PLATE I.

Mr. J. C. Ainsworth-Davis - Diagnosis and Treatment of Ureteric Calculi

FIG. 1.—Stone projecting from ureteric orifice, surrounded by bulbous oedema.

FIG. 2.—Right ureteric calculus and two phleboliths. Plain X-ray.

FIG. 3.—Opaque ureteric catheter and stone in lower part of right ureter.

FIG. 5.—Buerger's dilating olives.

FIG. 7.—Ureteric meatotomy for a stone impacted at and projecting from right ureteric orifice.

A. Cystoscopic view.

B. Sectional view.

FIG. 8.—Stone emerging from right ureteric orifice after ureteric meatotomy.

THE DIAGNOSIS AND TREATMENT OF URETERIC CALCULI.

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A ureteric calculus, with but rare exceptions, is a stone which has formed in the kidney and is attempting to pass down the ureter and will, in many cases, find its way into the bladder and pass naturally without any medicinal or instrumental aid.

If, however, the stone is rough or spiculated, this passage may be considerably delayed, or even prevented, by temporary or permanent impaction at either the pelvi-ureteral junction, the intra-mural part of the ureter or that part of the tube which crosses the sacro-iliac synchondrosis. The more a stone is held up during its migration, the more pronounced are the symptoms to which it gives rise and it is in just this type of case that a great deal can be done for the patient in the way of treatment both to effect the removal of the calculus and to diminish the severity of the accompanying renal colic.

There are three main varieties of ureteric calculus: *uric acid*, *calcium oxalate* and *calcium phosphate*. *Uric acid* stones rarely give rise to much difficulty owing to their small size and smooth surface. *Calcium oxalate* stones usually occur in aseptic urine, and *phosphatic* stones when the urine is infected. Sometimes a *mixed variety* occurs, such as a phosphatic calculus with a nucleus of calcium oxalate, which suggests that infection became superimposed on a pre-existing oxalate stone. Ureteric stones are usually single but may occasionally be multiple.

Two important *complications* may arise during the passage of a ureteric calculus, especially when arrested in some part of its course. These consist of *back pressure on the renal pelvis* and *infection*. *Back pressure* alone will cause dilatation of that part of the ureter proximal to the stone and also of the renal pelvis and is proportional to the degree of impaction. Congestion of the mucous membrane, immediately proximal to the stone, is common and thus bleeding may occur. Should *infection* supervene, dilatation of the renal pelvis becomes much more marked and the two factors will gradually and surely cause progressive destruction of the renal tissue, and the ultimate state of the kidney will depend on whether infection can be eradicated after the removal of the stone. It is this renal destruction which makes it essential to ensure an exact diagnosis of the state of affairs and which makes the removal of the stone a matter of absolute urgency before undue damage to the kidney has occurred.

Sometimes an impacted stone may cause the ureteral wall to give way, with formation of a *false diverticulum*, which will allow urine to pass down the ureter beside it; such a stone, however, is bound to grow and will eventually cause urinary obstruction by pressure from without.

Stones impacted in the upper parts of the ureter can only be accurately diagnosed by pyelography. When arrested, however, in the intra-mural part, cystoscopy is of the greatest assistance.

SYMPTOMS AND SIGNS.

The most typical symptom of a migratory calculus, especially if its passage is slow or if it is arrested, is renal colic, though hæmaturia is common and general constitutional symptoms may occur if infection has supervened.

Renal Colic.

This is due to violent peristaltic contractions of the ureter and begins over the kidney and radiates along the line of the ureter into the groin. It varies from a mild ache to a pain of the greatest severity, the patient rolling about in absolute agony with knees drawn up. *Severe shock, muscular rigidity and profuse sweating* may be present. An attack may last from a few minutes to some hours, and end suddenly by the slipping back of the stone into the renal pelvis. The point of maximum intensity of the pain usually corresponds with the position of the stone. When a calculus is in the *upper ureter, nausea and vomiting* may be marked features, which are replaced, if lower down, by *testicular pain and tenderness*. If the stone is in the *intra-mural portion of the ureter*, and especially when it is beginning to protrude through the ureteric orifice, there is a characteristic *pain at the end of micturition*, referred to the tip of the penis or to the labium majus. In addition, *pain* may occur *during coitus* and there may be *hæmospermia*.

Hæmaturia.

This is variable and occurs in about half the cases and may be brought on by exercise or follow an attack of renal colic.

Infection.

Infection, if present, is evident by examination of the urine and may give rise to *general constitutional disturbances*, as shown by *fever* and *sometimes rigors*.

DIAGNOSIS.

The diagnosis of a ureteric calculus is made by a consideration of the symptoms, a routine examination and certain special examinations, which have for their object: (1) the exact localization and size and shape of the stone (2) the degree of impaction, and (3) the functional value of the kidney.

Routine Examination.

During the course of this, the presence of infection of the *prostate* in the male and the *cervix* in the female will be determined and should not be overlooked as they may constitute ætiological factors. *Urethral stricture* or an *enlarged prostate* may be present. Occasionally, a stone can be palpated per rectum or per vaginam in the lower ureter. Some tenderness over the kidney and ureter may be present, together with some degree of muscular rigidity. Urine examination will show the presence or absence of infection.

Special Examinations.

Cystoscopy. Cystoscopy may show very definite changes at the ureteric orifice if the stone is in the intra-mural part of the ureter; it will determine the character of the ureteric efflux and will enable a ureteric catheter to be passed.

(a) **Appearance of the Ureteric Orifice.** The earliest change is some rigidity and pouting of the orifice and perhaps the presence of some punctate hæmorrhages in its immediate neighbourhood. Later, as the stone moves into the intra-mural part of the ureter, there is marked swelling of the orifice and the formation of surrounding bullous oedema. (Fig. 1, Plate I.) Hæmorrhage may be present, giving rise to hæmaturia.

(b) **Character of Efflux.** The efflux is more frequent in the case of a recently impacted stone but may be decreased in a later stage, especially when dilatation of the kidney has begun. The efflux may be clear or blood-stained, according to the damage to the ureteral wall, or be cloudy if infection is present. The volume is usually diminished, as is well shown after intravenous indigo-carmin.

(c) **Ureteric Catheterization.** In most cases, a ureteric catheter will be obstructed at the site of the stone, but if movements of introduction and withdrawal are combined with rotation, it is often possible for a small catheter to be passed beyond the stone to the renal pelvis. If this procedure is carried out in the presence of a severe attack of renal colic, the effect is dramatic; urine from the distended renal pelvis will drain through the catheter in a continuous flow under pressure and the pain of the renal colic will gradually diminish and finally cease. A specimen of urine can be obtained from the affected side and a unilateral urea concentration test carried out, if desired.

Pyelography. A preliminary film usually shows a shadow in the line of one ureter (Fig. 2, Plate I), and in most cases intravenous pyelography is sufficient to prove that this shadow is in the lumen of the tube, as shown by some dilatation immediately proximal to it. Difficulties in diagnosis arise when, owing to renal damage, there is poor secretion of the opaque medium. In such cases (Fig. 3, Plate I), an opaque ureteric catheter or bougie should be passed, if possible, beyond the stone and a double shift film taken. If a calculus is present, its shadow and that of the bougie move together and cannot be divorced. Intravenous pyelography is of the utmost importance in establishing the degree of dilatation of the renal pelvis and of the functional capacity of both kidneys.

TREATMENT.

This is divided into expectant, instrumental and operative, and the choice of these depends on four factors which must be carefully considered: (1) The size and shape of the stone, (2) the position of the stone, (3) the duration of impaction and (4) the condition of the kidney.

1. **Size and Shape of Stone.** Small stones should be treated expectantly though, if rough or spiculated, they may cause more difficulty in their passage than larger, smoother calculi.

2. **Position of Stone.** A stone impacted in the upper part of the ureter, which shows no sign of descending after one instrumental attempt at its dislodgment, should be treated surgically. Stones in the lower part of the ureter are ideal for instrumental removal and should respond to this method of treatment in at least three-quarters of the cases.

3. **Duration of Impaction.** The longer a stone has been impacted, the greater is the degree of peri-ureteral thickening and stricture formation, though in some cases instrumental dilatation may be sufficient to overcome the latter. If lying in a false diverticulum, operative measures are essential.

4. **Condition of the Kidney.** When good renal function is shown by pyelography and by continued attacks of renal colic, the stone can be treated expectantly or instrumentally. If, however, renal dilatation occurs from back pressure, as shown by pyelography and a *diminution* in the frequency and severity of the attacks of renal colic and especially should infection supervene, operation must be immediately carried out.

Expectant Treatment.

This is justifiable in the majority of patients who have previously passed stones, and in those in whom the stone is small and recently impacted, providing: (1) there is no evidence of renal back pressure as shown by pyelography and a diminution in the severity of the symptoms, (2) there is no infection, (3) that there is no obstruction in the lower urinary tract, and (4) that certain medical diseases of the kidney, which contra-indicate the taking of large quantities of fluid, are absent.

The treatment consists of taking fluids, such as Contrexèville, Vittel or barley water, together with diuretics, such as potassium citrate. Anti-spasmodics, such as atropine or papaverine are of value, and morphia or empirin compound may be necessary for pain. Expectant treatment should be checked by weekly radiograms and should not be prolonged for more than four weeks if there is no appreciable descent of the calculus.

Instrumental Treatment.

The passage of a ureteric catheter beyond the stone, as has been described, will immediately remove the pain of renal colic by diminishing the tension of urine in the renal pelvis. If some degree of hydronephrosis is present, the catheter should be left *in situ*, and it is remarkable how quickly the renal function will improve together with the contractile power of the pelvis, which is the propelling factor for the passage of the stone.

Occasionally, the catheter may dislodge an impacted stone, which will subsequently be passed without further treatment.

Stone Impacted in the Upper End of the Ureter. Two further procedures, which have been found of great value if a stone is impacted in this situation, are *ureteric dilatation* and the *injection of lubricants*, if possible proximal to the stone.

The first thing to be done in all such cases is to enlarge the ureteric orifice by means of the diathermy cutting current, applied through a ureteric meatotome. (Fig. 4). A ureteric catheter is passed through the orifice and its anterior lip

FIG. 4.—Ureteric meatotome.

divided along the line of the ureter by means of the projecting wire of the meatotome. By this means, the opening is enlarged sufficiently to allow of the passage of one or other of the various types of ureteric dilators. The ureter is

next dilated by graduated ureteric bougies or by Buerger's dilating olives (Fig. 5, Plate I), screwed on to a flexible stem and passed through a large bore circular cystoscopic sheath. A sheath of this description has been made for me by the Genito-Urinary Company and through it olives up to 28° Charrière can be made to engage with the impacted stone. When the ureter has been dilated with an olive larger than the calculus, a ureteric catheter is passed beyond the stone and 5 c.c. of sterile olive oil injected. Occasionally an attempt may be made to withdraw the stone by using a gum-elastic ureteric probang (Fig. 6), providing it can be passed beyond

FIG. 6.—Gum elastic ureteric probang.

it. No time, however, should be wasted by this somewhat dangerous procedure as much damage may be done to the ureteric mucous membrane, and in no circumstances should a metal extractor be employed.

The instrumental treatment described should be followed by diuretics and further X-rays to check the descent of the stone. If not successful, and especially if pyelography indicates the beginning of renal dilatation, surgical removal must not be delayed. Cystoscopic instrumentation is most likely to succeed in the case of a small, recently impacted stone but no definite rule can be laid down, as good results have sometimes been obtained in apparently impossible cases, which emphasizes the fact that this method of treatment is always worth at least one try.

Stones Impacted in the Lower End of the Ureter. A calculus in the intramural part of the ureter is ideal for cystoscopic instrumentation. The first procedure, as before, is to enlarge the orifice by means of ureteric meatotomy but, as a rule, it will be impossible to pass a ureteric catheter through the orifice, owing to the bullous oedema and swelling surrounding the stone.

The anterior ureteric wall overlying the calculus is stroked by the wire electrode projecting from the meatotome, whereby all the tissues are divided until the stone is fully exposed. (Fig. 7, Plate II.) Great care, of course, must be taken to prevent too deep a cut proximal to the stone and penetration of the posterior wall of the ureter. The procedure is almost entirely free from bleeding and if the orifice is watched for a time, it is occasionally possible to see the stone being "born." (Fig. 8, Plate II.)

In other cases, the treatment should be completed by the injection of olive oil through a ureteric catheter passed, if possible, beyond the stone. If desired, an attempt may be made to withdraw the stone by the use of the gum-elastic probang, though this is rarely successful at the time. As a rule, the stone will pass into the bladder within four days of the treatment, during which time diuretics and fluids are prescribed.

Operative Treatment.

Operative measures are indicated: (1) when expectant and instrumental measures have failed, (2) when dilatation of the kidney is commencing, as shown by pyelography, and diminution of the symptoms, (3) when infection has occurred, and (4) in calculous anuria.

By *operative treatment* is meant not only the removal of the stone, but also the cure of the disease to which it owes its origin and of any complications to which it has given rise. This naturally emphasizes the extreme importance of thorough urological investigation and a definite plan of action before operation is undertaken. In an aseptic urine, the removal of the calculus may be all that is necessary, but ætiological causes, such as chronic prostatitis, chronic cervicitis, upper or lower urinary tract obstructions, must be taken into account and dealt with at the same time or reasonably soon afterwards. Should the kidney from which the stone has come be totally disorganized by hydro- or pyo-nephrosis, it will require removal together with the ureter, down to and including the stone, though it is indeed remarkable how, in some cases, a hydro-nephrosis will contract down after removal of the obstructing cause, which indicates the need for conservative surgery in all but extreme cases.

A stone in the upper ureter is exposed by the usual kidney incision; if at the brim of the pelvis, by an incision from the anterior superior iliac spine, downwards and inwards, parallel to Poupart's ligament and two inches above it. A calculus in the lower end is best exposed by a median suprapubic incision. Some obstinate stones impacted in the intra-mural part will require removal by suprapubic cystotomy, combined with extra-peritoneal exposure of the lower end of the ureter.

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