar but smaller cysts are also present in the kidney containing the so-called solitary cyst. The term 'simple' is even less desirable, for in 7 per cent. of cases a papilliferous carcinoma is found to be growing from the lining of the cyst.

A solitary cyst can occur anywhere in the kidney, but there is a distinct predilection for the lower pole.

Ætiology.—Possibly the origin of the cyst is identical (but on a very small scale) with that of congenital cystic kidneys; or it could arise from bygone trauma or infection causing blockage of a tubule. The mature age at which the cyst usually is found is in favour of the latter supposition.

Clinical Features.—There are no pathognomonic symptoms or signs. Sometimes there are no symptoms until a swelling is noticed, at others there is a dull ache in the loin. The cyst can become infected and if a swelling is palpable, and particularly if the swelling is tender, the creditable diagnosis of pyonephrosis will be made. A spontaneous hæmorrhage into the cyst occurs from time to time, in which case sudden renal pain is likely to be experienced.

Occasionally the cyst presses on the pelvi-ureteric junction and causes urinary symptoms.

Pyelography is most likely to reveal a filling defect of one or more calyces simulating the deformity produced by a neoplasm, but typically more rounded (fig. 970). It is possible to distinguish a renal cyst from a renal neoplasm by aortography, but in view of the dangers entailed, and the fact that an exploratory operation will be required in any case, visualisation of the renal arterioles becomes merely a matter of academic interest.

Treatment.—Exploration should be advised in every case. Having displayed the kidney the operation is varied according to circumstances.

(a) **Kirwin's Method.**—When the cyst is blue domed and aspiration reveals clear fluid, that portion of the cyst wall lying above the surface is cut away. The interior of the unexcised portion of the cyst is swabbed with phenol in glycerine equal parts followed by the application of 95 per cent. alcohol.



FIG. 970. — Pyelograph in a case of a solitary renal cyst. (Mr. N. Matheson, Ashford, Middlesex.)

Thorikild Rovsing, 1862–1927. Professor of Surgery, Copenhagen.
Thomas Joseph Kirwin, Contemporary. Director of Department of Urology, Flower and Fifth Avenue Hospitals, New York.

The cavity is filled with perinephric fat and the edges of the cavity are approximated. The phenol destroys the lining membrane.

(b) *Partial nephrectomy* is performed if the contents of the cyst is blood-stained (one-third of the cysts that yield blood-stained aspirate contain a papilliferous neoplasm).

(c) *Nephrectomy* is performed if there are indications that the cyst is a malignant degeneration of a neoplasm, e.g. irregular induration at the periphery of the cyst.

Differential Diagnosis.—In sheep-raising districts *hydatid cyst of the kidney* is not a great rarity. The usual symptoms are a pain and a swelling in a hypochondrium. On the right side (if hydatid disease is suspected) the swelling is liable to be mistaken for a hydatid cyst of the liver. Occasionally the patient complains of passing 'grape skins' (ruptured daughter cysts) in the urine. The treatment is excision of the cyst, but in most reported cases the cyst has been large and nephrectomy has been considered to be more expedient.

Aberrant renal vessels are found on the left side more frequently than on the right; in females more often than males; unilateral examples are three times more common than bilateral.

There are four anatomical varieties (fig. 971):

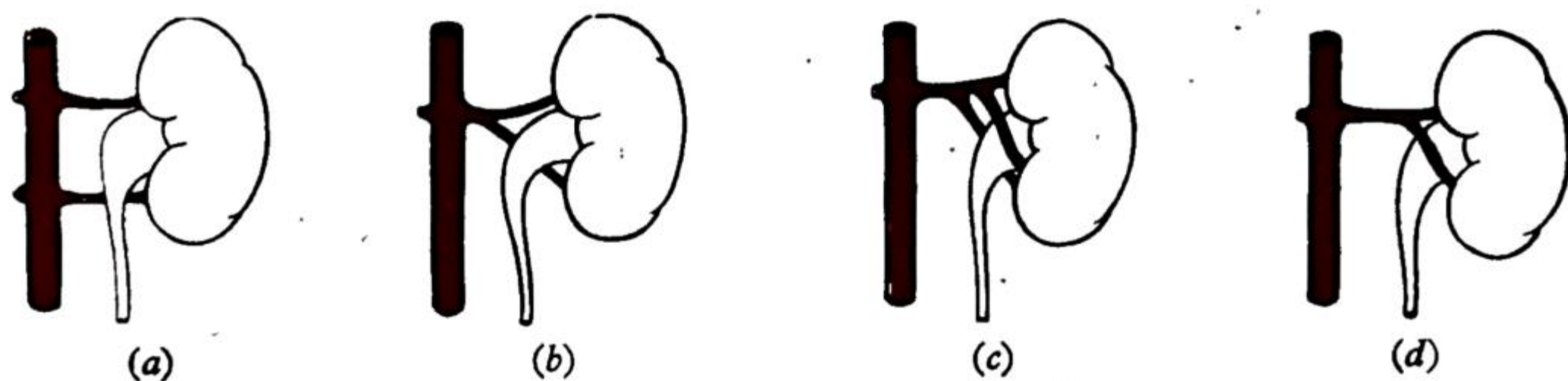


FIG. 971.—Varieties of aberrant renal vessels (see text).
(After F. L. Gill.)

(a) is the true polar artery originating from the aorta and entering the lower pole of the kidney. This is a common type.

(b) is also a true polar artery, originating as an early division of the renal artery.

(c) There are two inferior branches of the main renal artery and sometimes the pelvi-ureteric junction is caught by them in a scissors grip.

(d) The renal artery divides close to, but outside, the hilum and the inferior branch sometimes obstructs the renal pelvis.

Some hold that aberrant renal vessels are a cause of hydronephrosis (see p. 740); others believe that aberrant vessels in themselves are seldom a cause of that condition but that their presence accentuates a hydronephrosis existent on account of another reason.

Usually the aberrant artery is small; occasionally it is comparatively large, supplying one-quarter of the renal parenchyma, when its division is liable to cause infarction of a corresponding portion of the renal tissue.

On the other hand, an obstructing aberrant renal *vein* can be ligated and divided with impunity because the venous collateral circulation is very generous.

While aberrant renal vessels sometimes give rise to symptoms early in life, in a number of instances the first symptoms appear during the third decade—the period of life in which nephroptosis often commences.

(b) Of the Renal Pelvis and Ureter

Duplication of a renal pelvis is the most common anomaly of the upper renal tract and is found in over 4 per cent. of patients examined by pyelography.

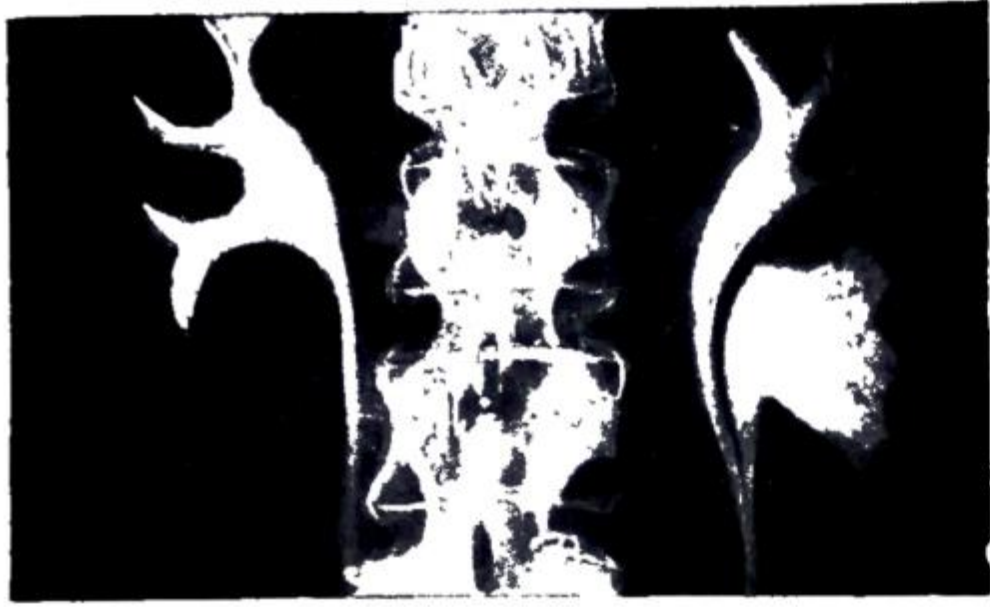


FIG. 972.—Pyelograph showing a kidney with a double pelvis.

It is usually unilateral, and is somewhat more common on the left side than on the right. The upper renal pelvis is comparatively small (fig. 972) and drains the upper group of calyces; the larger lower renal pelvis drains the middle and lower groups of calyces.

Duplication of a Ureter.—

Double ureters are present in addition to double renal pelvises in about 3 per cent. of cases submitted to pyelography. The ureters often join, usually in the lower third of their course (fig. 973), and have a common



FIG. 973.—Double ureter. Instrumental pyelogram.



FIG. 974.—Complete duplication of the left ureter as seen through the cystoscope.

orifice into the bladder. Less frequently the duplicated ureters open independently into the bladder (fig. 974), in which case the ureter draining the upper pelvis crosses its fellow, and opens below and medial to it (the Weigert-Meyer law).

A kidney with a double pelvis, and especially one with a double ureter, often has a double, or even a triple (fig. 975), blood supply. Sometimes a groove at the junction of the upper third with the lower two-thirds on the convex border marks the division.

Clinical Features.—While in many instances the existence of a double renal pelvis or a double ureter is found accidentally in the course of an investigation of the urinary organs, none the less a double kidney is more liable to become the seat of infection, calculus formation, or hydronephrosis than a normal kidney. Initially such disease is confined to one moiety of the duplication. In

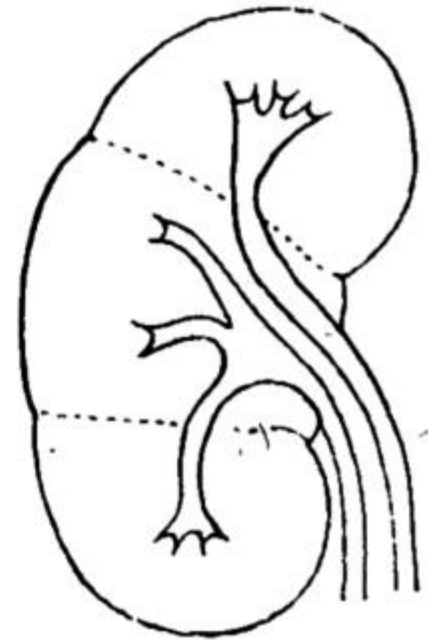


FIG. 975.—As a rule each of the segments between the dotted lines has an independent blood-supply. (After Carl Semb.)

Carl Weigert, 1845–1904. Professor of Pathology, Frankfurt-on-Main.
Georg Hermann Von Meyer, 1815–1892. Professor of Anatomy, Physiology and Histology, Zürich.

cases of complete duplication of the ureter rather frequently the lower ureteric orifice is the site of some degree of congenital atresia, which would account for the selective character of the pathological onslaughts.

Treatment.—Except when ureteric meatotomy can be performed in early cases of a stricture of a ureteric meatus, cystoscopic means of relieving the obstruction are unsatisfactory, especially in cases of Y-shaped bifid ureter, because a ureteric catheter cannot be made to enter the smaller bifurcation. On the other hand, heminephrectomy with removal of its ureter is eminently satisfactory when disease normally requiring total nephrectomy is confined strictly to one half of a kidney that has a double pelvis. The exception to the rule is, of course, a neoplasm.

Ectopic Ureteric Orifice.—Should a second ureteric bud arise from the mesonephric duct later than usual, the orifice of the accessory ureter is prone to occupy a grossly abnormal position hereinafter defined. This is a rare anomaly. In both sexes the existence of double ureter is determined by excretory pyelography.

In the female an ectopic ureter opens either into the urethra below the sphincter urethræ (fig. 976) or into the vagina, and causes an intractable incontinence of urine. Consequently, to be aware of the possibility of this condition is of considerable importance. The diagnosis can nearly always be made from the history alone. A girl or woman who has dribbled for as long as she can remember, despite the fact that she has a desire to void, and does urinate, has an ectopic ureteric orifice. The demonstration of this orifice is often extremely difficult, because it is guarded by a valve. The diagnosis can be established by giving an intravenous injection of indigo-carmin, and placing one swab into the vestibule and another in the vagina; the one coloured blue signifies the position of the ectopic orifice.

In the male the aberrant opening may be situated at the apex of the trigone, in the posterior urethra, in a seminal vesicle, or in an ejaculatory duct. As in all these diverse situations, the ectopic ureteric orifice is situated above the sphincter urethræ, the male patient is continent, but recurrent acute or chronic pyelonephritis is prone to supervene in the renal tissue served by the ectopic ureter. Posterior urethroscopy after the intravenous injection of indigo carmine is the only means of ascertaining that a male patient has an ectopic ureter.

Treatment.—*In the female* excision of that segment of the kidney served by the ectopic ureter usually is advisable, because so often it is hydronephrotic and chronically infected. In the rare event of the urine draining from it being sterile, implantation of the ectopic ureter into the bladder has been carried out successfully.

In the Male—Often no treatment is required. Should urinary infection persist in spite of treatment, heminephrectomy is indicated.

Congenital megalo-ureter may be unilateral (fig. 977) or bilateral, and in late stages is accompanied by hydronephrosis. Often the condition is symptomless until infection has occurred. If, however, the patient experiences pain, a diagnosis can be made before the onset of infection. The ureteric orifice on the affected side is normal in size and shape, but it is immotile, the efflux being a continuous trickle instead of intermittent ejections. A ureteric catheter passes easily. Excretory pyelography shows the whole length of the ureter greatly dilated.

Treatment.—In infected cases, per cystoscopic meatotomy and drainage of the dilated ureter with a ureteric catheter for about six weeks has been found to be

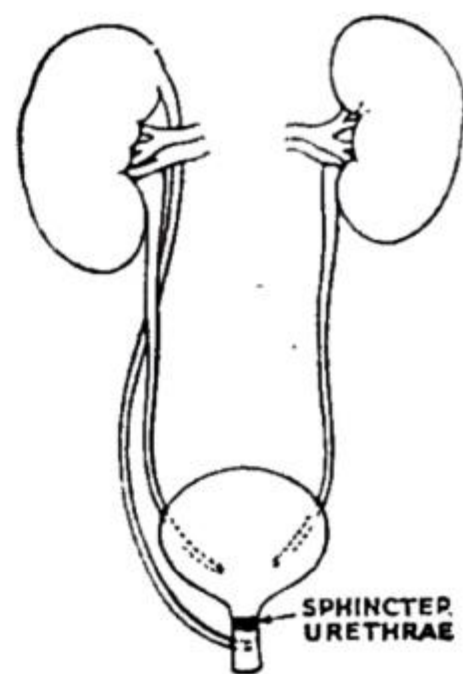


FIG. 976.—Ectopic ureter in a female.

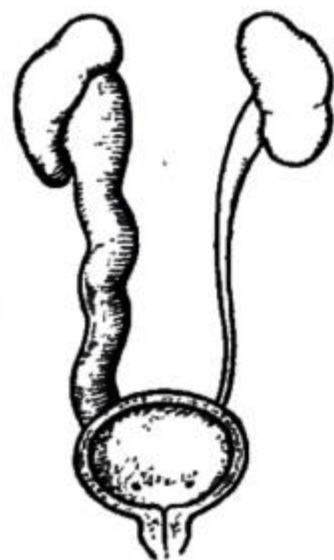


FIG. 977.—Unilateral congenital megalo-ureter.



FIG. 978.—Substitution of a segment of ileum for the megalo-ureter, which is shown attached to the bladder.

effective in clearing up the infection (O. S. Lowsley). Until recently the curative treatment has been unsatisfactory. It has now been found that the best results follow excision of the lower nine-tenths of the ureter with ligation of its entry into the bladder and the construction of a new ureter from an isolated segment of ileum (fig. 978), followed by anastomosis of its distal end with the fundus of the bladder. When the renal parenchyma is severely damaged, nephroureterectomy is curative. In bilateral cases occasionally presacral neurectomy is successful. Bilateral meatotomy is likely to prolong life, but eventually increasing renal failure and pyelonephritis prove fatal.

Post-caval Ureter.—The right ureter passes behind the inferior vena cava (fig. 979) instead of lying to the right of it. This is liable to give rise to obstructive symptoms. Should these symptoms warrant it, the ureter can be divided near the bladder, withdrawn behind the inferior vena cava, and reimplanted into the bladder.

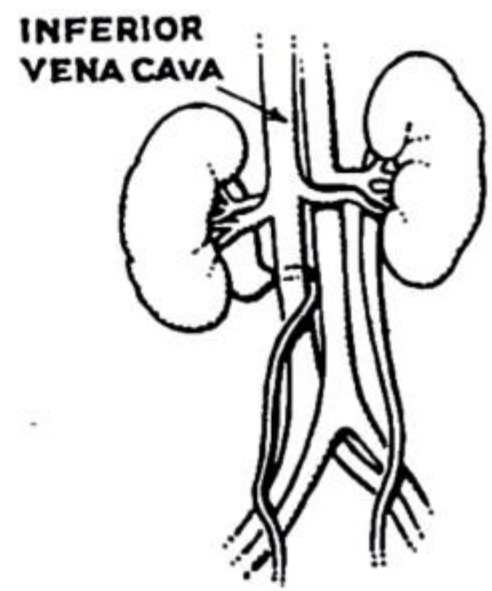


FIG. 979.—Post-caval ureter.

Congenital atresia of a ureteric orifice (*syn.* pin-hole meatus) is a precursor of a ureterocele and sometimes found in children undergoing cystoscopic examination for increased frequency of micturition or renal colic. As a rule, the opening is so small that the finest ureteric catheter cannot be made to enter it. Ureteric meatotomy (see p. 757) often remedies the condition.

Ureterocele is due to congenital atresia of a ureteric orifice which causes a cystic enlargement of the intramural portion of the ureter. Usually the wall of the cyst is composed of mucous membrane only, infrequently the muscle coat is included. Occasionally this condition is discovered in childhood; often it is not recognised until adult life. Women are more often affected than men, and in 10 per cent. of cases the condition is bilateral. A prominent symptom is increased frequency of micturition, but there may be renal colic and occasionally hæmaturia. In many long-standing cases secondary infection is present. The cystoscopic findings are characteristic: when the wall consists of mucous membrane there is a translucent cyst over which blood-vessels radiate (fig. 980); in the rare variety containing muscle in the wall, the cyst is opaque. In either case the sac is seen to enlarge rapidly with each efflux of urine, and then slowly to collapse.

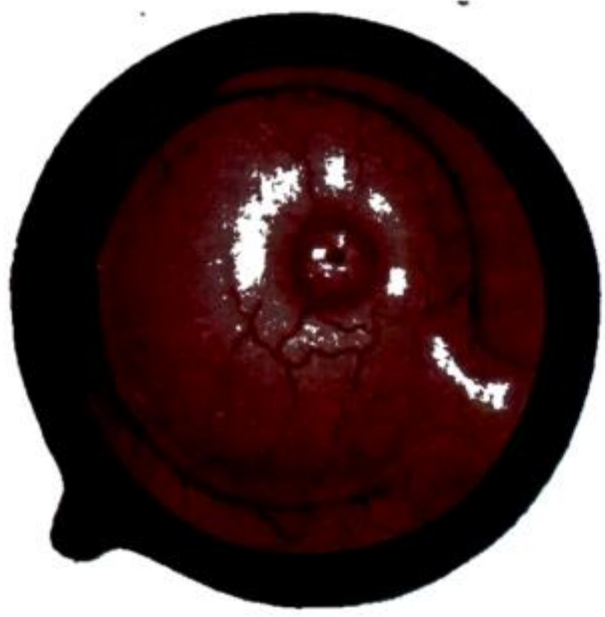


FIG. 980.—Right-sided ureterocele. (After J. C. Ainsworth-Davies.)

Treatment.—Burning a hole through the wall of the cyst with a diathermy electrode is a simple and highly satisfactory procedure. Ten days later the coagulated area commences to slough, and eventually leaves a wide but normally functioning ureteric orifice. In advanced unilateral cases associated with a hydro- or pyonephrosis and dilatation of the whole of the ureter, after a trial of the foregoing, nephrectomy is sometimes called for.

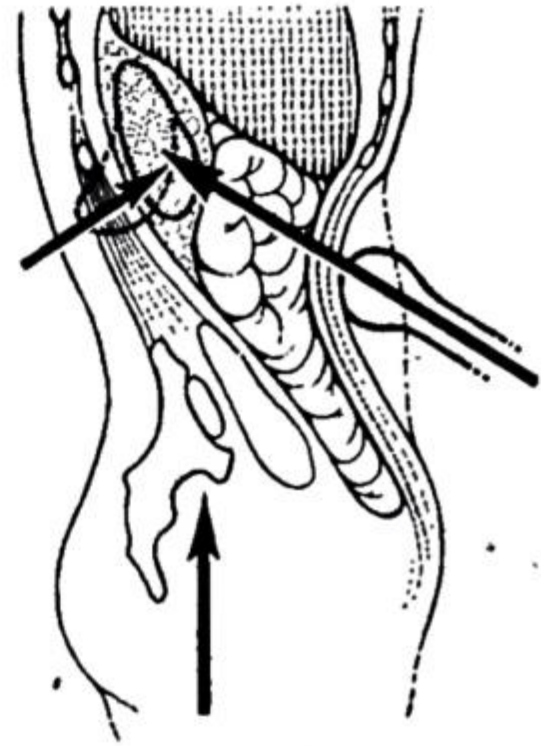
Ureteric Prolapse.—The ureteric mucous membrane prolapses through the ureteric orifice into the bladder. Occasionally the muscle coat is included, in which event the condition is an intussusception of the lower end of the ureter. The stenosis produced is slight, and is mainly due to accompanying œdema. Repeated dilatations with ureteric bougies are curative.

INJURIES TO THE KIDNEY

Injuries to a kidney incurred in civil life are very seldom the result of an open wound. Blows or falls upon the loin are the most fruitful sources of

such injuries, while blows from in front, crushing accidents, and falls on the buttocks or feet, all add their quota (fig. 981).

FIG. 981.—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 twelfth rib. As a result of a fall on the buttocks, the vascular pedicle may be damaged. (After F. Papin.)



The degree of injury varies considerably from a small subcapsular hæmatoma to a complete tear involving the whole thickness of the kidney (fig. 982) ;

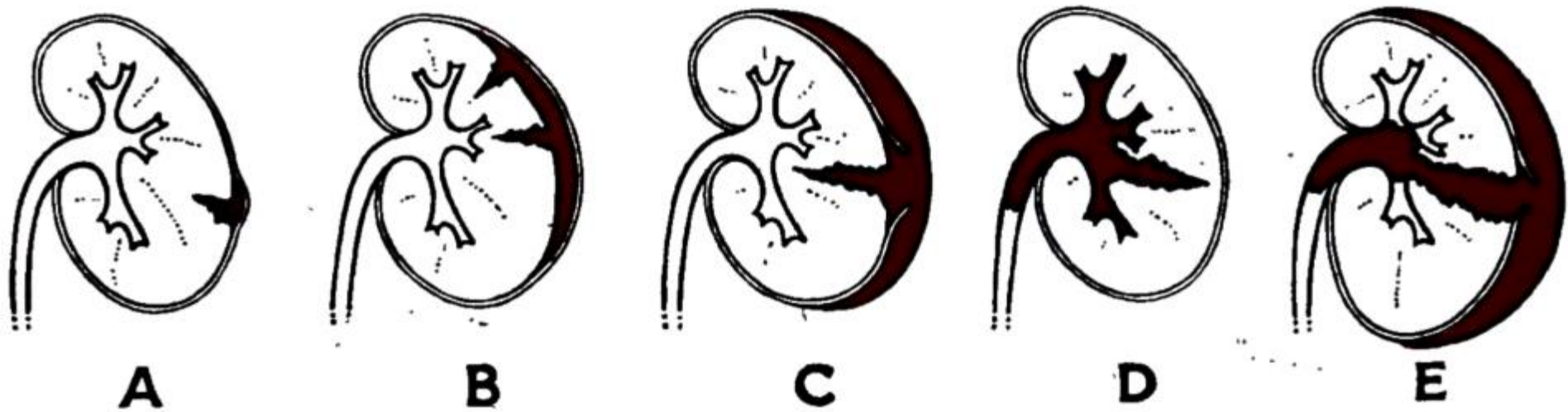


FIG. 982.—Various types of renal injuries : A, small subcapsular hæmorrhage ; B, large subcapsular hæmorrhage ; C, cortical laceration with perinephric hæmatoma ; D, medullary laceration with bleeding into the renal pelvis ; E, complete rupture. (After P. Adams.)

in addition, the kidney may be partially or wholly avulsed from its pedicle. Tears of the renal parenchyma follow the lines of the uriniferous tubules (fig. 983). The whole of one pole may be detached. The injury is extra-peritoneal, except very occasionally in children below the age of ten years in whom there is little, if any, perinephric fat ; consequently the peritoneum, being intimately related to the kidney, is liable to be torn in addition to the renal capsule, allowing blood and, perhaps, urine to escape into the peritoneal cavity.

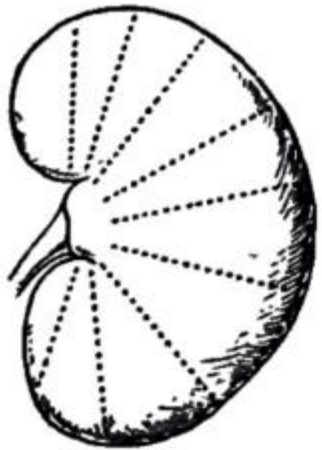


FIG. 983.—Diagram to show the usual lines of rupture of the kidney.

Clinical Features.—Rarely there is superficial bruising, but there is likely to be considerable local pain and tenderness.

Hæmaturia is a cardinal sign of a damaged kidney, but it may not make its appearance until some hours after the accident. If the hæmorrhage is profuse, it is liable to be followed by clot colic.

Severe Delayed Hæmaturia.—It is by no means exceptional for sudden profuse hæmaturia to occur between the third day and the third week after

the accident in a patient who, up to that time, appeared to be progressing favourably. Delayed severe bleeding is due to a clot becoming dislodged.

Meteorism.—In many cases of renal injury, abdominal distension comes on about twenty-four to forty-eight hours after the accident. In all probability it is caused by a retro-peritoneal hæmatoma implicating splanchnic nerves.

A *perinephric hæmatoma* should be suspected if there is even a slight flattening of the normal contour of the loin (fig. 984).

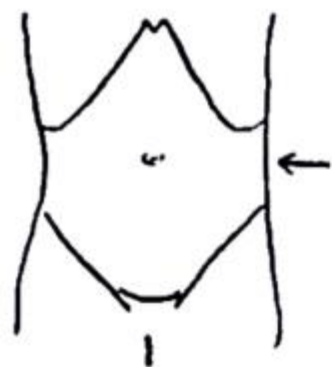


FIG. 984.

MANAGEMENT AND TREATMENT

The patient should be put to bed and orders are given that he is not to be allowed out of bed until permission for him to do so has been granted. This is an important detail in these days of 'early rising.' It is imperative to keep a frequent pulse-chart, and to save all specimens of urine, duly labelled with the time of voiding. A cloth having been laid across the abdomen, sandbags are placed on either side of the patient in order to keep the trunk at rest. Morphine is administered, and if hæmaturia is severe or shock is considerable, a drip blood transfusion is commenced. If facilities exist, excretory pyelography¹ should be arranged as soon as the patient has recovered sufficiently from the shock. On the injured side there may be an absence of excretion, extravasation of dye into the perirenal tissues, enlargement and irregularity of some of the calyces, or a normal outline. This form of examination is particularly valuable in demonstrating the presence or absence of a functioning kidney on the contralateral side.

Conservative treatment is continued if, after the patient recovers from shock, the pulse-rate remains steady and the hæmaturia lessens in amount. Penicillin and sulphatriad with an alkaline mixture are given to discourage infection. A close watch must be kept on the patient for several days; only when the hæmaturia ceases entirely, pyelography shows a normal outline on the injured as well as the uninjured side, and the local tenderness and rigidity abates can the vigil be relaxed. The patient should be kept in bed for a full week after the hæmaturia has ceased.

Operative Treatment.—If conservative measures are continued in patients in whom rigidity and tenderness persist for several days, after the expiration of about a week a certain number of them will develop a palpable swelling in the loin; this is either a perinephric hæmatoma or a collection of blood and urine. Drainage of this blood, or blood and urine, should be undertaken through a high grid-iron incision. When the peritoneum is reached, it is displaced medially with the finger. In this way the collection of fluid is entered and drained.

Exploration via the lumbar route is indicated when the hourly pulse-rate is rising, when the hæmaturia fails to abate after twenty-four hours and, in the opinion of many, when tenderness and rigidity in the loin persist after twenty-four hours, especially if a swelling in that region is palpable. Should

¹ In no circumstance must compression be used, as is usual in non-traumatic cases.

the necessity for an urgent operation be decided upon and facilities for pyelography are not available, the presence of a functioning kidney on the contralateral side can often be confirmed by chromo-cystoscopy. When the kidney is found to be ruptured in several places or the kidney pedicle is damaged, nephrectomy must be undertaken. Small tears can be closed over a piece of oxycel or a piece of detached muscle, either of which promotes hæmostasis. Larger single rents in the middle of the kidney are best dealt with by performing nephrostomy through the rent and suturing the kidney on either side of the tube in the manner just described. In laceration confined to one pole of the kidney, partial nephrectomy may be practicable.

When a sole existing kidney is sufficiently damaged to necessitate exploration, it must be repaired, if possible. Failing this, the wound is packed firmly with gauze in the hope that not only will the bleeding be controlled but possibly the ruptured kidney may heal.

Laparotomy.—When, following an abdominal injury, there are signs of intraperitoneal hæmorrhage or peritonitis, if the patient rallies from the initial shock, laparotomy should be performed. In the case of a child with intraperitoneal rupture of the kidney, abdominal nephrectomy is undertaken. In all other circumstances it is best to avoid a transperitoneal route to the injured kidney, for the mortality is higher than when nephrectomy is performed from a lumbar approach. Furthermore, there is no record of an injured kidney having been repaired transabdominally, doubtless because of technical difficulties and fear of leakage of urine into the peritoneal cavity subsequently.

Simultaneous splenectomy and left nephrectomy have been carried out successfully on a number of occasions when both the spleen and the left kidney have been found to be ruptured, but the mortality of cases of rupture of the kidney with damage to the liver or hollow organs, which are not infrequently further complicated by fractured ribs, pelvis, or vertebræ, is very high.

COMPLICATIONS AFTER RENAL INJURIES

Urinary infection and infection of a perirenal hæmatoma can be largely prevented by chemotherapy and antibiotics.

Clot retention is a troublesome complication in cases with severe hæmaturia. As a rule clot in the bladder can be evacuated by repeated syringing with a solution of warm 5 per cent. sodium citrate through a urethral catheter, or better a Bigelow's evacuator (see p. 805). If this is not effective, suprapubic cystostomy with removal of the clots is sometimes necessary.

RARE INJURIES

Rupture of a hydronephrosis may occur after a trivial injury, or even spontaneously. It usually results in a perirenal extravasation of fluid, but rupture into the peritoneum has occurred.

Pararenal Pseudo-hydronephrosis.—A cystic swelling develops in the loin, occasionally fairly rapidly—more usually in a matter of months after the injury. For

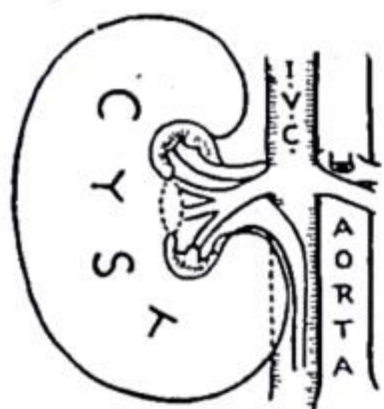


FIG. 985.—A pararenal pseudo-hydronephrosis.

the production of a pseudo-hydronephrosis (fig. 985) there must be present :

1. A complete tear of the renal cortex (see fig. 982 E). 2. Obstruction of the ureter from a pre-existing lesion, or from blood-clot. The treatment of choice is nephrectomy, with removal of the cyst. If adhesions around the cyst are forbidding, intracystic nephrectomy must suffice.

Aneurism of a renal artery is usually a recent or remote rare complication of injury to a kidney. The most frequent symptom is pain in the renal region, and when the aneurism is large a non-tender swelling will be felt. Only occasionally is it pulsatile, in which event a bruit may be heard. In most cases the

diagnosis is made on X-ray examination, which shows a shadow in relation to the pelvis of the kidney. Pyelography demonstrates that the swelling is extrarenal with the renal pelvis displaced laterally. Attacks of hæmaturia are not uncommon, and are probably due to congestion of the renal parenchyma. The aneurism may rupture into the peritoneal cavity or into the perirenal tissues, when the condition is rapidly fatal.

Treatment by nephrectomy and excision of the aneurism has been undertaken successfully on a number of occasions. In a few cases a saccular aneurism has been resected with preservation of the renal vessels and the kidney.

Rupture of a ureter can occur as the result of an accident causing hyperextension of the spine. The clinical diagnosis is impossible until a diminished quantity of urine is passed, followed by a swelling in the loin or iliac fossa. Excretory pyelography shows a diffuse shadow below the kidney on the injured side, and makes early diagnosis possible. So often is uretero-ureteric anastomosis followed by stricture that, provided the contralateral kidney is healthy, nephrectomy is the best course.

Injury of one or both ureters during a pelvic operation is considerably more common than the foregoing and occurs most often during the course of a difficult hysterectomy. Preliminary catheterisation of the ureters prevents such accidents, for with catheters within them, the ureters can be felt and seen unmistakably. The accident includes cutting the ureter across, ligating it, crushing it in forceps or removing a portion of its wall.

Injury Recognised at the Time of the Operation.—The uretero-vesical continuity should be restored by one of the methods described below, unless (a) the ureter and its kidney are hydronephrotic, when nephrectomy is advisable, provided, of course, the opposite kidney is healthy; or (b) the patient's condition is poor, when ligation of the proximal end of the ureter is the best course. If the patient rallies within two days, temporary nephrostomy is carried out. Later a reparative operation can be undertaken.

Injury not Recognised at the Time of the Operation:

(a) **Unilateral Injury.**—One of three things is bound to happen.

1. *No Symptoms.*—If one ureter is ligated securely with unabsorbable material and the contralateral kidney and ureter are normal, in 68 per cent. of cases the kidney on the obstructed side undergoes silent atrophy. Thus the accident remains unsuspected unless the patient, at some time later, undergoes a urological examination.

2. *Lumbar pain*→*hydronephrosis*→*pyonephrosis* occurs in less than a half of the remainder. Excretory pyelography reveals no excretion on the side of the lesion. To avoid infection of the developing hydronephrosis nephrostomy should be undertaken early. A reparative operation can be undertaken later (see below).

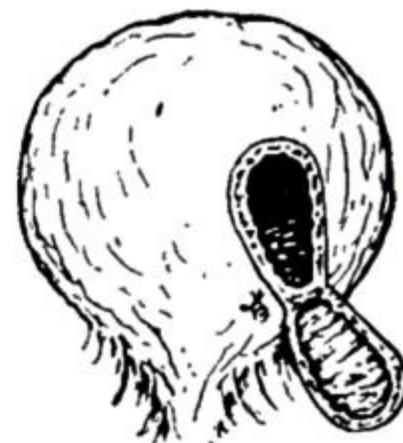
3. *A urinary fistula develops* through the abdominal incision or, following pan-hysterectomy, through the vagina. Again a temporary nephrostomy should be performed and a reparative operation postponed until œdema and infection have abated (six weeks).

(b) **Bilateral Injury.**—In cases of anuria following ligation of both ureters during hysterectomy an attempt is made to pass ureteric catheters, when both ureters will be found to be occluded. Bilateral nephrostomy, if it is not deferred too long, is likely to save the patient's life. Cases are on record where normal micturition has recommenced several weeks after bilateral nephrostomy, the explanation being that the ureters were ligated with catgut which in due course was absorbed and the continuity of the ureters became re-established. In the absence of this fortunate occurrence the ureters have been successfully implanted into the bladder.

Reparative Operations :

Implantation of the Ureter into the Bladder.—The ureter is mobilised and bisected longitudinally for $\frac{1}{2}$ inch (1.25 cm.). The bladder is opened and a tiny stab incision is made at the most convenient place for the ureter to enter, the stab being made obliquely to imitate the intramural course of the ureter. Stitches having been attached to the flaps of ureter, the ureter is drawn through the stab incision and retained there by passing the aforesaid stitches from within outwards through the bladder wall and tying them in pairs. The bladder is closed around a Malécot catheter.

Chiari's Operation.—If there is the slightest tension due to shortness of the proximal end of the ureter, Chiari's operation should be chosen. The results are remarkably good. A suitable flap of the bladder wall is fashioned, viz. —————→



The ureter is split as described above and each half is attached to the mucus surface of the distal third of the bladder flaps. A ureteric catheter having been introduced into the ureter, the excess of catheter is laid on the flap, which is stitched around the catheter to form a tube. This completed, the defect in the bladder is united also over the catheter, which is brought out of the extremity of the wound farthest away from the hinge of the flap. Into the opening through which the ureteric catheter emerges a Malécot catheter is introduced into the bladder. The adventitia of the ureter is stitched to the extremity of the newly constructed tube so as to make a secure junction. The abdominal wall is then closed with corrugated rubber drainage to the perivesical space.

MOVABLE KIDNEY (syn. NEPHROPTOSIS)

In many thin subjects, especially women with visceroptosis, the right kidney is readily palpable and to a certain extent movable. In 20 per cent. of cases the condition is bilateral. On rare occasions the kidney and its pedicle have a complete peritoneal investment, which permits a much wider degree of displacement ('floating' kidney).

Clinical Features.—As a rule the condition is found in the course of an abdominal examination, and is without clinical significance. On the other hand, if a patient with a movable kidney complains of a dragging pain in the loin *relieved by lying down*, in the absence of another cause, it is justifiable to attribute the symptoms to undue mobility of the kidney. In exceptional cases the displacement causes the ureter to become kinked, and an exacerbation of a pre-existing early hydronephrosis, gives rise to an attack of renal colic (Dietl's crisis), which passes off to be succeeded by others at irregular intervals.



FIG. 986. — Profound nephroptosis with sagging of the ureter and distension of the renal pelvis. Nephropexy indicated.

Pyelography.—In relevant cases excretory pyelography should be performed, with films taken in the upright as well as the prone position. In a small minority, kinking of the ureter with dilatation of the renal pelvis is demonstrated (fig. 986). In doubtful cases retrograde pyelography provides clearer definition.

Treatment.—When pain is considered to be caused by undue mobility of the kidney, an abdominal belt is of service. If the patient is very thin, an attempt should be made to increase her weight.

Achille-Etienne Malécot, 1852-?. He invented his catheter while he was an interne des Hôpitaux de Paris.
Hans Chiari, 1851-1916. Professor of Pathological Anatomy, successively at Prague and Strasbourg.
Joseph Dietl, 1804-1878. Professor of Pathology and Therapeutics. Crowned. In his later years he achieved fame as a politician.

Operation should be advised only in cases with definite pyelographic evidence of hydronephrosis.

Nephropexy.—There are many varieties of technique. The following is satisfactory and comparatively simple. The kidney is exposed through a lumbar incision and the uretero-pelvic junction is freed from adhesion, if such be present. The capsule of the kidney is incised along the length of its convex border, and each half is stripped towards the hilum. A transverse cut towards the pelvis divides each flap into two equal parts. One of the quarters is picked up in a hæmostat and rotated many times, so that it forms a cord. Commencing at the base, each end of a long suture intrefixes and re-transfixes the whole length of the cord, so that it is blended intimately with it. Having prepared each flap in this manner, the long ends of the sutures are passed through the lumbar muscles in such a way as to suspend the kidney in a position which favours free drainage of its pelvis, and permits its surface, bereft of capsule, to become adherent to the muscles.

HYDRONEPHROSIS

A hydronephrosis is an aseptic dilatation of the whole or part of the kidney due to a partial or intermittent obstruction to the outflow of urine.

A hydronephrosis may be unilateral or bilateral.

Ætiology :

Unilateral hydronephrosis is due to some form of *ureteral* obstruction, often at the pelvi-ureteric junction ; when it is situated lower in the ureter, the ureter above the obstruction is dilated also. The causes are as follows :

1. A kink, valve, or stenosis of congenital origin at the pelvi-ureteric junction.
2. Congenital atresia of the ureteric orifice (see p. 734).
3. Aberrant renal vessels were formerly considered to be a common cause of hydronephrosis. It is true that in a large number of cases of pelvic hydronephrosis an artery (fig. 987), or more usually a vein, is present over which the commencement of the ureter is kinked. Nevertheless, in many instances this is not an aberrant vessel, but a normal inferior renal artery or vein that has been displaced downwards by the enlarged renal pelvis. This displaced vessel, while adding considerably to the rapid increase in the size of the hydronephrosis, is not the cause thereof. Less frequently, a true aberrant artery passing to the lower pole of the kidney is found obstructing the pelvi-ureteric junction, when it is extremely probable that the abnormal artery is responsible for the hydronephrosis.
4. A calculus in the ureter or small calculus in the renal pelvis. The latter often gives rise to intermittent hydronephrosis.
5. Inflammatory stricture of the ureter following removal of a stone that was lodged in one portion of the ureter for a considerable time, or tuberculosis of the ureter. Stricture of the ureter also follows uretero-ureteric anastomosis or trauma of the ureter during a pelvic operation.



FIG. 987.—Pelvic type of hydronephrosis caused or aggravated by an aberrant artery.

6. Nephroptosis (see p. 739).

7. A diverticulum of the bladder pressing on the lower end of the ureter in relation to it.

8. Neoplasm of a ureter, or a neoplasm of the bladder involving one ureteric orifice.

9. Achalasia. Apart from achalasia of the ureteric orifice, hydronephrosis in the absence of any demonstrable cause (non-mechanical hydronephrosis) has been attributed to neuromuscular inco-ordination at the pelvi-ureteric junction.

Bilateral hydronephrosis is generally the result of some form of *urethral* obstruction, but it can also be caused by one of the lesions described above occurring on both sides.

When due to lower urinary obstruction, the cause may be :

(a) *Congenital*:

1. Atresia of the urethral meatus or, very rarely, phimosis.

2. Congenital valves of the posterior urethra, or congenital contracture of the bladder neck.

(b) *Acquired*:

1. A neoplasm of the bladder which involves both ureteric orifices. Occasionally a large diverticulum of the bladder compresses the lower ends of both ureters.

2. Prostatic enlargement or carcinoma; acquired contracture of the bladder neck.

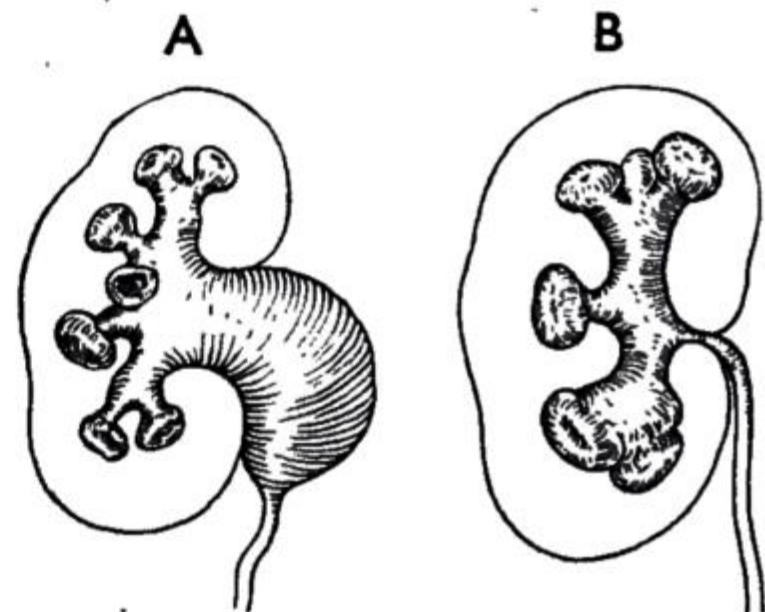
3. Carcinoma of the cervix (occasionally carcinoma of the rectum), involving both ureters.

4. Inflammatory or traumatic urethral stricture.

When the obstruction lies in the urethra, muscular hypertrophy of the bladder occurs, and the ureters, by reason of this hypertrophy, become partially obstructed in the intramural portion of their course.

Pathology.—In the beginning a hydronephrosis is open; that is, urine can escape from the dilated pelvis down the ureter. Often it becomes intermittent; finally it is closed. The pathological changes that occur differ in some respects according to whether the kidney has an extrarenal or an intrarenal pelvis (fig. 988), the former being much more common. In a kidney with an extrarenal pelvis, at first the pelvis alone becomes dilated

FIG. 988.—Hydronephrosis occurring in an (A) Extrarenal, (B) Intrarenal pelvis of the kidney, the latter being more liable to be compressed by a blood-vessel or a band.



(pelvic hydronephrosis) (fig. 987). As time goes on, if the obstruction is not relieved the calyces become increasingly dilated and the renal parenchyma is progressively destroyed by pressure atrophy. In a kidney with an

intrarenal pelvis the destruction of the parenchyma (fig. 989) occurs more rapidly. In either case, it is sometimes a matter of years before the



FIG. 989.—Renal type of hydronephrosis. The greater part of the renal parenchyma has been destroyed. Note the cluster of calculi in the lower pole.

diagnosis is made, by which time the kidney may be merely a lobulated sac containing pale uriniferous fluid of low specific gravity. On bisecting the specimen longitudinally a series of compartments representing the dilated calyces will be found. Only on rare occasions is the renal parenchyma destroyed in its entirety, although in advanced cases the amount remaining is very small.

CLINICAL FEATURES

Unilateral hydronephrosis is twice as common in females as in males, and occurs slightly more often on the right side than on the left. Although symptoms appearing early in life are not uncommon, usually the condition remains latent until the patient is between twenty-five and thirty-five years of age. Various types are encountered :

1. *Insidious*.—Pain is slight ; often there is only a dull ache or a sense of weight in the loin. On examination an enlarged, sometimes a greatly enlarged, kidney is found. In these cases the obstruction is usually at the pelvi-ureteric junction.

2. *Attacks of renal colic* occur. Often there is no palpable swelling.

3. *Intermittent Hydronephrosis*.—After an attack of renal colic with its accompanying abdominal rigidity passes off, a swelling in the loin is found. Some hours or days later, following the passage of a large quantity of urine, the pain is relieved and the swelling disappears.

Bilateral Hydronephrosis

1. *Due to Bilateral Upper Urinary Obstruction*.—This is rare compared with a unilateral lesion. Symptoms similar to those described above are present, sometimes on one side and sometimes on the other, or, what is more frequent, there are signs on one side only, and pyelography reveals some degree of hydronephrosis on the contralateral side as well as the affected side. Symptoms and signs may become manifest in the remaining kidney after its fellow has been removed for hydronephrosis.

2. *Due to Lower Urinary Obstruction*.—There is little to call attention to the hydronephrosis except, perhaps, a dull ache in the loins. The symptoms are overshadowed by those of the causative lesion. There is often polyuria of low specific gravity containing a small quantity of albumen. The kidneys are unlikely to be palpable because before the hydronephroses become large enough to be felt, signs of renal failure set in.

3. *Due to Pregnancy*.—Dilatation of the ureters and renal pelves occurs in every case of pregnancy. Both renal pelves and ureters are affected, but the right side to a much greater extent than the left. The dilatation commences during the first few weeks of gestation, and reaches its zenith between the

fifth and sixth months (fig. 990). It then remains stationary until after delivery, when involution occurs within two to twelve weeks. The condition is due to atony of the ureteric musculature brought about by the hormone progesterone. Possibly pressure of the foetal head on the ureters plays some part during the last months of pregnancy. The main importance of the condition is when infection supervenes (p. 761). Exceptionally the hydronephrosis persists.

Pyelography.—The diagnosis can often be made with certainty by *excretory pyelography*. When the hydronephrosis is advanced, films taken six to twenty-four hours after the injection of the medium may show a hydronephrotic kidney which was imperceptible on films taken at the routine times. As a rule the earliest pyelographic manifestation of a hydronephrosis is dilatation of the renal pelvis, for in the majority of cases the pelvis is extrarenal. The next change is decreasing concavity and then flattening of the minor calyces



FIG. 990.—Excretory pyelogram in a case of pregnancy. (Professor D. Baird, Aberdeen.)

FIG. 991.—The progress from normal to clubbing of the minor calyces in hydronephrosis, as seen radiologically. (After J. B. Macalpine.)



and dilatation of the major calyces, which are the first changes when the pelvis is intrarenal. In moderate-sized hydronephroses the minor calyces

become convex and finally club-shaped (fig. 991) and the major calyces considerably broadened. In advanced cases there is extreme dilatation of the renal pelvis and the calyces, or no excretion of opaque media. *Retrograde pyelography* (fig. 992) is required only when the results of excretory pyelography are inconclusive or when a clearer definition of an extrarenal pelvis is required to determine if a conservative operation is feasible.

Treatment.—*Nephrectomy* is indicated in advanced unilateral hydronephrosis when the contralateral organ is unimpaired.

Ligation and division of an obstructing blood-vessel, together with clearance of adhesions in the neighbourhood of the pelvi-ureteric junction, gives a lasting cure in the majority of cases. The objection to dividing the obstructing artery is that occasionally ischæmic infarction of the lower pole of the



FIG. 992.—Retrograde pyelogram of a hydronephrosis showing a greatly enlarged pelvis and dilated calyces.

kidney ensues. However, should this occur, it is apparent at once, and can be remedied by resection of the involved portion.

Nephro-plication (Stewart) is designed to remedy an early or a moderate-sized

Henry Hamilton Stewart, *Contemporary*. Surgeon, Royal Infirmary, Bradford.

hydronephrosis due to aberrant or displaced renal vessels. The dilated renal pelvis and the commencement of the ureter are dissected from these vessels, and any adhesions between the commencement of the ureter and the renal pelvis are divided. On squeezing the renal pelvis, pent-up urine passes down the ureter. The collapsed renal pelvis, with its attached ureter, can now be made to take up a position anterior to the obstructing vessels. In order to maintain this position and prevent contact of these vessels with the renal pelvis, the two poles of the kidney are approximated.

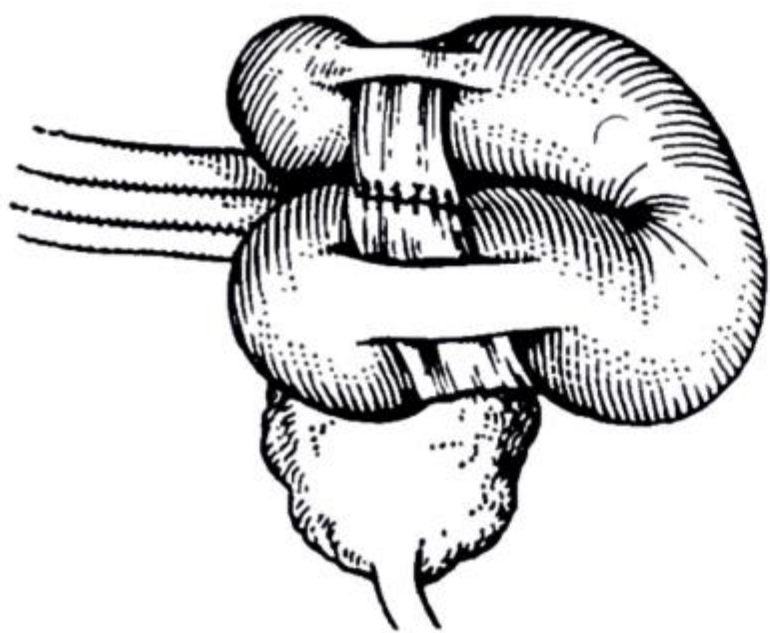


FIG. 993.—Nephro-plication completed using a band of fascia. (After Wilfred Adams.)

A kidney whose interior is dilated and whose parenchyma is consequently thinned is more amenable to folding than is a normal organ. A strip of fascia lata threaded through slots cut in the renal capsule is employed to maintain this position (fig. 993). The kidney is returned to its bed and the wound closed with corrugated rubber drainage.

Reconstruction of a hydronephrosis is employed in cases of more advanced pelvic hydronephrosis and when there is a stricture at the pelvi-ureteric junction. The zenith of importance of this operation is reached when the hydronephrotic kidney is the sole existing kidney. The affected kidney having been displayed, the upper third of the ureter and the renal pelvis is dissected. A renal vein overlying the pelvi-

ureteric junction can be divided, but an artery in this situation, whether aberrant or not, should be preserved. The anastomosis about to be described is made in front of such an artery. The upper end of the ureter is divided a short distance below the pelvi-ureteric junction. The ureter is dilated with bougies, and is laid aside temporarily. Up to this stage the steps of the operation are common to a number of procedures of which the Anderson-Hynes plastic operation on the dilated renal pelvis will be described. The redundant part of the renal pelvis, together with the ureteropelvic junction are resected as shown in fig. 994 A, a flap of the lower part of the pelvis being retained. The upper two-thirds of the opening thus created in the renal pelvis is closed with a 0000 plain catgut suture traversing all coats (fig. 994 B). The upper end of the ureter is slit for 3 cm. and its anterior edge is anastomosed to

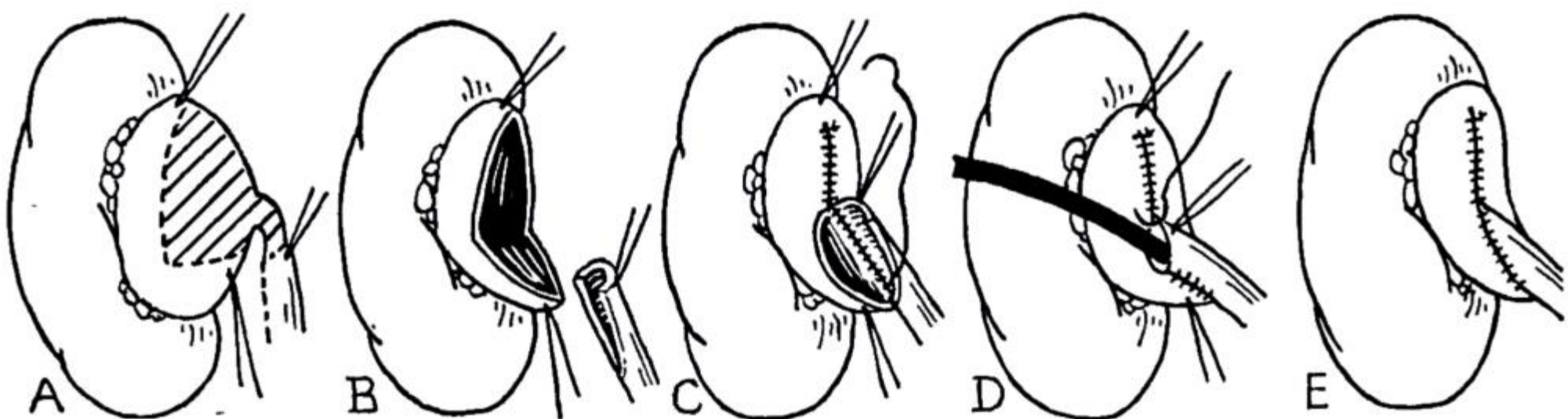


FIG. 994.—The Anderson-Hynes plastic reconstruction of a hydronephrosis. Note the placement of the stay sutures.

the anterior edge of the pelvic flap by a continuous suture of 0000 plain catgut (fig. 994 C). A ureteric catheter is passed into the ureter for a short distance; this is merely a temporary expedient to keep the deep sutured layer out of the way while the superficial edges are drawn together (fig. 994 D) in the same manner as were the deep. The catheter is withdrawn just before the anastomosis is completed.

The results of this operation have not been bettered by any alternative plastic procedure.

Renal pedicle sympathectomy (*syn.* denervation of the kidney) is often successful in relieving pain associated with small hydronephroses when no cause for the condition can be discovered. An incision that gives ample access to the renal pedicle is necessary. After the kidney has been exposed and delivered into the wound, the renal pedicle is freed from surrounding fat, so that the individual vessels are in full

view. Commencing at least 1 inch (2.5 cm.) from the hilum of the kidney, the delicate fibrils of the sympathetic plexus and connective tissue which lie between the vessels are dissected, picked up with fine dissecting forceps, and divided, and again divided near the hilum of the kidney. The process is repeated until all the vessels are cleared of these elements. During the dissection the left forefinger is placed behind the pedicle, and if hæmorrhage occurs from one of the renal veins, it can be controlled by forward pressure of this finger until the bleeding-point can be secured by a hæmostat. When the renal artery has been stripped as cleanly as possible, it is painted with 10 per cent. carbolic acid, which whitens sympathetic nerve fibres, thus enabling nerves that have been overlooked to be recognised and removed. The operation is concluded by clearing both aspects of the renal pelvis, the ureteric junction, and the upper inch (2.5 cm.) of the ureter of nerve fibres and strands of connective tissue. As a result of the operation, pain is relieved, and after many months the hydronephrosis often becomes less and less; ultimately, in some cases pyelography shows a normal outline.

Complications of a hydronephrosis in order of frequency are :

1. *Infection* = Pyonephrosis (see p. 767).
2. *Hæmorrhage into the sac* occasionally follows 1. If the hydronephrosis is open severe hæmaturia will result.
3. *Rupture* (see p. 737).

RENAL CALCULUS

Ætiology.—Considerable light has been thrown upon the cause of renal and other urinary calculi. The subject is a large and complicated one, and the following is a résumé of current opinion.

1. **Dietetic.**—By a deficiency of vitamin A renal epithelium sustains serious injury, and it seems probable that desquamated epithelium forms a nidus around which the stone is deposited. From a study of economic conditions in districts where urinary calculi are common, it is evident that the inhabitants suffer from dietetic imbalances. There is not only a deficiency in vitamin A, but often a grossly improperly constituted diet in general.

2. **Decreased Urinary Output of Citrate.**—The presence of citrate in the urine (normal 60 mg. per 100 ml.) tends to maintain in solution otherwise relatively insoluble calcium phosphate and carbonate. The excretion of citrate is under hormonal control and decreases during menstruation.

3. **Renal Infection.**—Infection favours the formation of urinary calculi. Both clinical and experimental stone formation is common when the urine is infected with a urea-splitting streptococcus, staphylococcus, or proteus organisms. The predominant bacteria found in the nuclei of urinary calculi are a staphylococcus and *Esch. coli*. A calculus which follows infection of the kidney is known as a secondary renal calculus; a primary renal calculus is one unaccompanied by infection, although infection may supervene as a result of such a calculus.

4. **Faulty Renal Drainage.**—Stones are prone to occur in patients with obstruction to the free passage of urine.

5. **Prolonged immobilisation** from any cause, e.g. paralysis, is prone to result in skeletal decalcification and an increased output of calcium in the urine. This, combined with the mechanical effects of recumbency on renal drainage (fig. 995), favours the deposition of calcium phosphate calculi. In uninfected cases spontaneous dissolution of the calculi sometimes occurs.

6. **Hyperparathyroidism**, although very rare, occurring perhaps in 0.2 per cent. of cases, is a sufficiently frequent cause of renal calculus to warrant consideration. In cases of multiple or recurrent urinary calculi this cause should be eliminated by bio-



FIG. 995.—In prolonged recumbency the fact that the urine has to travel uphill favours urinary stasis and consequent stone formation. (After A. C. McEachern.)

chemical tests (p. 250). Hyperparathyroidism results in a great increase in the elimination of calcium in the urine. It has been aptly remarked that these patients pass their skeleton in their urine. In cases of hyperparathyroidism the parathyroid adenoma should be removed before urinary calculi are treated.

7. **Randall's Hypothesis.**—As a result of careful histological work, A. Randall has proved that the initial lesion in many cases of renal calculus is an erosion at the apex of one of the renal papillæ. On this erosion are deposited urinary salts = Randall's plaque.

It has further been shown that minute concretions (microliths) occur normally in the renal parenchyma and R. J. Carr postulates that these particles are carried away like carbon particles from the bronchi by lymphatics. Should some of the renal lymphatic vessels become blocked by inflammatory exudate, it requires no stretch of imagination to realise how a subendothelial calculus is formed. Later the endothelium becomes ulcerated and a Randall's plaque results.

8. **Irreversibility.**—With the possible exception of calculi due to hyperparathyroidism and small cystine calculi, a renal calculus is an irreversible colloidal product: *irreversible* because it cannot be dissolved in its original solution; *colloidal* because it has entered into organic combination with some colloidal substance such as fibrin.

Varieties.—Stones found in the kidney belong to one of the following types, a mixture of the first two being especially common.

Oxalate Calculus (Calcium Oxalate).—Popularly known as the mulberry stone, it is covered with sharp projections. These cause the kidney to bleed, and altered blood is precipitated on the surface of the stone.

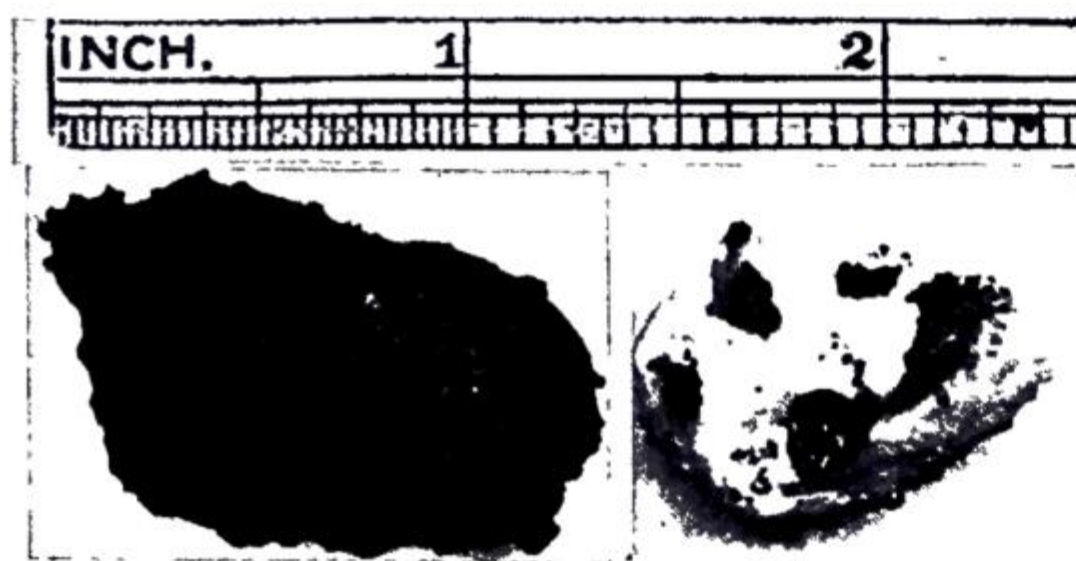


FIG. 996.

Fig. 996 shows two oxalate calculi. The larger one removed from the right kidney and the smaller from the left of the same individual. The larger is black, owing to altered blood. The smaller is beginning to be discoloured around its sharp projections. These specimens illustrate clearly the process by which the oxalate calculus changes its complexion.

An oxalate calculus, which is usually single, casts an exceptionally good shadow radiologically, and this is fortunate, for often by virtue of its rough surface it gives rise to symptoms when comparatively small. A calcium oxalate stone is very hard, and on section is laminated concentrically.

Phosphatic calculus (usually calcium phosphate, although sometimes combined with ammonium magnesium phosphate and, rarely, composed of the latter only) is smooth and dirty white. In an alkaline urine it enlarges rapidly, and often fills the renal calyces, taking on their shape (staghorn calculus, fig. 997). Because it is smooth, a phosphatic calculus gives rise to few symptoms until it has attained a large size. By reason of its size rather than its density, it is demonstrated readily by X-rays.



FIG. 997. — Phosphatic calculus. Note its branched nature (staghorn calculus).

Uric acid and urate calculi are hard and smooth and, because they are usually multiple, they are typically faceted. Their colour varies from yel-

low to reddish brown. Pure uric acid calculi are not opaque to X-rays, but absolutely pure uric acid calculi are uncommon; the majority contain enough oxalate crystals to render them opaque. Calculi of ammonium and sodium urate are sometimes found in children. Such stones are yellow, soft, and friable, and unless they contain impurities they do not cast an X-ray shadow.

Cystine calculi are wont to appear in the urinary tract of patients with cystinuria. Cystinuria is *not* an inborn error of metabolism; it results from a greatly diminished or absent resorption of cystine from the renal tubules. Cystine crystals

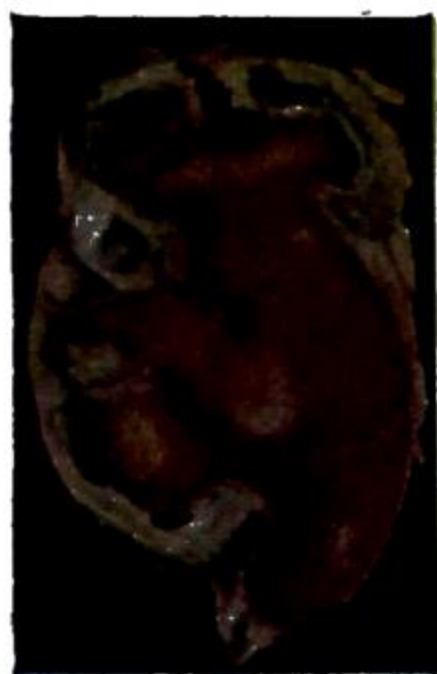


FIG. 999.—Cystine calculus which has destroyed the renal parenchyma. (Dr. L. C. Hermitte, Sheffield.)

are perfect hexagons: white, translucent, and appearing only in acid urine (fig. 998). Cystine calculi are usually multiple and may assume a cast of the renal pelvis and calyces (fig. 999). These calculi are soft, like beeswax, and pink or yellow when first removed. On exposure the colour changes to a greenish hue.

Cystine stones are encountered most commonly in young girls. They are radio opaque from the sulphur they contain—sufficiently so to cast a shadow when tiny.

Too often cystinuria and the cystine composition of the stones escape recognition.

Xanthine calculi are extremely rare. They are smooth and round, brick red in colour, and show a lamellar structure.

Indigo calculi are curiosities. Blue in colour, they are derived from indican.

Stones composed entirely of bacteria are very uncommon. They are soft and usually multiple.

Clinical Features.—Fifty per cent. of patients with renal calculus present between the ages of thirty and fifty, the remainder at any time of life. Males are more frequently affected than females, the ratio being 4 : 3.

The symptoms are not stereotyped and sometimes the diagnosis remains obscure until a radiological examination has been made.

Quiescent Calculus.—Some stones, especially those composed mainly of phosphates, lie dormant for a long period, during which time there is progressive destruction of the renal parenchyma. In most instances, secondary infection occurs eventually.

Pain is the leading symptom in 75 per cent. of cases.

Fixed renal pain is located in the renal angle posteriorly (fig. 1000), in the hypochondrium anteriorly, or in both situations simultaneously. It is often worse on movement, particularly on walking upstairs.

Ureteric¹ colic is an agonising pain passing from the loin to the groin, coming on suddenly, causing the patient to draw up his knees and roll about. It is

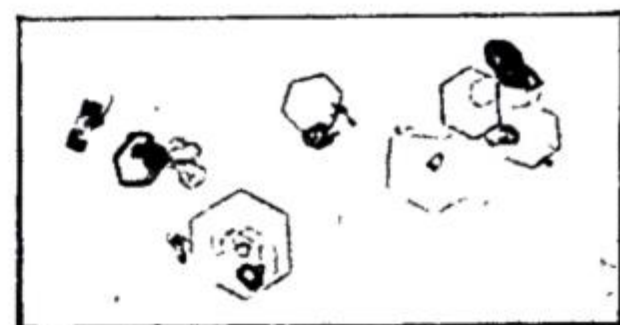


FIG. 998.—Cystine crystals (hexagonal) from the urine of a patient with cystinuria.

¹ Pain passing from loin to groin should be called ureteric colic, not renal colic.

often accompanied by vomiting, profuse sweating, and pallor. The pulse quickens, and as the attack progresses the temperature becomes subnormal.

Bouts of colic often recur for several hours, and occasionally continue for more than twenty-four hours. The condition is often due to a stone entering the ureter, but also occurs when a stone in the renal pelvis temporarily blocks the pelvi-ureteric junction.

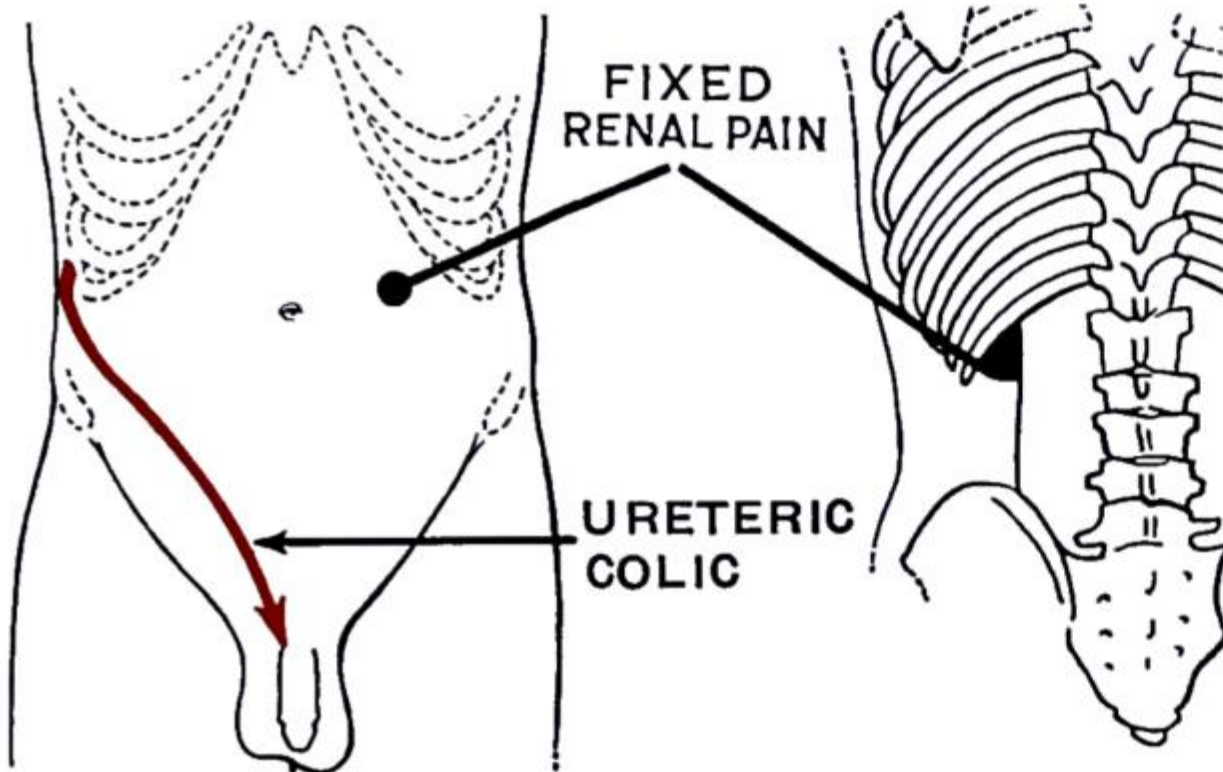


FIG. 1000.—The usual distribution of renal pain.

Abdominal Examination.—During an attack of ureteric colic there is rigidity

of the lateral abdominal muscles but not, as a rule, of the rectus abdominis. After the attack has passed off, often abdominal examination is negative. In patients with a dull, fixed pain usually there is tenderness over the affected kidney, especially if it is infected. Only when a calculus-containing kidney becomes the seat of a hydronephrosis or pyonephrosis of considerable size does it give rise to a palpable swelling.

Hæmaturia.—Infrequently, profuse hæmaturia is a leading, or the only, symptom. As a rule hæmaturia occurs in small amounts (enough to render the urine 'smoky') during or after an attack of pain. In about half the cases of renal calculus there is no blood in the urine, either to the naked eye or microscopically.

Pyuria.—In any case of renal calculus of considerable standing, infection of the kidney is liable to supervene, and pus will be found in the urine in varying amounts. When a large phosphate calculus is present, the passage of turbid urine, which on examination is found to be full of pus cells, is sometimes the chief symptom.

INVESTIGATION OF A SUSPECTED CASE OF RENAL CALCULUS

Radiography.—Before the examination the bowels should be emptied by giving a *vegetable* laxative, for minerals in the intestine cast a shadow (fig. 803). Radiographs of both kidneys, their ureters, and the bladder must be taken in every case. When a renal calculus is branched, there is no doubt concerning the shadow it casts. If a shadow is cast that *may* be a calculus in the kidney, exposures are made during full inspiration and full expiration. If the opacity moves with the kidney, and measurements from the lower pole of the kidney to the opacity remain stationary, then there can be no doubt that the shadow is intrarenal.

The most characteristic location for a renal calculus is opposite the spinous process of the first lumbar vertebra (pelvis of kidney).

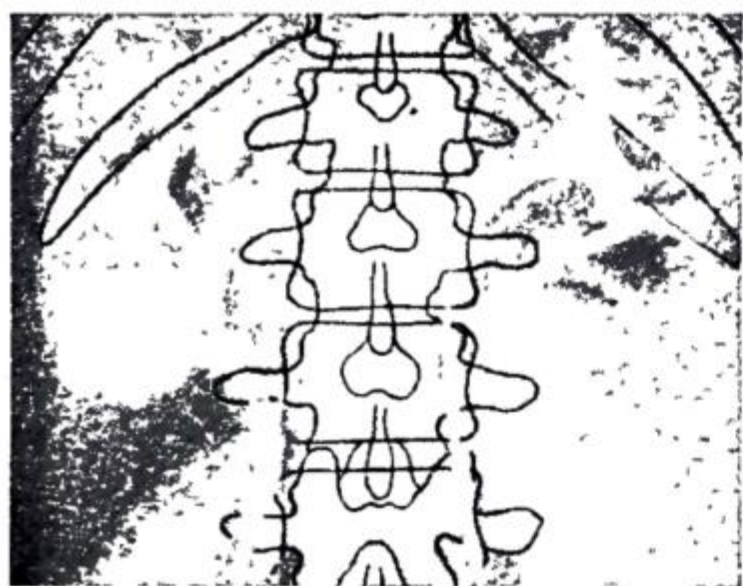


FIG. 1001.—The two shadows in the region of the right kidney were mistaken for calculi. They were due to enteric-coated pills of ammonium chloride. (After H. L. Kretschmer.)

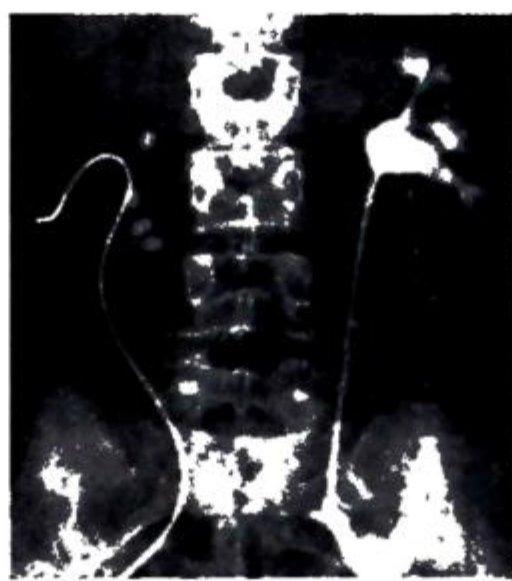


FIG. 1002.—Thought to be gall-stones, proved by ureteric catheter, etc., to be renal calculi.

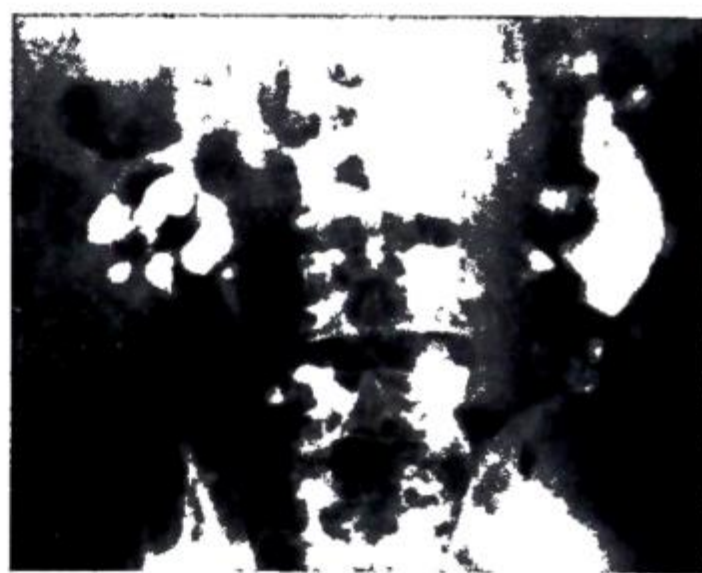


FIG. 1003.—Plain radiograph showing both kidneys full of stones. The patient, a man of forty-two, stated that he had enjoyed good health until one week before he came under observation.

The following structures and substances from time to time cast a shadow which at first sight may appear to be a renal calculus :

- (i) A calcareous lumbar or mesenteric lymph node.
- (ii) A concretion in the appendix or gall-stones in the gall-bladder.
- (iii) Drugs (e.g. bismuth, Blaud's pills, fersolate) or foreign bodies in the alimentary canal.
- (iv) Phleboliths.
- (v) The ossified tip of the twelfth rib.
- (vi) A chip fracture of the transverse process of a lumbar vertebra.
- (vii) Calcified tuberculous lesion of the kidney.
- (viii) A calcified suprarenal gland.

A doubtful shadow in relation to the kidney often can be proved to be extrarenal by a lateral radiograph. When the shadow can be shown to lie anterior to the bodies of the vertebræ, *ipso facto* it is anterior to the kidney. Such is the finding in calcified mesenteric lymph nodes, gall-stones, and opacities in the alimentary tract.

Excretory pyelography is of great assistance in confirming that the opacity is intrarenal, and also determining in which part of the kidney the stone is situated (fig. 1004). Excretory pyelography is also of great service

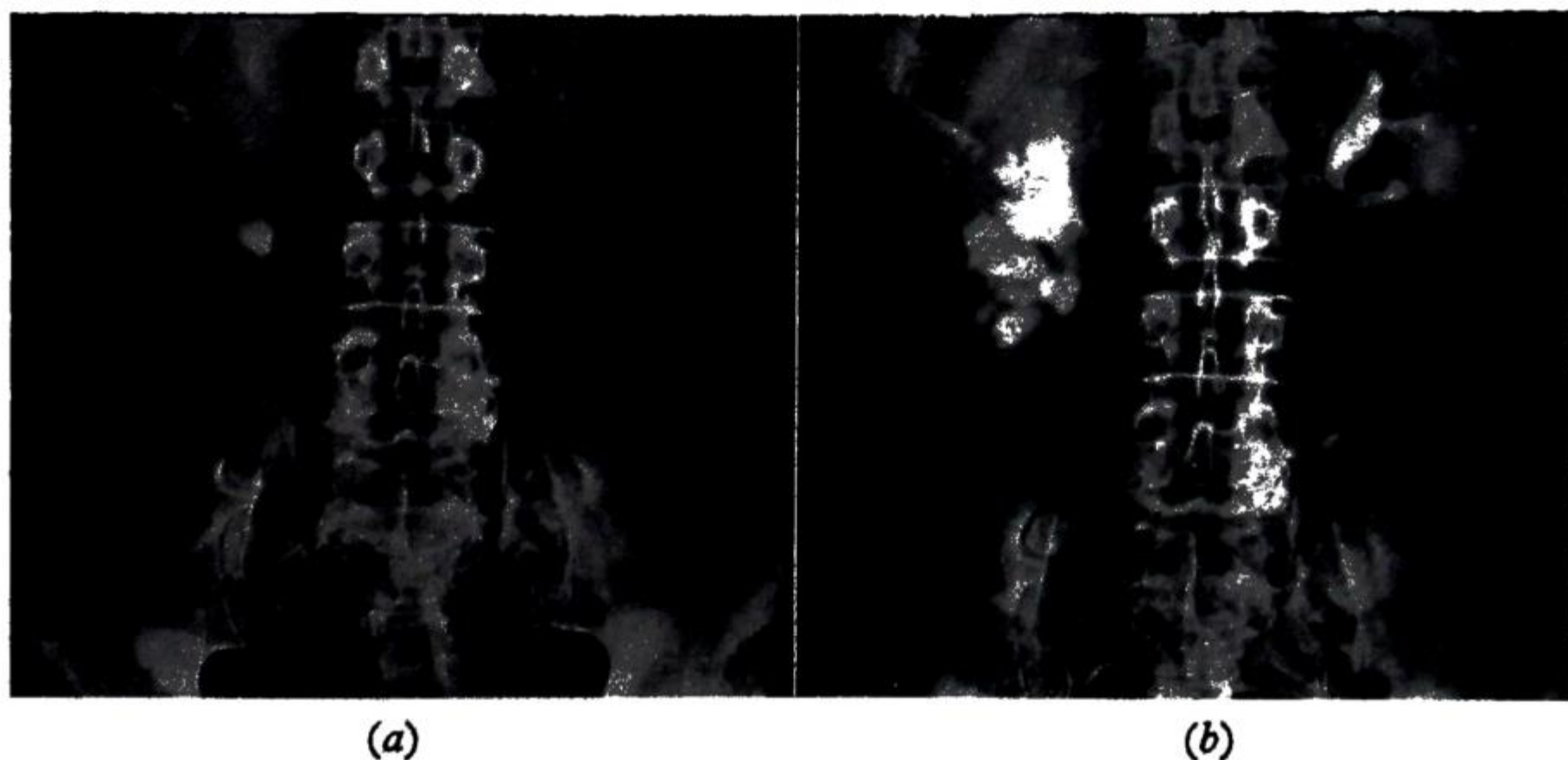


FIG. 1004.—(a) Plain X-ray showing a renal calculus. In which part of the kidney is it situated? (b) Same case. Excretory pyelogram. The stone is located in the pelvis of the kidney. Pyelolithotomy indicated.

in revealing the presence and normality or otherwise of the contralateral kidney.

The presence of a non-opaque calculus usually can be demonstrated by pyelography, for it causes a filling defect in the shadow cast by the medium. A similar defect is seen in papilloma of the renal pelvis (p. 782). Retrograde pyelography may be required to give a clearer delineation.

Cystoscopy.—If there is a urethral stricture or prostatic obstruction, it will be revealed by instrumental examination. Except in long-standing cases associated with infection, when evidence of cystitis is present, the appearance of the bladder wall is normal. The efflux from the affected side is increased if the stone lies irritating the renal pelvis, or decreased when a stone is blocking the pelvi-ureteric junction or when the parenchyma has been largely destroyed. The ureters should be catheterised and a specimen of urine from each kidney sent for bacteriological examination. This will determine if infection is present, and if so whether it is confined to the affected kidney.

Treatment of Ureteric Colic.—Unless the diagnosis has been confirmed radiologically, it is contraindicated to give morphine which masks symptoms and signs should the diagnosis be incorrect. One of the antispasmodics set out on p. 756 should be substituted.

OPERATIONS FOR THE REMOVAL OF RENAL CALCULI

Pre-operative Treatment.—If urinary infection is present, appropriate antibiotic treatment should be given for a week, and continued after operation as necessary.

All the operations about to be described have certain features in common. Via a lumbar incision (p. 783) the kidney is exposed and delivered on to the surface. In the small number of cases when delivery is impossible, the choice of procedure is more limited and the operation more difficult. A radiograph that shows the calculus or calculi clearly should be displayed in an illuminated viewing-box in the operating theatre. The stone or stones removed should coincide in every respect with the X-ray findings. Failure to account for some part of the shadow calls for a further search in the interior of the kidney.

In specially equipped clinics it is possible to radiograph the exposed kidney. This ensures that no stone or portion of stone within the kidney has been overlooked, and consequently reduces the number of so-called recurrences.

At the conclusion of all the operations to be described the kidney is replaced in its bed, and the lumbar wound closed with drainage of the perinephric space. If nephrostomy has been performed, the tube is either brought through the lumbar incision or through a stab incision; in either event it is anchored to the skin with a stitch.

Pyelolithotomy is indicated when a stone (it is usually solitary) lies in the renal pelvis, provided always the pelvis is extrarenal (see fig. 988). This operation has a wide application, for in nearly 50 per cent. of cases a renal calculus is so situated. Sometimes it is also possible to remove a stone or stones from a calyx by this route. The posterior wall of the renal pelvis is dissected free from its surrounding fat.

The kidney is grasped in the left hand so that the tips of the index and middle fingers lie beneath the renal pelvis, making it more prominent, while the thumb anteriorly prevents the stone slipping into one of the calyces. An incision is made on to the stone in the long axis of the renal pelvis (fig. 1005). The stone is removed with gall-stone or special forceps, care being taken to avoid breaking it. If pyelography showed a stone in a calyx and the renal pelvis is large, the stone can be located by the little finger introduced into the renal pelvis: should the stone be accessible, it can be grasped in forceps and removed by this route. After a stone has been removed via the renal pelvis, a bougie is passed through the pelvi-ureteric junction in order to dilate a possible stricture, and at the same time any adhesions present in this neighbourhood are freed, or an obstructing vein is divided between ligatures. When the kidney has been proved to be uninfected, the incision in the renal pelvis is closed by interrupted sutures of fine plain catgut. If the kidney is grossly infected, nephrostomy (p. 724) is performed before closing the incision in the renal pelvis.

Coagulum Pyelolithotomy is especially valuable in cases of multiple small calculi in the renal pelvis and calyces. The posterior aspect of the renal pelvis is exposed. A small incision, just large enough to admit a number 12 French rubber catheter, is made in the renal pelvis near the pelvi-ureteric junction. After the catheter has been introduced and the urine drained away, the interior of the kidney is irrigated with saline solution. A specially prepared solution of human fibrinogen is injected through the catheter while the assistant simultaneously injects one-tenth the amount of a freshly prepared solution of thrombin by a syringe, the needle of which is passed through the wall of the catheter. In this way the two substances are intimately admixed as they enter the renal pelvis. At this juncture the catheter is clamped. After an interval of six minutes, to allow the fibrinogen to coagulate, the catheter is removed and the incision in the renal pelvis enlarged. The coagulum partly extrudes itself, and can be lifted out with the stones and debris enmeshed within it.

Nephrolithotomy is indicated (1) when a calculus or calculi lies within an intra-renal pelvis, or the pelvis cannot be displayed because the pedicle is short, or because of adhesions due to a previous operation; (2) when the calculus can be palpated through the cortex; (3) when there is a branched calculus, and the state of the opposite kidney precludes nephrectomy.

An incision into the renal parenchyma is accompanied by considerable hæmorrhage, which is lessened by digital compression of the renal vessels maintained by an assistant. Also with a view to reducing hæmorrhage, the renal parenchyma is incised with a diathermy knife just behind and parallel to the most prominent part of the convex border of the kidney (Brödel's line). As the terminal branches of the anterior and posterior renal arteries meet along this line, no large artery is divided, thereby minimising the amount of subsequent cortical necrosis. The incision, usually about 1 inch (2.5 cm.) long, is made over that calyx containing the stone or stones, which are removed with lithotomy forceps. When only a small incision has been necessary and the kidney is uninfected, the renal incision can be closed by interrupted catgut sutures passing through the kidney substance but not penetrating the calyx, and tied over a piece of oxycel or muscle to enhance hæmostasis. If the incision is large, and in all cases where infection is present, nephrostomy is carried out by placing a small de Pezzer catheter through the incision into the renal pelvis. The incision is then closed on either side of the tube in the manner just described.

Pyelonephrolithotomy is a valuable means of removing a calculus situated deeply in a calyx, especially if such a stone is present in addition to one in the renal pelvis, and in cases of stones situated in more than one calyx. Pyelotomy is performed, and the little finger is introduced into the pelvis, and the calyx containing



FIG. 1005.—Showing the extent and direction of a pyelotomy incision.

The first operation of nephrolithotomy was performed by Ambroise Paré (1509–1590). His patient was a criminal condemned to death by hanging, instead of which Paré removed two stones from his kidney. Fifteen days later the patient was cured, secured his remission, and was given a grant of money.

Max Brödel, 1870–1941. Pathological Artist and Founder and Director of the Department of Art as Applied to Medicine (the first school of its kind in the world), Johns Hopkins University, Baltimore, U.S.A.
Joseph Hyrtl, 1811–1894, Professor of Anatomy, Vienna, also described the line.

the stone is palpated. If pressure is exerted on the corresponding convex border of the kidney, even a small stone can be palpated. An incision is made through the parenchyma as described for nephrolithotomy, and with the finger pressing on the calculus from within, it is readily grasped by lithotomy forceps introduced through the cortical incision, and withdrawn. In cases where stones lie in other calyces the procedure may be repeated, making two, or even three, cortical incisions. The incisions are closed as described under nephrolithotomy and pyelolithotomy respectively. If drainage of the interior of the kidney is necessary, the catheter is introduced through the cortical incision or, if there are more than one, through the most dependent.

Partial Nephrectomy.—When the stone is in the lowermost calyx—a fairly common position—resection of the lower pole of the kidney (see p. 785) is often a wise step. If the dilated calyx is not removed, its dependent position encourages further stone formation.

Nephrectomy (see p. 784) is indicated when the contralateral organ has been proved to be perfectly healthy and the stone or stones have destroyed much of the renal parenchyma. Large branched calculi are notorious for recurring, and if the other kidney is healthy, nephrectomy is often the best course to adopt in such cases.

Post-operative Treatment.—In non-infected cases a prophylactic course of sulphatriad is given for a week, together with alkalis and a high fluid intake. If a nephrostomy tube has been inserted, it is managed in the same way as that described on p. 724. In infected cases the interior of the kidney is irrigated with saline solution through the nephrostomy tube frequently, until the bleeding has ceased, and thereafter two or three times a day with solution G (see below). The tube is retained for at least fourteen days. These measures, by dissolving phosphatic débris, greatly reduce the incidence of recurrence.

Excessive hæmorrhage sometimes occurs, usually about the fourth day after an operation that necessitated incising the renal parenchyma. Blood transfusion and the administration of morphine are sometimes sufficient to tide the patient over this complication. Should hæmorrhage continue in spite of these measures, the lumbar wound must be reopened. In cases where the contralateral organ is healthy, nephrectomy is the best method to adopt. In other circumstances, placing a strip of oxycel in contact with the cut renal parenchyma of the reopened kidney, and resuture, together with nephrostomy, may prove successful.

Treatment of Renal Calculi by Dissolution.—Most renal calculi, because they are irreversible colloidal compounds, cannot be dissolved. The exceptions are (a) occasionally non-infected calcium phosphate recumbency calculi undergo spontaneous dissolution with a high fluid intake; (b) small cystine stones dissolve in an alkaline urine. A dose of sodium citrate mixture (p. 762), three times a day or more often, to maintain a urinary pH of between 7·6 and 8·0 is often sufficient to clear the urinary tract of these calculi; (c) small phosphate calculi can be dissolved by bringing them in direct contact with solution G:

Solution G :	{	Monohydrous citric acid	32·3 G.
		Anhydrous magnesium oxide	3·8 G.
		Anhydrous sodium carbonate	4·4 G.
		Distilled water	ad 1,000 ml.

The main field of usefulness of this solution is after the removal of branched calculi when the fluid, injected repeatedly through a nephrostomy tube, can be relied upon to dissolve calculous débris.

Treatment of Bilateral Renal Calculi.—Usually the kidney with the better function is operated upon first, the operation on the contralateral side

being postponed for two or three months. Exceptions to this rule are (a) if there is pain on one side, that side is operated upon first, for pain usually signifies that the stone is obstructing the outflow of urine from the kidney, the function of which will become increasingly impaired; (b) if there is a pyonephrosis on one side this should be treated by nephrectomy, or, if the patient's condition is poor, by nephrostomy.

PREVENTION OF RECURRENCE

Frère Jacques, that famous lithotomist of the Middle Ages, used to say, "I have removed the stone, but God will cure the patient." With the advance of knowledge our responsibilities do not end with the removal of the stone; provision must be made to prevent recurrence.

Recurrent calculi can be divided into two varieties

(a) *False Recurrence*.—Even a tiny fragment overlooked at the time of the operation is liable to become the nucleus of a new stone.

(b) *True Recurrence*.—The following constitute the more important precautions for the prevention of true recurrence.

The stone should be analysed so that by a proper diet and vitamin intake the patient may render his urine unfavourable to the formation of a similar stone. There should be a high fluid intake in all cases, regardless of the chemistry of the stone. In cases of multiple or recurrent calculi hyperparathyroidism must be excluded.

Uric-acid and Urate Calculi.—Those meats and fish rich in purine should be avoided. Sufficient sodium citrate and sodium bicarbonate are given to keep the urine slightly alkaline.

Calcium Oxalate Calculi.—Rhubarb, berries, plums, spinach, and tomatoes, which are rich in oxalate, can be taken if they are accompanied by a dose of calcium, or $\frac{1}{2}$ pint (300 ml.) of milk, because under these conditions oxalates are precipitated as an insoluble calcium salt in the intestine, and are not absorbed. At all times a diet adequate in calcium and magnesium is necessary; calcium oxalate is rendered less soluble in the presence of magnesium ions.

Phosphate Calculi.—Excessive alkalinity of the urine should be treated by giving ammonium chloride or another urinary acidifier. Phosphorus in the diet must be restricted to a maximum of 1,400 mg. per diem. Aluminum gel, 40 ml. t.d.s., p.c. and at bedtime, combined with the diet just referred to, drastically reduces the high incidence of recurrent phosphatic calculi.

Cystine Calculi.—Sulphur-containing proteins such as meat or fish are prohibited, and proteins with a low sulphur content substituted. Carbohydrates and fats are unrestricted. The urine must be kept alkaline permanently, and to this end sodium citrate and sodium bicarbonate are given in sufficient quantities, the patient testing the reaction of his urine night and morning.

Recumbency Calculi.—In patients doomed to long recumbency, sodium phytate taken by mouth forms insoluble calcium phytate, thus removing by the bowel one source of hypercalciuria.

In all types of calculi accompanied by infection, no effort should be spared to render the urine sterile and keep it sterile.

If there is any factor that predisposes to urinary stasis, be it a ureteric stricture, an enlarged prostate, or a urethral stricture, this should be remedied.

Complications of Renal Calculus

1. *Migration*.—The calculus may pass into the ureter (p. 754).

2. *Urinary Obstruction*.—Hydronephrosis (p. 740) or calculous anuria (p. 723) can arise.

3. *Infection* is a constant danger. All grades from a mild pyelonephritis to pyonephrosis are possible.

Frère Jacques, 1651–1719. Itinerant Italian lithotomist, after serving as a trooper in the French army, adopted semi-religious habit and cut for stone in the bladder.

URETERIC CALCULUS

A stone in the ureter nearly always has its birth in the kidney. When it enters the ureter the calculus is rounded or oval in shape. Should it

become arrested in its descent to the bladder, in time it becomes enlarged and elongated, resembling in shape a date stone (fig. 1006). In 90 per cent. of cases the stone is single.



FIG. 1006.—Ureteric calculus removed by operation.

Clinical Features.

—When a stone descends into the ureter there is an attack of ureteric colic, which is repeated at longer or shorter intervals, until the stone is ejected into the bladder or becomes impacted in the ureter. There are five locations of anatomical narrowing of the ureter where a stone is liable to become arrested (fig. 1007).

Ureteric Colic.—A stone in the upper third of the ureter produces symptoms identical with those of a stone blocking the pelvi-ureteric junction (p. 747). When a calculus enters the lower third of the ureter, the colic it produces often commences anteriorly at a lower level than the kidney, and is frequently accompanied by pain referred along the two branches of the genito-femoral nerve, to the testis in the male (fig. 1008), the labium majus in the female, and to the anterior surface of the thigh in

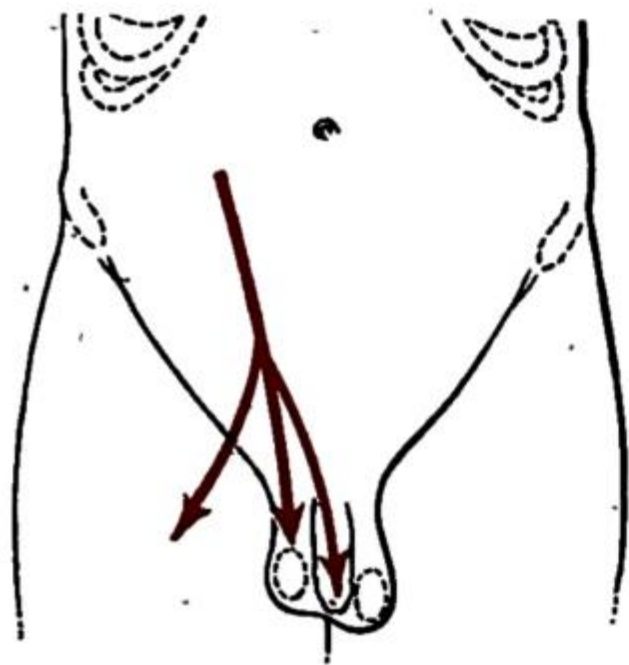


FIG. 1008.—Radiations of ureteric colic produced by a stone in the lower third of the ureter.

both sexes. The testis usually becomes retracted by spasm of the cremaster, and tender, the tenderness persisting for half an hour or more after the colic has ceased. The stone having entered the intramural portion of the ureter, the pain is referred to the tip of the penis in the male, and in both sexes there is strangury. In more than 50 per cent. of cases the stone is passed spontaneously.

Impaction.—When a ureteric calculus becomes impacted the attacks of colic pass off and give place to a dull pain, usually in the iliac fossa, for the calculus most often becomes impacted in the pelvic portion of the ureter. The pain

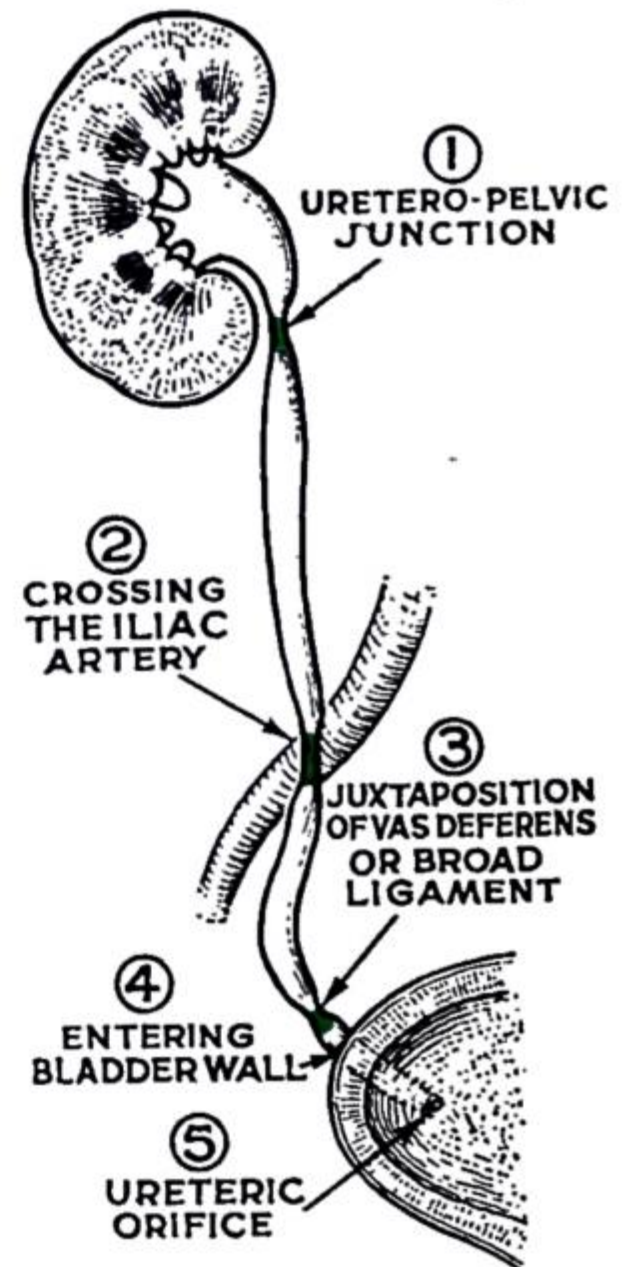


FIG. 1007.—Normal anatomical narrowings of the ureter. (After C. G. Higgins.)

is increased by exercise, and relieved by rest. Such pain varies in intensity and is often associated with backache due to distension of the renal pelvis. Complete cessation of pain sometimes occurs by the stone forming for itself a false diverticulum in the wall of the ureter by a process of pressure necrosis ;

subsequent perforation of the ureter occurs but rarely. Early in the attack complete cessation of pain, without passage of the stone, usually signifies complete obstruction of the lumen of the ureter and temporary cessation of renal function. If the stone is not removed within a fortnight the kidney is liable to atrophy.

Hæmaturia.—Some degree of hæmaturia is usual after an attack of ureteric colic, and it lasts for a few hours or a day. It is sometimes so slight as to require microscopic indentification.

Abdominal Examination.—There is tenderness and often rigidity in some part of the line of the ureter. On rare occasions a stone in the lower end of the ureter can be felt on rectal or vaginal examination. The principal difficulty on the right side is distinguishing the symptoms and signs produced by a ureteric calculus from those of acute appendicitis. The presence of blood and pus cells in the urine does not necessarily rule out appendicitis, for an inflamed appendix lying in juxtaposition to the ureter can give rise to ureteritis which causes slight hæmaturia.

Radiography.—Occasionally a typical elongated shadow in the line of the ureter renders the diagnosis undoubted; more often either no shadow is seen, owing to the small size of the stone and obscuration of it by intestinal gas shadows, or a shadow is seen which may or may not be a ureteric calculus.

Excretory Pyelography.—If the pyelograms show normal excretion on the affected side and the differential diagnosis between renal colic and acute appendicitis is at stake, immediate appendectomy should be performed, for when a calculus is present in the ureter invariably pyelography displays some aberration on the affected side. Soon after an attack of renal colic there is often either no excretion on the affected side or insufficient excretion to delineate the ureter. Forty-eight hours later, in most instances, a good shadow of the pelvis and the ureter is obtained, and if an opacity seen on the plain X-ray film is a ureteric calculus, it will be shown to lie in the line of the ureter (fig. 1009). A stone not visible in the plain

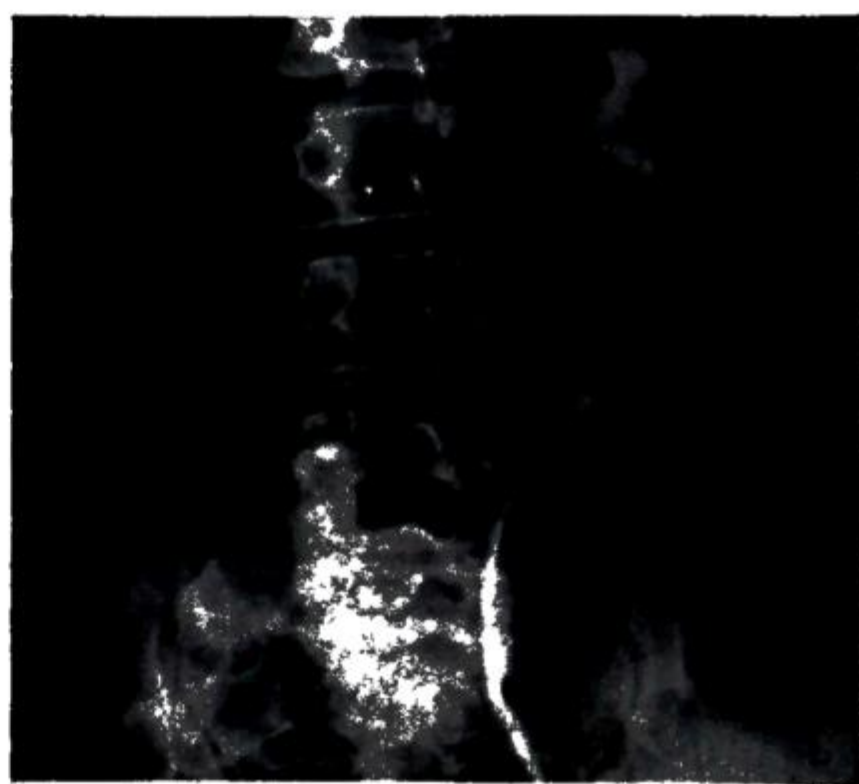


FIG. 1009.—Excretory pyelograph showing stone in the line of the ureter.

X-ray may become outlined in the ureter by the contrast solution. After a stone has been impacted for a week or more, a varying degree of hydronephrosis and dilatation of the ureter is often apparent.

Cystoscopy.—When a calculus is in the upper part of the ureter the ureteric orifice shows no abnormality, although after an intravenous injection of indigo-carmin the efflux from the affected side is accelerated soon after impaction and later retarded, especially if the stone has given rise to some degree of hydronephrosis. When a calculus has reached the lower third of the ureter, or sometimes when it is in the middle third, the ureteric orifice becomes patulous and its immediate vicinity bespattered with minute

petechial hæmorrhages. As the calculus descends to just above the bladder wall, these hæmorrhagic spots coalesce to form larger, bright-red extravasations.

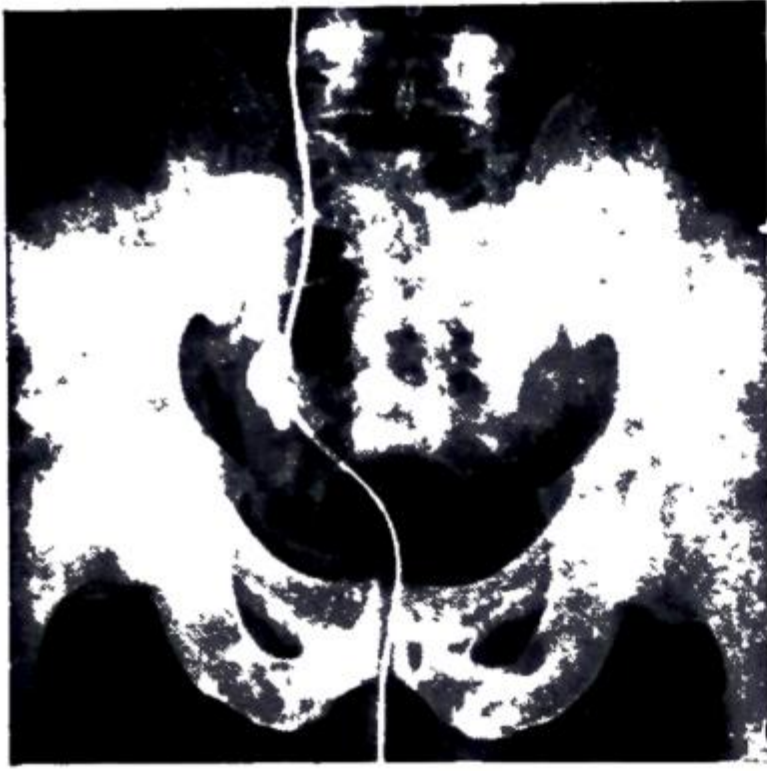


FIG. 1010.—Stone in the ureter. Catheter passed alongside the stone.

The stone having entered the intramural portion of the ureter, the ureteric orifice becomes grossly œdematous. Finally, the calculus may be seen pouting through (see fig. 961, p. 723).

The passage of an opaque catheter provides much information, and in conjunction with radiography confirms the diagnosis with precision. Especially when the efflux is increased, a catheter sometimes passes into the renal pelvis without hindrance, or, if arrested, after partial withdrawal and reinsertion (fig. 1010).

More often, especially when the efflux is diminished, a catheter fails to pass the obstruction and a radiograph shows the tip of the catheter abutting on the lower margin of the calculus.

Retrograde pyelography is seldom required. The only indications for its employment are when there is doubt concerning a shadow being a ureteric calculus and excretory pyelography shows absence or ineffective delineation of the corresponding renal pelvis and the ureter. It sometimes proves a means of displaying the presence of a ureteric calculus non-opaque to X-rays.

Treatment.—*Expectant.*—If the calculus as shown by radiography is small and the patient is having attacks of renal colic, there is a good chance that it will pass naturally. The patient is encouraged to drink large quantities of bland fluid; a urinary antiseptic and an antispasmodic are prescribed. The treatment is controlled by repeated radiographs and pyelography.

If the stone has been shown by radiography and pyelography to be situated in the ureter, and is of such a size that it may be expected to pass naturally, one of several antispasmodics which help to relieve the pain by relaxing the voluntary musculature of the ureter is indicated. Among the best in this respect are papaverine grain $\frac{3}{4}$ (50 mg.) intravenously, trasantin (Ciba laboratories) 1.5 ml. intravenously three times a day, or Tinct. ammi visnaga¹ (British Drug Houses Ltd.) drachms 2 (8 ml.) in a tumblerful of water three times a day before meals. The patient should be encouraged to drink large quantities (at least 5 pints (3 litres) in twenty-four hours) of bland fluid. The urine should be rendered alkaline (p. 762). The continuation of the treatment is decided by repeated radiographs and an occasional pyelograph. Expectant treatment should not be attempted in the presence of infection and not continued when there is little change in the position of the stone after three or four weeks, or when pyelography shows an increase in the size of the renal pelvis and the ureter above the stone.

Immediate and complete relief of pain is afforded by paravertebral block

¹ Ammi visnaga (Linn.) is an Eastern Mediterranean wild plant that has long been used by the local inhabitants as an antispasmodic for renal colic.

anæsthesia of the twelfth dorsal to the second lumbar sympathetic ganglia of the affected side with 10 ml. of 1 per cent. procaine.

Instrumental Treatment :

Before and after treatment by instrumentation, a soluble sulphonamide with an alkaline mixture should be given.

Ureteric Catheterisation.—A small stone half a centimetre or less in diameter arrested in any part of the ureter often passes after ureteric catheterisation. The catheter may be left in position for twenty-four to forty-eight hours, and 1 ml. of sterile liquid paraffin injected up the catheter before it is removed. This very frequently results in the stone being passed within a few hours or days. Five per cent. procaine injected into the ureter at the time of passing the catheter, and at intervals, often controls pain and overcomes spasm. In the presence of severe renal infection, if the catheter can be manipulated beyond the stone, the drainage afforded often prevents the development of a pyonephrosis. In this instance pelvic lavage with acriflavine 1 : 2,000 is employed in addition to systemic administration of a suitable antibiotic.

The following measures are suited to a calculus impacted either in the intramural portion of the ureter or in that part of the ureter immediately adjacent to the bladder.

Ureteric Meatotomy.—The ureteric orifice is the narrowest part of the



FIG. 1011. — Ogier Ward's electro-surgical ureteric meatotome. Meatotomy in progress.

whole ureter. By enlarging the opening a stone is often permitted to pass. When the stone is $\frac{1}{2}$ to 1 inch (1.25 to 2.5 cm.) above the ureteric orifice, Ogier Ward's meatotome is effective. Through an operating cystoscope the instrument is passed $\frac{1}{2}$ inch (1.25 cm.) up the ureter and its concealed blade is made to transfix



FIG. 1012. — Welland Howard's spiral stone dislodger in action.

the ureteric cusp (fig. 1011). With the cutting diathermy current the meatotome is withdrawn into the bladder, leaving the cusp divided and its edges coagulated.

The spiral stone dislodger (fig. 1012) can be used alone or in conjunction with meatotomy performed in the above manner.

Releasing a Stone Imprisoned at the Meatus.—When a stone is just inside the meatus or pouting through it, the anterior wall overlying the



FIG. 1013. —Diathermy meatotome, the platinum point of which can be protruded or withdrawn into its insulating sheath.

calculus can be divided by the more simple type of meatotome shown in fig. 1013, thus releasing the stone, which thereupon sometimes drops into the bladder.

R. Ogier Ward, Contemporary. Consulting Surgeon, St. Peter's Hospital for Stone, London.
Henry Welland Howard, 1877-1961 Associate Professor of Urology, University of Oregon, Portland, Oregon, U.S.A.

Operative treatment is indicated when :

- (a) It is judged that the stone is too large to pass naturally.
- (b) Expectant and instrumental treatments have failed.
- (c) There is increasing dilatation of the renal pelvis and calyces.
- (d) Infection is present.

Uretero-lithotomy.—The patient should be submitted to radiography just prior to the operation, in order to detect any change in the position of the calculus.

(a) **Stone is Impacted in the Lower Two-thirds of the Ureter but above the Spine of the Ischium.**—The operation for removal of a stone in this position is described first because it is the most common situation for a ureteric calculus requiring operative removal. With the patient in the dorsal position, an incision is



FIG. 1014.—Uretero-lithotomy.

made from a point $1\frac{1}{2}$ inches (3.75 cm.) above the anterior superior iliac spine to the middle of the inguinal ligament. The external and internal oblique muscles are divided in the direction of their fibres, likewise the transversus. The peritoneum is then gently mobilised by gauze dissection until the dilated ureter is found adhering to its under-surface. The stone is sought by palpation, and, if possible, is milked upwards or downwards to a convenient point for extraction. The ureter is incised longitudinally (fig. 1014) and the stone withdrawn by a scoop or forceps. Occasionally the stone is impacted so firmly that the only course is to incise the ureter directly over it. However, this practice should be avoided whenever possible, for the mucous lining

is ulcerated at the site of impaction, and its healing powers are thereby impaired. After extraction of the stone the incision in the ureter is closed by interrupted sutures of 0000 plain catgut passing through the muscular coats only. The lower end of the wound is drained down to the incision in the ureter, care being taken that the drainage tube does not impinge upon the iliac vessels. The drainage tube should be shortened on the third day and removed on the fourth, provided there is no leakage of urine.

(b) **Stone Impacted in the Upper Third of the Ureter.**—An incision similar to that for exposing the kidney (p. 763) is made; it can be prolonged downwards if necessary. The preliminary passage of a ureteric catheter helps in quick identification of the ureter during the operation.

(c) **Stone Impacted in the Juxtavesical or Intramural Portions of the Ureter.**—A midline, subumbilical extraperitoneal approach is often employed, the patient being in Trendelenburg's position. The peritoneum is stripped from the dome of the bladder and from the side wall of the pelvis. A dissection is then made between the posterior surface of the bladder and the wall of the pelvis. Often at this stage the stone will be felt. If this is not possible, the ureter must be identified where it crosses the iliac vessels, and traced downwards. Once the stone has been located it is removed in the same manner as described above.

INFECTIONS OF THE KIDNEY

Ætiology.—Renal infections arise in one of the following ways :

1. *Hæmatogenous.*—From the colon, infected tonsils, carious teeth, or from cutaneous infections, particularly boils or a carbuncle.
2. *Ascending along the peri-ureteral lymphatics* from the cervix uteri or the prostate.
3. *Ascending along the lumen of the ureter* from the bladder. This occurs in

cases of long-standing lower urinary obstruction with dilatation of the ureters, when, as a result of vesico-ureteral reflux, infected urine may be carried from the bladder to the renal pelvis. Another possibility is that motile organisms, e.g. *Esch. coli*, ascend along the dilated ureters.

On complete urinary investigation, which should always be undertaken after the acute phase of the infection has subsided, about 30 per cent. of males and a smaller number of females will be found to have an obstructive lesion in some part of the urinary tract. Moreover, with and without such a lesion, a focus of infection in the genital organs is demonstrable in a number of instances. So frequently 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*.

Bacteriology.—By far the most common organisms responsible are those of the coliform¹ group. Next comes the *Streptococcus faecalis*, followed by *Staphylococcus albus*. Then the *Proteus vulgaris*, *Proteus morgani*, *Pseudomonas pyocyaneus*, and *Staphylococcus aureus*, in that order. In females *Esch. coli* and, to a smaller extent, *Streptococcus faecalis*, predominate. The paracolon bacillus, *Proteus morgani*, and *Pseudomonas pyocyaneus* are relatively more common in males.

Esch. coli frequently occurs in pure culture. When *Streptococcus faecalis* is present, in nearly 40 per cent. of cases it occurs in association with another organism.

For practical purposes it can be stated that all bacilli infecting the urinary tract are Gram negative, and that the cocci commonly found in the urine are Gram positive.

In the presence of the common *Esch. coli* infection the urine is acid, as it also is in many types of streptococcal infection. Both staphylococci and *Proteus vulgaris* split urea, releasing ammonia, which causes the urine to become alkaline.

PYELONEPHRITIS

It is now conceded generally that renal infection, by whatever route it originates, is never confined to the renal pelvis. In hæmatogenous infection the renal parenchyma is attacked first, and often the infection spreads to the renal pelvis. In ascending infection the bacterial inflammation is not limited to the renal pelvis; it implicates the calyces, the pyramids, and at least some part of the adjacent parenchyma. It is, therefore, more correct to discard the term 'pyelitis' in connection with the latter type of infection, in favour of the more accurate designation 'pyelonephritis.'

ACUTE PYELONEPHRITIS

Acute pyelonephritis without retention of bladder urine, the commonest renal disease, is considerably more common in females, especially during childhood, at puberty, soon after marriage ('honeymoon pyelitis'), during pregnancy, and at the menopause. It occurs very much more often on the right side than on the left. Rarely it is bilateral.

¹ Coliform organisms comprise *Esch. coli*, *Esch. coli intermediate*, and *Aerobacter aerogenes*.

Harry de Riemer Morgan, died 1931. Voluntary worker at the Lister Institute, London.
Hans Christian Joachim Gram, 1853-1938. Professor of Medicine, Copenhagen.

Clinical Features.—Sometimes there are prodromal symptoms of headache, lassitude, and nausea. 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° or 103° F. (38.8° or 39.5° C.), and is remitting. Soon after the onset, increased frequency of micturition, due to cystitis, sets in, and when, as is often 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.

Bacteriological Examination of the Urine.—A mid-stream specimen, or, if that is impracticable in the female, a catheter specimen, 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 confirmative 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 twenty-four hours or more, the urine is often cloudy and pus cells abound. In all cases the investigation includes an 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. The sensitivity to antibiotics and sulphonamides is usually expressed as 0, +, ++, and +++, according to the width of the zone of inhibition produced.

Severe Cases.—There are repeated rigors and the temperature rises to 104° or 105° F. (40° or 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 the specimen is taken soon after a rigor, often gives a positive result. After some hours the pain is localised in one or, rarely, both loins. 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 coccal 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.

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 appendicitis, and acute cholecystitis. The urgent need is to differentiate acute appendicitis from right-sided pyelonephritis. The fact that the pain commenced in, and did not pass to, the right side greatly favours the latter condition. While pus cells in a centrifuged specimen of urine favour the diagnosis of pyelonephritis they do not exclude acute appendicitis, for the inflamed appendix sometimes is in contact with the ureter. Excretory pyelography

may prove of assistance, for in early acute pyelonephritis limited to the right kidney the concentration of medium in the renal pelvis and calyces on the affected side is often so poor that no shadow, or a very indefinite shadow, is cast.

Pyelonephritis of Pregnancy.—In spite of the fact that the hydro-nephrosis and hydro-ureter of pregnancy are perfect prerequisites for the development of infection, pyelonephritis occurs in only 2 per cent. of pregnancies. The condition usually develops between the fourth and sixth months of gestation, and is slightly more common in primiparæ than multiparæ. After the second pregnancy it is unusual. In 90 per cent. of cases the right side alone is affected. The initiating causes are often chronic urethritis or a cervical erosion. The symptoms do not differ from those of pyelonephritis occurring in the non-parous. As a rule, with appropriate treatment symptoms abate, and within a week the patient looks and feels well, but the urine may or may not still be infected. In about 10 per cent. of cases the disease runs a more severe and protracted course, and occasionally it results in abortion or premature delivery. In all patients who have had pyelonephritis of pregnancy, periodic examinations of the urine are necessary during the puerperium, for if the infection has not been eradicated, recrudescence of the symptoms is liable to occur during this period. In a few instances the infection lies dormant during pregnancy and manifests itself only during the puerperium, generally within the first week.

Pyelonephritis of infants and children is most common under the age of two years, when the sexes are equally affected. In older children it occurs much more frequently in females than in males. Often the infection commences acutely with rigors, the temperature rising to 103° or 104° F. (39.5° or 40° C.) remittently. In infants, more often than not, there are no symptoms referable to the urinary tract but only pyrexia, vomiting, anorexia, and loss of weight. Occasionally attacks of screaming due to colic occur. Slight terminal hæmaturia is sometimes present. In a number of instances a clue to the origin of the infection is apparent; in females vulvitis extending around the external urinary meatus; in circumcised males atresia with or without meatitis; in the uncircumcised, balanitis. Older children may complain of lumbar pain. In chronic cases increased frequency of micturition and slight intermittent pyrexia are the usual symptoms, but an examination of the urine to account for otherwise unexplained pyrexia may be the means of directing attention to the urinary organs. It should be noted particularly that seven out of ten boys with pyelonephritis have a congenital deformity of the urinary tract.

Pyelonephritis with retention of bladder urine occurs most frequently in men suffering from prostatic obstruction or stricture of the urethra, and in cases of fracture of the spine with injury to the spinal cord. (p. 1005). To a lesser extent it arises as a complication of retention of urine following operations. 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 the great majority of cases the infection is bilateral. Occasionally the condition arises spontaneously, but most often it is an ascending infection following the passage of a catheter or other instrument, or operations on the lower urinary tract. The old name for this condition was 'surgical kidneys,' and in the days of unsterile catheterisation it was frequent and dreaded.

Pathology.—At post-mortem examination the kidneys are enlarged and miliary abscesses can be seen beneath the capsules. On bisection there are numerous yellow streaks of pus in the parenchyma radiating from the medulla to the convex border. The renal calyces, pelves, and ureters are dilated.

Clinical Features.—The symptoms are similar to those of severe acute pyelonephritis without retention, but in addition, depending upon the amount of renal damage by back pressure, there will be superadded varying degrees of uræmia. There is rigidity and tenderness in both loins, though often more in evidence on one side than the other.

TREATMENT OF ACUTE PYELONEPHRITIS

If the urine is acid, as it is in the common coliform infections, alkalinisation of the urine has a most beneficial effect in relieving the symptoms and in inhibiting the growth of these organisms. The following mixture, given four-hourly or more often, is efficacious :

R	Sodium Citrate	gr. 20 (1·3 G.)
	Sodium Bicarbonate	gr. 20 (1·3 G.)
	Syr. aurantii	q.s.
	Aq. ad to	½ ounce (15 ml.)

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

To alkalinise the urine rapidly an intravenous injection of 10 ml. each of an isotonic solution of sodium lactate and a saturated solution of sodium bicarbonate (ampoules ready for use can be obtained from Crookes Laboratories) is very effective in ultra-acute cases.

When pain is severe, one of the antispasmodics (p. 756) is given and heat is applied to the affected loin by fomentations, an electric heating pad, or kaolin.

The patient should be instructed to imbibe large quantities of bland fluid, about 5 pints (3 litres) in the twenty-four hours. 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 and the result of the sensitivity tests, in comparatively mild cases a soluble sulphonamide can be given as directed below, but in really severe cases an antibiotic with a wide range of activity, e.g. 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 :

Sulphaforazole (gantrisin) is capable of high urinary concentration without risk of crystalluria and is of low toxicity. It is capable of controlling many *Esch. coli* and Gram-positive coccal infections and some strains of *proteus* and *Ps. aeruginosa*. The dose is 2 G. *statim* followed by 1 G. six-hourly until the temperature has remained normal for three days and cultures of the urine have proved sterile on three consecutive occasions.

Sulphamethiazole (urolucosil) has similar properties, but unlike other

sulphonamides it is unnecessary to insist on a high fluid intake while the patient is taking this drug ; indeed, in order to maintain a high concentration of the drug in the urine, it is an advantage to moderate the amount of fluid consumed each day. The dose is 0·1 G. five times daily.

Antibacterial Nitrofurans :

Nitrofurantoin (furadantin) is a synthetic antibacterial agent. Although when taken by mouth the blood levels remain low, the concentration in the urine is significant ; hence it is of value only in genito-urinary infections. It has been found to be particularly effective against *Esch. coli*, *A. aerogenes* and *proteus*, often it has proved lethal to antibiotic-resistant strains of these organisms ; it is valueless in *Ps. aeruginosa*. The drug is supplied in grooved tablets containing 0·5 G. The average dose by mouth is 5 to 8 mg. per kilo (2·2 to 3·6 mg. per lb.) of body weight. One-quarter of the dose is administered immediately after food three times daily and a further dose with cold milk last thing at night. If nausea or vomiting is engendered, the dose must be reduced.

Antibiotics.—All the antibiotics in general use have been given an extended trial for pyelonephritis.

Broad Spectrum Antibiotics.—While these are effective if employed in accordance with bacteriological findings, unlike the above drugs, when it is necessary to continue treatment for a prolonged period (which is not unusual) a number of dangers loom large. Firstly, there are the toxic properties, producing nausea, vomiting, and diarrhoea. Secondly, there is the alteration in the intestinal micro-flora these antibiotics produce, sometimes leading to monilia or staphylococcal enterocolitis. Thirdly, the frequency with which resistant variants emerge, often in a comparatively short time, is disturbing.

Streptomycin, if employed, should be given in four-hourly doses of 0·5 G. intramuscularly for not more than forty-eight hours. Attention is again directed to the liability of the eighth nerve to suffer damage if streptomycin is administered in the presence of depressed renal function.

Pseudomonas infections usually are resistant to all the above-mentioned therapeutic agents. Polymyxin B or neomycin are the only drugs with which to combat most of these infections. Neither should be administered for more than five days. The dosage set out in the instructions that accompany the ampoule of each of these drugs should be adhered to closely, and in the event of even a slight decline in urinary output the drug should be stopped at once.

Other Details of Treatment in all Cases.—Three days after commencing the treatment of pyelonephritis with any of the therapeutic agents described above the urine must be sent for culture. Should it be reported sterile a further sample is dispatched at the time of the complete urinary investigation (see p. 712). Despite the undoubted efficacy of modern antibacterial drugs, none is likely to succeed in sterilising the urine of a patient with an abnormality of the urinary tract. In the absence of a demonstrable abnormality, a history of previous urinary infection also reduces the likelihood of a cure, although to a lesser extent (L. P. Garrod).

Finally, it is necessary to follow up every patient who has had acute pyelonephritis, to have periodic cultures of the urine performed, to remedy as far as is possible any abnormality of the urinary organs, if such be present, and to seek and eradicate any focus of infection that might feed the kidneys with fresh supplies of bacteria. Only in this way can recurrence and, above all, the grave condition of chronic pyelonephritis be prevented.

CHRONIC PYELONEPHRITIS

Chronic pyelonephritis is an important, common, and dangerous disease. It is the most frequent cause of death from uræmia. Like its acute counterpart it can be primary, or secondary to an obstructive lesion of the urinary tract. According to Jan Brod chronic pyelonephritis is a renal inflammation that has spread from the renal pelvis. His reason for arriving at this conclusion is histological.

Pathology.—The inflammation is interstitial and microscopically scars resulting from the destruction of adjacent parenchyma can be seen. These scars are unevenly distributed and nearly always are more evident in one kidney than in the other. Histologically it can be seen that the brunt of the onslaught has been borne by the renal tubules; they are atrophic, often dilated, and sometimes cystic. In time many of them are vanquished and disappear in scar tissue. On the other hand, the glomeruli retain their normal structure until late in the disease.

Chronic pyelonephritis is almost three times as common in females as it is in males. Two-thirds of the affected females are under forty years of age, while 60 per cent. of the males are over forty.

Clinical Features.—It is possible, but unusual, for chronic pyelonephritis to remain asymptomatic until advanced renal insufficiency appears.

Lumbar pain, usually dull in character, is present in 60 per cent. of cases.

Increased frequency and dysuria are leading symptoms in 45 per cent. of cases.

Hypertension is present in 40 per cent. of cases, being more common in primary than in secondary pyelonephritis. It develops slowly and thus is more in evidence in long-standing cases. In 20 per cent. of cases the hypertension is of the accelerated¹ type.

Constitutional symptoms comprising lassitude, malaise, nausea, and headache constitute the main complaint in 30 per cent. of cases. Little wonder that the disease often remains unrecognised in these sufferers, perhaps for years.

Pyrexia. Attacks of pyrexia exceeding 100° F. (37.8° C.) are the main symptoms in 20 per cent. of cases. The determination to explain these attacks often leads to a thorough investigation including that of the urinary tract and the disease is brought to light.

Routine clinical examination in suspected cases should include examina-

¹ The term *malignant* hypertension is most undesirable. Malignant is a term that should be reserved for neoplasms.

tion of the genitalia (including palpation of the prostate) taking the blood pressure and retinoscopy, as well as a thorough examination of the urine.

Proteinuria.—On account of the late destruction of the glomeruli, contrary to glomerulonephritis the amount of protein passed in the urine is small (5 G. daily). Likewise the number of casts is small. Specimens obtained by ureteric catheterisation often show great differences in these respects on the two sides.

Bacteriological Examination of the Urine.—Pathogenic organisms are found in 80 per cent. of cases: *Esch. coli* and/or *Streptococcus faecalis* frequently, *proteus* and *Ps. aeruginosa* seldom.

Treatment is on the whole unsatisfactory. In secondary cases, even if the cause can be removed, the renal pelves have frequently lost their musculature and are fibrotic and non-contractile. Moreover, once the parenchyma has been damaged it is a locus of predilection for blood-borne organisms. Consequently chemotherapy and antibiotics confer as a rule only temporary benefit. The longer the infection has persisted, the more difficult is it to eradicate. For this reason, when prolonged treatment is required, there is a definite place for the following inexpensive drug.

Mandelic acid and its salts are often curative in coliform infections and those caused by streptococcus faecalis. Ammonium mandelate 2 G. (or better, mandamine, which is mandelic acid and hexamine combined), together with a capsule of 1 G. ammonium chloride, is given six-hourly. Fluids are restricted to 2½ pints (1.5 litres) in the twenty-four hours. It is essential that the urine be kept acid (pH 5.3 or less). Contraindications to this form of therapy are impairment of renal function and infections producing ammoniacal decomposition of the urine.

In nearly 50 per cent. of patients with pyelonephritis due to infection by one organism only, in whom infection persists in spite of treatment with antibacterial drugs, it is found that the original organism has been replaced by another, e.g. *streptococcus faecalis*, instead of *Esch. coli*.

It is highly important to eradicate distant foci of infection whenever possible. Removal of sclerosed fat from the renal pelvis and denervation brings improvement in some cases. In occasional cases when the disease is unilateral and associated with the accelerated types of hypertension, the results of nephrectomy are astoundingly good.

HYPERTENSION AND A UNILATERAL RENAL LESION

Renal ischæmia regularly produces increased arterial tension. It has been established with reasonable certainty that ischæmia of the renal parenchyma leads to the formation of a vasopressor substance. Too often cases are labelled essential hypertension without a thorough urological examination. Sometimes in a case of hypertension a unilateral diseased kidney is demonstrated and nephrectomy is followed by permanent lowering of the blood pressure. The most amenable lesion in this respect is chronic pyelonephritis with a short history of high blood pressure. Occasionally patients with renal tuberculosis, a renal neoplasm, or renal calculi with infection have been permanently benefited, in so far as hypertension is concerned, by removing the diseased kidney.

INVESTIGATION OF A CASE OF PYELONEPHRITIS

The following investigations are carried out in chronic cases a week or more after treatment with antibacterial drugs, and in acute cases after the acute phase has subsided with treatment.

Such investigations are directed to unfolding a cause of obstruction to the upper or lower urinary tract, and/or a source of infection, which is present most often in the genital organs or the urethra.

(a) *The Clinical Examination is Repeated.*—The kidneys are palpated for tenderness and enlargement, and the bladder for chronic retention of urine. In middle-aged or elderly males the prostate is examined for enlargement or fibrosis. Especially in male children, atresia of the meatus or meatitis is sought.

(b) *Radiography* of the urinary tract will reveal or eliminate the presence of a urinary calculus.

(c) *Excretory Pyelography.*—In chronic pyelonephritis and after an attack of severe acute or recurring acute pyelonephritis, changes in the pyelographic shadow or shadows will be manifest. Some of these are similar to those of early hydronephrosis, but they are more unequally distributed. Although the calyces become flattened or clubbed, this is more in evidence in one part of the kidney than another. Persistent poor definition in one group of calyces is presumptive evidence of chronic infection. In cases of longer standing the renal pelvis becomes slightly dilated, but, unlike hydronephrosis, the dilatation of the calyces predominates. In 70 per cent. of cases of chronic pyelonephritis there is asymmetry of the two kidneys, both in size and in the speed with which the medium is excreted. When as a result of a severe acute infection the parenchyma has been the seat of considerable suppuration deformed calyces will be revealed.

(d) Examination of the cervix uteri with a speculum often displays cervicitis or cervical erosion. Examination of the secretion expressed by prostatic massage sometimes accounts for the presence of infection. If no infection is found in these situations, a possible focus in carious teeth or infected tonsils is sought.

(e) *Cysto-urethroscopy* should be undertaken only in cases of prostatic obstruction when there is insufficient residual urine to render the bladder palpable. After the instrument has been passed, residual urine, if any, is measured. In both sexes examination of the urethra may show chronic urethritis or the presence of a stricture. In the female urethro-trigonitis is commonly found. Hitherto unconfirmed obstruction to the prostatic urethra by an enlarged middle lobe or contracture of the bladder neck may be demonstrated. Evidence of cystitis is the most common cystoscopic finding. Sometimes the ureteric orifice, or orifices in bilateral cases, is seen pouting, œdematous, or gaping. Delay in efflux is usual on the affected or more affected side. Ureteric catheters are passed and specimens collected from each kidney. These specimens are examined for cells and bacteria. By these means it is ascertained whether the infection is bilateral or unilateral. In male children valves in the posterior urethra, or a contracture of the bladder neck, are sometimes revealed.

Treatment.—When an obstructive lesion is found in any part of the urinary passages, after the infection has been controlled as far as possible, the obstruction is removed.

PYONEPHROSIS

The kidney is converted into a multilocular sac containing pus or purulent urine, with a varying amount of renal parenchyma in its walls. A pyonephrosis can result from infection of a hydronephrosis, follow acute pyelonephritis or, most commonly, arise as a complication of renal calculus (calculous pyonephrosis). As a rule the condition is unilateral. Like a hydronephrosis, a pyonephrosis can be open or closed ; sometimes closure is intermittent.

Clinical Features.—In cases of open pyonephrosis, which is more common than closed, there is pyuria, often obvious to the naked eye. There is constant pain in the affected loin, worse at night, and a renal swelling is palpable. When the condition arises as an infection of a hydronephrosis the swelling may be a large one. When the pyonephrosis is open an evening rise of temperature to 99° or 100° F. (37.2° or 37.7° C.) is usual ; if the pyonephrosis becomes closed, the temperature is considerably higher. Pyuria, when present, gives rise to cystitis, and sometimes symptoms of that condition are the chief complaint.

Investigation.—Plain radiography may reveal the presence of a calculus. Excretory pyelography shows the same vagaries as advanced hydronephrosis, in that the appearance of the shadow of the dilated renal pelvis and calyces is long delayed and may be absent. Cystoscopy often reveals chronic cystitis with a purulent efflux from the ureter of the affected side. In closed cases the bladder is likely to be normal and the passage of a ureteric catheter either becomes arrested, most usually at the pelvi-ureteric junction, or passes the obstruction and give exit to pent-up purulent urine.

Treatment.—In early cases of infection of a hydronephrosis, by anti-bacterial drugs and the passage of a ureteric catheter to drain infected urine from the renal pelvis, occasionally it is possible to reconvert the pyonephrosis into a hydronephrosis. Should the pyonephrosis be due to an impacted stone in the ureter or a comparatively small stone blocking the pelvi-ureteric junction, the stone should be removed and suitable drainage of the kidney provided. In most other unilateral cases, when the associated anaemia, which usually is present, has been rectified, nephrectomy is undertaken. Should the capsule prove to be densely adherent to the surrounding structures, subcapsular nephrectomy (see p. 784) is performed. Rarely, when the patient's general condition cannot be improved, nephrostomy is carried out, a measure to be avoided if possible because it renders subsequent nephrectomy more difficult. When a pyonephrosis arises in a sole existing kidney, or the condition is bilateral, permanent nephrostomy is the only measure that can be adopted.

CARBUNCLE OF THE KIDNEY

The source of origin of the organism is usually a cutaneous lesion, such as a boil, carbuncle, whitlow, or an abscess of the breast, and the *staphylococcus aureus* is conveyed to the kidney via the blood-stream.

Morbid Anatomy.—On splitting open the kidney there is a necrotic



FIG. 1015.—Carbuncle of the kidney.
(Mr. J. G. Yates-Bell, London.)

mass of tissue, usually localised, involving the parenchyma (fig. 1015).

Ætiology.—More often than in other staphylococcal bacteræmias a portal of entry is to be found. Occasionally a blow on the loin determines the issue.

Clinical Features.—Men are more frequently affected than women, and the right side more often than the left. There is an ill-defined, tender swelling in the loin, persistent pyrexia, and leucocytosis, signs that simulate closely a perinephric abscess. In early cases the urine contains neither pus cells nor organisms, but after a few days, as a result of much centrifuging,

staphylococci can sometimes be isolated. Pyelography often shows compression or obliteration of a group of calyces, an appearance that does not differ from adenocarcinoma of the kidney.

Treatment.—Penicillin has proved curative in a comparatively small proportion of early cases, but in these it is always difficult to be certain of the diagnosis. When the response to antibiotic therapy is not dramatic the kidney must be exposed, the carbuncle incised, and the necrotic material scooped out with the finger. Hæmorrhage is not excessive and can be controlled by pressure over a moist warm pack. A drainage tube is passed down to, but not into, the resultant cavity and the wound is closed around the tube. Penicillin, or another antibiotic if the staphylococcus is penicillin-resistant, is continued for at least ten days. Nephrectomy is necessary only in a few widespread carbuncles, and usually the reason for the magnitude of the carbuncle is an unbridled faith in the continued use of antibiotics as opposed to exploration. Although this conservative operation is often successful, it is sometimes followed by a persistent discharging sinus that can be remedied only by secondary nephrectomy. Primary nephrectomy is indicated only when the major part of the kidney is involved by the carbuncle.

PERINEPHRIC ABSCESS

A perinephric abscess can arise in many ways. The most common are depicted in fig. 1016. Other causes are infection of a perirenal hæmatoma and perforation of the

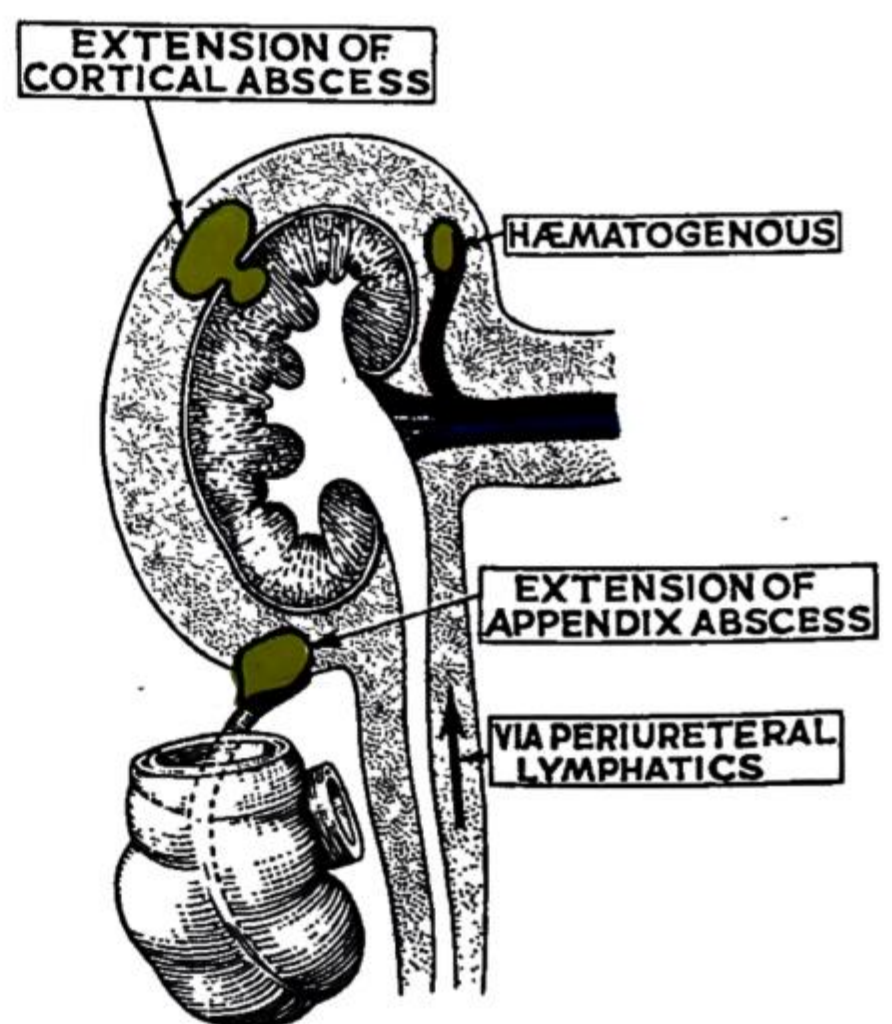


FIG. 1016.—Sources of perinephric abscess.

renal capsule from undue delay in operating upon a pyonephrosis or a renal carbuncle. A tuberculous perinephric abscess can arise from an advanced pyonephrosis or from tuberculosis of a nearby vertebra.

Clinical Features.—The classical symptoms and signs of a perinephric abscess are a high, swinging temperature, rigidity, tenderness, and fullness in the loin (fig. 1017). If the suppuration commences in the lower part of the perinephric fat, local signs present early, but when the suppuration is confined to the upper portion of the perinephric fat which lies beneath the lower ribs, it produces no visible swelling, and even rigidity and tenderness may be absent. The leucocyte count is always raised, often to 20,000 per c.mm. As a rule no pus or organisms are present in the urine, even if a ureteric specimen is examined.



FIG. 1017.—An advanced perinephric abscess.

Radiography often shows obscuration of the psoas shadow, with one or more of the following additional signs—scoliosis with concavity towards the abscess and elevation and immobility of the diaphragm on the affected side.

There are no characteristic early signs on excretory pyelography, except:

Mathé's Sign.—Absence of the downward displacement that occurs in the erect posture in every normal kidney. Two radiographs, one in the lying posture and one in the erect posture, during excretory pyelography are required.

In late cases the kidney can be shown to be displaced, especially forwards, if a lateral view is obtained.

Treatment.—Under antibiotic cover a lumbar incision large enough to enable the surgeon to open up pockets both above and below the kidney is made. At the same time the surface of the kidney is palpated for an unruptured cortical abscess, which, if present, should be incised. A specimen of pus having been obtained for bacteriological examination, the wound is closed with ample drainage. Appropriate antibiotic treatment follows.

RENAL TUBERCULOSIS

Ætiology and Pathology.—Tuberculosis of the urinary tract cannot arise except as a blood-borne infection from a distant focus, which, in 75 per cent. of cases, is impossible to discover. As a result of a shower of bacterial emboli, bilateral juxta-glomerular microscopical lesions occur and, as shown by necropsy on patients who have died of pulmonary tuberculosis, these minute lesions frequently heal.

When clinically recognisable, in the great majority of cases renal tuberculosis commences in one kidney only. A group of microscopical lesions

coalesce and discharge pus and tubercle bacilli along one set of tubules, and the apex of the pyramid which gives exit to the discharge becomes ulcerated (fig. 1018 A). Alternatively, and somewhat less frequently, in the same way an abscess forms in the parenchyma, and later bursts into a calyx (fig. 1018 B).

Course : *Tuberculous bacilluria* is a convenient term to designate a very early lesion of the renal cortex when no abnormality in the affected kidney can be detected, even by retrograde pyelography. Tuberculous bacilluria is usually transient, but on occasions it persists for many months, even for years. Should it do so, a demonstrable lesion of the kidney develops ultimately.

A *macroscopical lesion*, once established, without treatment progresses rather slowly, and not infrequently other similar lesions appear in the same

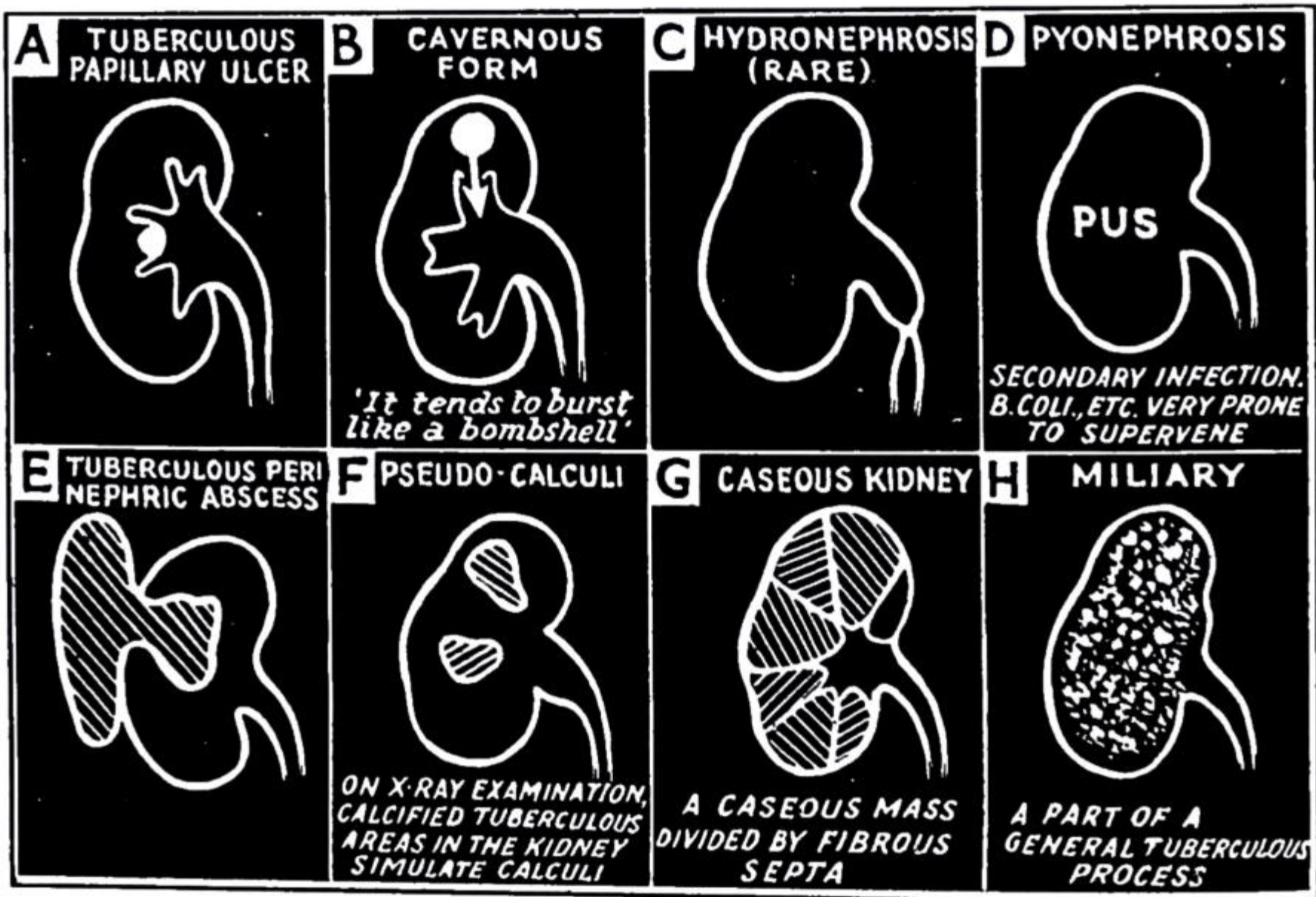


FIG. 1018.—Blackboard sketches of types of tuberculous kidney (macroscopic pathology).¹

kidney. Sometimes the infection remains confined to the affected kidney for months or years, causing one or other of the changes depicted in fig. 1018 C to G. More often the disease spreads along the ureter (tuberculous ureteritis) to give rise to tuberculous cystitis. Eventually the second kidney becomes implicated by infection ascending along the peri-ureteral lymphatics, or by vesico-ureteral reflux. In the male, renal and genital tuberculosis are frequently associated, often before the bladder and posterior urethra are involved, in which event the genital infection probably occurs in the following way. An urgent desire to micturate causes the internal sphincter to open, while at the same time, because there are no immediate facilities for emptying the bladder, voluntary closure of the external sphincter is called into play. At that moment infected urine is forced under pressure into the mucosal crypts of the prostate and the common ejaculatory ducts (C. A. Wells).

¹ G is known also as the 'putty kidney' and by the French as the 'cement kidney.' It is nature's method of performing (ineffective!) nephrectomy.

Clinical Features.—Rare during childhood, renal tuberculosis reaches its zenith between twenty and forty years of age. Men are affected twice as commonly as women, and the right kidney somewhat more commonly than the left.

Frequency.—The earliest symptom is increased frequency of micturition. Often this is the only symptom. It is progressive, the patient complaining that (over a period of months) the frequency has increased both by day and by night.

The causes of the persistent, progressive, and unremitting frequency are, in order of sequence :

1. Polyuria. The output of the inflamed hyperæmic kidney is increased.
2. Irritation of the bladder by caseous débris passed down the ureter.
3. Tuberculous cystitis.
4. Increasing diminution of bladder capacity from fibrosis.
5. Secondary infection.

Pyuria.—In early cases the urine is pale and slightly opalescent. The presence of pus cells without organisms in an acid urine is extremely suggestive of tuberculous urinary infection. It is very unlikely that tubercle bacilli will be found in a single bladder specimen.

Bacteriological Examination of the Urine.—Because of the fundamental necessity of avoiding contaminants, particularly the acid-fast smegma bacillus, in this vitally important investigation the patient must be admitted in order to obtain a 'pooled' specimen. This consists of centrifuged deposits of early morning mid-stream specimens on six successive days, kept in the laboratory under sterile conditions. When, after staining a specimen of the sediment with Ziehl-Neelsen's acid-fast stain, acid-fast bacilli are found, it is highly probable that they are tubercle bacilli, but the proof lies in culture or guinea-pig inoculation, either of which is reliable. Modifications of Loewenstein's medium have made it relatively easy to cultivate tubercle bacilli in approximately three weeks. Animal inoculations require six weeks before the result is obtained.

In no field of medicine is the diagnosis more exact. The microscope demonstrates tubercle bacilli in 72 per cent., the guinea-pig test in 94 per cent., and the culture medium in 98 per cent. of cases.

Tuberculous Epididymitis.—Aching in a testis may be an early symptom.

Painful Micturition.—Once tuberculous cystitis has set in, micturition becomes increasingly painful. First there is suprapubic pain if the bladder cannot be emptied immediately; later a burning pain accompanies micturition, and when secondary infection has occurred there is superadded agonising pain after micturition referred to the tip of the penis or to the vulva, often associated with terminal hæmaturia (strangury).

Renal pain is often absent throughout the process of complete destruction of the kidney. Sometimes the patient complains of a dull ache in the loin.

Hæmaturia.—In 5 per cent. of cases the disease is ushered in with severe painless hæmaturia occurring from an ulcer situated on a renal papilla.

Franz Ziehl, 1857-1926. Neurologist, Lübeck.

Friedrich Neelsen, 1854-1894. Pathologist, Dresden.

Ernst Loewenstein, Contemporary. Pathologist, University of California, San Francisco.

During the hæmorrhage, and after it has ceased, investigations may or may not demonstrate the presence of a renal lesion and tubercle bacilli in the urine. In the latter event more typical symptoms commence some months later. Apart from a few drops of blood at the end of micturition in cases complicated by severe cystitis, macroscopical hæmaturia occurs only occasionally.

Constitutional Symptoms.—A continuous slight loss of weight is usual. Evening pyrexia to 99° F. (37.3° C.) occurs when the disease is fully established. A high temperature is indicative of a secondary infection by another organism, or disseminating tuberculosis.

On Examination.—It is unusual for a tuberculous kidney to be palpable.

When a patient with renal tuberculosis has an enlarged kidney which can be felt, it is by no means certain that this kidney is the one that is diseased, for compensatory hypertrophy sometimes renders the healthy kidney both large and tender.

The line of the ureter, and (in the male) the prostate, vesicles, vas, and epididymis, should be examined for thickening, which bespeaks tuberculous invasion of these parts.

Investigation :

A plain radiograph sometimes shows areas of calcification in the kidney.

Excretory pyelography reveals fairly typical pathological changes (figs. 1019 and 1020). The earliest manifestation is persistent irregularity and



FIG. 1019.—Excretory pyelogram showing a small localised lesion. Healing took place under conservative treatment. (Professor E. Wildbolz, Berne.)

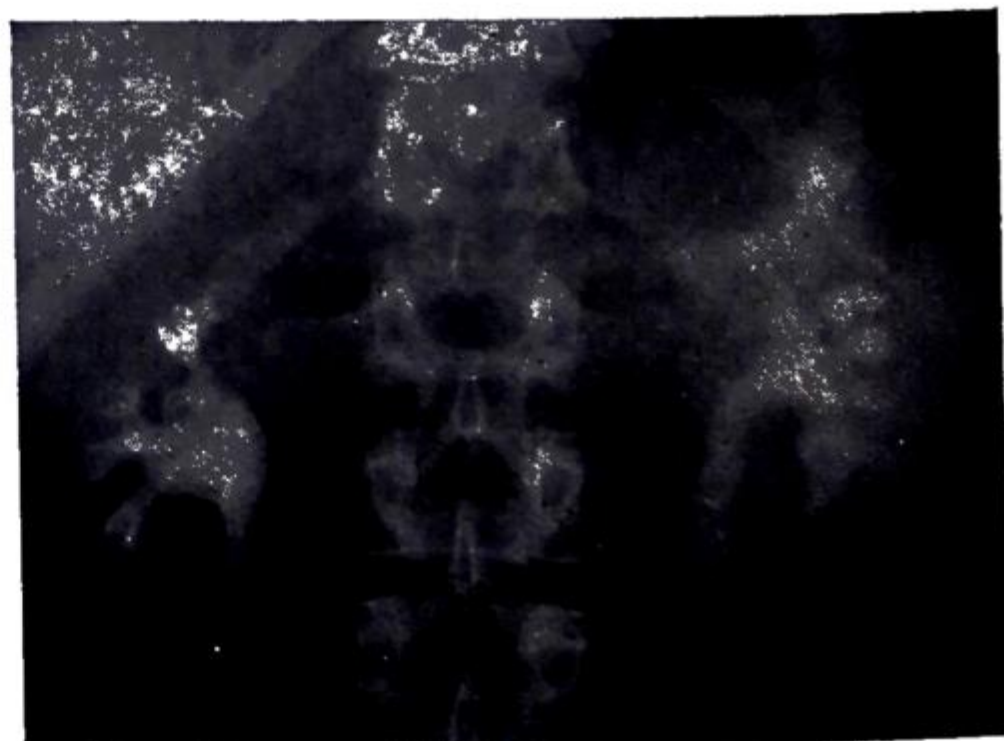


FIG. 1020.—Excretory pyelogram showing more advanced renal tuberculosis with involvement of the ureter. Nephro-ureterectomy was performed. (Professor Wildbolz.)

slight dilatation of a calyx. More gross lesions of the cavernous type are readily apparent. Often, in late cases, the contralateral ureter becomes dilated also; this is not necessarily an indication of disease spreading to the opposite side, for frequently the dilatation is due to the cicatrised bladder causing obstruction to the ureter in its intramural course.

Cystoscopy.—When increased frequency is the only symptom and it has not been present long, the bladder and the ureteric orifices are normal. A unilateral cloudy efflux is sometimes observed. Either more frequent efflux or a delay in excretion of indigo-carmin is indicative of the side that is diseased. In 10 per cent. of cases there is an absence of efflux on the affected side, and no pathological changes in the bladder. These are

examples of a closed ureter leading to so-called autonephrectomy, or a pyonephrosis. Hyperæmia around a ureteric orifice is the earliest cystoscopic sign of vesical involvement. Infiltration follows, and the mucous membrane of the affected ureteric orifice pouts. Tubercles appear, usually lateral to the ureteric orifice, and over its intramural projection; later they appear in the dome of the same half of the bladder. By confluence of a circumscribed group of tubercles, a tuberculous ulcer, which has an irregular periphery, may form. Such an ulcer is seen near the affected ureteric orifice and often also in the dome of the bladder. Later bullous œdema frequently surrounds and hides the ureteric orifice, which can be detected only by the efflux of indigo-carmin. In long-standing cases, as a result of sclerosing peri-ureteritis, which causes shortening of the ureter, the ureteric orifice becomes displaced upwards and its mouth remains open (fig. 1021). As the disease progresses, the capacity of the bladder becomes increasingly diminished. At any stage, if a secondary infection supervenes, the intense generalised inflammation of the bladder wall obliterates many of the characteristic features of urinary tuberculosis just described above.

Bilateral ureteric catheterisation should be carried out in early cases and the urine from each kidney examined for pus and tubercle bacilli. In later cases, when the signs displayed by excretory pyelography are indubitable, ureteric catheterisation can be limited to the supposed sound side, and the urine collected therefrom will confirm or disprove that the side in question is free from infection.

Retrograde pyelography is necessary to establish the diagnosis in early cases. Appearances, such as shagginess of a calyx or an abscess of the parenchyma connected to a calyx by a narrow neck, are often displayed by this method when excretory pyelograms appear normal. Retrograde pyelography is also of great assistance in cases of unilateral renal tuberculosis (fig. 1022) too advanced to concentrate dye given intravenously.



FIG. 1022. — Retrograde pyelogram showing advanced tuberculosis of the right kidney and ureter.

Abdominal aortography sometimes gives valuable information unobtainable by pyelography. Renal tissue surrounding a tuberculous lesion that fails to heal under conservative treatment is comparatively ischæmic, and is displayed in an arteriograph as an island lacking in vascular pattern. The information thus obtained is of particular value when possibilities of performing partial nephrectomy are being considered, but, as emphasised before, the dangers of aortography are its drawbacks.

Examination of the Lungs.—A radiograph of the thorax and examination of the sputum, if present, should be undertaken to exclude active pulmonary tuberculosis.

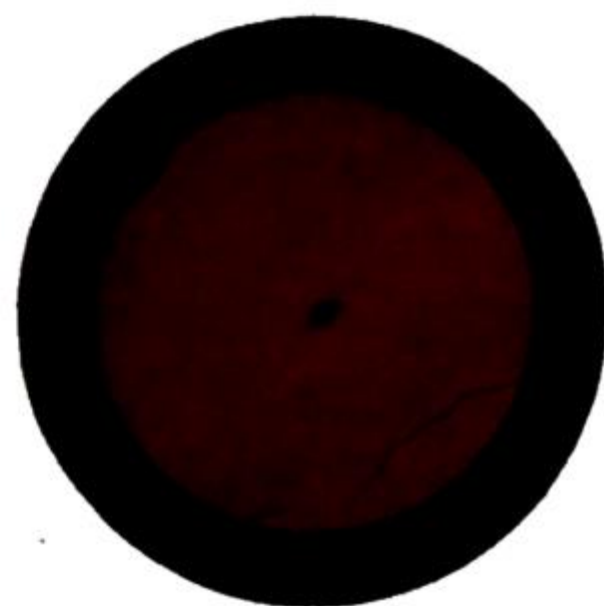


FIG. 1021. — Golf-hole ureter. It fails to close between the effluxes. (D. Newman.) (*British Journal of Surgery.*)

Treatment.—In all cases sanatorium treatment for a minimum of six months, and an average of one year, is highly desirable.

Antibiotic therapy should be commenced as soon as the diagnosis has been established. By trial and error have emerged three fundamental principles :

1. Resistance of *Mycobacterium tuberculosis* to anti-tuberculous therapeutic agents can be rendered improbable by avoiding the administration of any one of them singly and by ringing the changes rather frequently.

2. The drugs must be given continuously throughout the whole period of treatment.

3. Treatment must be prolonged : one year is not long enough. Eighteen months should be looked upon as within the low effective period for a case of average severity.

The drugs employed are :

(a) *Streptomycin*, 1 G. intramuscularly twice weekly.

(b) *Isoniazid*, 50 mg. per 10 Kg. of body weight (300–600 mg.) by mouth daily, in three divided doses.

(c) *Sodium para-amino-salicylic acid* (P.A.S.), 5 G. administered orally three times a day in fruit juice, which helps to mask its nauseating properties.

These drugs are always administered in a combination of two, viz.: 1 and 2, 1 and 3, 2 and 3, the combination being changed every two months.

Viomycin.—Because of its toxicity this antibiotic is held in reserve for those few who become resistant to the above antibiotics and yet for whom it is imperative to subdue the infection for a limited period, for instance when operation has been decided upon. The dose is 1 to 2 G. administered intramuscularly twice weekly.

Conservative measures alone are likely to prove successful in cases of:

(a) Tuberculous bacilluria—no lesion demonstrable.

(b) A cortical lesion so small as to be no larger than an apple pip.

Conservative measures alone are also indicated in patients with advanced bilateral renal lesions, especially those with active pulmonary tuberculosis,¹ and in all but a few cases of tuberculosis of a sole remaining kidney (see Partial Nephrectomy).

Operative Treatment.—Some lesions belonging to category (b) are surrounded by so much necrotic and fibrous tissue that antibiotic agents do not reach the organisms in sufficient concentration to kill them. Unilateral lesions of this character and those in which the disease is more advanced call for operative treatment, the optimum time for which is at the end of four months of conservative treatment.

According to circumstances one of three operations is carried out.

1. **Partial nephrectomy** (see p. 785) has been rendered practicable by antibiotic therapy. The indications are :

(a) When a small ulcero-cavernous lesion is confined to an upper or a lower polar calyx. If such a lesion appertains on both sides and unilateral

¹ Only 4 per cent. of patients with pulmonary tuberculosis develop renal tuberculosis and in the great majority of these the lesion is unilateral.

partial nephrectomy has been undertaken, should the second lesion fail to heal within three months, it can be treated similarly.

(b) When tuberculosis is confined to one moiety of a double kidney (see fig. 975, p. 732).

(c) When such a lesion is limited to one half of a horse-shoe kidney.

2. **Nephrectomy** (see p. 784).—The indications are a unilateral lesion with one of the following characteristics :

(a) Gross impairment of renal function on the affected side.

(b) Two focal lesions not located in one pole.

(c) Cavernous lesion middle calyx.

Nephrectomy is indicated also in cases of bilateral tuberculosis when one organ is much more diseased than the other, provided the renal function tests on the less involved side are satisfactory. Unless the lesion in the remaining kidney is a very small one, a cure cannot be expected in these circumstances, but often the symptoms are ameliorated.

3. **Nephro-ureterectomy**.—If, on investigation, the ureter as well as the kidney proves to be diseased, nephro-ureterectomy (figs. 1023 and 1024), in which, through a separate incision, the ureter is divided and ligated



FIG. 1023.—Typical cavernous lesion upper pole; smaller lesion communicating with lower calyx.



FIG. 1024.—Tuberculous pyonephrosis. Nephro-ureterectomy.

at its entrance to the bladder before commencing lumbar nephrectomy, is the operation of choice. By total removal of the ureter a possible source of continued infection of the bladder is removed, and the incidence of post-operative wound infection and sinus formation is reduced.

Post-operative Treatment.—After any of the above operations, nine months' sanatorium and antibiotic therapy should be regarded as a minimum.

This to be followed by at least eighteen months' continuance of antibiotic therapy as an out-patient.

Hydronephrosis of a sole existing kidney (due to tuberculous cicatricial contracture of the bladder around the lower end of the ureter) is a rather frequent and dangerous complication of renal tuberculosis. If uræmia is to be prevented, the ureter must be divided and implanted into the fundus of the bladder, if that procedure is feasible; in other circumstances it has been implanted with amelioration of symptoms into an artificially constructed bladder pouch (see p. 832). The latter operation is called for also in cases of intractable tuberculous cystitis and 'thimble' bladder (see p. 816).

Bilateral inoperable renal tuberculosis should be treated by at least two years of sanatorium and antibiotic treatment.

Prognosis in renal tuberculosis has improved since the advent of sanatorium and antibiotic treatment. In spite of such measures, 15 per cent. of those apparently cured develop a contralateral lesion within two years. Long-term statistics show that the ultimate prognosis is better in women (90 per cent. living) than in men (72 per cent.) (E. Ljunggren).

ABACTERIAL PYURIA

That sterile pyuria indicates urinary tuberculosis is almost axiomatic. Nevertheless, a small group of cases of abacterial pyuria is definitely non-tuberculous. The symptoms simulate renal tuberculosis very closely, and it is only when repeated examinations of the urine, and in the male the seminal fluid, fail to reveal *micrococcus tuberculosis* or other bacteria, and cultures and guinea-pig inoculations are negative, that the diagnosis can be made. Pyelography occasionally shows slight dilatation of the renal pelvis and ureter of one or both sides; more usually this examination is negative. Cystoscopy reveals a severe cystitis and often diminished bladder capacity. Occasionally amœbiasis is responsible.

Treatment.—Aureomycin usually cures the condition in three days. In cases resistant to this treatment 0.3 G. of neoarsphenamine intravenously weekly for four weeks is often successful. In rare instances, when amœbiasis is responsible, treatment with emetine hydrochloride is likely to eradicate the infection.



FIG. 1025.—Angioma of the kidney. The kidney was excised for profuse painless hæmaturia.

NEOPLASMS OF THE KIDNEY

Benign Neoplasms

Adenoma.—Pea-like cortical adenomata are sometimes found at necropsy. They give rise to no symptoms during life, and are of academic interest only.

Angioma is usually of the venous type, and may give rise to profuse hæmaturia. Fig. 1025 shows a kidney containing a venous hæmangioma. The patient, who was a woman of thirty-five, had attacks of painless hæmaturia extending over five years.

Truly benign tumours of the kidney are so rare that a good rule is *all neoplasms of the kidney which can be recognised clinically should be considered malignant and treated as such.*

Hans Wildbolz, 1873–1940, Professor of Urology, Berne, first described abacterial pyuria.
Einar Ljunggren, *Contemporary*. Professor of Surgery, Göteborg, Sweden.

MALIGNANT NEOPLASMS

Clinically neoplasms of the kidney are divided into two classes :

Those occurring in children between the ages of one and seven.

Those occurring in adults after the age of forty.

Between the ages of seven and forty malignant neoplasms of the kidney are most unusual.

THOSE OCCURRING IN CHILDREN

Wilms's tumour (*syn.* nephroblastoma) is a mixed tumour containing epithelial and connective tissue elements arising from embryonic nephrogenic tissue, situated originally in one or other poles of the kidney. In early infancy such tumours are very occasionally bilateral. Far more common is a unilateral tumour. As shown by fig. 1026, the time of predilection for the appearance of a Wilms's tumour is during the first four years of life.

Exceptionally a tumour appearing in adult life is proved by histological examination to be a Wilms's tumour.

Pathology.—*Macroscopically.*—On section the neoplasm is a greyish-white or pinkish-white colour; its consistence varies with the rapidity of the growth.

Microscopically it is composed mainly of two types of cells—epithelial and connective-tissue. Cartilage, bone, and smooth or striped muscle fibres are occasional findings. The epithelial and connective-tissue cells exist side by side, but one type is usually predominant. Thus the tumour is composed of mixed cellular elements, some of which are radio-sensitive and some radio-resistant. Consequently, the radio-resistant elements show an unabated continuance of activity in spite of radiotherapy.

Clinical Features :

Abdominal Tumour.—The symptomatology is always the same. An abdominal tumour (fig. 1027) appears and progresses rapidly, while the general health deteriorates. Examination of the abdomen reveals a mass which may be enormous; the bulk of the tumour is on one side of the abdomen. Wilms's tumour tends to grow within a capsule, pushing the rest of the kidney aside; thus the reniform shape of the kidney is lost early.

Pyrexia.—Half these patients have some elevation of temperature, which will disappear when the tumour is removed.

Hæmaturia when it occurs (25 per cent.), occurs late and is a sign of ill omen. It denotes that the previously encapsulated tumour has burst into the renal pelvis, and all patients suffering from a Wilms's tumour with this sign die within nine months (L. Stuart Scott).

Pyelography shows gross deformity of certain of the calyces.

Metastases.—Wilms's tumour metastasises early, mainly by the blood-

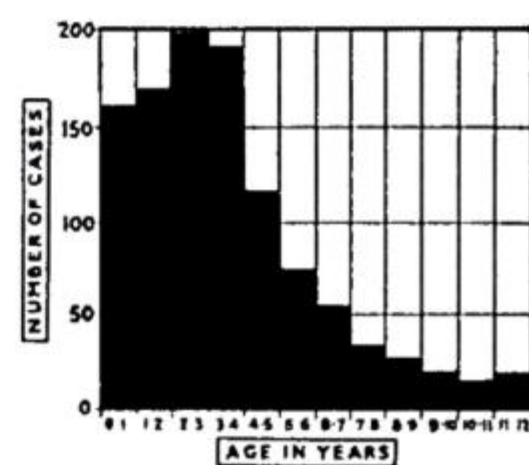


FIG. 1026.—Age incidence of 1,000 published cases of Wilms's tumour. (After L. Stuart Scott.)



FIG. 1027.—Wilms's tumour.

stream to the lungs, less commonly to the liver, rarely to bones, and exceptionally to the brain. Lymphogenous dissemination is much less common.

Differential Diagnosis.—From a practical standpoint there is but one swelling with which Wilms's tumour can be confused, and that is a retro-peritoneal neuroblastoma, but as the treatment is precisely the same such differentiation resolves itself into an academic exercise. However, if radiography reveals bone metastases, this distinctly favours a neuroblastoma. In passing, it must be stressed that although these abdominal tumours arouse considerable diagnostic interest, for fear of accelerating dissemination, multiple examinations by, for instance, a class of students, must be forbidden.

Operative Treatment.—The earlier nephrectomy can be carried out, the better. Only if the tumour is too large to be removed without undue shock should preliminary X-ray therapy be given—for while admittedly the size of the tumour is reduced by irradiation, in many instances this is more than counterbalanced by a delay of over a month while such treatment is given. In performing the operation the abdominal (or abdomino-thoracic) route is chosen, and what is so salient is that the renal pedicle should be ligated as a first step with as little disturbance to the mass as possible.

Post-operative Treatment.—Nitrogen mustard can be given intravenously during the immediate post-operative period in a dosage of 0.4 to 0.8 mg. per Kg. of body weight followed in two or three weeks by radiotherapy to the side operated upon.

Prognosis.—The operative mortality is about 15 per cent. In spite of nitrogen-mustard therapy and irradiation, metastases prove fatal within two years in about 70 per cent. of cases. The main hope lies in earlier diagnosis.

Inoperable Cases.—Provided the patient's general condition is even moderately good nitrogen mustard and radiotherapy should certainly be given.

Although it is a forlorn hope, occasionally the tumour has disappeared and the patient has survived for five or more years.

THOSE OCCURRING IN ADULTS

I. **Grawitz tumour** (*syn.* adenocarcinoma; hypernephroma) is the commonest neoplasm of the kidney (75 per cent.). It arises in the cortex, possibly from a pre-existing adenoma, probably *per primam* in cells of the uriniferous tubules.

Pathology.—A tumour of moderate size is spherical in shape, and it often occupies one or other pole, the seat of election being the upper pole; less often it is in the central portion of the kidney. On section



FIG. 1028.—Adenocarcinoma of the kidney.

shape, and it often occupies one or other pole, the seat of election being the upper pole; less often it is in the central portion of the kidney. On section

Paul Grawitz, 1850-1932. Professor of Pathology, Greifswald, Germany.

it is characteristically yellow (due to lipoid); less often it is dull white, or semi-transparent. Hæmorrhagic areas are often seen. The tumour is divided into numerous lobules by fibrous septa (fig. 1028). The larger the tumour the more extensive is central hæmorrhage and necrosis.

Microscopical Structure.—The most common appearance is solid alveoli of cubical or polyhedral clear cells, with deeply stained small rounded nuclei and abundant cytoplasm containing lipoids, cholesterol, and glycogen. The cells may also be arranged in the form of papillary cysts or tubules. In a much smaller percentage the cells are granular (dark). Clear and dark cells can co-exist in different parts of the same tumour. In all cases the stroma is scanty but rich in large blood-vessels, the walls of which often appear, in places, to consist of tumour cells.

Spread.—As the tumour enlarges, it encroaches upon a group of calyces and is prone to grow into the renal veins. Pieces of growth becoming detached are swept into the circulation, to become arrested particularly in the lungs and bones (fig. 1029). Occasionally, when a secondary growth appears in a long bone, it remains the only metastasis for a long time—sometimes a year or more.

While spread by the blood-stream predominates, spread by lymphatics occurs also, in some cases before the former. If the tumour bursts through the renal capsule into

the perirenal tissues, it then metastasises to the lymph nodes in relation to the hilum of the kidney, and from there to the para-aortic and other lymph nodes.

Clinical Features.—Men are more often attacked than women, the ratio being 2 : 1. Typically the first sign is painless, profuse, intermittent hæmaturia. Clot colic may follow. Pain in the loin is sometimes a leading symptom. Occasionally the first manifestation is a palpable renal swelling. In the male over thirty-five years of age a rapidly oncoming varicocele is a suspicious, but rare, sign of a malignant tumour of the kidney.

Atypical Cases.—(a) In no less than 25 per cent. of cases the primary growth remains 'silent,' the patient presenting because of some manifestation of secondary deposits such as a painful enlargement of a bone (fig. 1030), a spontaneous fracture, persistent cough, or hæmoptysis. In other words, with the exception of a



FIG. 1030.—Radiograph showing metastases from a Grawitz tumour.

few cases of bone metastases, one-quarter of all cases are inoperable by the time they reach the surgeon.

(b) There is a type in which persistent pyrexia (100° to 102° F. (37.8° to 38.9° C.)) is the only symptom, there being no infection to account for the

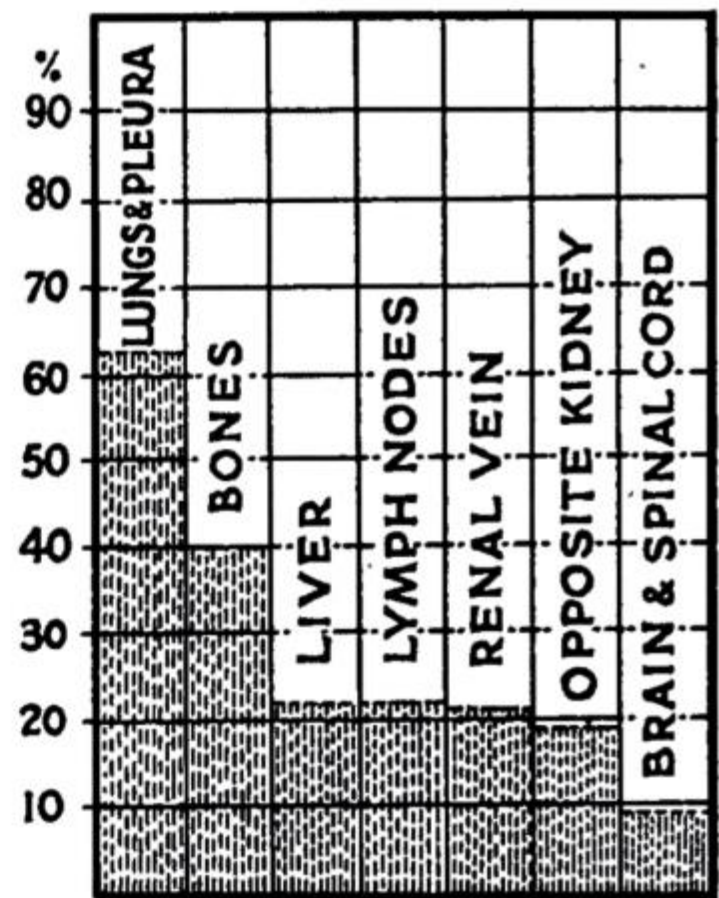


FIG. 1029.—Sites of metastases from neoplasms of the kidney. (N. A. Harvey's statistics.)

temperature. Such pyrexia usually disappears after nephrectomy: should it persist metastases are present.

(c) In a small group of cases the patient presents on account of lassitude and is found to be extremely anæmic, the anæmia being out of proportion to that which could be expected from the hæmaturia, if such be present.

Differential Diagnosis.—(a) Hæmorrhage into a hydronephrosis, (b) congenital cystic kidney with hæmaturia, or (c) a solitary cyst of the kidney can simulate a renal neoplasm to a point of nicety.

Early Diagnosis.—By the time a patient has the classical triad of symptoms, viz. hæmaturia, pain, and a palpable renal tumour, he nearly always has metastases. It is therefore of paramount importance to endeavour to make an early diagnosis and any one of these symptoms calls for a thorough renal investigation. Patients with painless hæmaturia, or hæmaturia not accompanied by symptoms of acute cystitis, should be examined cystoscopically while the bleeding is in progress. If blood is seen issuing from one ureteric orifice, and there is a clear efflux from the other, the information gained is of considerable importance, but is by no means conclusive evidence of a renal neoplasm. Extremely suggestive is bleeding occurring from a palpable kidney. When blood is not seen issuing from a ureter, but an enlarged middle lobe of the prostate or a papilloma of the bladder is discovered, it is of paramount importance not to jump to a conclusion that the source of the hæmorrhage has been found. Investigation must proceed until each kidney has been proved satisfactorily to be culpable or not culpable.

Pyelography.—The early diagnosis rests almost entirely on pyelography.

Excretory pyelography is seldom conclusive in early cases, because of lack of precise definition, and in late cases because there is poor or absent concentration of the medium, but at all times it is of great value in determining the function of the contralateral kidney.



FIG. 1031.—Retrograde pyelogram in a case of a Grawitz tumour of the left kidney. The only symptom was one attack of painless hæmaturia.

Retrograde pyelography is often required because of the better delineation it affords. The principal pyelographic changes that occur when a kidney is the seat of an adenocarcinoma are:

(a) Filling defects due to invasion of one or more of the minor or major calyces. Very characteristic is failure of the medium to enter one major calyx.

(b) Elongation and compression of one or more calyces and sometimes of the renal pelvis. This gives rise to what is known as the 'spider-leg' deformity (fig. 1031). In congenital cystic kidneys the 'spider legs' are broader, more clearly cut, and involve most if not all the calyces; moreover, the condition is bilateral.

(c) Displacement of the renal pelvis and the distorted calyces downwards

in growths occupying the upper pole. Growths of the lower pole often displace the ureter inwards.

(d) In advanced cases (which may give no shadow on excretory pyelography) the interior of the calyces and renal pelvis are so encroached upon that they are represented by a few, irregular, widely separated, medium-filled opacities.

Radiograph of the thorax should always be taken before deciding as to what is the right course of treatment. It is not rare for a hitherto unsuspected metastasis or metastases in a lung to be revealed in this way.

Treatment.—In cases without metastases the treatment is nephrectomy with removal of the perinephric fat.

The incision is a matter of personal preference, the objective being to gain wide exposure of the enlarged kidney and especially of its pedicle. The abdominal approach so excellent in children is not always facile in elderly subjects with a rigid thoracic wall. The lumbar incision with a thoracic 'trap-door' (see p. 783) meets almost every requirement, though when the diaphragm is much raised by upward pressure of the tumour some choose a thoraco-abdominal incision.

Preliminary Division of the Renal Pedicle.—The highest aim should be to deal with the renal pedicle before manipulating the kidney, otherwise blood-borne metastases are highly probable as a direct result of the operation. Before undertaking ligation and division of the renal pedicle the renal vein should be palpated delicately between the finger and thumb for a tumour-thrombus which if present calls for opening the vein and extracting the thrombus. Similarly, should thrombus be seen within the severed renal vein, while the assistant compresses the inferior vena cava, the ligature should be cut in the hope that the tongue of tumour will be swept out in the hæmorrhage that ensues, or that it can be picked out before reclosing the vein.

In other respects the details of the operation do not differ from those described on p. 784.

Radiotherapy :

Pre-operative irradiation sometimes renders a large tumour smaller but, because of the uncertainty and the delay in operation entailed, pre-operative irradiation is not advised.

Post-operative irradiation has been proved statistically to be of value.

In inoperable cases radiotherapy should be given. Deep X-ray therapy often results in dramatic regression of a metastasis, but too often the improvement is only temporary and there follow other metastases that are less radio-sensitive.

Prognosis.—Even some of the largest neoplasms have been followed by a permanent cure. In operable cases 44 per cent. of the patients are alive and well after three years, and 30 per cent. after five years.

Grawitz Tumour with a Solitary Metastasis.—A number of patients with a solitary metastasis in a long bone have been treated with varying success by wide local excision and bone graft, or by amputation in addition to nephrectomy. In not a few the neoplasm of the bone has received prior treatment in the belief that it was a primary bone tumour, the true nature of the growth being revealed by the pathological examination.

On several occasions a solitary metastasis in the lung has been removed by lobectomy, and in a few instances a metastasis has been excised from other situations. These enterprising endeavours have not met with lasting success—but freedom from symptoms for up to two years has been obtained.

2. **Papilloma of the renal pelvis** is similar in structure to papilloma of the bladder. It tends to invade the kidney proper, and to take on malignant characteristics. It also spreads down the ureter and may invade the bladder. Papillomatous growths of the renal pelvis constitute 9 per cent. of renal neoplasms.

Clinical Features.—Hæmaturia is often continued for months at a time. A renal swelling is absent, except in rare cases where the pelvi-ureteric junction becomes occluded and a hæmonephrosis results, in which event there is lumbar pain. Occasionally renal colic occurs from blood-clot passing down the ureter.



FIG. 1032.—Pyelograph showing a papilloma of the right renal pelvis. (Professor Carl Krebs, Aarhus, Denmark.)

Pyelography reveals a characteristic filling defect of the renal pelvis (fig. 1032).

Treatment.—Nephrectomy *with extended ureterectomy* is the correct treatment. The intramural portion of the ureter along with the ureteric orifice must be excised in continuity. This is accomplished by sleeve resection of the bladder wall in the immediate vicinity of the structures in question.

3. **Squamous-celled carcinoma of the renal pelvis** is the least common variety of malignant disease of the kidney. In some instances it appears to be preceded by leukoplakia and in 30 per cent. of cases a stone or stones are present, usually in the renal pelvis.

Unless the stone gives rise to symptoms, this is the most elusive of all renal neoplasms for it causes to indefinite abdominal pain which finally becomes localised in the region of the involved kidney. Hæmaturia is either only to be found on microscopical examination of the urine, or is slight. Excretory pyelography shows a kidney excreting little or no medium. Retrograde pyelography sometimes reveals a deformed renal pelvis. Owing to diagnostic difficulties, by the time nephrectomy is performed there are widespread metastases that are radio-resistant. This neoplasm has the worst prognosis of any renal neoplasm.

Primary neoplasms of the ureter are rare. Like those of the renal pelvis, they can be papillomata, papillary carcinoma, or squamous-celled carcinoma. The symptoms are identical with those of a neoplasm of the renal pelvis, although hydro-nephrosis, hæmonephrosis, and pyonephrosis are more frequent accompaniments. Occasionally a portion of a papillomatous growth can be seen protruding from a ureteric orifice. Usually the diagnosis is made by pyelography.

For a localised tumour the treatment is wide resection of that part of the ureter containing the tumour, followed by bridging the gap by means of an isolated segment of ilium, viz. —————→

In the case of papillomata of the ureter, and other diffuse neoplasms, nephro-ureterectomy, including that segment of the bladder containing the intramural portion of the ureter, is required. On the whole, the prognosis of tumours of the ureter is very poor, largely on account of late diagnosis.



EXPOSURE OF THE KIDNEY

The kidney lies in a deep recess beneath the rigid bulwarks of the thoracic cage and, having regard to the possibility of a short renal pedicle, no one incision will meet all requirements.

A lumbar approach is usually employed, with the possible exception that some other route may be preferable for nephrectomy in the case of large neoplasms.

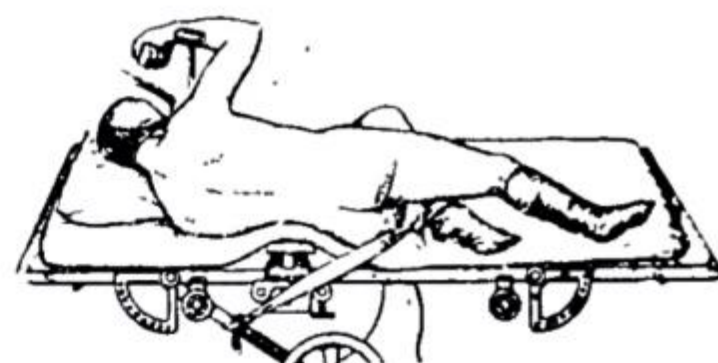


FIG. 1033.—Position on the operating table for exposure of the kidney by Morris incision.

The Oblique Lumbar Incision (Morris).—The patient is placed in the lateral 'kidney' position (fig. 1033). The incision commences $\frac{1}{2}$ inch (1.25 cm.) below and $\frac{1}{2}$ inch lateral to the angle made by the twelfth rib with the outer border of the sacrospinalis, and it passes downwards and outwards towards the anterior superior iliac spine (fig. 1034). Within the limits of the incision, all muscular layers are incised until the extraperitoneal fat is reached. This incision is effective, but it gives rise to more bleeding, and is more liable to be followed by post-operative hernia than :

Mayo's Incision.—The patient lies prone, with the arms above the head. The bridge of the operating table is raised so that the loins are thrown into prominence. The incision commences over the centre of the sacrospinalis at the level of the upper border of the twelfth rib, and passes directly downwards to the tip of the third lumbar spinous process, where it curves outwards to form a \perp (fig. 1035).



FIG. 1034.—Morris's incision.



FIG. 1035.—Mayo's incision.



FIG. 1036.—Nagamatsu's incision.

1. The sacrospinalis sheath is incised vertically, and the erector spinæ 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.

5. The perirenal fascia of Zuckerkandl is incised, and the perirenal fat is cleared by blunt dissection from the capsule of the kidney. During these manipulations the twelfth dorsal nerve is preserved carefully.

If more room is required, ligaments uniting the twelfth rib to its vertebra are severed, and the twelfth rib is dislocated upwards. If still more room is needed, the twelfth rib is excised subperiosteally.

Nagamatsu's Incision.—The position on the operating table is that shown in fig. 1036. The incision has a dorsal and a lumbar component.

The dorsal component commences just above the superior border of the twelfth rib. From this point it is carried upwards parallel to the lateral border of the sacrospinalis to end in the tenth interspace. The latissimus dorsi and serratus magnus muscles are divided in the length of the incision and short segments of the eleventh and twelfth ribs are resected medial to their angles.

The lumbar component is a continuation of the dorsal incision and in all respects is similar to Morris's incision. It extends to the lateral margin of the rectus abdominis.

Sir Henry Morris, 1844–1926. Surgeon, Middlesex Hospital, London.
 William J. Mayo, 1861–1939. Surgeon, Mayo Clinic, Rochester, U.S.A.
 Emil Zuckerkandl, 1849–1910. Professor of Anatomy, Vienna.
 George Rio Nagamatsu, Contemporary. Surgeon, Flower and Fifth Avenue Hospitals, New York.

To free the flap for upward retraction the costo-vertebral ligament is divided; this exposes the posterior attachment of the diaphragm to the quadratus lumborum muscle. By severing this attachment below the pleural reflection, the diaphragm and the pleura attached to it can be freed and retracted upwards. Thus the entire retroperitoneal space on the side of the lesion and the medial quarter of the retroperitoneal space of the opposite side are completely accessible.

The operation is a set one, and attempts to convert a Morris incision which is found to be inadequate will, in all probability, prove unsatisfactory.

Lumbar Nephrectomy.—The renal pedicle is cleared of fat so as to display its vascular components. After isolating the ureter it is divided between hæmostats with a diathermy knife, as far from the kidney as possible; its distal end is ligated. Commencing inferiorly, a portion of the vascular pedicle is caught in a long hæmostat, care being taken to avoid the renal pelvis. A short hæmostat is placed in juxtaposition nearer to the kidney, and the tissue between the hæmostats is divided. The process is repeated until all the pedicle has been severed, thus freeing the kidney. At the most, three such sectionings are required. The disconnected kidney, with the short hæmostats attached to its vessels and a long hæmostat attached to the ureteric stump is dropped into a bowl which is removed from the immediate vicinity.

Each moiety of the renal pedicle is ligated by transfixion, which makes slipping impossible. Only when it is certain that hæmostasis is complete are the ends of the ligatures cut, and the wound closed, with drainage if thought necessary.

Subcapsular Nephrectomy.—When the kidney is densely adherent to surrounding structures, the possibility of injuring the duodenum, colon, spleen, adrenal gland, or the pleura is greatly reduced by employing the subcapsular operation. An incision is made through the renal capsule along its convex border, and the capsule is separated from the parenchyma by blunt dissection. After freeing the capsule 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 the manner described above. When the pedicle is short and inaccessible, instead of attempting to ligate it, the hæmostats can be left attached to it for four days, and then removed surprisingly uneventfully. Exceptionally, it is necessary to excise a kidney by morcellement, hæmorrhage being controlled by oxycel or sterispon (gelfoam).

Partial Nephrectomy (Semb).—Very wide lumbar exposure such as that afforded by Nagamatsu's incision is most desirable. Manual compression of the kidney substance or the renal pedicle for ten minutes at a time is not harmful and will control bleeding adequately. A cuff of the capsule is turned down or up as the case may be. The blood vessels supplying the part to be resected are ligated outside the kidney if they are small and do not interfere with the branches supplying the remainder of the kidney. A transverse incision in the anterior wall of the kidney (fig. 1037 A) gains excellent access to the interior. The calyx of the part to be resected is isolated mainly by blunt dissection (fig. 1037 B). This accomplished the calyx is severed and its proximal end is closed with a double 0000 catgut suture. The stump is

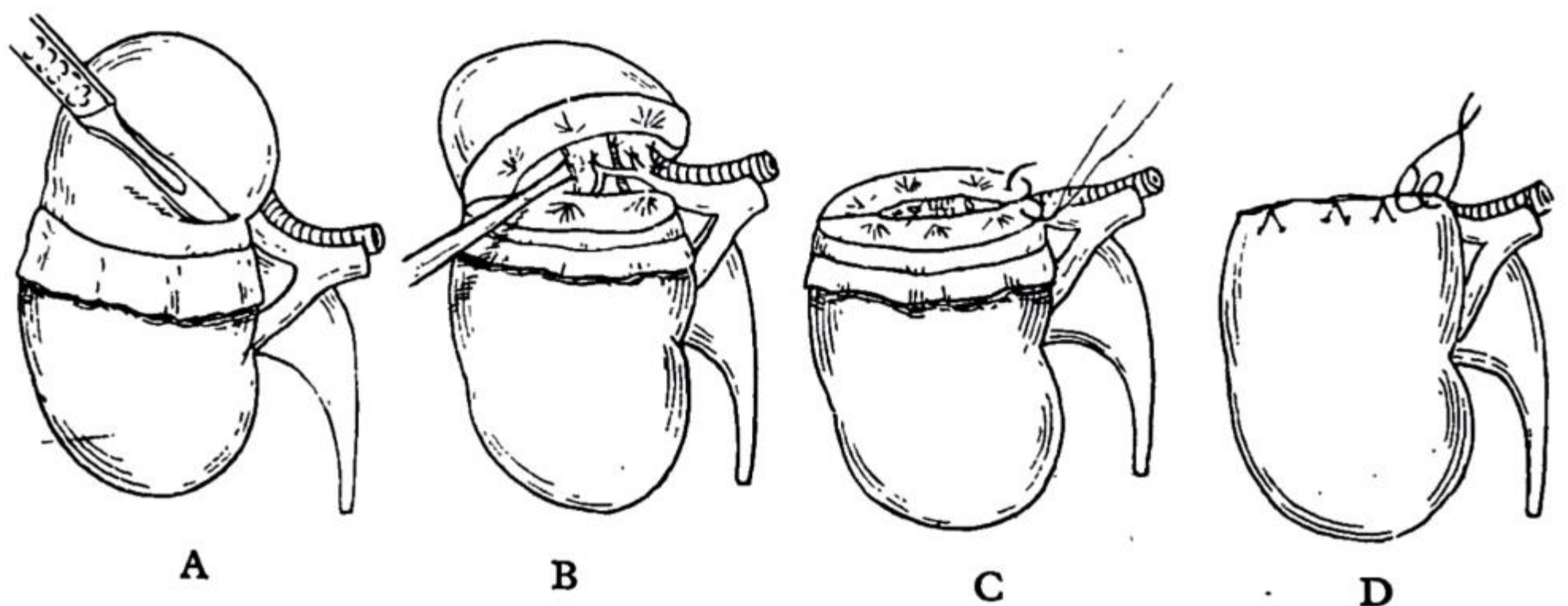


FIG. 1037.—(A) Incising the anterior wall of the kidney; capsule turned back.
 (B) Isolating the trunk of the affected calyx.
 (C) Closing the renal parenchyma.
 (D) Approximating sutures over the flap of capsule which has been returned to cover the stump. (After C. Semb.)

allowed to drop back and it is covered with a piece of perirenal fat. If necessary a piece of the renal pelvis is resected and the proximal end closed as in the Anderson-Hynes operation (see p. 744). The parenchyma is closed (fig. 1037 C) by interrupted double X sutures. The substance of the pyramids holds stitches well, that of the parenchyma proper tends to cut out. Therefore, as far as possible, stitches are avoided here until the cuff of capsule has been brought over the suture line. Excess of capsule is rolled to form a buffer: parenchyma stitches tied against this (fig. 1037 D) hold well. The bedwarped kidney is replaced and the wound is closed with drainage. Leakage of urine through the tube is exceptional.

Transabdominal nephrectomy is sometimes employed for the removal of a large renal swelling. A sandbag placed under the affected loin helps to keep hollow viscera from the field of operation. On no account should the route be employed if there is any question of the lesion being infected. The incision is a T-shaped one. A long upper paramedian incision is made, and at the level of the umbilicus a transverse extension is carried through the rectus muscle and the muscles of the lateral abdominal wall. After the peritoneal cavity has been opened, a longitudinal incision is made through the peritoneum of the posterior abdominal wall lateral to the colon, and the colon, with its mesocolon intact, is displaced towards the middle line by gauze dissection, thus displaying the perirenal fat. On the right side the duodenum is also mobilised. When necessary the renal vessels can be ligated close to the aorta and inferior vena cava before the kidney is handled.

CHAPTER XXXIII

THE URINARY BLADDER

HAMILTON BAILEY

Surgical Anatomy.—Possessing an anterior, superior and posterior surface (fig. 1038) and being lined by transitional epithelium, the average bladder is capable of holding approximately between 400 and 500 ml. of urine without over-distension.

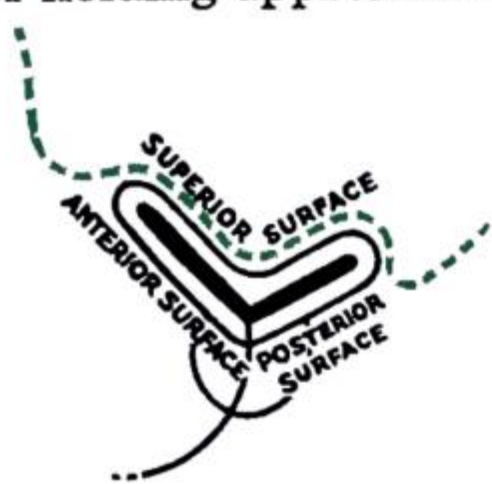


FIG. 1038.—The shape of the bladder when empty. (After F. H. Gerrish.)

The greater part of the thickness of the bladder wall is made up of a muscular coat of unstriated muscles, known as the **detrusor muscle**, the fibres of which are arranged in three more or less distinct strata.

The *internal layer* is thin, and its fasciculi have a reticular¹ arrangement.

The *middle layer* is thicker than the others, and consists of densely interlaced fasciculi running mainly in a circular direction. When hypertrophy of the musculature of the bladder occurs it is the fasciculi of this layer that stand out and give rise to the characteristic trabeculation of the bladder wall (see fig. 1109, p. 836). While this layer is virtually absent within the limits of the trigone, its fibres are so well marked below that structure as to warrant their being accorded the

dignity of the term **sphincter vesicæ**. The **trigonal muscle** is a separate entity derived from a prolongation of the longitudinal layer of each ureter. In the trigone the muscular strands from each side decussate, and eventually are inserted into the wall of the posterior urethra.

The *external layer* is composed mainly of longitudinal fibres. Some of the fibres of this layer are prolonged in the pubo-prostatic ligaments, to be inserted into the pubic bone on either side of the middle line.

Supports of the Bladder.—The bladder, while being tolerably movable, is tethered in various ways. By convention, several parts of the related pelvic fascia are described as **true ligaments of the bladder**. One of these is the rectovesical portion of the pelvic fascia, which is an important means of fixation of the bladder posteriorly. At the base of the bladder this fascia is united closely to the muscular tunic, but it thins out rapidly as it is reflected upwards. The two lateral true ligaments of the bladder are indistinct, and unworthy of description, but the anterior ligaments, or **pubo-prostatic ligaments**, are well defined, and are of great surgical importance. Each stretches from the front of the prostate and adjacent portion of the bladder to the lower part of the periosteum of the pubis.

The urachus and obliterated hypogastric arteries, together with the folds of peritoneum overlying these structures, help to moor the bladder, and are called the **false (median and lateral umbilical) ligaments of the bladder**, as also does condensation of fascia around the blood-vessels passing to the bladder (fig. 1039), known as the **superior and inferior vascular pedicles**.

Arteries.—The two main arteries of the bladder are the superior and inferior vesical arteries (fig. 1040), both of which are derived from the anterior trunk of the internal iliac artery. The obliterated hypogastric artery, which became thrombosed within a few days after birth, is a



FIG. 1039.—Coronal section through the lower third of the bladder of a male, showing the inferior vascular pedicles.

¹ Reticular (Lat. *reticularis*) = resembling a net.

continuation of the superior vesical artery. Smaller arterial branches from the obturator and inferior gluteal artery, and in the female from the uterine and vaginal arteries, also help to nourish the bladder.

Veins form a complicated plexus on the antero-inferior surface of the bladder; in the male the prostatic plexus (see fig. 1106, p. 834) is continuous with the vesical plexus, which drains into the internal iliac vein.

Lymphatics accompany the veins, and drain into the nodes along the internal iliac vessels. Some of the lymphatics from the fundus of the bladder pass to nodes situated at the promontory of the sacrum.

Physiology.—Micturition is partly a reflex and partly a voluntary act. The nerves concerned in the act of micturition are:

The sympathetic fibres, which arise in segments twelfth dorsal to third lumbar. These fibres pass *via* the presacral nerve and the sacral sympathetic chains to the inferior hypogastric plexus, and thence to the bladder.

The parasympathetic innervation, which is derived from the anterior primary divisions of the second, third and fourth sacral segments. These fibres pass through the pelvic splanchnic nerves to the inferior hypogastric plexus, from which they are distributed to the bladder.

The somatic innervation also comes from the second, third and fourth sacral segments as the pudendal nerves, which pass not to the bladder itself, but to the sphincter urethræ (striated muscle).

While the sympathetic nerves convey afferent painful stimuli of over-distension *from* the bladder to the brain, it is unlikely that either set of autonomic nerves convey *to* the bladder any cortical impulses, such impulses being transmitted via the pudendal nerves to the sphincter urethræ, relaxing the latter. At the same time stretching of the muscle fibres by the urine that has collected in the bladder initiates a reflex which is mediated

through the parasympathetic nerves, and the detrusor muscle contracts. The neuro-genic theory, then, ascribes the act of micturition to a stretch reflex which, if the time or place are not propitious, can be inhibited by cerebral control (fig. 1041).

ECTOPIA VESICÆ (syn. EXSTROPHY OF THE BLADDER)

There is an absence of the lower abdominal wall and of the anterior wall of the bladder.

Ætiology.—The embryological origin of ectopia vesicæ is not completely understood. The condition has been attributed to forward displacement of the cloacal membrane, preventing closure of that part of the anterior abdominal wall lying between the umbilicus and the genital tubercle. Another explanation is that the deformity is the result of rupture of the bladder *in utero*, due to atresia of the urethra.

Clinical Features.—Ectopia vesicæ occurs once in 50,000 births, and may be complete or incomplete. In the more common complete variety, because of the pressure of the viscera behind it, the deep-red posterior bladder wall protrudes through the defect (fig. 1042). If the exposed mucous membrane, which bleeds readily, is drawn gently upwards, the paler, wet trigone is

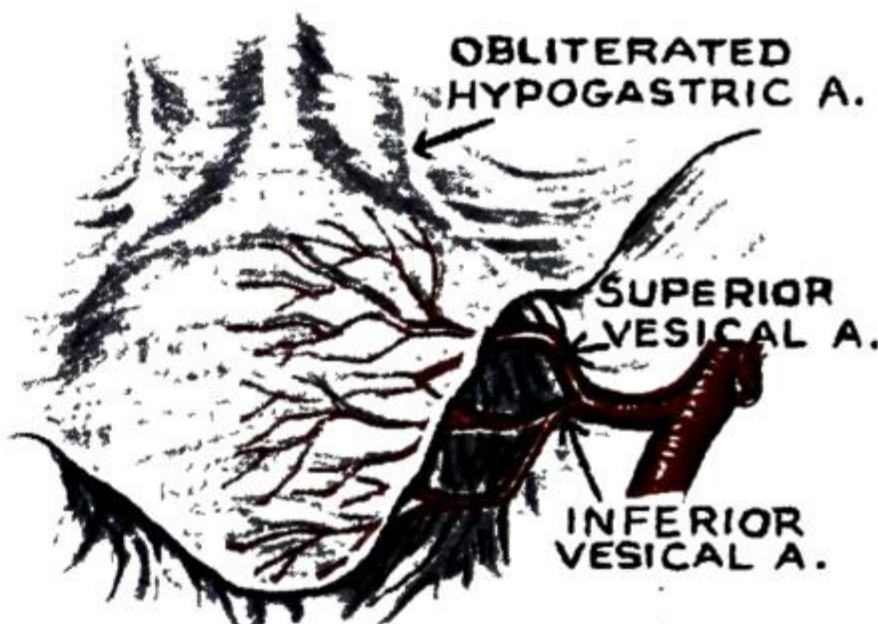


FIG. 1040.—The main arterial supply of the bladder as seen from the posterior aspect.

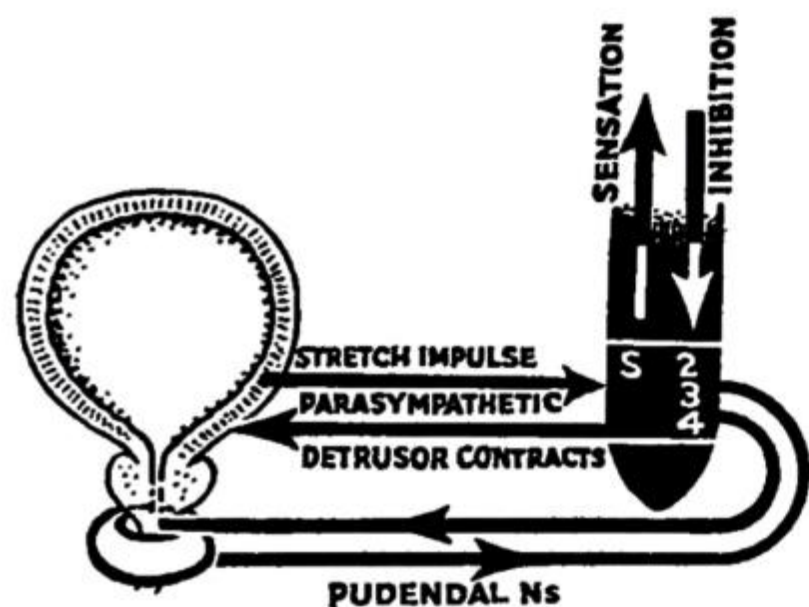


FIG. 1041.—The nervous control of the bladder. The sympathetic innervation has been omitted for the sake of simplification.

displayed, and effluxes of urine from the ureteric orifices can be seen. There is a well-defined line of demarcation between the protruding mucous membrane and the adjacent skin, and, especially after reducing the extruded bladder wall beneath the mucocutaneous junction, the firm edge of the hernial ring can be felt. Usually the umbilicus is absent. The sex ratio is about 5 males to 1 female. *In the male*, the completely epispadiac penis is broader and shorter than normal and not infrequently bilateral inguinal herniæ are present; the prostate and seminal vesicles are rudimentary or absent, whereas the testes are normal and descend more often than not. *In the female*, the clitoris is cleft and the labia minora are separated anteriorly,

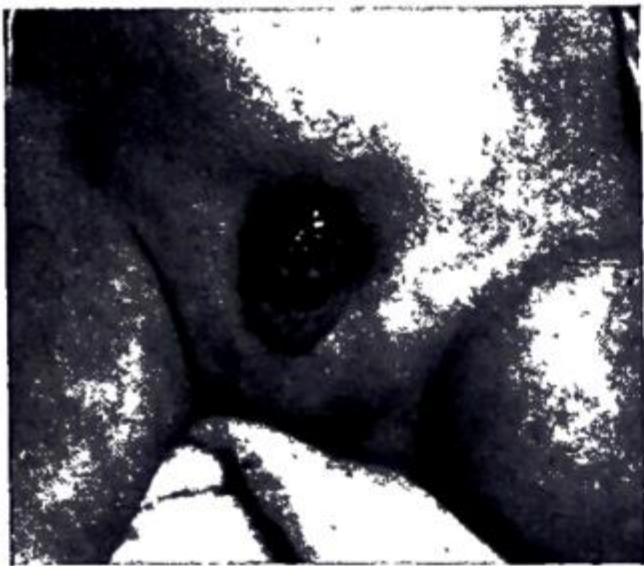


FIG. 1042.—Ectopia vesicæ in a male infant.



FIG. 1043.—Showing the separation of the pubes in a case of ectopia vesicæ. (The late Professor Grey Turner, London.)

exposing the vaginal orifice. In both sexes there is separation of the pubic bones (fig. 1043), which are connected by a strong ligament, and except for the fact that the patient has a waddling gait, this bony defect causes no disability; indeed, in those female sufferers who become pregnant, it facilitates delivery. The linea alba is as wide as the separation of the pubic bones. In the rare incomplete form the pubes are united and the external genitalia are more normal.

The lot of a patient with ectopia vesicæ is particularly unfortunate. A portable urinal seldom keeps him dry for long, and the odour of urine always accompanies him. Frequently the extroverted vesical mucous membrane becomes ulcerated and painful. It undergoes metaplastic changes, and sometimes becomes the seat of an adenocarcinoma. Attempts to prevent recurrent attacks of ascending pyelonephritis by chemotherapeutic and antibiotic agents are only partially successful; 50 per cent. of those afflicted die of renal failure before the age of thirty.

Ectopia vesicæ is often associated with other congenital abnormalities.

Treatment.—The following is the most usual, and until recently was the standard, method of treatment.

(a) *Implantation of the Ureters into the Bowel.*—The operation is undertaken between four and six years of age. One ureter can be transplanted at a time, three months intervening between the operations, or both transplantations are undertaken at the same operation.

(b) *Excision of the mucous membrane of the bladder* can be deferred for at least six months. It is accomplished by incising the mucocutaneous junc-

tion and peeling the mucous membrane off the muscle wall by gauze and, when necessary, sharp dissection. If neoplastic changes are present or threatened, the whole thickness of the bladder must be removed at a much earlier date.

(c) *Repair of the ventral hernia* is required in most cases. Often it can be accomplished satisfactorily with flaps taken from the rectus sheaths. At a later date this can be followed by :

(d) *Plastic reconstruction* of the mons veneris in the female, or in the male an operation to remedy the epispadias.

Uretero-intestinal Anastomosis.—The preparation of the colon is the same as that described on p. 549. The abdomen is opened by a right lower paramedian incision. The patient is then placed in the Trendelenburg position and the small intestine is packed away from the pelvis. The right ureter is sought as it crosses the common iliac artery just above its bifurcation. An incision is made through the overlying peritoneum in the line of the ureter, from the pelvic brim to near the bladder, and the ureter is identified and surrounded by a ring forceps. Suspended by the latter, the ureter is dissected from its bed towards its entry into the bladder, where a hæmostat is applied across it. The ureter is cut across proximal to the hæmostat, and its distal stump is ligated. The extremity of the mobilised portion of ureter is trimmed obliquely and one end of a chromic catgut suture furnished with an eyeless needle at each end is passed along the lumen for $\frac{1}{3}$ inch (8 mm.), and out of the wall, the suture being tied so lightly that it cannot strangulate any of the ureteric tissues (fig. 1044 inset). The prepared, mobilised ureter is wrapped in a swab and the cut edges of the parietal peritoneum are approximated. The left ureter is next isolated and divided on the left side of the pelvic colon, the mobilised proximal portion is then drawn into the peritoneal cavity through a small incision on the right side of the pelvic colon, after which it, too, is prepared for transplantation as was its fellow. The edges of the peritoneum having been approximated on the left side of the colon, suitable areas on the right anteromesial surface of the colon are selected for the transplantation of each ureter. They should enter the colon obliquely without tension or looping, the left lying $1\frac{1}{2}$ inches (3.75 cm.) higher than the right. The right ureter is transplanted first. A line $1\frac{1}{2}$ inches long, extending downwards and to the left side of the anterior longitudinal band, is demarcated by stay sutures, and put on the stretch. The peritoneal and muscular coats are incised, but not the mucous membrane. In order to expose an elliptical area of mucous membrane, the beak of a blunt hæmostat may have to be introduced into the submucosa, and its blades opened. Bleeding-points having been controlled, a tiny incision is made into the extreme lower end of the exposed mucous membrane. One needle of the ureteric suture, then the other, is passed into the lumen of the bowel and brought out by piercing its wall $\frac{1}{2}$ inch (1.25 cm.) lower down, the second needle emerging a $\frac{1}{4}$ inch lateral to the first (fig. 1044), so that when the suture is tied the end of the ureter is pulled into the lumen of the bowel and fixed against its inner wall. The incision in the outer coats of the bowel is approximated over the ureter. A second layer of sutures, commencing beyond the fixation stitch, buries the first line of sutures. When it has been ascertained that the ureter is not compressed by the stitches (if obstructed, the ureter is likely to distend above the last stitch), the long ends of the last stitch are brought through the edges of the

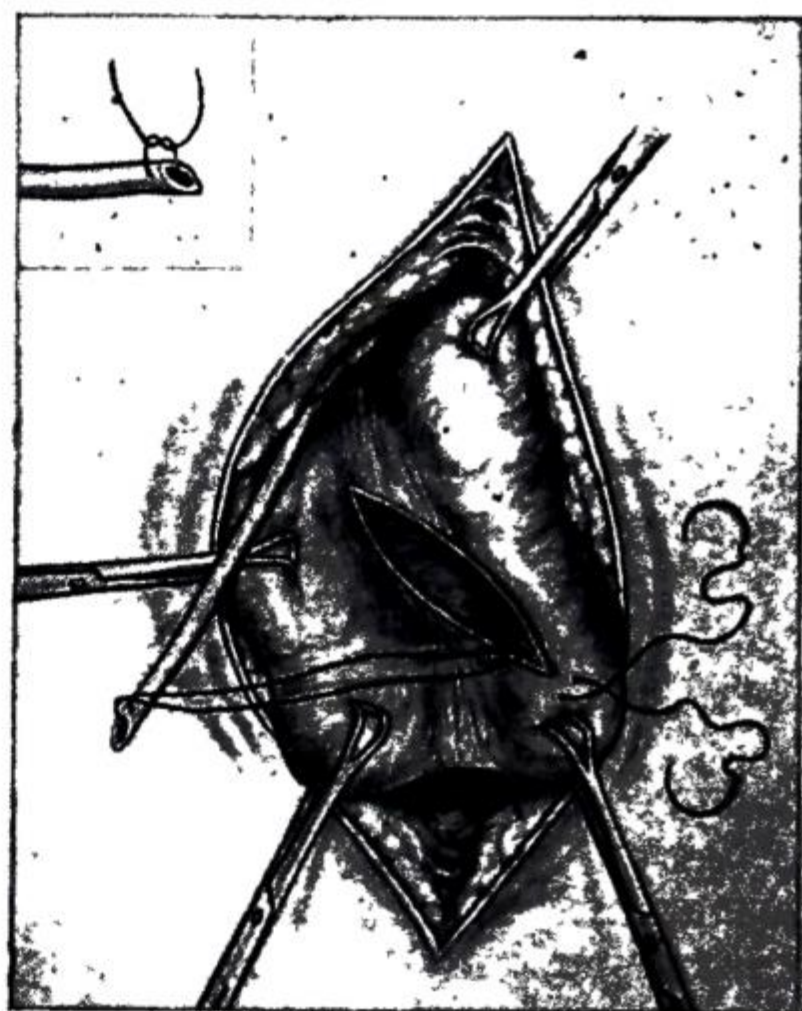


FIG. 1044.—Uretero-intestinal anastomosis. The suture being passed through the wall of the pelvic colon. Inset shows the method of attaching the suture to the cut end of the ureter.

incision in the parietal peritoneum; after this stitch has been tied the ureter has no intraperitoneal course. The left ureter is implanted in the same way, $1\frac{1}{2}$ inches (3.75 cm.) above the right. After the omentum has been laid over the field of operation, the patient is brought to the horizontal position and the wound is closed. A full-sized Foley's catheter is inserted through the anus no farther than the rectal ampulla, the balloon then being inflated. This permits all urine being measured until the third day, when the catheter is removed. There must be a full fluid intake, intravenously until the danger of meteorism has passed. If oliguria or anuria supervene, treatment is as described on p. 719.

Results.—Comparatively few (less than 100 reported) who have undergone successful uretero-sigmoidal implantation for ectopia vesicæ live for twenty years. The causes of the untimely demise are (1) stricture at the site of anastomosis and bilateral hydronephroses, (2) recurrent pyelonephritis and (3) hyperchloræmic acidosis (see p. 79). The avoidance of stenosis by employing the Reed Nesbit technique (see p. 832) is disastrous in the colon because of the increased risk of reflux (C. Wells). Little wonder, then, that efforts are being made to find a better solution to this problem.

Alternative Methods:

1. Lowsley's Operation.—Through a left lower paramedian incision the recto-sigmoid junction is divided completely and its lower end is closed. The ureters (or the trigone) are transplanted into the excluded lower segment, so that the rectum functions as a bladder. The sigmoid is mobilised for a sufficient distance to permit it being drawn through the perineum immediately anterior to the anus. Thus both the original anal canal and the new anal canal are encompassed by the external sphincter ani muscle (fig. 1045). The new canal is then drawn anteriorly beneath the skin of the perineum, to emerge through a small gap created by removing a disc of skin; here the cut edges of the sigmoid are united to the cut edges of the skin (fig. 1045). In this way the external sphincter encircles both the anus (outlet for the urine) and the sigmoid

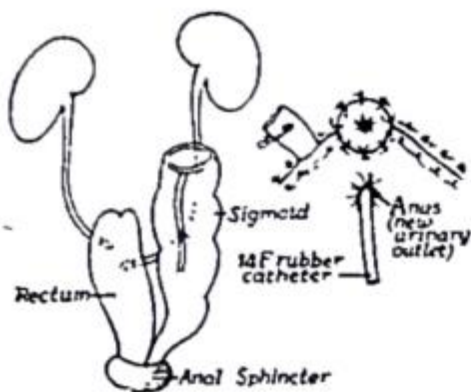


FIG. 1045.—Lowsley's operation for ectopia vesicæ.

stoma (outlet for the fæces), providing complete separation of the streams as well as voluntary control of fæces and urine.

2. Primary Plastic Repair of the Exstrophy.—There has been a revival in interest in primary plastic repair of the extroverted bladder, and a number of successful results have been reported recently. The operation should be undertaken during the first few weeks of life, because if it is delayed the exposed bladder fails to grow; in addition, mucosal pseudo-polyps form, making the bladder thicker and more difficult to invert (O. Swenson). Other surgeons wait until the infant is six months of age. In the past the great deterrent of plastic repair in this condition has been that the patient remained incontinent; in a number of instances, by modern technique, continence has been attained within two years of the operation, this being especially so in the case of females. The periphery of the bladder is freed (fig. 1046 A) just sufficiently to unite its freshened edges. The Denis Browne principle of operation (see p. 867) is also undertaken on the epispadiac urethra. At the same time some attempt is made to form an external sphincter by raising a strand of muscle and fascia from the superior margin of the incomplete triangular ligament (fig. 1046 B). The reconstructed bladder is then covered with imbricated flaps cut from the rectus sheath on either side.

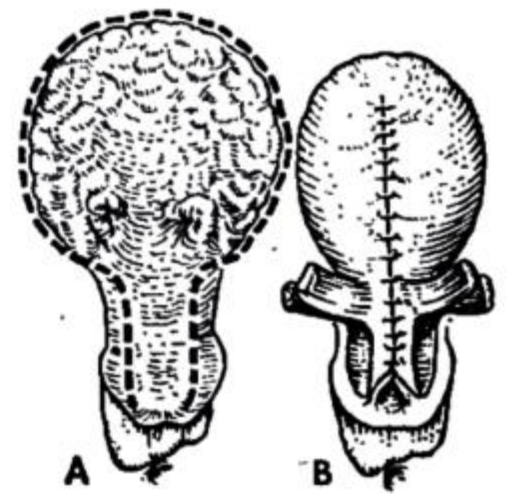


FIG. 1046.—Plastic reconstruction of ectopia vesicæ. (After J. K. Lattimer et al.)

It is probable that in the future plastic repair of the bladder in very early life will become the standard method of treatment, and that diversion of the urinary stream will be undertaken only in patients who remain incontinent.

Charles Alexander Wells, *Contemporary*. Professor of Surgery, Liverpool.
Oswald S. Lowsley, 1884–1955. Director, Department of Urology, James Buchanan Brady Foundation, New York Hospital, New York.
Orvar Swenson, *Contemporary*. Surgeon, The Floating Hospital for Infants and Children, Boston, Mass., U.S.A.

3. **Ileo-ureterostomy.**—In late untreated or failed cases of ectopia vesicæ in adults, after excising the exstrophic bladder, the construction of an ileal bladder (see p. 832) with implantation of the ureters into this man-made bladder, is the most suitable operation in the circumstances.

RUPTURE OF THE BLADDER < **Extraperitoneal 80 per cent.**
Intraperitoneal 20 per cent.

The past fifty years has witnessed a complete reversal in the ratio of intraperitoneal to extraperitoneal rupture of the bladder, brought about by (*a*) a reduction of intraperitoneal rupture due entirely to greater national sobriety (an inebriated person is likely to become embroiled in a quarrel, to have a full bladder and to tense his abdominal muscles late or not at all when he is about to receive a blow on the abdomen), and (*b*) by the increased frequency of traffic accidents and greater vehicular momentum, with their toll of fractured pelves.

Ruptured bladder is seventy times more common in males than in females. This remarkable discrepancy can be accounted for partly by the more commodious pelvis of the female.

A rare type of accident causing rupture of the bladder, peculiar to the female, is falling in a squatting position on to a projecting object, the anterior vaginal wall receiving the brunt of the violence.

Extraperitoneal Rupture.—Ten per cent. of fractured pelves are complicated by a ruptured bladder. A lateral crushing injury resulting in severe disruption of the architecture of the true pelvis and tearing of the bladder

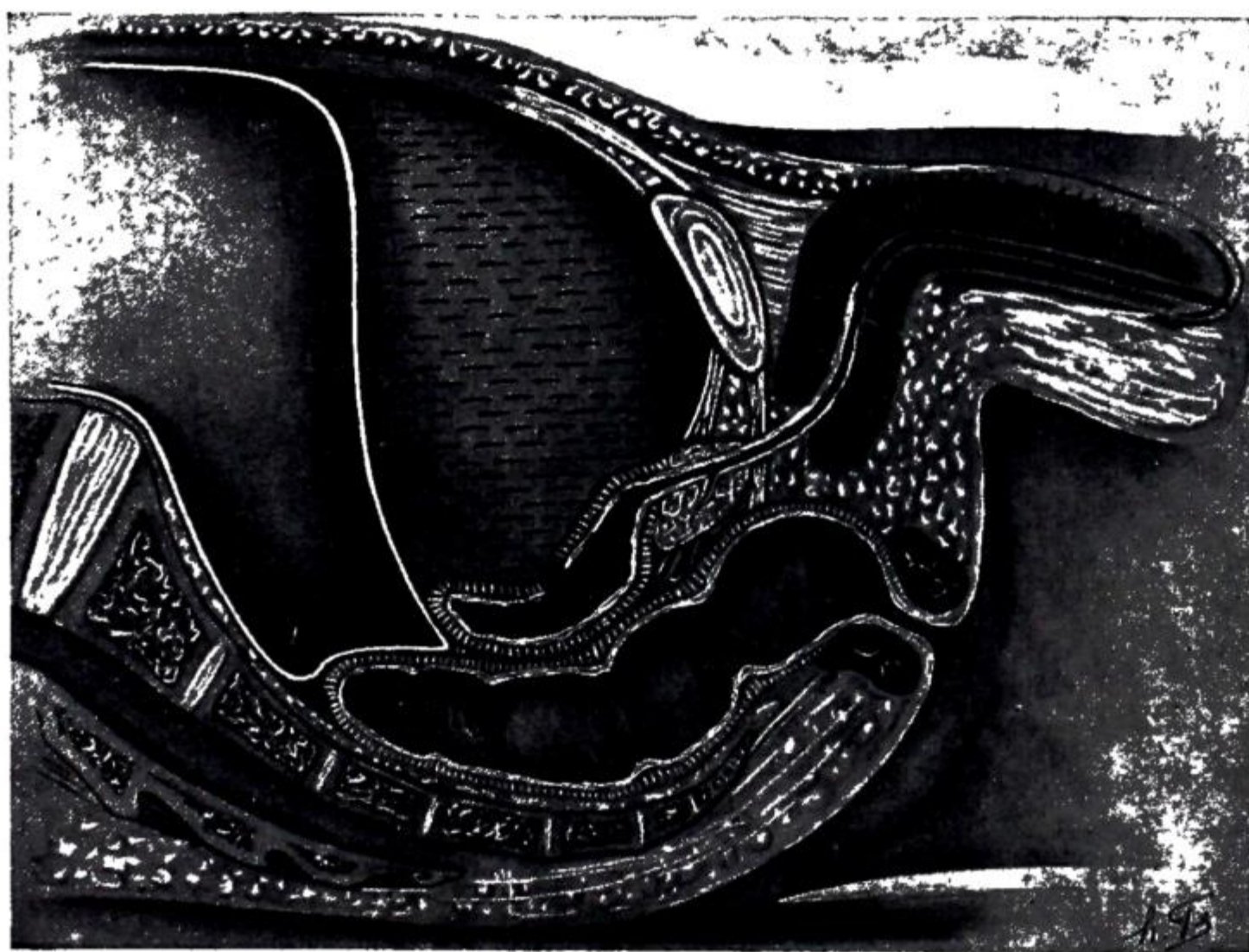


FIG. 1047.—Extraperitoneal rupture of the bladder.

from its ligamentous moorings, is the usual cause. A bladder containing even a small quantity of urine is not immune to such violence, while a full organ is extremely vulnerable. Exceptionally, the bladder is perforated by a spicule of bone.

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 pubis (fig. 1047); later, the extravasated urine passes up the anterior abdominal wall between the fascia transversalis and the peritoneum, causing necrosis of the intervening connective tissue. In the male extraperitoneal rupture of the bladder can be distinguished from intrapelvic rupture of the urethra, for in the latter the prostate is impalpable or felt with difficulty (see fig. 1151, p. 870).

It should be noted that 35 per cent. of patients with a fractured pelvis, *without rupture of the bladder or urethra*, suffer from retention of urine, and 30 per cent. pass urine containing gross or microscopical quantities of blood, the former being due to bruising of the bladder wall and the latter to tearing of its mucous membrane.

Intraperitoneal Rupture.—There is sudden, agonising 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

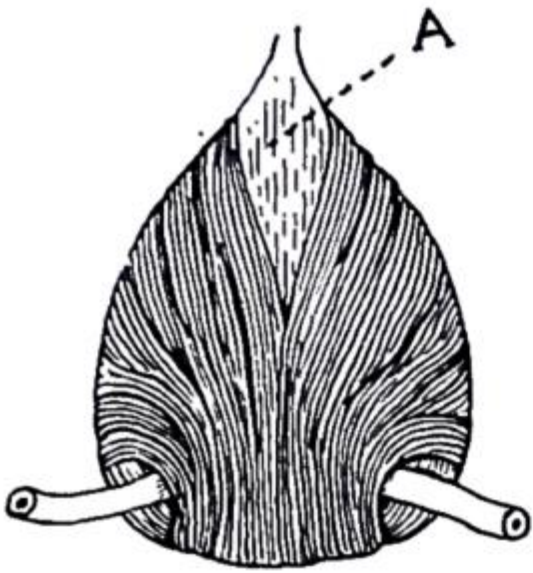


FIG. 1048.—Intraperitoneal rupture of the bladder occurs within the area A. The tear is nearly always longitudinal, i.e. it follows the direction of the fibres of the external muscular coat.

so that sometimes the patient resumes his occupation, but the abdomen commences to distend. Although there are exceptions, following the accident the patient has no desire to micturate. On examination a varying degree of abdominal rigidity and, after a few hours, 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 bulging in the rectovesical pouch. When the urine is sterile, symptoms and signs of peritonitis are delayed for many hours.

Confirming a Suspected Diagnosis.—The passing of a catheter and the introduction of a measured quantity of saline solution, and then attempting to recover it, is so often inconclusive, and therefore dangerous, that it should never be employed. While excretory pyelography is invaluable for visualising the kidneys it, too, is untrustworthy as a means of diagnosing rupture of the bladder.

Retrograde cystography is the only reliable method of proving the integrity or otherwise of the bladder. It should be carried out at the same time that radiographs of the bony pelvis are taken. The solution used must be iodoxyl,

of which there are several proprietary preparations. This solution (150 ml. will be required) is aseptic, non-irritating and, if absorbed, non-poisonous, and is free from the dangers of oil embolism. Full aseptic precautions must be taken before a catheter is passed and the solution is injected with a bladder syringe. Particularly characteristic of extraperitoneal rupture is the 'tear-drop' bladder (fig. 1049) due to its elevation by extraperitoneal extravasation of blood and urine.

Treatment.—It is abundantly clear that when there are reasonable grounds for suspecting rupture of the bladder, operation should be undertaken without delay.

Intraperitoneal Rupture.—Lower laparotomy is performed. Urine is removed by suction, after which the patient is placed in Trendelenburg's position. The edges of the rent, which is usually situated in the posterior part of the dome of the bladder, are trimmed and sutured by two layers of interrupted catgut stitches, and the operation completed by stitching a large Malécot catheter into an extraperitoneal suprapubic incision in the bladder. The latter ensures intravesical tension being kept at a minimum during healing of the sutured tear. In all but cases with obvious infection the peritoneum can be closed without drainage. The abdominal wall is repaired around the Malécot catheter, not omitting drainage of the prevesical space with a piece of corrugated rubber. Following the operation, antibiotic therapy is given until the temperature has been normal for three days.

Extraperitoneal Rupture.—Suprapubic cystostomy is performed, and the prevesical space is drained. It is unnecessary to attempt to suture the tear, which in these circumstances heals readily.

Prognosis.—When operation is performed within twelve hours the mortality is approximately 11 per cent.; when operation is delayed to twenty-four hours the mortality rises to 55 per cent. As in the days of ancient Greece, when the condition was regarded as inevitably fatal, without operation the mortality is 100 per cent.

WOUNDING OF THE BLADDER DURING OPERATION

Operations in which the bladder is liable to be injured are (1) inguinal or femoral herniotomy (especially during the performance of the low operation for strangulated



FIG. 1050.—Perforation by a diathermy cutting loop (1) in the anterior perimeter = prevesical extravasation; (2) in the posterior perimeter = pararectal extravasation.

femoral hernia); (2) hysterectomy (particularly panhysterectomy by either the abdominal or vaginal route) and (3) excision of the rectum. In all these operations, to minimise this accident the bladder must be emptied *after* the patient has been

In 1839 Dr. Walther, a General Practitioner of Pittsburg, successfully sutured an intraperitoneal rupture of the bladder of a blacksmith.



FIG. 1049.—The 'tear-drop' bladder of extraperitoneal rupture. (Dr. J. E. Kicklighter, Sarasota, Florida.)

anæsthetised. If the injury is recognised at the time of its infliction, the bladder must be repaired in two layers and urethral catheter drainage maintained for seven days. If it is not so recognised, the treatment is similar to that of rupture of the bladder.

When accidental perforation of the bladder occurs during endoscopic resection of a bladder tumour, or the prostatic capsule is perforated during transurethral prostatectomy, for practical purposes the perforation is always extraperitoneal. If the patient is under local or spinal anæsthesia, sudden pain, usually referred to the epigastrium, is experienced. When the accident is recognised at the time, drainage of the bladder with a large urethral catheter, and the administration of antibiotics, usually suffice. If the accident is not recognised at the time, suprapubic drainage of the prevesical space in the case of an anterior perforation, or perineal drainage of the pararectal space in the case of a posterior perforation (fig. 1050), is urgent and imperative.

RETENTION OF URINE

Retention of urine is divided into acute, chronic and retention-with-overflow.

Acute retention is often, speaking more correctly, acute-on-chronic retention, for, except in traumatic cases, it seldom occurs unheralded.

Ætiology.—The condition is comparatively rare in women and children, and the most frequent causes are :

<i>In the male</i>	<i>In the female</i>	<i>In the male child</i>
Prostatic enlargement. Urethral stricture. Acute urethritis.	Retroverted gravid uterus. Disseminated sclerosis. Hysteria.	Meatal ulcer with scabbing.

Other causes :

Post-operative retention. Following spinal anæsthesia. Blood-clot in the bladder. Rupture of the urethra (see p. 869). Neurogenic (injury or disease of the spinal cord).	Acute urethritis or prostatitis. Urethral calculus (see p. 883). Ring around the penis (see p. 890). Ropy mucus from cystitis. Certain drugs (see p. 797). Muscular atony from advanced age.
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Clinical Features.—The patient has not passed urine for some hours, and is unable to do so. The swelling caused by a full bladder often can be seen in a thin person; it is somewhat tender to palpation, and dull to percussion above the symphysis pubis. An attempt is made to elicit the cause of the retention. The floor of the urethra is palpated for induration of a stricture, the prostate is examined and the reflexes are tested.

Treatment.—It is of paramount importance never to relieve, or attempt to relieve, acute retention and forthwith send the patient home. He must always be confined to bed immediately, and kept there for at least twenty-four hours after relief has been obtained. Once the patient is in suitable surroundings, if the general condition is good, the effect of administering a dose of morphine and a hot bath is tried. In a proportion of cases the patient is able

to pass urine into the bath. If this fails, catheterisation is attempted. This should always be performed with full aseptic ritual. A soft rubber (Jaques) catheter or a Foley's catheter (fig. 1051), is employed ; if this is unsuccessful,



FIG. 1051.—Foley's catheter.



FIG. 1052.—Tiemann's catheter.

a Tiemann's hard rubber catheter (fig. 1052) should be tried. This often succeeds in passing the obstruction. Should this catheter not be available, or fail, and the case is one of a suspected enlarged prostate, a large bi-coudé¹ gum-elastic catheter (fig. 1053) is tried. On the other hand, when the case



FIG. 1053.—Bi-coudé catheter.

(The bevel indicates the direction of the bend at the opposite end of the catheter.)



FIG. 1054.—Olivary catheter.

is one of urethral stricture, a gum-elastic olivary catheter (fig. 1054) is selected.

All catheters (and gum-elastic bougies) are calibrated in the French scale (F.),² and as the narrowest part of the urethra is the external urinary meatus, unless there is reason to believe that the urethra is strictured, it is usual to choose a catheter with a diameter a little less than that of the orifice, viz. —————→



On Decompressing an Overfull Bladder.—Once a catheter has been made to enter a distended bladder it is advisable to allow the urine to escape intermittently a few ounces at a time. While decompression is in progress the catheter can be fixed temporarily in the urethra, and in order to control the flow of urine a stopper is inserted into its mouth. Four ounces (120 ml.) of urine is permitted to escape each hour until the bladder is empty. Decompression can be carried out more evenly and more slowly, which is desirable, if the mouth of the catheter is connected by sterile rubber tubing to the drip chamber of an intravenous infusion apparatus (fig. 1055).

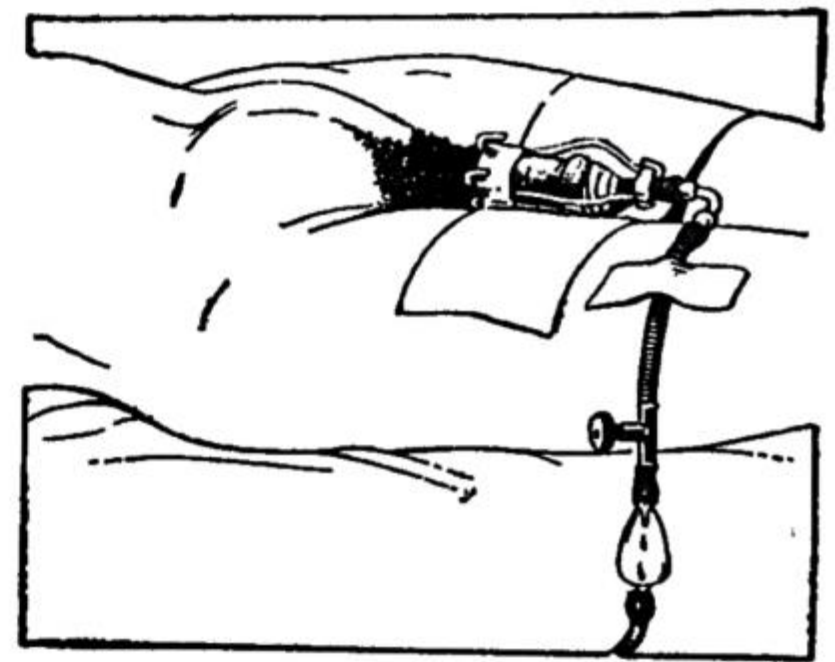


FIG. 1055. — Decompression of the bladder using the dripper of an intravenous saline apparatus.

A minority of surgeons consider slow decompression unnecessary. Just as those who have seen a death resulting from anæsthetising the urethra with a solution of cocaine forbid the use of this drug for this purpose, so those who have encountered a case of reflex anuria from catastrophic catheterisation forbid sudden emptying of an overfull bladder. Obviously, in both instances, it is well to be forewarned.

If, after a reasonable attempt with catheters, the bladder has not been entered, one of three courses may be adopted, according to circumstances.

¹ coudé (adjective) = bent ; 'coude (noun) = elbow.

² The French scale is also known as Charrière's scale, so called after Joseph Charrière (1803-1876), a Paris surgical-instrument maker.

James Archibald Jaques, 1815-1878. Works Manager, William Warne and Co. Ltd., India Rubber Mills, Barking, Essex, improved and patented the soft rubber catheter.
 Frederic Eugene Baisal Foley, Contemporary. Urologist, Miller and Ancker Hospitals, St. Paul, U.S.A.
 George Tiemann & Co., Instrument Manufacturers, New York.

1. **Suprapubic Puncture with a Hollow Needle.**—Suprapubic puncture with a lumbar puncture needle is a useful method of relieving acute retention when catheterisation has failed or the apparatus for introducing a suprapubic catheter cannot be obtained readily. The danger of this method is that if the bladder is allowed to refill after it has been punctured, leakage into the prevesical space is liable to follow.

2. **Suprapubic Catheterisation (Riches' Technique).**—A catheter is inserted into the bladder suprapubically through a $\frac{1}{2}$ -inch (1.25 cm.) incision made under local anæsthesia 1 inch (2.5 cm.) below the level at which the anterior surface of the bladder curves upwards and backwards

to form the dome. The fibres of the linea alba are severed in the length of the incision. After the special catheter has been mounted on its introducer (fig. 1056 (a), (b)) it is passed through the incision until its sharp point touches the surface of the bladder, and the instrument is passed into the bladder with a short, sharp thrust directed backwards and downwards. The introducer is removed and the advancer (fig. 1056 (c)) is

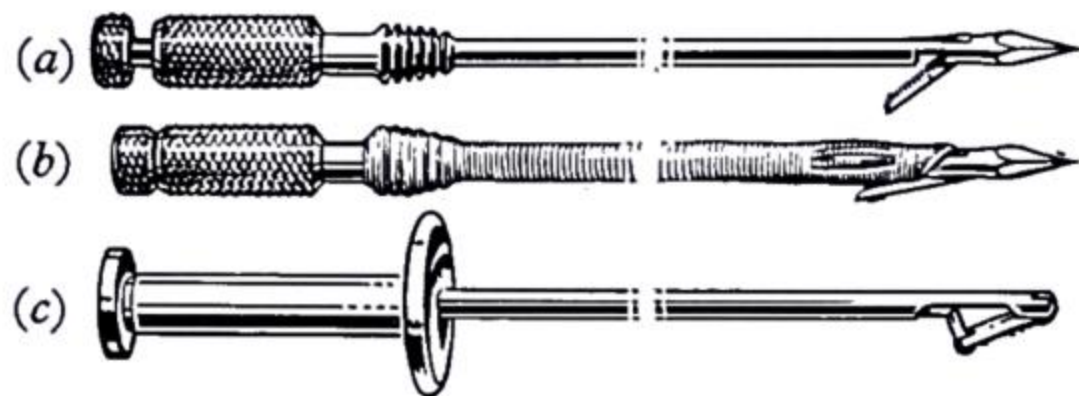


FIG. 1056.—(a) Riches' suprapubic catheter introducer; (b) the catheter stretched on the introducer; (c) the advancer.

passed down the lumen of the catheter and its expander is opened. By its agency the catheter is carried towards the trigone, and 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.

3. **Immediate Prostatectomy.**—Possibly immediate prostatectomy in cases of benign enlargement of the prostate in relatively fit men (see p. 840).

CHRONIC RETENTION

The principles of treatment are similar but not urgent. In the case of chronic retention due to an enlarged prostate, unless renal function tests show that the patient is unfitted for prostatectomy in the very near future, no attempt should be made to empty the bladder.

RETENTION WITH OVERFLOW

Retention with overflow is referred to also under the headings of 'false incontinence' (see p. 799) and 'prostatic enlargement' (see p. 837).

The general principles which govern the treatment of this condition are similar to those of acute retention, but decompression of the bladder must be carried out very slowly.

THE INDWELLING CATHETER AND THE CLOSED SYSTEM OF CATHETER DRAINAGE

All varieties of retention of urine, if not diagnosed and relieved early, allow the bladder to become overdistended, and paresis of its musculature ensues. Therefore when the bladder contains more than 15 oz. (450 ml.) of urine, so probable is it that re-catheterisation will be required that it is advisable to retain the catheter. To retain the catheter for several days at least is also the rule after major pelvic operations. The incidence of ascending infection is nearly halved by connecting the catheter (urethral, suprapubic or perineal) to sterile tubing conducted to a sterile collecting bottle (fig. 1057), and employing irrigations only if clot retention demands them. When a catheter has been

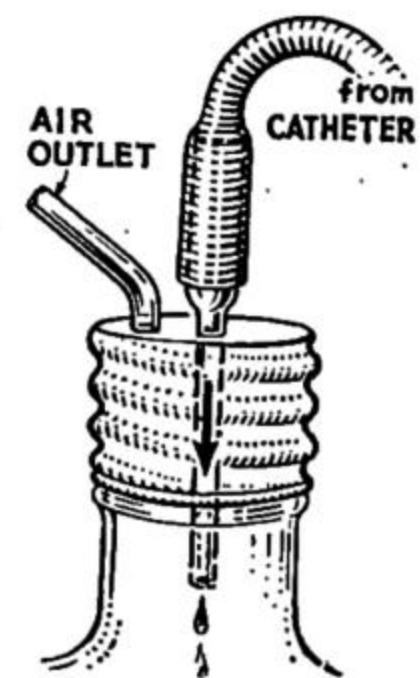


FIG. 1057.—Screw-topped intravenous-giving set adapted for use as a drainage bottle for urine. (After L. N. Pyrah.)

in situ for five or more days, even if special precautions are taken to prevent it, some degree of urethritis is likely to supervene. To change the catheter in the presence of urethritis entails a grave risk of infection from the anterior to the posterior urethra, and thence to other parts of the urogenital system (fig. 1058). Consequently, rather than replace a urethral catheter through an infected urethra, it is wise to perform suprapubic catheterisation of the bladder, or perineal urethrostomy and drain the bladder via the urethrostomy wound.

SPECIAL FORMS OF RETENTION OF URINE

Post-operative Retention of Urine.—Retention of urine can be encountered after any operation on any part of the body. The reasons why a patient who has undergone an operation is unable to pass urine are numerous. When the patient is an elderly male, prostatic obstruction, hitherto latent, should be suspected. Some individuals have a 'bashful' bladder, the owner of which is unable to micturate in the presence of another person. Many cannot urinate while lying or sitting in bed. Another extremely common cause is sedation: when a sufficient quantity of an analgesic drug to relieve pain is administered, frequently the desire to micturate is suppressed until the sympathetic nerve fibres are stimulated from overdistension of the organ. Pain on attempting to pass urine is another frequent cause after lower laparotomy, herniorrhaphy and ano-rectal operations. After operations upon the pelvic viscera, retention of urine is so common that it is usual to forestall it by inserting a catheter at the conclusion of the operation.

Treatment.—If the male patient, while supported, is permitted to stand for a few minutes, he is often able to empty his bladder. Parasympathetic stimulating drugs should be avoided; too often they are valueless, but their particular danger is that of necessity they stimulate intestinal peristalsis in the unaffected upper reaches of the intestine, as opposed to those affected by paresis below, and consequently they are liable to precipitate paralytic ileus. If after a reasonable trial the patient cannot pass urine, he or she must be catheterised.

Acute Retention due to Drugs other than Sedatives.—A number of the newer drugs are prone to induce or precipitate retention of urine. Methantheline bantline bromide, used to decrease secretion and motility in peptic ulcer, antihistamine drugs, antihypertensive drugs, anticholinergic drugs (belladonna; probanthine) and isonicotinic acid hydrazine compounds (chemotherapeutic agents for tuberculosis) have all been responsible for producing acute retention of urine. Indeed, 'drug retention' has become a clinical entity.

Retention of Urine due to Lesion of the Spinal Cord.—The bladder, the nervous control of which is disrupted because of a complete or incomplete lesion of the spinal cord, passes through various stages of dysfunction.

The Atonic Neurogenic Bladder.—Immediately following the injury

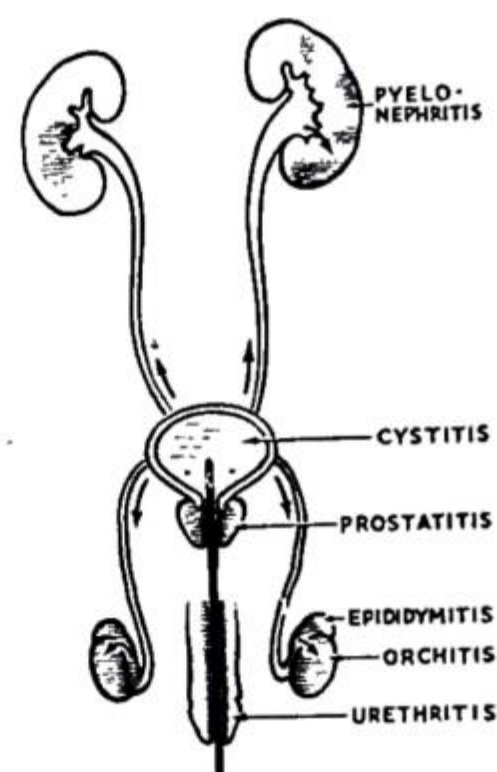


FIG. 1058.—Complications liable to follow changing a urethral catheter in the presence of urethritis. (After C. G. Scorer.)

the detrusor muscle becomes paralysed, the sphincter vesicæ contracted tightly and the sphincter urethræ relaxed. The only factor permitting any evacuation of the bladder is the elasticity of its walls. In lesions situated above S.2 (see fig. 1041) to below D.4-6, because the sympathetic innervation of the bladder is intact, the patient can appreciate when the bladder becomes filled to capacity. If allowed to do so, the bladder becomes greatly distended and paralytic overflow incontinence ensues. This phase (due to spinal shock) lasts for days, weeks or even months. As recovery from spinal shock takes place, depending on the level of the lesion, automaticity or autonomy of bladder function occurs, but before it does so it passes through two intermediate phases.

(a) *Phase of Ineffectual Emptying Contractions.*—Contractions of the detrusor muscle occur, but because the sphincter vesicæ remains in spasm, small quantities only of urine are voided frequently. This phase is of short duration.

(b) *Phase of Hypertonicity.*—The detrusor passes into spasm. The sphincter vesicæ relaxes physiologically and the sphincter urethræ reflexly (D. Munro).

The Automatic (syn. Reflex) Bladder.—When the lesion is situated above the centre of micturition the bladder empties reflexly every one to four hours, the amount of residual urine varying from case to case. When the filling reaches a certain point the detrusor muscle contracts reflexly—a condition similar to that seen in early infancy.

The autonomous bladder results when a complete lesion is situated at a level that will destroy the centre for micturition (see fig. 1041, p. 787), or the lesion is in the cauda equina. Emptying of the bladder is dependent upon the precarious and inefficient control by the nerve plexus situated between the muscular strata of the bladder wall. Continual dribbling is the outcome, but the bladder can be emptied by manual compression. Residual urine, however, is never absent and dilatation of the ureters and, eventually, of the renal pelvis and calyces, results.



FIG. 1059.—Portex Gibbon catheter in place.

Treatment.—The most practical solution of the problem of how best to relieve retention of urine during the vigil of the period of atonicity is to pass, with the strictest aseptic precautions, a catheter of portex tubing 1.5 mm. in diameter which is so designed that it can be retained by its wings in both the male (fig. 1059) and in the female. It is advisable to introduce the tubing at the earliest possible time, as there is evidence that overdistension prejudices the eventual development of detrusor contractions (J. C. Ross). Especially important is early drainage in the female, for otherwise wet beds favour the development of bedsores. Should the tubing become blocked with mucus, usually it can be freed by suction applied with a needle and syringe to its distal end. A

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 Norman Otway Knight Gibbon, *Contemporary*. Surgeon, Walton Hospital, Liverpool.
 James Cosbie Ross, *Contemporary*. Surgeon, Royal Southern Hospital, Liverpool.

high fluid intake (6 pints (3 litres) in the twenty-four hours) must be insisted upon. Usually chemotherapeutic and antibiotic agents are held in reserve in case infection supervenes.

The state of automaticity is heralded by return of bulbo-cavernosus reflexes (erections) and anal reflexes, and should the catheter tubing become blocked, urine will be passed alongside the catheter.

With the return of detrusor activity *bladder training* is commenced. At first the catheter is spigoted and released at regular, but lengthening, intervals. Later the catheter is removed and the reflexes initiated by the patient lifting himself in his chair or bed, again at regular intervals by the clock (D. Munro). Drinks are given every hour during the twelve hours of day, but none between seven p.m. and seven a.m.

Enhancing or Initiating Automaticity in Refractory Cases.—Cystourethrography is invaluable in determining (1) spasm of the sphincter vesicæ, (2) contracture of the prostatic urethra, (3) prostatic shelf obstruction and (4) spasm of the sphincter urethræ.

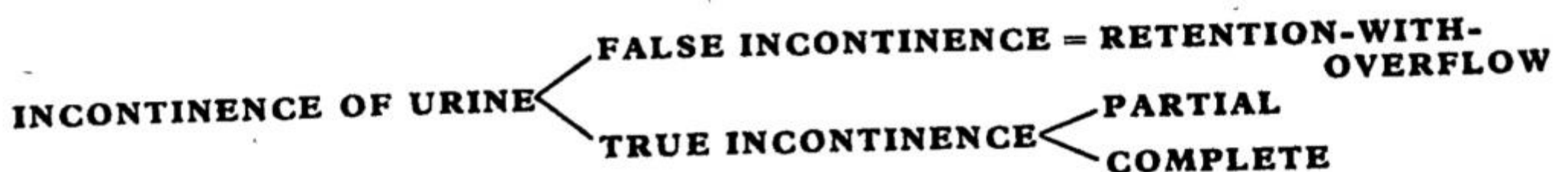
Transurethral resection of narrow strips of the vesical neck and prostatic urethra between five and seven o'clock is often very successful in types of obstruction 1, 2 and 3. Pudendal neurectomy sometimes abolishes spasm of the sphincter urethræ. For this operation the patient is placed in the jack-knife position (see p. 622) and the pudendal nerves are exposed as they leave Alcock's canal (fig. 1060), and resected. In the few cases that do not respond to pudendal neurectomy, endoscopic resection of a portion of the sphincter urethræ is likely to succeed.



FIG. 1060.—Incisions for bilateral pudendal neurectomy. (D. Band.) (British Journal of Urology.)

The State of Autonomy.—Manual expression of urine by the patient, if he has the use of his arms, plus contracture of the abdominal muscles, if they are not paralysed, is the only (but often tolerably successful) method of avoiding life-long urethral or suprapubic catheter drainage.

Persistent Retention of Urine following Excision of the Rectum.—In 10 per cent. of cases of extirpation of the rectum retention of urine persists for three months or more. The weight of opinion, founded upon the absence of cytometric substantiation of damage to the parasympathetic nerve supply to the bladder, is that the retention is due to mechanical factors, notably sagging of the bladder into the space formerly occupied by the rectum. In the great majority of cases the retention can be remedied permanently by transurethral resection of the prostate. In most of the patients the prostate is not large, and consequently the resection can be carried out easily and quickly. For this reason J. Emmett advises that if after two weeks the patient is unable to empty his bladder and his general condition is satisfactory, transurethral prostatic resection should not be postponed. In this way the patient is spared what will probably be a long period of invalidism and a considerable risk of the supervention of urinary infection.



False incontinence has been dealt with already in connection with retention of urine.

Partial Incontinence.—The patient is unable to exercise full control,

Benjamin Alcock published the details of his canal in 1836. He was dismissed from his post as Professor of Anatomy at Cork in 1855 (for breach of Anatomy Acts), and disappeared in America.
John L. Emmett, Contemporary. Professor of Urology, Mayo Clinic, Rochester Min., U.S.A.

and loses urine without warning. There are two main varieties of this disability :

1. **Stress incontinence** is not uncommon in women. The pubococcygeal muscle plays an important part in maintaining control of urination in women. Weakness of that muscle due to overstretching or partial tearing of it during labour is the principal cause of stress incontinence, but weakness of the muscles of the pelvic floor in general, and of this muscle in particular, sometimes occurs in nullipara. Expulsive acts such as coughing or sneezing may be sufficient to cause an escape of urine.

Treatment.—In the absence of an obvious cause requiring operative treatment on its own merits, e.g. fibromyomata, prolapse of the uterus, *non-operative treatment* can be recommended, and if carried out conscientiously for a sufficient length of time, the results are often extremely good. The treatment consists of voluntary exercises to tighten the rectal and vaginal sphincters carried out a dozen times three times a day, regardless of where the patient is or what she is doing. Although not strictly necessary, progress can be measured by introducing into the vagina at, say, monthly intervals, an instrument known as a perineometer, which consists of a rubber bulb connected to a manometer, and noting the strength of the pressure exerted on the bulb.

Operative Treatment.—In patients with considerable bulging of the anterior vaginal wall (cystocele) anterior colporrhaphy frequently improves continence. In the absence of a cystocele an operation to rectify sagging of the bladder neck can be undertaken in cases in which there is little or no improvement after a course of exercises.

Everard Williams' operation for stress incontinence is simple, and gives as good results as more complicated procedures. A Foley's catheter having been introduced into the bladder, the bladder neck and adjoining portion of the urethra are exposed via the retropubic route. The lower part of the bladder and the intrapelvic portion of the urethra are mobilised, but there is no necessity to separate the urethra from the vagina. Three chromic catgut sutures are introduced on either side, each traversing the wall of the urethra or that of the bladder neck, being careful not to penetrate the mucous membrane. The sutures are then passed through the fascia covering the deep surface of the pubic bones near the symphysis. When the sutures are tied they suspend the bladder neck and the commencement of the urethra. The incision is then closed.

2. **Enuresis in Children.**—Nocturnal enuresis is usually a continuance of infantile bed-wetting. Occasionally it commences months or years after voluntary micturition has been established. In 4 per cent. of cases involuntary micturition is only diurnal; in 12 per cent. of cases it is both nocturnal and diurnal. In all patients who have reached the age of four or over, a cause for the involuntary micturition should be sought :

1. The urine should be examined for pus and organisms.
2. Phimosis or atresia meati, if present, should be corrected; likewise vulvitis or vaginitis.
3. Radiography and excretory pyelography may reveal a hydronephrosis, an ectopic ureteric orifice or a urinary calculus. Voiding cysto-urethrography is invaluable for detecting urethral valves (see p. 866).

4. Urethroscopy sometimes shows inflammation of the verumontanum, in which event periodic dilatation with a urethral bougie is sometimes beneficial.
5. Thread worms should be eliminated.
6. Spina bifida and epilepsy can cause enuresis.

In the great majority (over 90 per cent.) no cause for the enuresis is discovered, in which event the condition is described as primary enuresis.

Treatment.—Many forms of treatment have been advocated, and the literature on this subject has become voluminous. The results of treatment are difficult to assess, as the majority of sufferers gain control at or before puberty. The treatment not to follow is the restriction of fluids several hours before going to bed, and periodic wakening of the child at night. Restriction of fluids is especially harmful, as it causes the urine to become concentrated, and thus more irritating to the bladder. The following routine is recommended. The importance of *not* relieving the bladder at once during the day-time is explained to the patient as soon as he or she is old enough to understand that an effort must be made to increase the time between the urge to micturate, and voiding. The objective is to increase the bladder capacity by such training. Plenty of fluid in the form of fruit juices are permitted right up to bed-time. Dextroamphetamine sulphate 20 mg. is prescribed to be given at bed-time to prevent deep sleep; this can be continued for several weeks without harmful effect, by which time many patients have learned to arise when the bladder is full.

Complete Incontinence.—The urine dribbles away without fully distending the bladder. This is the result of either extensive damage to the sphincter urethræ or a central nervous lesion affecting its nerve supply (the pudendal nerves). Rupture of the urethra, difficult labour, perineal prostatectomy, as also, but less frequently, retropubic prostatectomy and endoscopic resection, account for a certain number of cases. The remainder are due to organic spinal or cerebral disease, which include, in early life some form of spina bifida, in middle life disseminated sclerosis or tabes dorsalis, and late in life a cerebrovascular accident.

Appliances for the Relief of Incontinence.—In the female it is impossible to fit any apparatus that will keep the patient dry. Cellulose is the most satisfactory dressing for use with napkins. A rubber drawsheet must be provided in bed. In the male the choice lies between a dribble-bag and an incontinence clamp (fig. 1061). So unsatisfactory is the use of any of these expedients that if there is a good prospect of its success, an operation to obviate the necessity for resorting to them is indicated.



FIG. 1061.—An incontinence clamp.

Operative Treatment:

Millin's operation for incontinence in the male is suited particularly to cases of post-prostatectomy incontinence. A rubber catheter 12 to 16 F. (the size to some extent varying inversely with the degree of incontinence) is passed, and fixed in the urethra. The patient is then placed in the lithotomy position. A mid-line incision is made in the perineum through the skin and fascia, exposing the underlying muscles, care being taken not to incise the muscle layer, which usually is thin and ill-

developed in these cases (disuse atrophy). The ischio-cavernosi are retracted the better to display the all-important objective in this operation—the bulbo-cavernosus. The latter muscle is pleated with transversely placed stitches of fine silk, which are tied just tight enough to grip the catheter within the urethra. The wound is then closed in layers, and the catheter is withdrawn.

Muscle sling operation is applicable to either sex, the gracilis being used to form a sling around the urethra (fig. 1062) in the attempt to provide muscular control in cases where the voluntary musculature of the region is paralysed. Provided the wound does not become infected, the results sometimes more than fulfil expectation. In a personal case the operation was performed on a middle-aged woman with incontinence due to tabes dorsalis: the patient was fully continent when seen last, which was ten years after the operation.



FIG. 1062.—Transplantation of the gracilis muscle to make a new sphincter urethrae.

Ileo-ureterostomy (see p. 832).—The collection of urine from an artificial bladder into an ileostomy bag (especially if a plastic operation has been performed on the ileostomy opening so as to render it spout-like and covered with skin) is so much more water-tight than a portable urinal worn over the genitalia, and the incidence of pyelonephritis is so much less, that the substitution of an artificial for a normal non-functioning bladder is a change for the better, not only for the patient but for those with whom he or she lives (the uriniferous odour is reduced, sometimes to vanishing point). The operation is particularly successful in cases of incontinence due to spina bifida (C. Wells).

VESICAL CALCULUS

Definition.—A primary vesical calculus is one that develops in sterile urine; it often, but not necessarily, originates in a kidney and passes down the ureter to the bladder, where it enlarges.

A secondary vesical calculus occurs in the presence of infection.

A vesical calculus can occur also by the deposition of urinary salts upon a foreign body in the bladder.

Incidence.—Until the twentieth century vesical calculus was one of the most prevalent disorders among the working classes, and the incidence was especially high in childhood and adolescence. In Europe, North America, and Australasia, owing to improved diet, especially an increased protein-carbohydrate ratio, vesical calculus is comparatively rarely encountered, except in males over fifty years of age (usually as a complication of prostatic obstruction). The most remarkable fall in incidence is among children—formerly the highest, now only 1 per cent. It should be remembered that in India, China, South America and Iraq vesical calculus is still common.

Composition and Cystoscopic Appearance.—Most vesical calculi are composite, but have one component in excess, and assume the appearance of that variety. In two-thirds of cases the stone is solitary.

I. *Oxalate calculus* is a primary calculus that grows slowly. Usually it is of moderate size, and is solitary. Its surface is uneven and often spiculated; sometimes it bristles with spines (fig. 1063).



FIG. 1063.—'Jack-stone'¹ calculus. This type of vesical calculus is typically found in a post-prostatic pouch.

¹ 'Jack-stone' = the kernel of the fruit of the jack tree. These fruit stones are used for a game played by children in the U.S.A.

Although calcium oxalate is white, the stone is usually dark brown or black because of deposits of blood pigment upon it.

2. *Uric acid and urate calculi* are round or oval, fairly smooth, and vary in colour from pale yellow to light brown: they may be single or multiple. These stones also are primary.

3. *Cystine calculus* occurs only in the presence of cystinuria (see p. 747).

4. *Phosphatic calculus* is composed of triple phosphates and occurs in urine infected with urea-splitting organisms. It grows rapidly and often attains a large size. In some instances it occurs on a nucleus of one of the foregoing types of calculus; much more rarely on a foreign body. In others the nucleus is composed of desquamated epithelium and bacteria. When single, the stone is round; when multiple, it is faceted. It is dull white in colour, and comparatively soft.

A vesical calculus is usually free to move in the bladder. It gravitates to the lowest part of the organ, which, when the patient is erect or sitting, is the bladder outlet. In the recumbent position (as also at cystoscopy) the stone occupies a position behind the inter-ureteric ridge. Less commonly the stone is wholly or partially fixed in a diverticulum or a post-prostatic pouch. In either of these situations the stone may be partially or completely hidden from view.

Clinical Features.—Males are eight times more often affected than females.

(a) *Latent.*—When a stone is situated in a post-prostatic pouch or a diverticulum of the bladder, it is usually discovered unexpectedly at cystoscopy or on X-ray examination.

(b) *Typical.*—*Increased frequency* is a common, and the earliest, symptom. Unlike other forms of frequent micturition, it is not much in evidence during the night. After micturition the patient does not feel fully satisfied that the bladder is empty.

Pain is most in evidence in cases of spiculated oxalate calculus. It occurs at the end of micturition, and is usually referred to the tip of the penis or to the labia majora; more rarely to the perineum or suprapubic region. Pain and discomfort are much in evidence during exertion, and are aggravated by jolting movements (e.g. riding in a vehicle). If the patient lies down, the symptoms tend to pass off because the stone falls away from the sensitive portion of the bladder, the trigone. Thus he usually sleeps peacefully through the night. In young boys, screaming and pulling at the penis with the hand at the end of micturition is indicative of vesical calculus.

Hæmaturia is characterised by the passage of a few drops of bright red blood at the end of micturition, and is due to the stone abrading the vascular trigone—a fact that also accounts for the pain.

Interruption of the urinary stream during the act occurs in about 17 per cent. of cases. This symptom is not pathognomonic of vesical calculus, but when it occurs in addition to typical symptoms, it strengthens the clinical diagnosis.

Acute retention of urine from a vesical calculus is extremely uncommon in adults, but not so in children.

Masked.—The symptoms of a concomitant persistent cystitis may overshadow those that might be occasioned by the stone.

Rectal or vaginal examination, when accompanied by abdominal palpation, occasionally enables a vesical calculus to be felt. Unless the stone is large, rectal examination is negative in the adult male, but in a female or child a calculus of moderate size can often be felt.

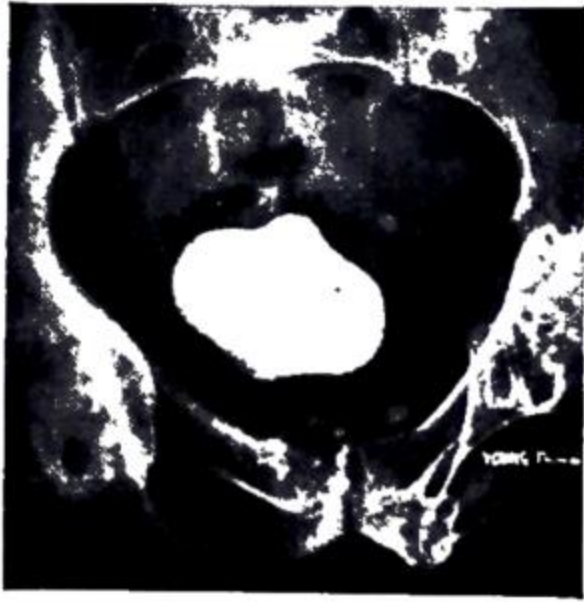


FIG. 1064.—Radiograph showing a vesical calculus. A coronet of prostatic calculi is displayed also.

Examination of the urine will reveal blood, and possibly pus or crystals typical of the calculus, e.g. envelope-like in the case of an oxalate stone, or hexagonal plates with cystine calculi.

Radiography.—In at least 92 per cent. of cases vesical calculus can be demonstrated on an X-ray film (fig. 1064). Radiographs of the whole of the urinary tract should be taken, after which excretory pyelography is carried out. The former will reveal or disprove the presence of opaque renal or ureteric calculi, while the latter will help to determine the normality or otherwise of the kidneys.

Cystoscopy is essential for the final diagnosis. Frequently, on introducing the sheath of the cystoscope, a significant 'click' will be felt when a free-lying stone comes in contact with the instrument. As described already, cystoscopy usually determines the composition of the calculus (fig. 1065). Stones non-opaque to X-rays can be seen. If the radiograph shows more stones than are counted on cystoscopy, a diverticulum must be sought carefully (Ogier Ward). A hanging stone, i.e. one dangling from the dome of the bladder, usually is explained by an unabsorbable suture, used at a previous operation, upon which urinary salts have been deposited.



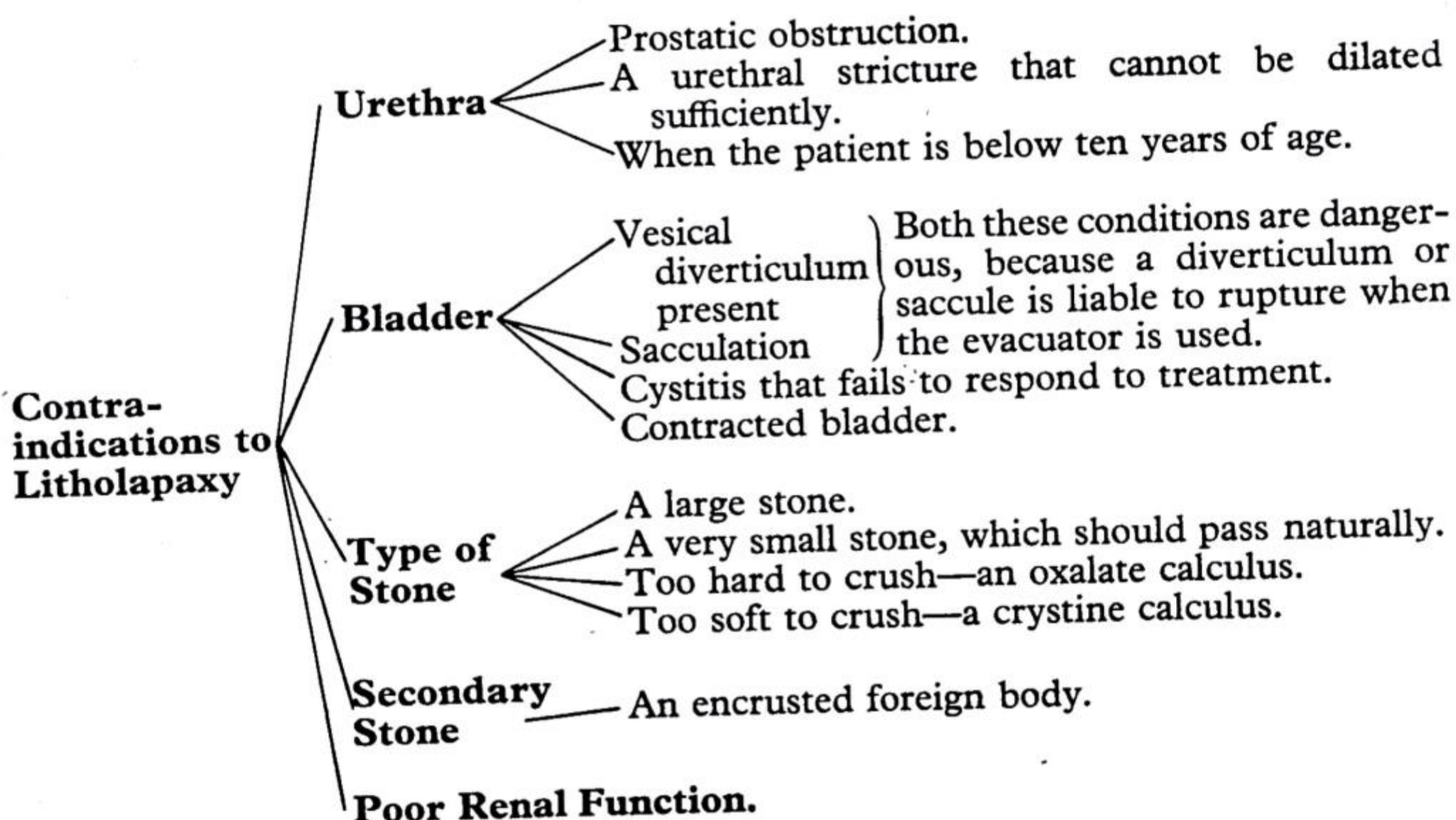
FIG. 1065.—An oxalate stone in the bladder as viewed by a cystoscope.

In all cases the whole of the bladder wall is inspected: in primary calculus aseptic cystitis is basal; in secondary calculus bacterial cystitis is universal, but is most severe at the seat of the stone. In appropriate cases the exit of the bladder is examined for prostatic enlargement or the presence of contracture of the bladder neck.

Treatment:

Litholapaxy.—In certain circumstances this non-cutting operation of crushing the stone with a lithotrite is highly satisfactory. However, the contraindications to the method must be known.

Ronald Ogier Ward, Contemporary. Consulting Surgeon, St. Peter's Hospital for Stone, London.



Technique.—For several days before the operation a urinary antiseptic is administered to reduce infection of the bladder. While blind litholapaxy is preferred by those who have had much experience with the solid lithotrite, its only advantage is that, by reason of its solidity and greater strength, harder stones can be crushed than is the case with an instrument that contains a light and telescope incorporated in its shaft. Canny Ryall's cystoscopic lithotrite enables the stone, and such fragments as are necessary, to be seized under vision. The instrument, with its obturator in place, is introduced into the bladder, and rotated so that its closed jaws point downwards. The obturator is removed and the bladder is irrigated with boric lotion by means of two 6-ounce (200-ml.) syringes until the lotion is returned clear. The bladder is then filled with not more than 10 ounces (300 ml.) of the solution, and after inserting the telescope, the stone is seen. The screw on the handle of the instrument is turned, and the jaws thereby opened. The distal blade is hooked over the centre of the stone (fig. 1066) and by rotating the screw handle the proximal movable blade is advanced so that the stone is grasped firmly. The ocular end of the lithotrite is depressed, thereby lifting the calculus away from the bladder wall. After withdrawing the telescope slightly,

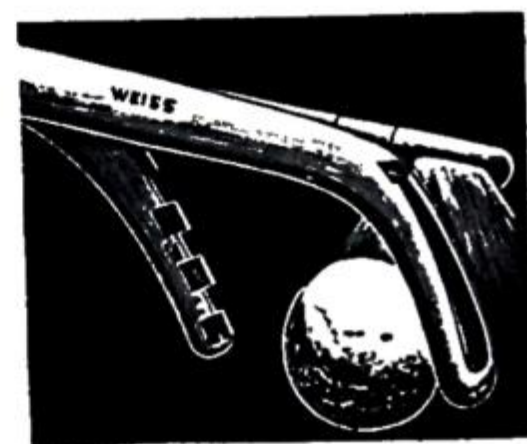


FIG. 1066.—A cystoscopic lithotrite.



FIG. 1067.—An evacuating cannula.

to prevent damage to the light bulb, the screw is turned slowly, breaking the stone. Large fragments are crushed into small ones by repeating the manœuvre. With the jaws closed, the lithotrite is rotated so that the jaws point upwards, and after removing the telescope and allowing the lotion to escape, the instrument is withdrawn.

Evacuation of the Fragments.—An evacuating cannula (fig. 1067), the largest that the urethra will take, is passed, and 6 ounces (200 ml.) of lotion are introduced into the bladder. The evacuator (fig. 1068), filled with lotion and with its tap closed, is fitted on to the cannula. The tap is opened and the bulb is elevated so as to depress the beak of the cannula towards the base of the bladder, after which the bulb is compressed slowly. The bulb is then permitted to expand, and the returning lotion carries with it sand and fragments of the stone which, being heavier than the lotion, drop into the glass receptacle. Compression of the bulb and aspiration is continued until no further fragments fall. The beak of the cannula is turned to the left and to the right, and



FIG. 1068.—Freyer's modification of Bigelow's evacuator.

Henry Jacob Bigelow, 1818-1890. Surgeon, Massachusetts General Hospital, U.S.A.

suction is applied in these situations. To save time in emptying and refilling two evacuators can be used. If at any time the bulb fails to expand, this may be due to blocking of the eye by bladder mucosa, in which event release can be effected by further compression of the bulb and slight rotation of the instrument. Blockage of the cannula by fragments of the stone can sometimes be remedied in the same way, but more often they must be dislodged by detaching the evacuator and passing the obturator of the cannula. When no more fragments can be aspirated, the evacuator is detached and the bladder is irrigated until the lotion is returned clear. The cystoscopic lithotrite is reintroduced, and if no fragments remain, a Foley's catheter is passed. After the patient has been returned to bed the catheter is connected to a sterile bottle. Usually the catheter can be removed in twenty-four hours. As soon as it is assured that the patient is passing urine without difficulty, he can return home. A urinary antiseptic should be prescribed for ten days.

Suprapubic Lithotomy.—The alternative to litholapaxy is removal of the stone through a suprapubic incision, after which the bladder is closed around a Malécot catheter (suprapubic cystostomy).



FIG. 1069.—Young's cystoscopic rongeur.

Lithotomy in Special Circumstances.—Provided infection is controlled, a stone associated with an enlarged prostate can be removed in the course of a suprapubic or retropubic prostatectomy.

When the stone is associated with contracture of the bladder neck, it can be removed in the course of an open operation for that condition.

In the case of a fibrous prostate the stone should be removed by preliminary suprapubic cystostomy, prior to transurethral resection.

A very small stone sometimes can be removed by means of an evacuator after passing the largest-sized cannula commensurate with the calibre of the urethra.

For stones too large to pass through the cannula but small enough to pass through the urethra, removal by seizing the stone in the jaws of a cystoscopic rongeur (fig. 1069) is ideal.

FOREIGN BODIES IN THE BLADDER

A piece of catheter or bougie may become broken off and remain in the bladder. The variety of foreign bodies which have been removed from the bladder is astonishing. I have removed at various times a manicure stick, a hair-clasp (fig. 1070), several hairpins and a lump of candle-grease. The presence of such objects in the bladder is usually accounted for by urethral masturbation or attempts to produce a miscarriage. Occasionally a foreign body enters through the wall of the bladder, e.g. a piece of rubber tubing after cystostomy; unabsorbable sutures used in an extravesical pelvic operation. The diagnosis rests on cystoscopy, and in the case of radio-opaque foreign bodies on preliminary radiography.

Complications of a Foreign Body in the Bladder:

1. Cystitis, which is the most common complication.
2. Perforation of the bladder wall.
3. Vesical calculus.

Treatment.—A small foreign body can be removed per urethram by means of an operating cystoscope or Young's cystoscopic rongeur. When the foreign body is heavily encrusted, penetrating the bladder wall, or accompanied by severe cystitis, the suprapubic route should be chosen. A foreign body composed of paraffin wax can be dissolved by the introduction of equal parts of xylol and water into the bladder for half an hour.



FIG. 1070.—A hair-clasp in the bladder.

Frère Jacques de Beaulieu, 1651–1714, was the most famous Journeyman Lithotomist; he mainly practised the perineal operation using a bread-knife.

DIVERTICULUM OF THE BLADDER

Definition.—It is most important to distinguish a saccule from a diverticulum of the bladder. The normal intravesical pressure at the commencement of micturition is about 50 cm. of water. Pressures as great as 100 cm. are reached by a hypertrophied (trabeculated) bladder (see fig. 1109, p. 836) endeavouring to force urine past an obstruction. This pressure thrusts the mucous lining between the inner layer of hypertrophied muscle bundles, so forming multiple saccules. If one or more, but usually one, saccule is forced through the whole thickness of the musculature of the bladder wall it becomes a diverticulum.

Ætiology

(a) **Congenital diverticulum** is rare and unimportant. It is situated in the middle line anterosuperiorly, and represents the unobliterated vesical end of the urachus. It empties with the bladder, and is symptomless. Unless it is the seat of a neoplasm, it requires no treatment.

(b) *Pulsion Diverticulum.*—It must be admitted that most diverticula of the bladder are acquired. Nevertheless, as only a small proportion (about 6 per cent.) of patients with obstruction to the lower urinary tract develop a diverticulum, those that do so must possess a congenital weakness of the bladder wall at the point through which the diverticulum protrudes, or even a small vesical bud in this situation. The associated obstructive lesion, in order of frequency, is contracture of the bladder neck, benign enlargement of the prostate, fibrous prostate, urethral stricture and congenital valves of the posterior urethra.

Pathology.—The majority of diverticula are single, but sometimes two or more are present. Usually the mouth of the diverticulum is situated above and to the outer side of one ureteric orifice. Exceptionally, it is near the middle line behind the interureteric ridge. The size varies from that of a hazel nut to a sac larger than the bladder itself, the average (fig. 1071) being the size of a tangerine orange. As a diverticulum at the seat of election enlarges, it does so in a downward direction and develops a short neck, which overlies, and is liable to obstruct, the corresponding ureter. The diverticulum is lined by mucous membrane continuous with that of the bladder, unless severe in-

fection has converted the lining mucous membrane of the diverticulum into granulomatous tissue. The wall is composed of fibrous tissue, varying in thickness, with a few muscle fibres scattered through it, but insufficient to render it capable of contraction. The orifice is always much smaller than the diverticulum itself and the ostium, unlike the rest of the diverticulum, sometimes contains sufficient muscle fibres to enable it to open and contract, but this is unusual. There is often a considerable amount of fat around the sac: this is perivesical fat that has become adherent to the diverticulum.



FIG. 1071.—Diverticulum of the bladder excised in the case of a man of twenty-nine ($\frac{1}{3}$ rd scale).

Complications

1. **Recurrent Cystitis.**—As the pouch cannot empty itself, there remains a stagnant pool of urine within it—concealed residual urine. Once this becomes infected, the infection persists and continues to reinfect the main cavity of the bladder. In long-standing cases peridiverticulitis causes dense adhesions between the diverticulum and surrounding structures.

2. **Vesical calculus** due to stagnation and infection is present in 20 per cent. of cases, most often in the main bladder cavity, sometimes in the diverticulum as well, less often in the diverticulum only. On rare occasions a dumb-bell calculus fills the diverticulum and projects into the bladder.

3. **Hydronephrosis and hydroureter**, consequent upon compression of the lower end of the corresponding ureter, are liable to be followed by pyelonephritis and pyonephrosis.

4. **Neoplasm** arising in a diverticulum—→ is a comparatively uncommon complication which, contrary to what might be thought, nearly always proves to be not a papilloma but a carcinoma. Unless the diagnosis is made at a very early stage, the prognosis is poor, because extravescical invasion through the thin wall of the sac occurs so readily.



Clinical Features.—An uninfected diverticulum of the bladder may cause no symptoms whatsoever. When a diverticulum of a bladder is disclosed the patient is nearly always a male (95 per cent. of cases). While the majority with this condition are between fifty and seventy years, it is not unusual at an earlier age. Exceptionally the patient is a child.

There are no pathognomonic symptoms of a vesical diverticulum; they are those of lower urinary tract obstruction, recurrent cystitis, and pyelonephritis. Hæmaturia (due to cystitis, vesical calculus, or, rarely, a neoplasm) is a leading symptom in one-third of cases. In a few uncomplicated cases micturition occurs twice in rapid succession. Occasionally this phenomenon is encountered in prostatic obstruction and tabes dorsalis, but when the first specimen is clear and the second cloudy, diverticulum of the bladder should be strongly suspected. Rarely, a large diverticulum is felt per rectum, or, in cases of chronic retention of urine, two swellings are recognised rising out of the pelvis, one being the bladder and the other the diverticulum.

Cystoscopy is the usual means of discovering the diverticulum. Most often its orifice is seen as a clear-cut hole about the diameter of a lead pencil, the depths of which are black and unilluminated. Usually trabeculation of



FIG. 1072.—Usual cystoscopic appearance of the orifice of a diverticulum of the bladder.

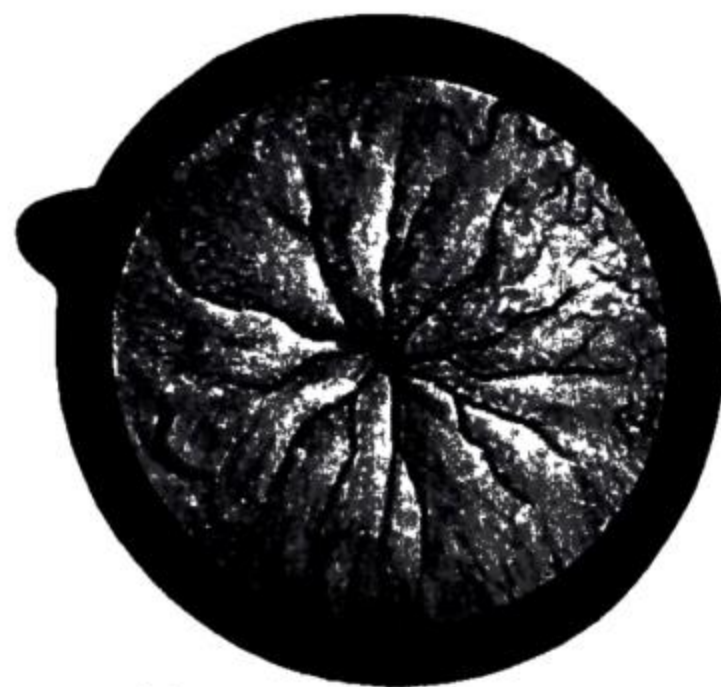


FIG. 1073.—Occasional appearance with inadequate distension of the bladder.

the bladder is present only in the neighbourhood of the orifice (fig. 1072). With inadequate distension of the bladder, sometimes the mouth of the diverticulum is seen closed, when the mucous membrane around the potential orifice is thrown into radiating pleats (fig. 1073); therefore when searching for a diverticulum it is important to have the bladder fully distended. In heavily infected cases much irrigation is necessary before a clear view of the bladder wall can be obtained. The differential diagnosis of a diverticulum from sacculation of a trabeculated bladder is not difficult, for the orifice of the saccule is relatively large, and the shallow interior can be seen. It is sometimes possible to pass an endoscope (but not a cystoscope) into a diverticulum and examine its interior.

Excretory pyelography will not only exclude or reveal implication of the upper urinary tract, but in many instances the accompanying cystogram will give information regarding the size of the diverticulum.

Retrograde cystography is employed only when the former fails to show the pouch clearly. The bladder is emptied of urine, and filled with a non-irritating medium such as neo-hydriol. Radiographs taken before and after (fig. 1074) micturition show the dimensions and position of the diverticulum clearly. Retrograde cystography is prone to awaken latent infection. Consequently, if it is deemed necessary, the patient should be given an antibiotic of wide activity, and be admitted for the examination.

Indications for Operation.—A vesical diverticulum gradually increases in size, and once infected the infection cannot be eradicated permanently. Therefore, unless the pouch is small, empties, and is uninfected, it should be removed, usually before the associated lower urinary tract obstructive lesion is treated.

Pre-operative Treatment.—When, as is usual, the urine is infected, suitable preparative antibiotic treatment is given. In the presence of gross sepsis and retention of urine, it is necessary to resort to an indwelling urethral catheter for forty-eight hours at a time, and give bladder washes. Only in exceptional cases, when the infection cannot be controlled by these means, is suprapubic cystostomy indicated, and then a second tube should be passed into the diverticulum and stitched to the orifice so that both cavities can be irrigated frequently. Suprapubic cystostomy renders subsequent diverticulectomy more difficult.

Combined intravesical and extravesical diverticulectomy is the operation that is practised most frequently. Cystoscopy is performed, and a large ureteric catheter is passed up the ureter on the affected side, and left in place, 8 ounces (240 ml.) of lotion remaining in the bladder. With the patient in the Trendelenburg position, the anterior bladder wall is exposed through a 5-inch (12.5-cm.) suprapubic incision. The peritoneum is dissected upwards, and that side of the bladder bearing the diverticulum is cleared from surrounding structures with the fingers until some part of the pouch is brought into view. The bladder is then incised in the middle line near its dome, and emptied by suction. The interior of the diverticulum is packed



FIG. 1074.—Diverticulum of the bladder shown by cystography.

with a strip of gauze, and with the fingers of one hand in the bladder and the recti muscles retracted widely, the diverticulum is freed from surrounding structures by gauze and sharp dissection. Usually the neck of the diverticulum can be separated from the ureter, and when the pouch is free it is severed from its attachment to the bladder with a diathermy knife. The resulting defect is closed in two layers. The cystostomy incision is sutured around a Malécot catheter, and the abdominal wall is closed, leaving a $\frac{1}{2}$ -inch (1.25-cm.) drainage tube in the extravescical space which housed the sac.

An alternative method, which is helpful when the sac is densely adherent, is to carry the incision in the bladder down to the rim of the diverticular orifice, then to detach the diverticulum, together with its fibrous rim. With hæmostats applied to the neck of the detached diverticulum, and a finger inside it, dissection of it with gauze and scissors, keeping close to the sac, is much facilitated. Occasionally the ureter is so incorporated in the wall of the neck that it must be severed and the proximal end reimplemented into another portion of the bladder.

HERNIA OF THE BLADDER (*syn.* TRACTION DIVERTICULUM OF THE BLADDER)

A portion of the bladder protruding through the inguinal or femoral hernial orifice occurs in 1.5 per cent. of such hernias treated by operation (Sir Cecil Wakeley). The condition is relatively frequent in femoral and direct inguinal herniæ, but the total number of cases occurring in connection with indirect inguinal herniæ is greater because the latter type of hernia is so much more common. The disposition of the protrusion of the bladder in the hernia varies, and in order of frequency is :

(a) *Intraperitoneal*.—The protruded portion of bladder lies wholly within the hernial sac, usually along with other contents.

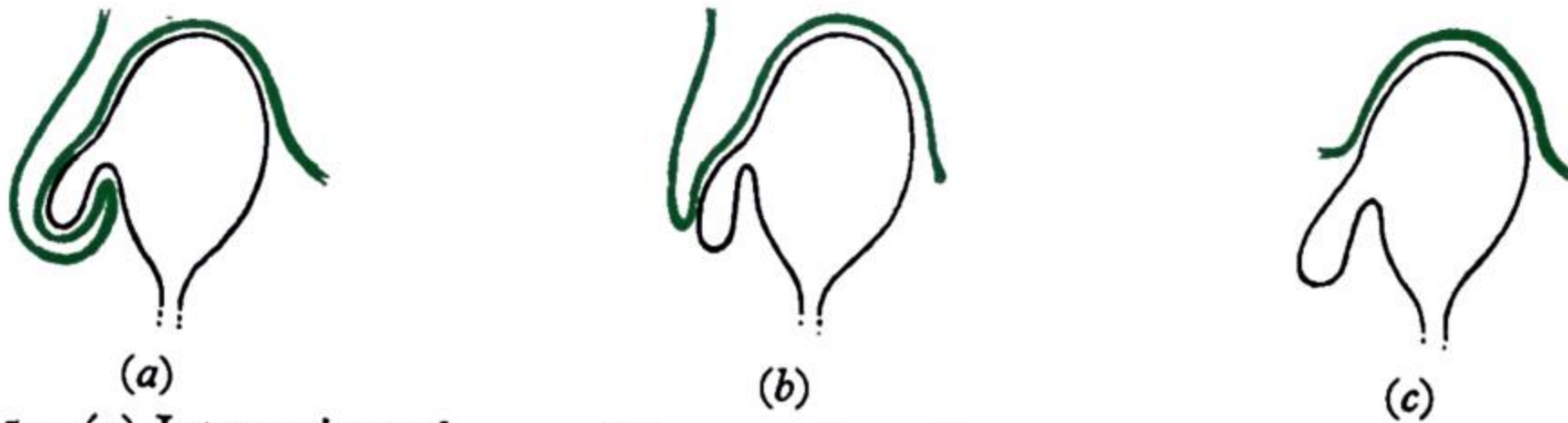


FIG. 1075.—(a) Intraperitoneal, (b) paraperitoneal, (c) extraperitoneal hernia of the bladder.

(b) *Paraperitoneal*.—An extraperitoneal vesical protrusion lies on the medial side of the hernial sac.

(c) *Extraperitoneal*.—There is no sac, the hernia being composed solely of a pouch of bladder.

The great majority of herniæ of the bladder are discovered during operations for hernia. *The intraperitoneal variety* causes but little difficulty, for the bladder protrusion can be reduced into the peritoneal cavity. In *the paraperitoneal variety*, usually the peritoneal sac can be peeled off the bladder by gauze dissection; if this can only be partially accomplished, the hernial sac must be ligated below its neck. *The extraperitoneal variety* is liable to be mistaken for a thickened peritoneal sac, and opened, in which case escape of urine should be obvious.

Clinical Features.—Usually there are no symptoms referable to the bladder, unless there is prostatic or urethral obstruction, when, in a few cases, in order to empty the bladder completely the patient finds it necessary to exert pressure on the hernia. Suspicion of a bladder hernia can be confirmed by cystoscopy or cystography.

Accidental Wounding of the Bladder during an Operation for Hernia.—When recognised at the time, the wound in the bladder should be closed by a double layer of sutures, and either an indwelling catheter is retained for a week or temporary suprapubic cystostomy is performed. If the accident is not recognised at the time, unless early operation is undertaken to repair the rent and drain the prevesical space or peritoneal cavity, as the case may be, together with suprapubic cystostomy, the outlook, especially in the rare intraperitoneal variety, is grave.

Sir Cecil Wakeley, Contemporary. Consulting Surgeon, King's College Hospital, London.

BLADDER FISTULÆ

Vesico-vaginal fistula "is the greatest misfortune that can happen to a woman, the more so because she is condemned to live with it and cannot hope to die from it" (J. F. Dieffenbach).

Ætiology:

1. *Obstetrical Causes.*—From time immemorial the usual cause has been protracted or neglected labour. At the present time this does not appertain in Europe, the U.S.A. or in Australasia, where the general standard of obstetric care is of a high order. Unfortunately the precipitate rise in the number of cases due to causes 2 and 3 has countered the great fall in those arising from cause 1.

2. *Gynæcological Causes.*—The operations chiefly concerned with this complication are total hysterectomy (notably by the abdominal route) and anterior colporrhaphy.

3. *Radiotherapeutic Causes.*—First and foremost is the radium treatment of carcinoma of the cervix uteri; to a lesser extent irradiation of the pelvic viscera by other means is responsible.

4. *Direct Neoplastic Infiltration.*—Exceptionally an untreated advanced carcinoma of the cervix uteri ulcerates through the anterior fornix to implicate the bladder.

When a wound of the bladder is recognised and repaired at once leakage is uncommon, but escape of urine will quickly follow if such damage is passed unnoticed. However, most vesico-vaginal fistulæ are the result of ischæmic necrosis of the bladder wall due to prolonged pressure of the foetal head in obstetric cases, while in gynæcological cases the ischæmia is brought about by catching the bladder wall in a hæmostat, including the bladder wall in a suture or perhaps even by local œdema or hæmatoma. Leakage due to necrosis of tissue seldom manifests itself before five to twelve days after the operation.

An intractable fistula following radium treatment of carcinoma of the cervix uteri often arises from avascular necrosis years after the apparent cure of the original lesion.

Clinical Features.—There is incontinence of urine from the vagina, and, as a consequence, excoriation of the vulva. Digital examination of the vagina reveals a localised thickening on its anterior wall. On inserting a bivalved speculum, urine will be seen escaping from an opening in the anterior vaginal wall. It is usually possible to pass a bent probe from the vagina into the bladder. Cystoscopy is often difficult, owing to the contraction of the bladder from cystitis and the escape of urine from the fistula; however, usually the tip of the probe that has been passed can be seen transitorily, emerging through an area of granulation tissue.

Differential Diagnosis between a Uretero-vaginal and Vesico-vaginal Fistula.
—If a swab is placed in the vagina and a solution of methylene blue is injected through the urethra the vaginal swab becomes coloured blue. In the case of a uretero-vaginal fistula the vaginal swab is not so coloured. Uretero-vaginal fistula is discussed on p. 738.

Treatment.—Operation must be postponed until four to six months after the development of the fistula. This all-important injunction is to enable

viable tissue in the neighbourhood to recover fully and for scar tissue to consolidate. Perhaps this long period of wearisome inaction can be shortened a few weeks by the administration of cortisone.

Closure of the Fistula by the Vaginal Route.—As a rule, the patient should be placed in the lithotomy position, but if the fistula is drawn behind the symphysis pubis, better access can be obtained by placing the patient's knees on a low stool with the abdomen and thorax resting on the operating table. While the posterior vaginal wall is retracted with a Sims' speculum, the vaginal edges of the fistula are excised. The scar tissue in the edges of the bladder wall is also excised, but a minimum of the latter structure is removed—just enough to reveal an oozing surface devoid of scar tissue. When feasible, the reparative stitching should be carried out in the long axis of the vagina. Mattress sutures of silkworm gut or tantalum wire are used. These traverse the bladder wall (but not its mucosa) and the whole thickness of the vagina. If necessary, an incision is made in the vaginal wall on either side parallel to the original incision to relieve tension on the suture line. The operation is concluded by inserting a catheter through the urethra into the bladder. J. Chassar Moir recommends that No. 4 polythene tubing be used for this purpose as it is less irritating than rubber. Extra eyes having been cut, thread is bound around the catheter at the correct distance from the eyes, and tied. One long end of the thread is passed deeply through a lip of the external urinary meatus and tied to its fellow. Thus the catheter is retained for fourteen days, which is so important. All blood and clot is irrigated from the bladder. As soon as the patient has been returned to bed, the catheter is connected to a sterile bottle. If the vaginal suture line encroaches upon the urethra, it is better to withhold a catheter in the urethra and to perform suprapubic cystostomy, with aspiration of the urine by continuous suction.

In cases following radium necrosis a more extensive operation is required because so often the avascular area that must be excised leaves a large defect that cannot be closed by the above means without tension. The difficulty can be overcome by extensive mobilisation of the bladder by the suprapubic route which will allow the edges of that organ to be brought together. The suture line of the bladder is reinforced by omentum, or even the gracilis muscle has been brought through the obturator foramen for that purpose. From the vaginal side the defect can be bridged by skin flaps cut from the labia minora.

Vesico-intestinal Fistula

Congenital (see p. 616).

Inflammatory.—Colonic diverticulitis is the most common inflammatory cause, and sometimes it is stated to be the commonest of all causes of vesico-intestinal fistula, but this statement is open to question. Other inflammatory causes are Crohn's disease, pelvic appendix abscess, tuberculous peritonitis and suppurative parametritis.

Neoplastic.—Carcinoma of the pelvic colon ulcerating into the bladder or, more rarely, carcinoma of the bladder ulcerating into the colon or rectum. A large number of cases prove to be neoplastic colo-vesical fistulæ.

Clinical Features.—The condition is more common in men than in women, a reason being that because of the interposition of the uterus, a communication between the bowel and the bladder is anatomically difficult in the female. In cases due to colonic diverticulitis sometimes there are inaugural bladder symptoms due to the inflamed diverticulum impinging upon the bladder (see p. 526). Once a vesico-intestinal fistula has penetrated the full thickness of the bladder wall, in addition to intractable cystitis, the patient passes gas per urethram (pneumaturia). Occasionally faecal matter or particles of food are passed with the urine, and more rarely still urine is passed via the bowel. There is often an inflammatory or neoplastic mass to be felt in the recto-vesical or utero-vesical pouch.

Cystoscopy.—That a vesico-intestinal fistula is present may be obvious (fig. 1076). If the fistula is small and its edges smooth, it is likely to be inflammatory. An attempt should be made to pass a ureteric catheter through the communication and, if successful, to inject neo-hydriol or other suitable medium, which will render the segment of bowel involved radio-opaque. Other methods of investigation which may help in determining accurately the situation of the fistula are retrograde cystography and a barium enema.

James Marion Sims, 1813–1883, while a country Practitioner at Montgomery, Alabama, was the first to succeed in closing a vesico-vaginal fistula.
John Chassar Moir, Contemporary. Professor of Obstetrics and Gynæcology, Oxford.

Treatment.—The establishment of a defunctioning colostomy above the fistula brings about remarkable improvement in most cases, for no more gas and faecal matter enters the bladder and the cystitis responds to urinary antiseptics. A vesico-intestinal fistula from whatever cause never soundly heals spontaneously. If the general condition improves, a further operation is undertaken to separate the fistulous communication between the bladder and the bowel, and if the lesion is inflammatory, the opening in each viscus is closed and patched with omentum. The operation is concluded by performing temporary suprapubic cystostomy. After the cystostomy wound has healed, a further operation to close the colostomy is undertaken, although if it is deemed necessary, this must be postponed until that portion of the intestine bearing the (closed) perforation has been resected and the anastomosis has healed.

Cases due to Carcinoma.—By the time a fistula between the bowel and the bladder has developed, as a rule, the growth is inoperable or requires pelvic evisceration for its attempted eradication. As so often these patients are unfitted for the latter stupendous undertaking, it is best to leave the patient with the defunctioning colostomy performed in the first instance. Exceptions do occur and occasionally it is warranted to undertake segmental resection of the colon and a partial or complete cystectomy.

Osteo-vesical Fistula.—When necrosis of the pelvic bones, notably the pubis, causes a communication with the bladder, there results what may be called an osteo-vesical fistula (fig. 1077). Such a fistula follows rupture of the bladder associated with fractured pelvis, treated inadequately in the first instance, or as a result of a gun-shot wound. Excision of the fistula, which is often a very difficult procedure, is the only hope of a cure.



FIG. 1077.—Typical X-ray appearances in osteo-vesical fistula.



FIG. 1076.—Cystoscopic view in the case of a vesico-intestinal fistula. Bubbles of gas can be seen issuing from the orifice of the fistula.

CYSTITIS

Both acute and chronic cystitis occur at all times of life, and in both sexes, but they are especially common in women.

Predisposing Causes

1. Important, especially in chronic cases, is incomplete emptying of the bladder, such as occurs in prostatic obstruction, urethral stricture, stenosis of the external urinary meatus, diverticulum of the bladder, pregnancy, and more particularly the puerperium, cystocele, and injuries and diseases of the spinal cord.
2. The presence in the bladder of a calculus, foreign body, or neoplasm.
3. Lowered general resistance from intercurrent disease and avitaminosis.

Avenues of Infection

1. *Descending* from the kidney along the lumen of the ureter.
2. *Ascending* from the urethra probably occurs frequently. The shortness of the urethra is held responsible for the comparatively common occurrence of cystitis in females. Undoubtedly the passage of urethral instruments is a source of cystitis in both sexes, more especially when residual urine is present in the bladder. This does not imply that the instrument was necessarily unsterile at the time it was passed, but rather that instrumentation awakens a latent infection in the posterior urethra.
3. *Lymphogenous.*—The rich lymphatic network at the base of the bladder which communicates with the prostate (fig. 1078), the seminal vesicles or the cervix uteri, and the rectum, provides an avenue by which organisms can reach the bladder from these commonly infected structures.

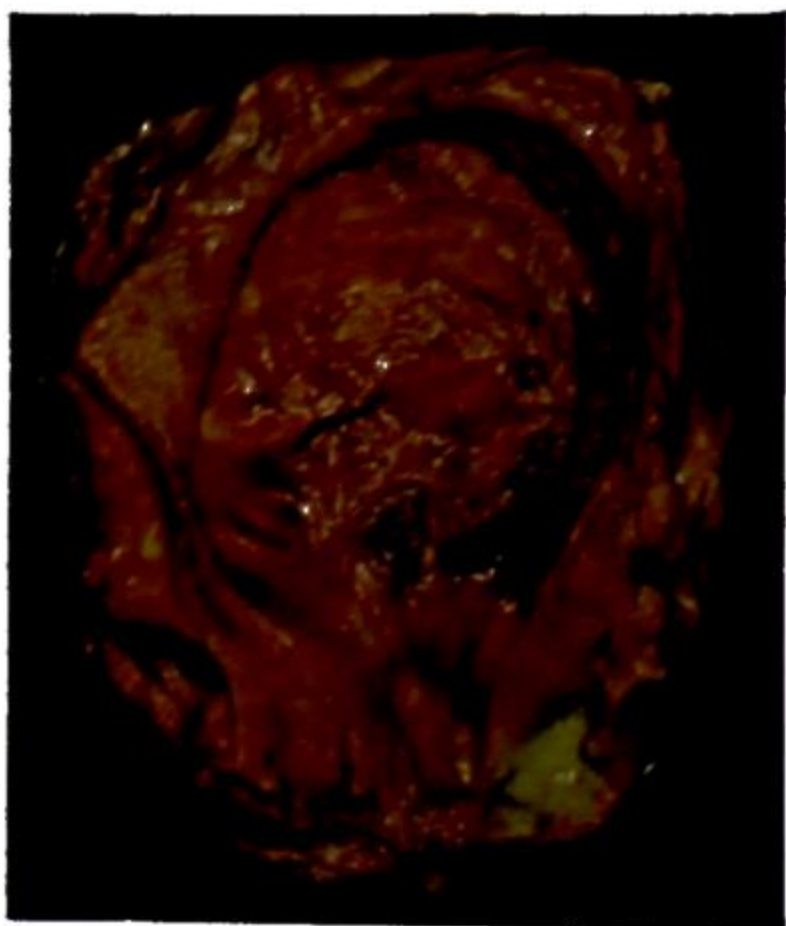


FIG. 1078.—Acute cystitis. The patient, aged forty-four, died of ascending pyelonephritis. The primary focus was acute prostatitis, and pus around the prostate can be seen in the specimen. (Dr. L. C. Hermitte, Sheffield.)

4. *From Adjacent Structures.*—Fistulous communications with the intestine, the vagina, and the Fallopian tube, or by suprapubic cystostomy.

5. *Hæmatogenous.*—Metastasis from a distant focus is exceptional. Interstitial cystitis is regarded as a probable example.

When cystitis has been brought under control, every endeavour should be made to search for, and, if present, treat, a primary focus of infection or remove a predisposing cause. In many cases none can be found.

Bacteriology.—*Esch. coli* is the commonest infecting organism. Less frequently *Streptococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus albus*, *B. proteus* or *Ps. aeruginosa* is responsible. *B. proteus* and *Staphylococcus albus* are urea-splitting organisms that cause persistent alkalinity of the urine. Under 'Special Forms of Cystitis,' tuberculous and typhoid cystitis will be considered.

The presence of pus cells without organisms calls for repeated examinations for the *M. tuberculosis* and the gonococcus (an exceedingly rare cause of cystitis). Having eliminated these possibilities, the condition may be one of abacterial cystitis.

Clinical Features.—The severity of the symptoms varies greatly; those of acute cystitis are usually the more distressing, but some chronic cases vie with them in intensity.

Increased frequency is the outstanding symptom. It is in evidence both during the day and at night. The desire to empty the bladder occurs from every hour to every few minutes, and often it is so urgent that if the bladder cannot be emptied forthwith, incontinence results. In severe cases, because of loss of sleep, the patient looks drawn and haggard.

Pain varies from mild to agonising. When the inflammation is situated in the dome of the bladder, pain is referred to the suprapubic region, while when, as is often the case, the inflammation involves the trigone, pain is referred to the tip of the penis, the labia majora, and the perineum.

Hæmaturia.—The passage of a few drops of blood-stained urine or blood-stained debris at the end of micturition is a frequent accompaniment. Less often the whole specimen is blood-stained, but more so at the end (hæmorrhagic cystitis).

Pyuria is always present, except in some cases of trigonitis and interstitial cystitis (see later). If urine is passed into two glasses, the second is the more cloudy.

Pyrexia.—In chronic cases the temperature is usually normal; in acute cases, unless the cystitis is secondary to pyelonephritis, it seldom rises above 100° F. (37.7° C.).

On examination there is tenderness over the bladder suprapubically,

per rectum, or per vaginam. In the acute stage it is necessary to differentiate between cystitis secondary to pyelonephritis and primary cystitis. Absence of tenderness over the renal angles and a normal or slightly elevated temperature also point to a non-renal origin. The absence of a urethral discharge or a tender swelling of the prostate eliminates a primary focus in the urethra or the prostate. A mid-stream specimen of urine in the male, or either a mid-stream specimen (after cleansing the vulva) or a catheter specimen in the female, should be sent for bacteriological examination with a request that the organisms responsible be tested regarding their sensitivity to antibiotics and sulphonamide. The only other investigation that is permissible at this stage is excretory pyelography, and normal renal shadows substantiate a non-renal origin of the infection.

Treatment should be commenced forthwith, and modified if necessary when the bacteriological report is to hand. The patient is urged to drink plentifully; barley water is suitable; spirits and coffee are forbidden. If the urine is acid, the alkali mixture set out on p. 762 is prescribed. In severe infections it is a good practice to commence treatment with nitrofuratoin 7 to 10 mg./Kg./day in divided doses. This drug has a broad spectrum of antibacterial activity and is particularly effective against *Esch. coli* and pathogenic cocci. Should the response to this drug prove unsatisfactory, when the bacteriological report is received it is possible to select an antibiotic with some precision. In all but severe cases, after seven to ten days the symptoms should be greatly or completely ameliorated, but the necessity for further treatment depends on the cystoscopic findings.

Cystoscopy is required in every case of cystitis, but it should always be postponed until the infection has been wholly or partially controlled by appropriate treatment. According to the severity of the inflammation, the cystoscopic appearance varies from mild to severe changes in the bladder wall as follows:

1. Mild hyperæmia, localised or generalised.
2. Intense hyperæmia with scattered mucosal hæmorrhages (hæmorrhagic cystitis).
3. Bullous œdema.
4. Membranous cystitis due to sloughing of the mucosa.
5. Ulceration where a slough becomes detached.

In types 4 and 5 daily gentle irrigations of the bladder through a catheter with 1 : 5,000 solution of acriflavine, gradually increasing the strength to 1 : 1,000, are often beneficial. To leave in the bladder 4 ounces (120 ml.) of sterile liquid paraffin is soothing—some of the paraffin is retained in the bladder for up to three days.

SPECIAL FORMS OF CYSTITIS

Acute Abacterial Cystitis (*syn.* Acute Hæmorrhagic Cystitis).—The patient, always a young or middle-aged male, presents with symptoms of severe cystitis. Pus is present in the urine, but no organism can be cultured therefrom. The condition, which sometimes is associated with abacterial urethritis, commonly follows recent venereal exposure. While tuberculous cystitis always must be ruled

out by cultural or biological tests, the fact that excretory pyelography shows normal excretion on both sides strongly favours acute abacterial cystitis. In 60 per cent. of cases, by special cultural methods the pleuro-pneumonia-like organism which frequently accompanies acute abacterial urethritis is found.

Although this is a self-limiting disease its course can be shortened by the antibiotic therapy recommended for abacterial urethritis (see p. 874). When cystoscopy is performed after the acute symptoms have abated, abundant mucosal hæmorrhages are seen, and presumably at its height the infection causes a truly hæmorrhagic cystitis. In spite of the fact that pleuro-pneumonia-like organisms abound on the vulva, no case of acute abacterial cystitis has been reported in a female—a truly remarkable and unexplained fact.

Chronic trigonal cystitis is a common form of chronic cystitis in women, often associated with chronic urethritis. Cystoscopy shows increased vascularity of the trigone, œdema of its mucous membrane (most marked towards the apex) and, in severe cases, there is a pseudo-membrane limited to the trigone. Frequently polypi are present in the posterior urethra (see fig. 1171, p. 884). The urethra is commonly narrow—25 F. or less, instead of the normal 35 F.

In all cases of chronic trigonal cystitis a primary focus of infection must be sought, by far the most common of which is either (*a*) the cervix uteri (chronic cervicitis or a cervical erosion) or (*b*) the intestinal tract, notably chronic colonic diverticulitis. Therefore in this condition no examination is complete without examining the cervix by means of a vaginal speculum, and should the cervix prove healthy a barium enema is requested for evidence of colonic diverticulosis. The latter is necessary in every case, whether the cervix is healthy or not, if there is a history of attacks of low left-sided abdominal pain.

Treatment.—In addition to the usual measures, urethral polypi should be destroyed by light fulguration and the urethra dilated, if necessary. Cervicitis or a cervical erosion is treated by excising the glandular tissue of the cervix with a diathermy loop and diverticulitis by low residual diet, regulation of the bowels and a course of phthalylsulphathiazole (see also p. 809 for further treatment of diverticulitis).



FIG. 1079.—Retrograde cystograph showing exceedingly contracted ('thimble') bladder in a case of tuberculous cystitis.

Tuberculous cystitis is always secondary to renal tuberculosis and unless treated early is a particularly relentless form of chronic cystitis.

Living Pathology.—Cystoscopy shows that early tuberculosis of the bladder commences around one ureteric orifice or in the neighbourhood of the trigone. In long-standing cases there is much fibrosis, and the capacity of the bladder is so much reduced that it has earned the name of 'thimble' bladder. This feature can be well shown by cystography (fig. 1079).

Treatment.—After nephrectomy (or, what is highly important, nephro-ureterectomy if the ureter is also diseased) for the associated renal tuberculosis, which is always advanced, combined with sanatorium treatment and the prolonged administration of antituberculous drugs, usually tuberculous

cystitis heals. Local treatment of persistent tuberculous cystitis consists in instillations of a substance inimical to *M. tuberculosis*. Among the best is B53, a soap derived from a branched fatty acid, having a high inhibitory index for the *M. tuberculosis*. A correctly buffered 0.5 per cent. solution containing local anæsthetic is instilled and retained for one hour. A fortnight's course can be repeated after an interval of a week.

When the bladder is considerably contracted but free from ulceration, remarkable relief from the distressing symptoms (almost hourly very painful micturition that interferes with sleep) can be achieved by ileocystoplasty, which is an extremely efficacious method of increasing the capacity of a contracted bladder.

When tuberculous contracture threatens to implicate the sole existing kidney by back pressure, as shown by dilatation of the ureter on excretory pyelography, in addition to ileocystostomy the ureter is implanted into the newly constructed pouch of intestine (see p. 832) with every hope of conserving renal function as well as rendering the patient symptom free.

Ileocystoplasty.—After pre-operative sterilisation of the alimentary tract (see p. 549) a 6-inch (15-cm.) coil of ileum with an ample blood supply as demonstrated by transillumination is disconnected, leaving its mesentery intact, and the continuity of the intestine is restored by anastomosis. After closing the ends of the donor segment it is anastomosed to the dome of the contracted bladder (fig. 1080).

Interstitial Cystitis (*syn.* Hunner's Ulcer; Elusive Ulcer).—For practical purposes Hunner's ulcer can be said to be a condition peculiar to women. The average age for the commencement of symptoms is forty-two years. It can cause more pain, mental anguish and associated neurosis than does carcinoma of the bladder; as a consequence, sometimes the incessant painful micturition it occasions leads to drug addiction and even suicide.

Ætiology is still as obscure as it was when Guy Hunner first described the condition in 1914. Certainly it does not commence as an ordinary pyogenic infection of the mucous membrane, but rather as an infection of the paravesical tissues secondary to, it is suggested, infection of the adnexæ, or even to infection from a more distant focus such as the nasopharynx. Some believe the condition is due to an attenuated *M. tuberculosis* which so far has defied isolation. In a number of instances the symptoms have commenced three or four months after a pelvic operation.

Pathology.—As a result of the paracystitis, fibrosis of the vesical musculature ensues, leading to contracture of the bladder and areas of avascular atrophy of the mucous membrane. Finally, ulceration of the submucosa occurs in the least vascular portion of the bladder, namely the fundus. Often the capacity of the bladder is reduced to 1 to 2 ounces (30 to 60 ml.). The characteristic linear bleeding ulcer is a crack due to splitting of the mucous membrane when the bladder is distended under anæsthesia for cystoscopy.

Microscopically inflammation of all coats of the bladder is present with granulation tissue in the submucosa underlying the ulcer. The muscularis is hypertrophied and the peritoneum in proximity to the area of maximum disease is decidedly thickened.

Clinical Features.—Bladder capacity becoming much reduced, increased frequency, eventually every hour both day and night, is the leading symptom. Pain, relieved by micturition and aggravated by jarring and overdistension of the bladder

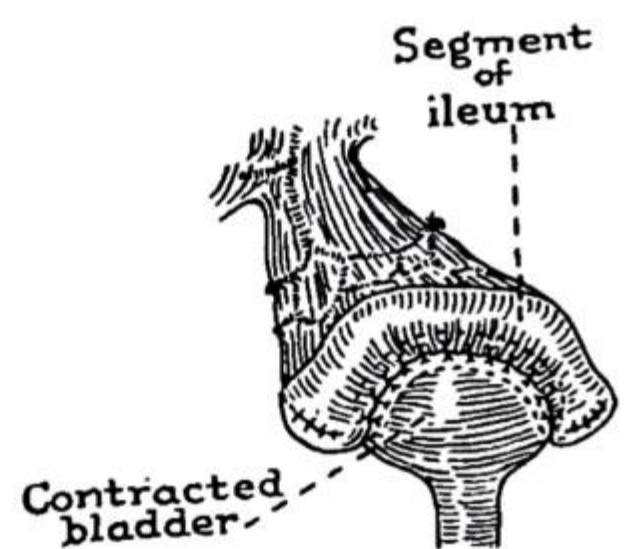


FIG. 1080. — Ileocystoplasty using a 6-inch segment of ileum. (After D. O. Ferris.)

B53 is produced in the laboratories of the Irish Medical Research Council.

Guy LeRoy Hunner, *Contemporary.* Emeritus Professor of Gynæcology, Johns Hopkins University, Baltimore, U.S.A.

is the second and most characteristic symptom. In early cases the urine is crystal clear and sterile; in later cases it contains ordinary pyogenic bacteria in under half

the specimens examined, in the remainder the urine remains sterile. In 60 per cent. of cases hæmaturia is a leading symptom. Occasionally the hæmaturia is violent; one of my patients with this condition was admitted with her bladder distended with blood clot.

Cystoscopy.—The lesion appears in the roof of the bladder as a star-shaped area of intense congestion in which a fissure (fig. 1081) can be seen as the bladder is distended. The ulcer, if ulcer it can be called, bleeds readily.

Treatment.—(a) Once a week, and after a time at increasing intervals, (1) the bladder is emptied and 30 ml. of 0.25 silver nitrate solution is instilled, leaving this in for three minutes; (2) the solution is evacuated and the bladder washed with 30 ml. of normal saline solution; 30 ml. 1:250 solution of procaine is instilled and the patient is asked to retain it for as long as possible.


FIG. 1081. — Hunner's 'ulcer,' cystoscopic appearance.

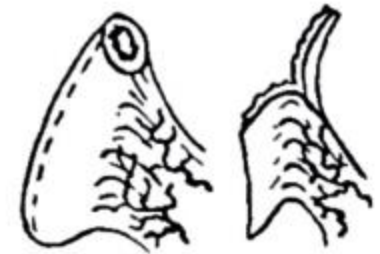


(b) A short hypodermic needle is vulcanised into the distal end of a ureteric catheter. This is passed into the bladder *via* a cystoscope and the needle is made to penetrate the mucous membrane at several points in proximity to the lesion. This allows the injection of 250 mg. of hydrocortisone and 1,500 turbidity units of hyaluronidase in 30 ml. of normal saline solution, which is the optimum dose to be injected at one session. The hyaluronidase causes spreading of the hydrocortisone which helps to dispose of fibrous tissue. Neither of the above is curative, but each gives symptomatic relief in the majority of cases.

(c) Should neither prove satisfactory for any length of time fulguration of the area sometimes gives a long remission.

(d) In long-standing cases with much bladder contraction excision of that part of the dome of the bladder bearing the lesion, followed by ileocystoplasty (see fig. 1080), has been tried, but after a few months of amelioration all have relapsed, due, presumably, to a recrudescence of the inflammation. Therefore no reconstruction should be performed until the infection is, as far as can be ascertained, defunct.

Excision of the dome of the bladder with repair by a patch of ileum with its mesentery intact, viz.  has given more lasting results than the foregoing, and at the time of writing appears to be the method of choice of dealing with interstitial cystitis with pronounced contracture.



Alkaline encrusting cystitis is a rare condition occurring particularly in elderly women, and due to urea-splitting organisms, *Staphylococcus albus* and *Proteus vulgaris*. A deposition of phosphates occurs on the mucosa of the bladder, and the urine smells strongly of ammonia. The symptoms are those of chronic cystitis of many years' duration, and the passage of necrotic material, phosphatic crystals, and sometimes, but seldom, pus and organisms. Radiography occasionally shows a partial or complete outline of the bladder. Cystoscopy performed under spinal or general anaesthesia shows encrustations, usually limited to the base and the sides of the bladder. Removal of the encrustations with forceps through an operating cystoscope, and afterwards light fulgurating of the resulting raw areas, is of value. Daily irrigations of the bladder with solution G (see p. 752) or $\frac{1}{2}$ per cent. acetic acid controls some cases. In a very heavily encrusted bladder, suprapubic cystostomy should be performed, together with curettage of the bladder mucosa. Connecting the suprapubic cystostomy tube with a tidal lavage apparatus containing dissolvent solution sometimes clears up recalcitrant cases.

BILHARZIASIS OF THE BLADDER

Geographical Distribution.—The disease is endemic in the greater part of Africa, throughout Palestine, Syria, Arabia, Iran, and Iraq. It is met with frequently in Portugal and in Greece, and in the islands of Madagascar, Mauritius, and Cyprus. Dwellers along the valley of the Nile have suffered from time immemorial. The condition also occurs along the shores of some of China's great lakes. Marshes

Theodor Maximilian Belharz, 1825–1862. Assistant Professor of Medicine, Cairo.

or slow-running fresh water provide a favourable habitat for the particular fresh-water snail (*Bullinus contortus*) which is the intermediate host.

Mode of Infestation.—The disease is acquired while bathing or standing in infected water. Agricultural workers in districts where bilharzia is rife become infected and reinfected time and again. The free-swimming bifid-tailed embryos (cercariæ) of the trematode *Schistosoma hæmatobium* penetrate the skin by their motile and erosive secretory powers. Shedding their tails, which enable them to swim, they enter blood-vessels and are swept by the blood-stream into all parts of the body. All perish save those that are carried to the liver. Once within the liver the survivors flourish by sustaining themselves on erythrocytes and they develop into male and female worms. The female is long, smooth and slender and is furnished with two weak suckers anteriorly. The male is broader, shorter (11 mm. in length), bossilated and provided with a strong sucker at either end. Sexual maturity having been attained, the nematodes leave the hepatic nursery and enter the portal vein. Here the male bends into the shape of a canoe and in so doing a gutter (the gynæcophoric canal) is formed along its length. Into the groove a female nestles and, thus conjugating, the pair (fig. 1082) paddle their way against the stream towards the inferior mesenteric vein. The long journey is accomplished in short stages, the male's suckers serving as anchors to the vein wall during periods of rest. *Schistosoma hæmatobium* worms have an affinity for the vesical venous plexus, and to reach it they must pass along porta-systemic anastomatic channels, the most important in this respect being the venules in relation to the lumbar lymph nodes (N. Makar); other communications being venules in relation to the lower part of the ureters.



FIG. 1082.—Conjugating male and female *Schistosoma hæmatobium* trematodes. (After A. Looss.)



FIG. 1083.—A bilharzia hæmatobium ovum.

Having reached one of the smaller radicles of the vesical plexus the pair can go no further coupled, so the female, now pregnant but still comparatively slender, parts from the male and moves forward until she enters a submucous venule so small that she completely blocks it. She now proceeds to lay about twenty ova in a chain, and after each is deposited, by slightly withdrawing herself, the venule contracts upon the ovum. Each ovum is provided with a terminal spine (fig. 1083) which penetrates the vessel wall. Aided by muscular contraction of the bladder, and perhaps by secretory fluid, some of the ova reach the lumen of the bladder; others die incarcerated in the mucous membrane. A heavily infected subject passes many hundreds of ova a day. If the ova reach fresh water, the low osmotic pressure of the new environment causes this envelope to burst and there emerges the miracidium, which is ciliated. To survive, the miracidium must reach and penetrate the intermediate host within thirty-six hours. Within the snail's liver the miracidium enlarges and gives rise to myriads of daughter cysts, broods of which are set free on the death of the snail. A single miracidium thus begets thousands of cercariæ to complete the life-cycle.

Clinical Features.—After penetration of the skin there may arise urticaria, which lasts for about five days and sometimes recurs (swimmer's itch). After an incubation period ranging from four to twelve weeks, high evening temperature, sweating, and asthma, together with leucocytosis and eosinophilia of over 10 per cent., sometimes lasts several weeks. Usually an asymptomatic period of several months supervenes before the ova laid in the bladder wall find egress and occasion the typical early sign and symptom of intermittent, painless, terminal hæmaturia. Men are three times more often affected than women. Native patients of the peasant class rarely consult a doctor for this hæmaturia *per se*, so many late cases are encountered.

Examination of the Urine.—The last few millilitres of an early-morning specimen of urine are collected and centrifuged. It is essential that all receptacles be absolutely dry. The ovum is recognised without staining under the low-powered microscope. Examination on several consecutive days may be required. Even so,

Napoleon's troops who served in his march to the Pyramids suffered from hæmaturia.

Naguib Makar, *Contemporary*. Senior Surgeon, Jewish Hospital, Cairo.

a negative result does not exclude bilharziasis, especially in patients no longer resident in bilharzial districts.

Cystoscopy.—Dependent on the length of time the disease has remained untreated, cystoscopy will reveal one or more of the following :

1. *Bilharzial pseudo-tubercles* are the earliest specific appearance. The pseudo-tubercles are larger, more prominent, more numerous, more yellow and more distinctly grouped (fig. 1084) than those of tuberculosis.



FIGS. 1084.—Bilharzial tubercles ; (1085) Bilharzial nodules ; (1086) 'Sandy patches'
(After N. Makar.)

2. *Bilharzial nodules* (fig. 1085) are due to the fusion of tubercles in the presence of secondary infection. They are larger and greyer than the foregoing.

3. 'Sandy patches' are the result of calcified dead ova with degeneration of the overlying epithelium. They occur in the first instance around one (fig. 1086) or both ureteric orifices. Considerable calcification of this nature is visible on the radiograph.



FIG. 1087.—Bilharzial ulcer. (After N. Makar.)

4. *Ulceration* is the result of sloughing of mucous membrane containing dead ova, or what is even more common, sloughing of a bilharzial papilloma. The ulcer is shallow (fig. 1087), bleeds readily and its common position is the posterior wall of the bladder.

5. *Fibrosis* is mainly the result of secondary infection. The capacity of the bladder becomes much reduced. Contracture of the bladder neck is also a common result of bilharzial fibrosis.

6. *Granulomata.*—Bilharzial masses due to an aggregation of nodules form. They are sessile, soft and bleed

rather readily when touched.

7. *Papillomata* are distinguished from the foregoing by being more pedunculated (fig. 1088). They vary in size from that of a pea to that of a walnut and they may be single or multiple. Rarely do bilharzial papillomata become carcinomatous.

8. *Carcinoma* is a common end-result in grossly infected bilharziasis of the bladder which has been neglected for years. It usually commences, not in a papilloma, but in an ulcer, and is therefore a squamous-celled carcinoma. The peak age incidence of bilharzial carcinoma is thirty-nine years—twenty years younger than ordinary carcinoma of this organ.

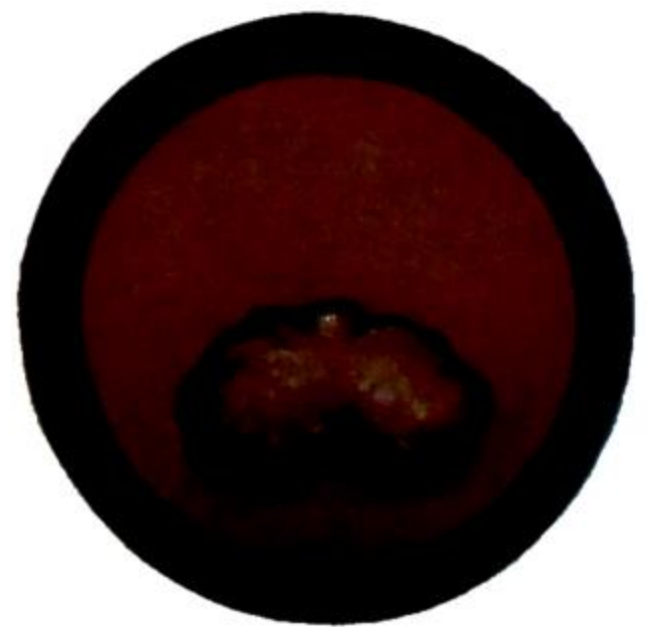


FIG. 1088.—Bilharzial papilloma. (After N. Makar.)

Treatment.—Lesions 1 to 6 inclusive can be expected to heal under general treatment by antimony preparations as described on p. 643. It takes many months for dead ova to be expelled, and even after repeated courses

John Christopherson, 1868–1955, Director of Civil Hospitals, Khartoum, introduced the treatment of bilharziasis by the intravenous injection of tartar emetic.

and healing of the bladder lesion, living bilharzial worms have been found at necropsy in the portal system. In addition to general treatment, healing of bilharzial ulcers and granulomata are expedited by light diathermy coagulation. Bilharzial papillomata and, of course, carcinoma do not respond to general treatment: these lesions require the same surgical measures as non-bilharzial papillomata and carcinomata, in addition to general treatment.

Other Complications and their Treatment:

(a) *Secondary bacterial cystitis* is commonly present in cases of some standing and the treatment of it must be thorough and prolonged.

(b) *Urinary calculi*, especially vesical and ureteric occur more frequently when bilharzial lesions of the bladder are present. Litholapaxy is better avoided in cases where there is ulceration of the bladder wall.

(c) *Stricture of the ureters* affects the last inch of the ureters. These strictures often respond to dilatation but sometimes require transplantation of the affected ureter into another part of the bladder.

(d) *Prostato-seminal vesiculitis*, like tuberculosis of those structures, is made worse by prostatic massage, and general treatment alone must be employed.

(e) *Contracture of the bladder and contracture of the bladder neck* must be treated in the same ways as similar contractures of non-bilharzial origin.

(f) *Bilharzial urethral strictures* are often accompanied by fistulæ, and can be cured only by excision of the fistulous tracks and urethroplasty (see p. 868).

NEOPLASMS OF THE BLADDER

More than 95 per cent. of primary tumours of the bladder originate in its mucous membrane; the remainder are connective-tissue growths—angioma (the least uncommon), myoma, fibroma, and sarcoma. These are too rare to merit further description in this work, as also is a phæochromocytoma arising in the bladder wall from an accessory adrenal gland.

Secondary involvement of the bladder can occur from extension of a malignant neoplasm of a neighbouring organ, particularly the large intestine (sigmoid and rectum), the uterus or an ovary.

On rare occasions the first symptoms of a carcinoma of the pelvic colon are those of cystitis. Cystoscopy reveals a circumscribed area of intense inflammation, usually on the left side of the fundus. If the diagnosis is not made and treatment carried out at this stage, a vesico-intestinal fistula results (p. 812).

This, however, is a convenient place to describe another uncommon benign bladder tumour which is not so rare as to be classified as a pathological curiosity.

Endometrioma is characterised by a localised, smooth, vascular projection on the bladder wall, sometimes containing chocolate-coloured cysts; and at other times translucent cysts of a bluish hue. The tumour enlarges and bleeds during menstruation. The treatment is partial cystectomy.

PRIMARY EPITHELIAL TUMOURS OF THE BLADDER

Ætiology.—Apart from the fact that epithelial tumours occur in aniline-dye workers, and workers in other industries using similar chemicals, more frequently than in other persons; that carcinoma of the bladder not infre-

quently arises in cases of long-standing vesical bilharziasis, especially when it is chronically infected and encrusted; and that, as with epithelial tumours of the tongue, leukoplakia must be regarded as a precarcinomatous condition, nothing is known as to the cause of tumours of the bladder.

Some believe that these tumours are all due to a carcinogen (as yet unidentified) excreted in the urine, and that so-called recurrences are new neoplasms brought into being by the self-same carcinogen. Others maintain that some papillary neoplasms of the bladder are due to a filtrable virus and quote papillomata acuminata (see p. 895) as a pertinent analogy.

Whatever the cause, it is an established fact that tumours of the bladder are increasing in frequency at a rate that can be accounted for neither by improved methods of diagnosis nor the ageing of the population nor by a combination of these factors: also these tumours of the bladder are occurring at an earlier age than was the case ten or twenty years ago.

Tumours of the Bladder as an Industrial Disease.¹—Papillomata and especially carcinomata of the bladder occur with considerable frequency among aniline-dye workers and in workers in several other industries where certain chemicals, notably aromatic amines and coal-tar products, are used. Although in Britain the manufacture of β -naphthylamine was banned in 1952, as the bladder tumours take up to twenty years to develop, and as the exposure need not have been long, new cases due to absorption of β -naphthylamine continue to occur and are to be expected for a number of years to come (M. L. Kennedy). Means have not been found for doing without other, though less potent, carcinogens, such as benzidine, α -naphthylamine and auramine, and new cases from absorption of these chemicals are bound to occur.

Vesical tumours occurring as an industrial disease do not differ in appearance or behaviour from those not related to chemical exposure.

Classification.—There is a bewildering number of classifications of epithelial tumours of the bladder in current use. After due consideration it has been decided to include two of these: first a clinico-cystoscopic classification and second a histological grading.

I <i>Clinico-Cystoscopic</i>	II <i>Histological</i>
Villous papilloma. Diffuse papillomatosis. Malignant papilloma. Nodular carcinoma. Carcinomatous ulcer.	Papilloma. Transitional-cell carcinoma $\left\{ \begin{array}{l} \text{Differentiated.} \\ \text{Anaplastic.} \end{array} \right.$ Squamous-cell carcinoma. Adenocarcinoma.

Pathology:

Benign Villous Papilloma.—The earliest stage of a primary growth is not seen cystoscopically, but it can be surmised from microscopical data as a minute red excrescence of mucous membrane no larger than a pin's head; later it becomes tufted. From these tufts spring villi—long, finger-like projections composed of three or four layers of transitional epithelium surrounding a capillary vessel with a minimum amount of supporting fibrous tissue. Thus the fully developed papilloma appears like a red sea anemone with delicate tentacles eddying to and fro with each and every

¹ Workers exposed to this hazard should have a sample of urine centrifuged and examined for red cells at 3-monthly intervals.

movement of the bladder contents. Most benign papillomata are pedunculated, the pedicle is slender and its central core of fibrous tissue and blood-vessels springs from the submucosa. Much more rarely it is sessile, the villi then taking origin from the mucous membrane. By far the most frequent location of a primary villous papilloma is above and to the outer side of one ureteric orifice, which, as the growth increases in size, may become obscured. The ureteric orifice is sometimes obstructed by the neoplasm and a varying degree of hydronephrosis and hydroureter results. Usually the growth remains localised for months or even years, gradually increasing in size, and on rare occasions it fills the greater part of the bladder. I have removed a papilloma arising from a single stalk weighing nearly 3 lb. (1.5 Kg.). Size without any of the changes about to be described is not necessarily a sign of malignancy. At any time during its existence other, less mature, growths are liable to appear. When the bladder is examined cystoscopically for the first time, multiple growths are present in over one-third of cases. Daughter growths are often situated at points of contact of the bladder mucosa with the neoplasm when the bladder is empty (fig. 1089). At other times they are situated near the parent growth, and probably arise from the detachment of small portions of the parent neoplasm. Some maintain that no seeding is possible without abrasion of normal mucous membrane. In the case of a villous papilloma, irrespective of the method of its removal, the prospect of the reappearance of the neoplasm within three years is 50 per cent., and in 15 per cent. of these the reappearance will, on histological examination, prove to be malignant (V. F. Marshall). Therefore every villous papilloma is potentially malignant, and should an open operation be deemed necessary meticulous precautions must be taken to prevent implantation of cells in the abdominal wall, for if they gain this situation they take on a malignant character.

Diffuse papillomatosis is a term used to signify a condition in which multiple small growths are disseminated over a relatively wide area of the bladder wall. Pedicle formation is not so pronounced as in the solitary variety, and therefore malignancy must be regarded as less remote. To justify a diagnosis of diffuse papillomatosis a stage must have been reached when multiplicity has outstripped the ability to keep the bladder clear by endoscopic destruction of the neoplasms and/or patches of abnormal (more vascular and oedematous) epithelium are present as well as papillomata. The behaviour of these neoplasms has led some to believe that the condition is due to a



FIG. 1089.—Papilloma with daughter implantations ('kiss cancer').

virus infection (vide papillomata acuminata of the vulva and the glans penis, pp. 887, 895).

Malignant Papilloma.—Malignant change in a papilloma is characterised by the appearance of one or more of the following alterations: (a) the villi become stunted, closely packed, and swollen, resembling a cauliflower; (b) the growth becomes sessile (90 per cent. of villous papillomata are pedunculated); (c) the bladder wall immediately adjacent is more vascular and œdematous; (d) the surface of the growth becomes ulcerated, shows areas of necrosis, or becomes encrusted with urinary salts; (e) a bladder tumour accompanied by cystitis is nearly always malignant.

Multiplicity of the growth is not necessarily a sign of malignancy, provided the daughter growths are limited to two or three and the rest of the bladder mucous membrane is normal. When this number is exceeded and/or a patch of œdematous vascular mucosa is seen (indicating that sloughing of a

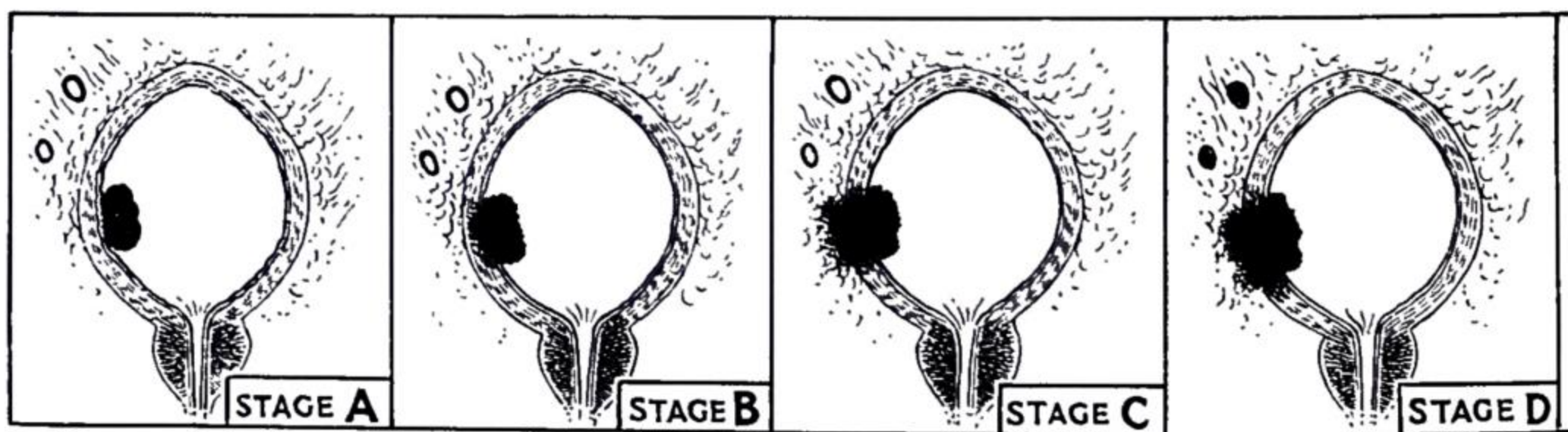


FIG. 1090.—The five stages of progression of a malignant papilloma of the bladder. Implantation daughter growths within the bladder have been omitted. Stage E (not shown) distant metastases occur. (After C. Dukes and F. Masina.)

papilloma has occurred) the growths must be deemed malignant. Unablated, this neoplasm, like other forms of vesical carcinoma, invades the bladder wall (fig. 1090) and gives rise to regional and distant metastases.

Nodular Carcinoma.—Instead of being tufted, the surface is bald from the outset. The tumour, which is sessile, becomes lobulated (fig. 1091), is deep red, and bleeds on being touched. It is liable to become covered with a powder of phosphates. Later the surface becomes ulcerated in places. Lymphatic metastases occur earlier than is the case in malignant papilloma. Nodular carcinoma is the second most common form of carcinoma of the bladder.



FIG. 1091.—Nodular carcinoma of the bladder, sometimes known as the 'bun-shaped' tumour.

Carcinomatous ulcer is similar in appearance to a carcinomatous ulcer elsewhere, and occasionally it arises in a patch of leukoplakia. This type of growth occurs in the base of the bladder and on the trigone. This is the most malignant carcinoma of the bladder.

Primary adenocarcinoma of the bladder occurs only in about 1 per cent. of cases. It is a highly malignant tumour commencing in the fundus of the bladder of relatively young patients, and is believed to arise in the remnants of the urachus. Secondary adenocarcinoma of the bladder from a primary neoplasm in the stomach, colon, rectum or prostate is more common than that originating in the bladder.

Sites of Election of Carcinoma of the Bladder.—Massed statistics show that the lateral walls and the trigone are the portions of the bladder attacked most frequently by a malignant epithelial tumour.

Metastases.—Lymphatics do not exist in the submucosa of the bladder, therefore superficial tumours do not metastasise (P. Aboulker). While undoubtedly favouring *local* recurrence, when a carcinoma has invaded the muscle coat (but no further) it is doubtful if metastasis occurs. For these reasons, on the whole, vesical neoplasms are slow to metastasise and the incidence of distant metastases is relatively low, irrespective of the histological characters of the tumour. On the other hand, once the neoplasm has penetrated the musculature and has reached the prevesical fat, dissemination *via* the numerous lymphatic channels and, toward the bladder-base, the vesical venous plexus affords plentiful opportunities for would-be metastases to escape—and escape they do—into the lymphatics, to reach the lymph nodes along the external iliac and common iliac vessels, thence to the para-aortic lymph nodes and from there to the mediastinal lymph nodes. By the blood-stream they can be swept to the lungs, liver, bones or the brain.

Clinical Features.—*Benign Papilloma.*—Painless, bright red, intermittent hæmaturia is the only symptom for a long period. The hæmaturia may last for a few hours or a few days, and then it ceases. After an interval of weeks or months, bleeding recurs; as time progresses the intervals become shorter and the hæmaturia more severe and of longer duration. Eventually the resulting anæmia may be so severe as to necessitate blood transfusion. Clot retention sometimes occurs, as also dysuria if the growth obstructs the internal urinary meatus. A slight ache in one loin is not uncommon, and usually signifies a commencing hydronephrosis. Occasionally, when papillomata are multiple or large, there is increased frequency of micturition from a feeling of incomplete emptying of the bladder. Bimanual rectal or vaginal examination is entirely negative. In 80 per cent. of cases painless hæmaturia remains the only symptom and sign.

Malignant Neoplasm.—In 95 per cent. of cases the initial symptom is intermittent hæmaturia, which eventually becomes continuous. It is a sad fact that in spite of this ominous sign more often than not twelve or more months elapse before the patient presents for treatment, and this is not always the patient's fault. Occasionally (in carcinomatous ulcer) the first symptoms are those of severe cystitis. In all cases sooner or later cystitis supervenes, and painful, frequent, blood-stained micturitions are the dominating symptoms in established cases. As time goes on, strangury occurs at the end of each act of micturition. A late manifestation due to nerve involvement is pain referred to the suprapubic region, the groins, perineum, the anus or down the thighs. "Oh, Lord, when Thou takest me, take me not through my bladder," was the nightly prayer of an old surgeon living in London.

Pierre Aboulker, Contemporary. Chef de Service, Hôpital St. Louis, Paris.

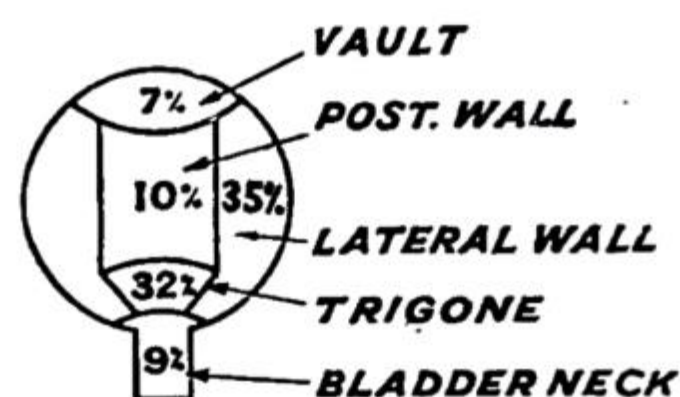


FIG. 1092.—Sites of carcinoma of the bladder. (*American Urological Association Statistics.*)

Investigation:

Examination of the Urine.—If necessary the urine is examined for microscopical evidence of blood. A midstream specimen should always be sent for culture.

Excretory Pyelography.—Occasionally the preliminary plain film shows a faint shadow of an encrusted neoplasm of the bladder. As a rule in cases of papilloma, excretory pyelography displays normal kidney function. When the neoplasm is obstructing a ureteric orifice, dilatation of that ureter will be apparent. In the case of a large neoplasm a filling defect of the bladder (fig. 1093) is likely to be revealed.



FIG. 1093.—Cystograph in a case of malignant papilloma of the right side of the bladder.

Cystoscopy is the mainstay of diagnosis. It should be performed in every case of hæmaturia. The main cystoscopic appearances of bladder tumours have been described under 'Pathology'.

Following cystoscopy, but before any trans-urethral operation or biopsy is undertaken, the following important examination is made.

Bimanual palpation under general anaesthesia (recto-abdominally in the male and recto-vaginally in the female), with the patient's abdominal musculature completely relaxed and the bladder absolutely empty, is of salient importance in determining the stage of progression of the neoplasm and the potentialities of a cure by any given method. When a papilloma is impalpable, it is most unlikely that it has invaded the deeper layers of the bladder wall. While a very large papilloma sometimes can be felt, the tumour is mobile within the bladder (fig. 1094 (A)). When a localised but definite thickening can be made out which is as movable as one would expect the bladder to be, it is probable that the bladder wall is infiltrated, but not penetrated (fig. 1094 (B)).

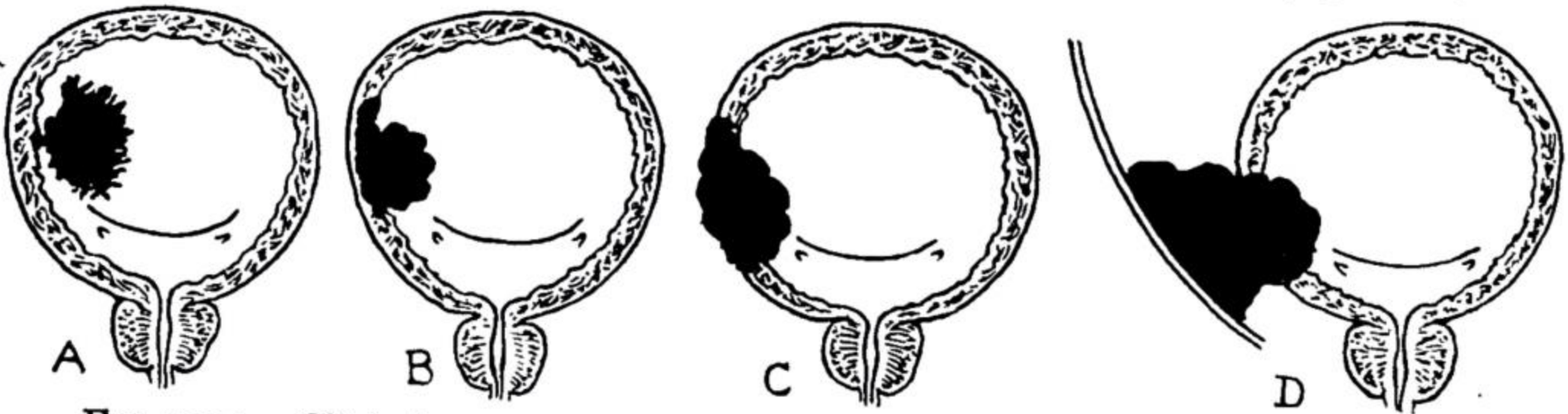


FIG. 1094.—Clinical assessment of the stage of progression of a bladder tumour by bimanual palpation. (After D. M. Wallace.)

On the other hand, if in addition the mass is larger than would be expected from the cystoscopic appearance but is not fixed, extravescical spread (fig. 1094 (C)) has certainly occurred and the ultimate prognosis, irrespective of the method of treatment, is poor. When a mass is easily palpable, fixed to the bony pelvis (fig. 1094 (D)) and firm to stony-hard in consistency, palliative measures alone are advisable.

The careful studies of H. J. Jewett have shown that the degree of infiltration, as adjudicated by bimanual palpation under general or spinal anaesthesia

is a more valuable criterion of potential curability than the degree of malignancy revealed by histological studies. As will be appreciated, the adversary of the method is obesity.

Biopsy.—The removal of a tiny piece of tissue is useless in most instances—the biopsy must be adequate, by which is meant removal of a large piece of tissue with a resectoscope, a procedure necessitating complete anæsthesia (Gershom J. Thompson). It is also important to submit for histological examination a piece of tissue as near to the bladder wall as possible and, even more important, a piece of tissue that includes the underlying vesical wall itself. Another method of obtaining a biopsy specimen, suited particularly to large growths and doubtful areas of exuberant mucosa, is by means of cystoscopic rongeur forceps (see fig. 1069), the jaws of which are hollowed, and can be made to bite. An advantage of this method is that a specimen obtained in this way is not seared by heat.

Treatment:

While the treatment of a solitary pedunculated papilloma is standardised except for comparatively minor details in technique, the same being true if a few seedlings are present, as we proceed from the probably malignant to the undoubtedly malignant bladder tumour, so the gulf of controversy as how best to eradicate the neoplasm widens. At the present time vacillation between ultra-radical operations to wholly conservative measures is to some extent influenced, on the one hand, by the appearance of new isotopes or new methods of applying them, and, on the other, by better methods of diverting the urinary stream after removal of the bladder.

Cystodiathermy.—The widely employed method of destroying benign papillomata is coagulation diathermy applied by an electrode through an irrigating cystoscope. A small solitary papilloma can be treated satisfactorily, employing local anæsthesia of the urethra, the patient being ambulatory. For larger growths a general or spinal anæsthetic is given which permits more massive fulguration, but necessitates in-patient treatment. If daughter growths are present, they are fulgurated first.

The electrode is made to impinge upon the surface of the tumour, and the current is switched on. Blanching and coagulation occur in that part of the tumour in contact with the electrode, with the formation of bubbles of hydrogen (fig. 1095). When a considerable number of villi have been destroyed, the electrode is withdrawn and applied to another area. Often the electrode adheres to the fulgurated tissues, and on withdrawing it pieces of coagulated tissue are adherent to it, and the electrode must be removed and scraped. The process is repeated until all the growth has been destroyed or the medium becomes too cloudy for further progress. At the close of the operation the bladder is washed out with 1:4,000 silver nitrate, and 3 ounces (100 ml.) of the solution are left in.


Sulphafurazole is prescribed and the patient is recystoscoped in four weeks' time, when further treatment is carried out if necessary. Larger papillomata



FIG. 1095.—Cystodiathermy of a papilloma of the bladder.

Edwin Beer, 1876–1938, Surgeon, Mount Sinai Hospital, New York, introduced fulguration of bladder tumours in 1910.

Gershom J. Thompson, *Contemporary*. Head of Section, Urology, Mayo Clinic, Minnesota, U.S.A.

can be destroyed more quickly by Kidd's diathermy cystoscope. Instead of the necessarily small electrode that must be used with a standard cystoscope, in Kidd's instrument a relatively large ball electrode is incorporated on the beak of the cystoscope, viz. 

Excision with a resectoscope is indicated when the tumour is too large to be destroyed at one (or at the most two) sessions of cystoscopic electroscopic coagulation, and especially for small papillary carcinomata with little or no infiltration. The instrument used for this purpose is a modification of the diathermy-cutting loop prostatic resectoscope with a longer shaft than that employed for the prostate. Transurethral electro-excision is conducted under general or spinal anaesthesia. After the main part of the tumour has been sheered away, electro-excision of the base flush with the bladder wall (fig. 1096) is accomplished. Cautiously a slight gutter is then made beneath the site of attachment. Avoidance of downward pressure minimises perforation of the bladder—the leading danger of this excellent method. The irrigating fluid should be



FIG. 1096.—Transurethral electro-excision of the stalk of a pedunculated papilloma, the head of which has been removed by previous cuts.

distilled water, in which tumour cells exfoliated during the procedure are unlikely to survive.

Transvesical Excision of a Large Villous or a Malignant Papilloma.—

The bladder is distended with 1 : 4,000 silver-nitrate solution and the viscus is exposed by a suprapubic incision. The contents of the bladder having been evacuated by a trocar and cannula (fig. 1097), which permits suction of the fluid contents so

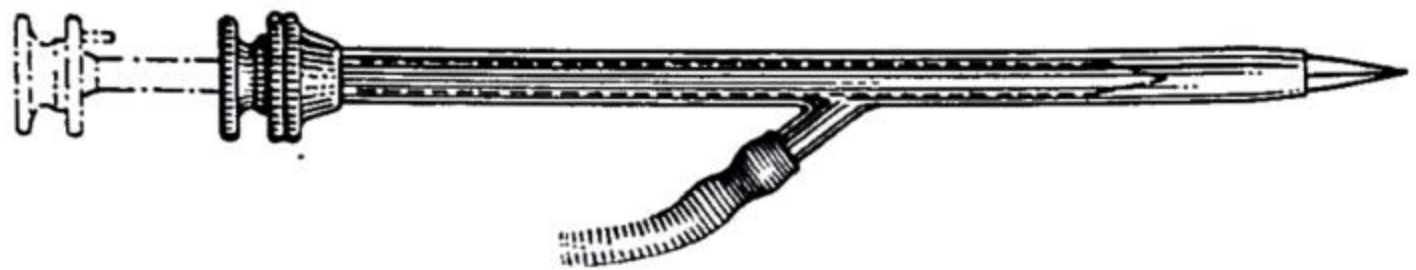


FIG. 1097.

that none is spilled, the edges of the abdominal wall are covered with packs soaked in silver-nitrate solution or 60 per cent. alcohol, as a precaution against contamination of the wound by detached tumour cells. The bladder is opened, and after placing the patient in Trendelenburg's position, a self-retaining retractor is inserted. The surface of the tumour is lightly coagulated (with the object of prevention of detachment of cells). It is then picked up with toothed dissecting forceps as near the bladder wall as possible. An innocent tumour can be elevated so that there is a substantial pedicle of normal mucous membrane. This is transected with the diathermy needle. After coagulating bleeding-points, the area from which the papilloma sprang is electro-coagulated. In the case of a sessile neoplasm, a diathermy loop electrode (fig. 1098) allows excision of the tumour down to, and including a fraction of, the muscle layer. This accomplished, the cut surface is lightly fulgurated. The bladder can then be closed with indwelling urethral catheter drainage. Corrugated rubber drainage of the prevesical space is also necessary.

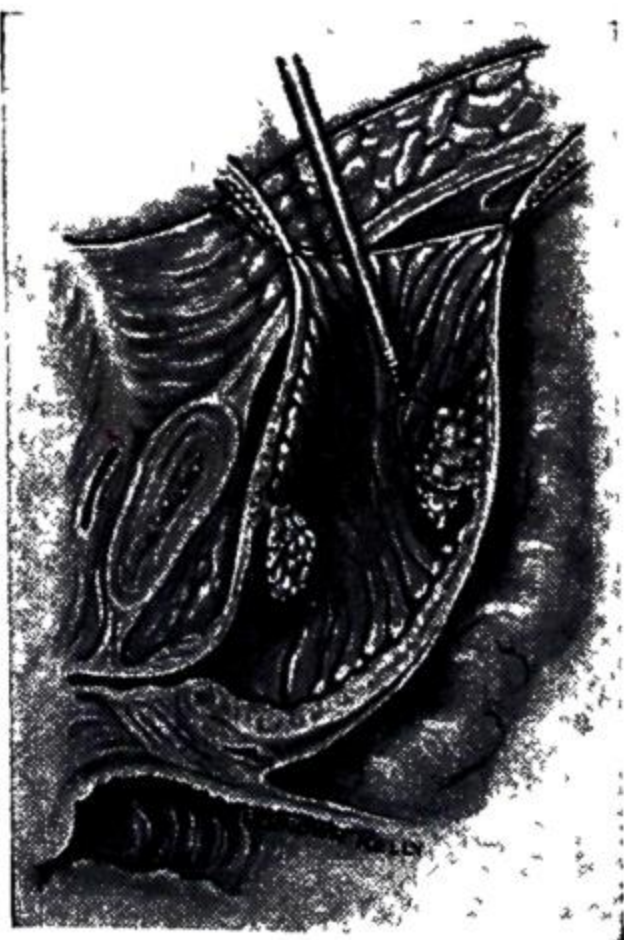


FIG. 1098.—Transvesical excision of a bladder tumour with diathermy loop electrode. (After A. R. C. Higham.)

Follow-up.—After the papilloma has been destroyed, endoscopically or by open operation, it is

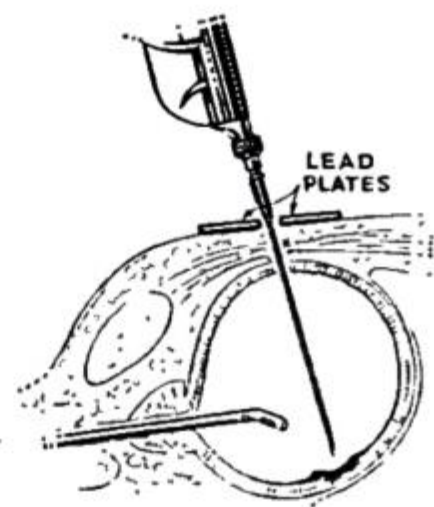
Francis Seymour Kidd, 1878–1934. Surgeon-in-charge of the Genito-Urinary Department, The London Hospital.

essential that the patient be examined cystoscopically, commencing at three-monthly intervals and, if there is no recurrence, gradually lengthening the interval to one year. In 30 per cent. of cases there is no recurrence. In the remainder there are recurrences, either at the site of the original lesion or in another part of the bladder, but as a rule they can be kept under control with regular cystodiathermy.

Additional or Alternative Methods:

(a) **Implantation of Radon Seeds.**—Through the opened bladder the seeds are inserted into the site of origin and the immediate (1 cm.) vicinity of the excised tumour, sufficient seeds being inserted to deliver a maximum dose of 7,000 r. It is advisable to insert a Foley's catheter and to fill the balloon with a saturated solution of lead nitrate; this acts as a screen against radiation of the opposite side of the bladder (R. Darget). The bladder is then closed with the foregoing urethral catheter drainage. The advantage of radon over radium is that the seeds need not be removed.

(b) **Implantation of Radioactive Gold Grains (^{198}Au).**—The gold grains are a fraction of the size of radon seeds, and are inserted by means of a repeater gun, which is loaded with fifteen of these minute cartridges. This isotope has a half-life of two and a half days, and its emanations are such that it is necessary to collect and save all urine of the patient until the isotope half-life has expired. Further, it is necessary for the operator, and particularly his first assistant (who operates the gun), to be protected. Emanations from the bladder are screened by the lead plates shown in the illustration, but if several patients are to be treated in this way within fourteen days, the assistant must be protected more effectively. As a rule the neoplasm is resected endoscopically not quite flush with the bladder wall. Three days later, when bleeding has ceased, after the bladder has been distended a cystoscope is passed. The assistant then directs the needle of the gun into the bladder above the pubes. The cystoscopist holds the cystoscope in one hand and takes the needle of the gun in the other, and directs its point near the base of the growth. The assistant fixes the gun, and fires, viz. —————→



These manœuvres are repeated until the desired number of gold grains (seven to fifteen) have been implanted into the base and vicinity of the tumour. In the female, the needle of the gun can be inserted along the urethra or through the anterior wall of the vagina by the operator himself.

(c) **Radioactive tantalum wire (^{192}Ta)** has a long half-life (four months), and it therefore can be stored in the hospital ready for use when required, instead of having to be obtained from an atomic pile for each patient. Another advantage is that the wire is fully active during the whole of its sojourn in the bladder wall; consequently the dose is controlled, not by multiplying the wires, but by one (or at the most two) standard wire left in for a sufficient time. The wire is bent hair-pin fashion with a loop provided at the blunt end. Through the opened bladder the sharp ends of the wire are drawn beneath the base of the tumour by means of a twin boomerang needle, which enters and emerges some millimetres from the periphery of the neoplasm. The wire having been inserted, a plastic or rubber catheter is passed from the external urinary meatus and its tip is attached to the loop of wire by a stitch, viz. —————→



(d) **Nylon sutures containing radioactive cobalt (^{60}Co .)** are inserted in the same way. V. Vermooten stresses that the bladder be mobilised (see partial cystectomy) before it is opened, so that with a finger on the outside of the bladder opposite the tumour the sutures can be inserted as near the outer surface of the bladder as possible.

(e) **Deep X-ray Therapy.**—At a *prima facie* perusal the views expressed on the value of deep X-ray therapy of bladder tumours unsuitable for resection and those that recur quickly after resection appear diametrically opposed. The larger number

Raymond Darget, *Contemporary*. Professor of Urology, Faculty of Medicine, Bordeaux.

David Mitchell Wallace, *Contemporary*. Surgeon, St. Peter's Hospital for Stone, London.

Vincent Vermooten, *Contemporary*. Urologist-in-Chief, Parkland Hospital, Dallas, Texas, U.S.A. ●

of surgeons incline to the view that the intractable irradiation cystitis with diminished bladder capacity and the proctitis or vaginitis that the patient suffers as a result of this form of irradiation, together with the nausea and vomiting, hardly merit the few lasting favourable issues. Other surgeons emphasise an absence of such complications and a favourable response in about 30 per cent. of cases, but as a rule six months must elapse before the improvement is noticeable cystoscopically. The explanation of this seeming paradox is that the favoured few are able to refer their patients to a department equipped with a 4,000,000-volt linear accelerator.

(f) **Intracavitary Irradiation.**—A solid source of radiation (radium or radioactive cobalt ($^{60}\text{Co.}$)) is placed in the centre of a balloon catheter, which is passed into the bladder. The balloon is then distended with air. Another technique is to employ a radioactive solution of sodium or bromine to distend the balloon. Both methods have been tried on an extensive scale. The results have been disappointing because (a) the balloon compresses and flattens papilliferous growths against the bladder wall, so that only certain fronds receive the full impact of the irradiation; (b) in the case of solid growths, a dose sufficient to penetrate the thickness of the neoplasm will damage the normal part of the bladder. Theoretically a colloidal solution (little or no absorption of the colloid solution occurs) containing suspended radioactive gold should be most effective, for a very superficial dose is delivered, and the solution reaches the whole surface of every frond. However, here again the results have not fulfilled expectations, and the dangers of irradiating the members of the staff is a constant worry.

Excision of a Part or the Whole of the Bladder:

Partial Cystectomy (*syn.* Segmental Resection).—Although employed almost entirely for solid types of tumour, which are more malignant than the papilliferous, this operation gives a five-year cure rate in 45 per cent. of cases. It is the operation *par excellence* for endometrioma of the bladder. Its disadvantage is that many malignant tumours of the bladder are situated near the trigone, where the operation is inapplicable. In a few clinics this operation has been abandoned in favour of other methods. After exposing the bladder, the first step is to mobilise the organ. The prevesical fat is dissected from either side of the urachus so as to enable this structure to be clamped, divided and ligated. The lateral walls are dissected from the peritoneum, exposing the terminal ends of the ureters. That side of the bladder containing the growth is freed, so that the finger can reach well beyond the site of neoplastic infiltration. During this stage of the operation the peritoneum is sometimes opened inadvertently, in which case the hole is closed by a purse-string suture. As a result of mobilisation, a large part of the bladder can be drawn out of the wound. The bladder is emptied, opened and the incision into it is extended to within 1 inch (2.5 cm.) of the growth with the diathermy knife. That part of the bladder containing the growth, together with a surrounding inch of the whole thickness of healthy bladder wall, is excised. When the neoplasm is situated near a ureteric orifice, the ureter should be divided before the excision is carried out, and after the excision has

been completed, transplantation of the ureter into the bladder is performed. The defect in the bladder is closed by an inner continuous suture and an outer layer of interrupted sutures, provision being made for the introduction of a Malécot catheter. The abdominal wall is closed with drainage of the prevesical space by a piece of corrugated rubber.

Subtotal Cystectomy.—Like total cystectomy, the operation is conducted intra-peritoneally. The whole of the bladder is mobilised to the entrance of the ureters into the bladder wall posteriorly and to within a finger's-breadth of the internal urinary meatus anteriorly. A new bladder is then constructed, utilising a segment of ileum with its blood supply intact, the graft being split along its length. Some have found that if the donor intestine is split near the mesenteric border, after the mucous membrane has been removed the remaining coats can be brought into apposition (fig. 1099 (A)) in such a way as to leave the serous surface

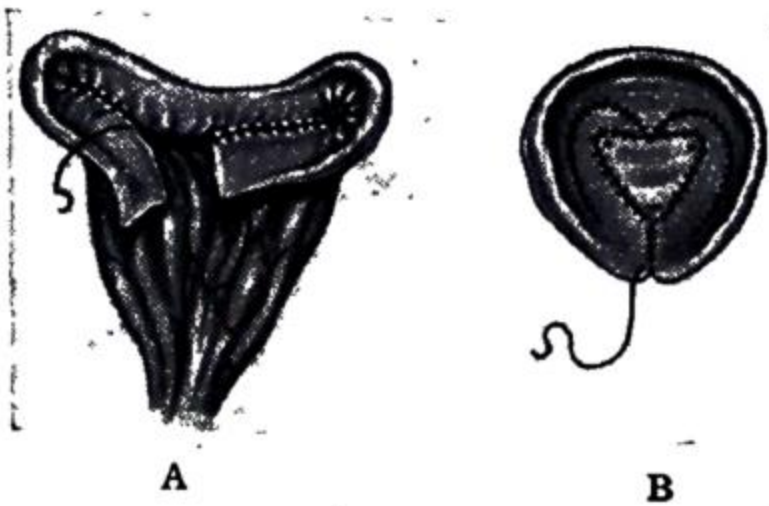


FIG. 1099.—Subtotal cystectomy leaving only the trigone, with reconstruction of a new bladder from a segment of ileum with its blood supply intact. (After W. C. Shoemaker et al.)

facing suitably for the new bladder to be constructed (fig. 1099 (B)) with a serous lining. In a matter of months the serous lining is said to be converted into stratified squamous epithelium.

Total Cystectomy.—The indications for total cystectomy are somewhat controversial. Provided the patient is fit to withstand this very severe operation it would be justifiable to undertake it in the following circumstances: (1) Profuse papillomatosis uncontrolled by other methods; (2) Multiple tumours of high-grade malignancy, believed to be confined to the bladder; (3) Carcinoma involving the bladder neck in either sex; (4) Recurrences in a small contracted bladder that has resulted from oft-repeated conservative operations; (5) Recurrence after well-chosen partial cystectomy.

Operation.—With the bladder empty, right lower laparotomy is performed, and the incision is carried down far enough to expose the upper half of the symphysis pubis. The peritoneum having been opened, the iliac and para-aortic lymph nodes and the liver and the kidneys are palpated. Having decided to proceed, the operating table is tilted and the ureters are isolated and divided as low as possible in the same way as described on p. 789. A suitable rubber catheter is passed along the lumen of each ureter, and the urine is allowed to drip into a bottle placed away from the operation area. No harm will result from ligating the internal iliac arteries; this step greatly minimises subsequent hæmorrhage.

In the operation of pelvic evisceration (see p. 664) it has been found that to make no attempt to suture the peritoneal floor results in fewer cases of post-operative intestinal obstruction than if a tense sutured diaphragm is left stretched across the empty pelvic basin. The same principle has been applied to the operation of total cystectomy, and instead of tediously separating the peritoneum from the fundus of the bladder, a large disc of pelvic peritoneum centred on the area attached to the underlying bladder is isolated by encirclement with a scalpel. To accomplish this the peritoneum is incised along the brim of the bony pelvis anteriorly, from one incision used to display the ureter to the other, while posteriorly this incision extends from these lateral sites across the bottom of the rectovesical pouch in the male or the pouch of Douglas in the female. So commences, from above, the dissection *en bloc* of the bladder and its overlying peritoneum, together with the prostate and all the fascia and fat surrounding these structures, while in the female, instead of the prostate, the uterus and the greater part, or all, of the urethra is included in the block of tissues to be removed. Throughout the operation the dictum is 'shun the bladder!', by which is meant that the operator keeps the dissection so far away from this organ that its walls are seldom even seen, let alone touched or grasped in any kind of forceps. The dissection commences behind the pubes and extends laterally, sweeping all fat and fascia of the retropubic space backwards, mainly by means of a swab mounted on a holder. This clearing process is effected on either side until the obturator vessels and nerve are seen. Frequently there is a small artery and corresponding vein passing from the obturator vessels to the bladder. This vascular bundle must be divided between ligatures.

One of the most important steps of the operation is to find the correct plane of cleavage between the prostate and the rectum. This is accomplished in the following way: the vas deferens is identified and followed proximally. *En route* this will lead to the superior and inferior vesical vascular pedicles, which are ligated and divided. Proceeding along the course of the vas, a seminal vesicle beneath a layer of fascia comes into view. When the fascia covering both seminal vesicles has thus been displayed, the vasa are ligated and divided some way from their termination.

The stage is now set to find the correct plane between the prostate and the fascia covering the rectum. It is essential to see clearly (not dissect) each seminal vesical through its covering of fascia, paying especial attention to the lower borders of the vesicles. At this level the fascia is incised transversely (fig. 1100), and dissecting scissors are inserted. Keeping close to the lower border of the vesicles, the incision is deepened in the direction of the base of the prostate. This leads to the space of Proust between the prostate and the rectum, and only after this has been found for the first time in the operation blunt-finger dissection is employed to separate the prostate from the rectum.

In this way the lateral true ligaments of the bladder (the pubo-prostatic ligaments) are defined on either side. These ligaments contain many veins of the inferior vesical

*James Douglas, 1675-1742. Physician to Queen Caroline, wife of George I.
P. T. Proust described the space in his M.D. thesis Sur la Peritonite (Paris, 1822). No other particulars of him are obtainable.*

plexus; therefore it is expedient to clamp them in right-angled hysterectomy forceps before dividing them. After the bladder has been removed, the clamp, first on one side and then on the other, is taken off and individual bleeding-points are ligated.

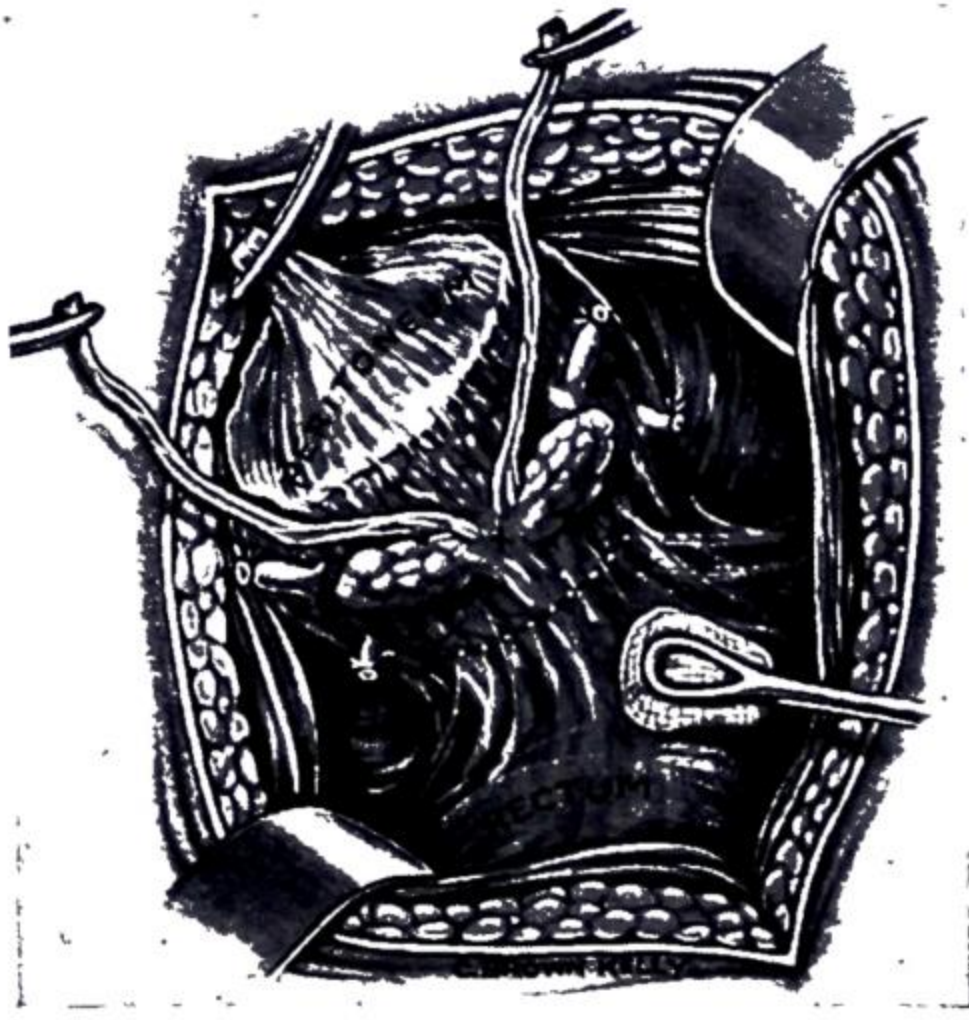


FIG. 1100.—Finding the plane of cleavage between the prostate and the rectum. (After T. Millin and F. Masina.)

cutaneous ureterostomy in the hope that at a later date internal transplantation could be substituted. To-day the trend of current opinion is that ileo-ureterostomy is much to be preferred, as it obviates or greatly minimises the three inherent dangers of uretero-colic anastomosis, to wit infection, stenosis and hyperchloræmic acidosis.

Ileo-ureterostomy.—A coil of ileum, with its blood supply intact, is isolated as described on p. 817. The left ureter is brought through the pelvic mesocolon, and

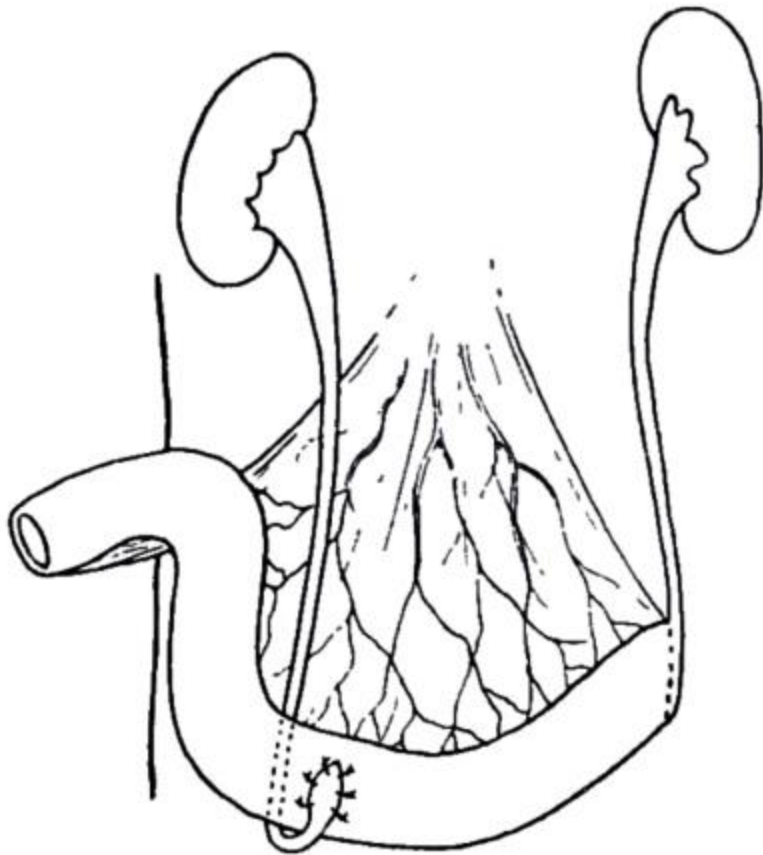


FIG. 1101.—Ileo-ureterostomy. (After C. Wells.)

after the ureter has been cut obliquely, end-to-end anastomosis is performed between the ureter and the left open end of the intestine. The right ureter is also cut obliquely, and it is joined to an elliptical opening made in the side of the coil (fig. 1101). In each case the anastomosis is effected by the method of Nesbit (fig. 1102), which greatly minimises stricture formation at the site of the anastomosis. The coil of intestine is tacked lightly to the peritoneum of the anterior abdominal wall at the level of the pelvic brim. The distal end of the coil is brought

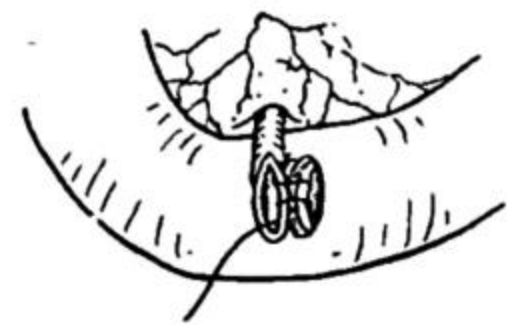


FIG. 1102.—Another method of performing ileo-ureterostomy. (After R. S. Nesbit.)

out through a stab incision in the right lower abdomen, and because of the anchoring of the intestine to the peritoneum, the opening is made a little lower than is the case when ileostomy is performed for ulcerative colitis. The method of anchoring the ileostomy opening to the abdominal wall, and the after-care of the orifice so formed, in no way differs from that described on p. 533.

Reed M. Nesbit, *Contemporary*. Urologist-in-Chief, University Hospital, Ann Arbor, Michigan, U.S.A.

The last attachment of the bladder—the membranous urethra—is severed as follows: with the left index finger behind the apex of the prostate and the thumb in front, the prostatic urethra is pinched (to prevent spill). Exerting upward traction on the prostate, the membranous urethra can be drawn into the pelvis sufficiently to permit its transection with a scalpel or scissors, whereupon prostatesclectomy has been accomplished. Remaining bleeding vessels are ligated. For total cystectomy to be truly radical, the lymph vessels and nodes of the pelvis at least up to the bifurcation of the iliac artery should be included, but of necessity this increases the operating time and the mortality.

Diversion of Kidney Urine.—Until recently the standard practice was to implant the ureters into the sigmoid colon or, if the condition of the patient was giving rise to anxiety, to perform

CHAPTER XXXIV

THE PROSTATE AND SEMINAL VESICLES

HAMILTON BAILEY

Embryology.—The prostate arises from the primitive urethra as a series of solid buds (fig. 1103); in a matter of weeks these become canalised. Budding takes place into the surrounding mesenchyme, which becomes differentiated into the muscular and connective tissue of the gland. In man, the buds arise from all sides of the urethra, and can be arranged into five groups—*anterior, middle, posterior, and two lateral*. These are the forerunners of the lobes of the prostate. The buds which go to form the anterior commissure (it is hardly worthy of being designated as a lobe) are formed only in man and the great anthropoids.

Skene's tubules that open into the female urethra are the homologues of the prostate.

Surgical Anatomy.—As can be seen in transverse section (fig. 1104), embedded in a dense fibromuscular stroma lie the glandular elements of the prostate and their ducts which, for the most part, open into the posterolateral grooves on either side of the verumontanum. The epithelium of the whole of the glandular system is columnar. Commencing peripherally, and passing centralwards, beneath the anatomical capsule lie the long branched **prostatic glands proper**. From accumulated experience this region is named the **carcinomatous zone**. Beneath this thick envelope, and separated from it by an indefinite capsule, lies another mass of secreting elements, also branched. These are the **submucosal glands**—and the zone that they occupy is known as the **adenomatous zone**. Still nearer the urethra are the unbranched **mucosal glands** whose mouths open directly into the urethra.

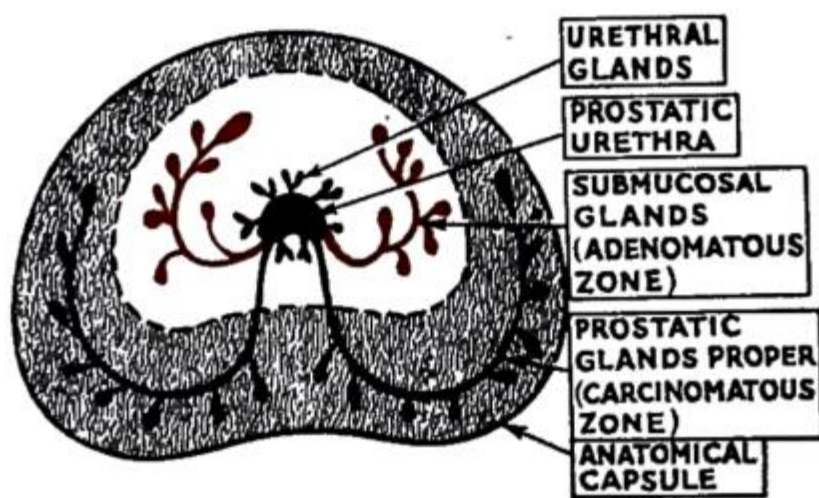


FIG. 1104.—Distribution of the normal glands of the prostate, transverse section. (After J. C. B. Grant.)

Into the prostatic urethra, therefore, open the prostatic ducts proper, the ducts of the submucosal and mucosal glands, as well as common ejaculatory ducts and the prostatic utricle (see fig. 955, p. 716). No wonder that chronic infection of the prostatic urethra is difficult to eradicate!

Turning now to the macroscopical arrangement as seen in sagittal section, it is essential to appreciate clearly certain relationships and divisions of the prostate set out in fig. 1105. The middle lobe is that part of the prostate included between the common ejaculatory ducts and the prostatic urethra. This middle lobe contains more secretory

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FIG. 1103.—The prostate towards the end of the fourth month of intra-uterine life. SV = seminal vesicle, PU = prostatic utricle. (After E. J. Evatt.)

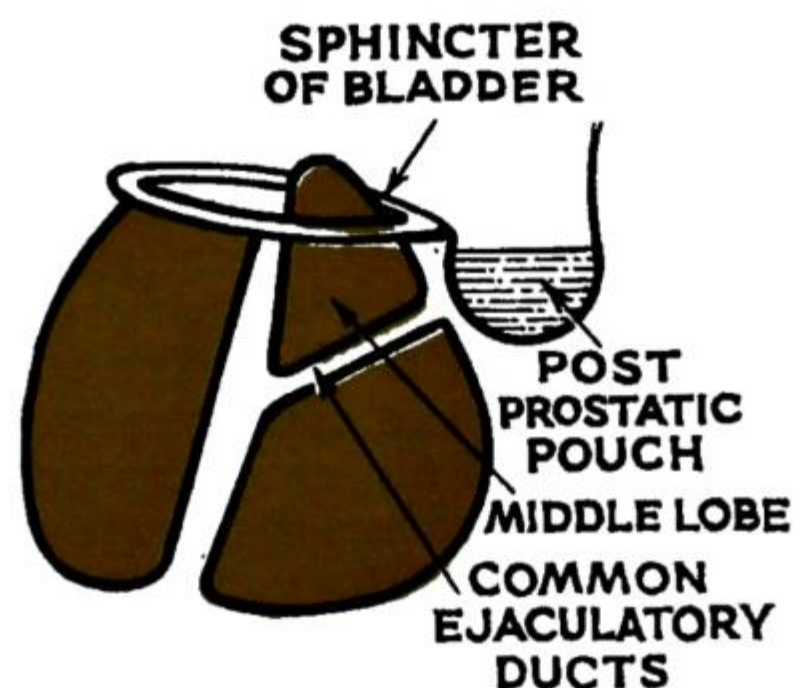


FIG. 1105.—The surgical subdivisions and relationships of the prostate.

Alexander J. C. Skene, 1838–1900. Surgeon, Long Island College Hospital, New York.

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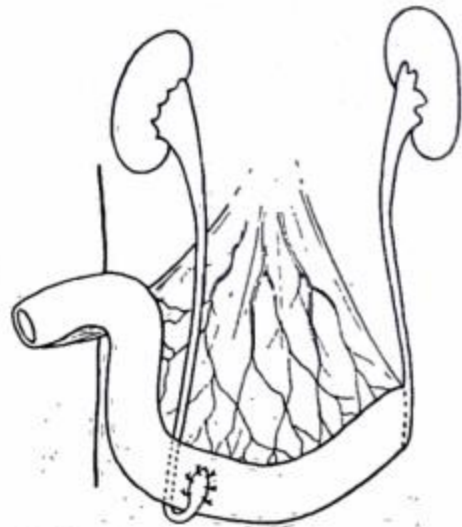


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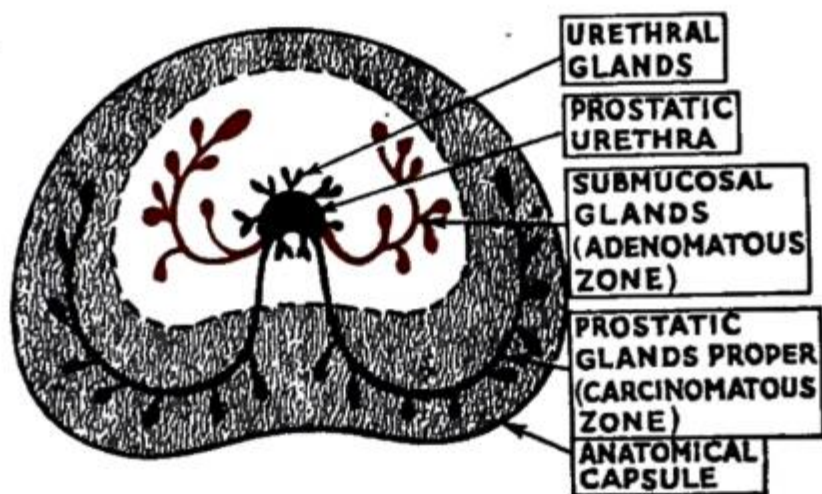


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Turning now to the macroscopical arrangement as seen in sagittal section, it is essential to appreciate clearly certain relationships and divisions of the prostate set out in fig. 1105. The middle lobe is that part of the prostate included between the common ejaculatory ducts and the prostatic urethra. This middle lobe contains more secretory

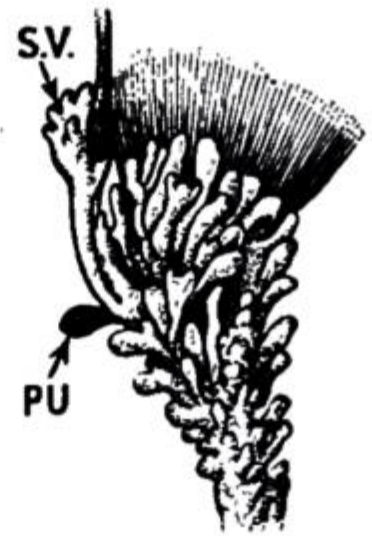


FIG. 1103.—The prostate towards the end of the fourth month of intra-uterine life. SV = seminal vesicle, PU = prostatic utricle. (After E. J. Evatt.)

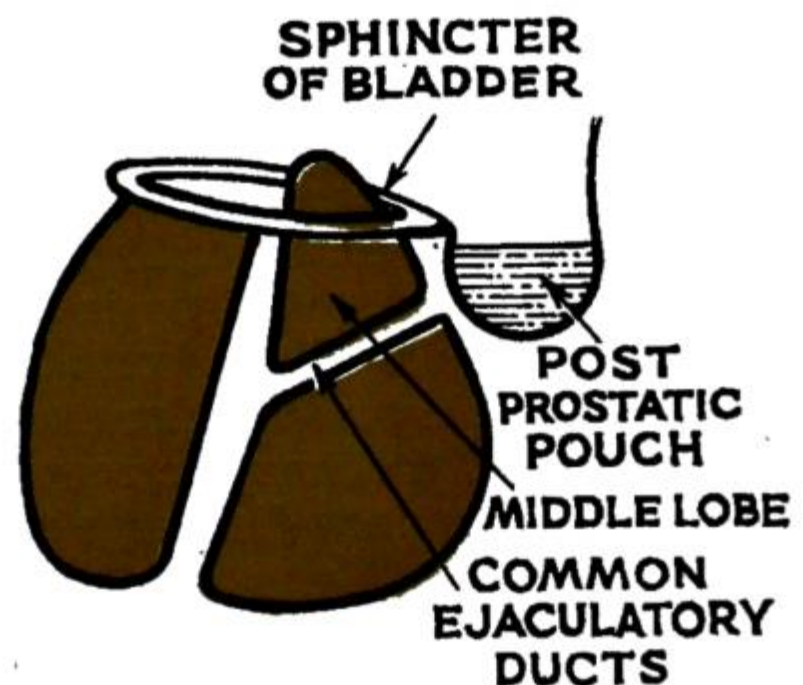


FIG. 1105.—The surgical subdivisions and relationships of the prostate.

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