URETERIC CALCULUS

Hunterian Lecture delivered at the Royal College of Surgeons of England on 13th March, 1952 by V. W. Dix, F.R.C.S. Surgeon, The London Hospital

Introduction

This study of ureteric calculus is based on my own experience during the last 20 years. During this period (up to the end of 1950) I have made records of 464 cases. London Hospital out-patient cases have not been included unless I have notes about them in my personal files. It will be seen (Table I*) that more than half of them came to me during the war, when, in 1943-45, for a period of a little more than two years, I was in charge of the Urological Centre of the M.E.F. In this relatively short time I saw 242 cases of ureteric calculus.

Table I

| Ureteric Calculus |  |
|--------------------|---|
| M.E.F. cases       | 242 |
| Other cases        | 222 |
| **Total**          | 464 |

| Renal Colic (No Proof of Calculus) |  |
|-----------------------------------|---|
| M.E.F. cases                      | 112 |
| Other cases                       | 164 |
| **Total**                         | 276 |

| M.E.F. Cases                      |  |
|-----------------------------------|---|
| Calculus passed                  | 100 |
| No record                         | 27  |
| Operation                         | 115 |
| **Total**                         | 242 |

| Operations Performed (M.E.F. Cases) |  |
|-------------------------------------|---|
| Ureterolithotomy                    | 92 |
| Enlargement of ureteric orifice     | 21 |
| Evacuation from bladder            | 5  |
| Other operations                   | 3  |
| **Total**                           | 121 |

(Six patients each had two operations.)

In discussing the relationship between ureteric calculi and unexplained attacks of renal colic, and in describing the criteria adopted in this series to establish the diagnosis of a calculus, I shall use primarily my M.E.F. cases. I have therefore set out in Table I figures for cases of renal colic

* The figures in Tables I, II, and III differ slightly from those which I used in a discussion on stones in the lower third of the ureter at the Royal Society of Medicine in May, 1951 (Proc. R. Soc. Med., 1951, 44, 933). At that time I had not indexed certain cases, most of them from the years 1939 and 1940.

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in which there was no proof that a stone had been passed and also some additional details of the cases of calculus.

I have little doubt that nearly all the 112 M.E.F. cases of colic were in fact cases of calculus, but they did not satisfy the criteria which I had laid down for a definite diagnosis. They were all cases of colic in which a complete examination of the urinary tract revealed no lesion.

The five cases of evacuation of the stone from the bladder are not included in error. All the symptoms had been ureteric in each case, but the patient was unable to pass the stone from his bladder. Three of the stones were small enough for evacuation without crushing, and two had to be crushed before evacuation.

The analysis of M.E.F. cases shows that it was not difficult, even in the conditions of military life, to keep good records of these cases, the M.E.F. figures of only 27 incomplete records out of a total of 242 being as good as any I have been able to achieve in the normal conditions of civilian life.

Since I shall make no reference in this study to the work of others, some explanation is required for an attitude that might seem unduly dogmatic or self-centred. It does not imply in any way an indifference to such work, but rather expresses my belief that, in certain circumstances, the experience of one observer may be more valuable if presented in this way. I consider that the special conditions of my M.E.F. experience justify this method of presentation; it was unusual numerically, and I combined the offices of surgeon, registrar, house-surgeon, and outpatient clinical assistant, so that there is little in my records that is not the result of my own observations.

The Relationship between Calculi and Unexplained Attacks of Renal Colic

What I shall say in this section refers almost entirely to oxalate calculi, which occur in the absence of infection and present a less complicated picture than that of phosphatic calculi.

Analysis of the calculus was made in 118 of my M.E.F. cases. There were 73 oxalate calculi, 12 phosphate calculi, three urate calculi and 30 mixed calculi. Of the mixed calculi 28 contained oxalate, most of them having only a small admixture of phosphate. Although no new aetiological factor emerged from an examination of these records, it is impossible to examine them without concluding that concentration of the urine is perhaps of more importance than any other factor in the case of Europeans living in a hot, dry climate. Many of the patients in my M.E.F. series had never before had anything wrong with the urinary tract, and the finding of oxalate crystals in the urine was a commonplace even in men who had never had colic.

It is generally accepted that the mere passage of oxalate crystals in the urine may cause colic or haematuria or both. My experience is that oxalate crystals only very rarely cause symptoms, with the possible exception of mild dysuria, which might equally well in a hot climate be
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the result of passing very concentrated urine. I have not yet seen a case in which oxalate-producing fruits such as strawberries or raspberries caused an attack of colic or haematuria, although I have excellent secondhand knowledge that such cases exist. It must be remembered that an accretion of oxalate crystals no bigger than half the size of the head of a pin may cause colic or haematuria. This may occasionally be proved by finding the calculus in the urine, and more often by observing changes in the ureteric orifices after the calculus has passed.

My contention that colic and haematuria are symptoms of the passage of a calculus (a macroscopic body, however small) and not of oxaluria per se cannot be proved. Nevertheless the following observations suggest that it is so: oxalate crystals are found very frequently in the concentrated urine of those living in hot climates without causing symptoms; colic and haematuria are very rare after eating oxalate-producing substances; calculi, so small that they would not produce symptoms after leaving the ureter, are occasionally recovered from the urine; and cystoscopy performed within a day or two of the colic will reveal changes in the ureteric orifice if the calculus has been passed.

I believe, therefore, that almost all the cases of unexplained colic of which I have records were in fact cases in which a calculus had been passed. They are all cases in which I was convinced by the evidence that the attack really was renal colic. If I had the slightest doubt I recorded them as "? renal pain: negative examination."

Criteria for the Diagnosis of Ureteric Calculus

It is necessary to define the criteria which I have used in this study to establish the diagnosis of calculus.

If the stone has been passed and preserved by the patient, or if it is seen in the ureteric orifice or in the bladder on cystoscopy, there is clearly no doubt about the diagnosis.

When no shadow was seen in the X-ray following an attack of colic, the case was not recorded as one of calculus unless changes were seen in the ureteric orifice on cystoscopy or there was a definite history of cessation of the stream during micturition. The changes in the ureteric orifice seen for four or five days after the stone has passed through it are either oedema of the orifice or haemorrhages round it, or both. Sudden cessation of the stream of urine passing from the bladder is a reliable diagnostic symptom which occurs when the stone is only just small enough to pass through the urethra. This symptom is nearly always accompanied by a sharp stab of pain, and it is often followed immediately by a sensation of something shooting out of the urethra before the normal stream is re-established.

When a shadow is present in the X-ray following an attack of colic, I hope to show that there can be no doubt about the diagnosis if it is confirmed as a calculus by more than one of the diagnostic methods described below.
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Although I believe that most unexplained attacks of colic are caused by calculi, all cases recorded here as calculus have satisfied the criteria set out above; and if there has been any bias in my classification of cases it has been in favour of the less satisfactory diagnosis of unexplained renal colic.

Diagnosis and Diagnostic Methods

As an introduction to this part of my paper I should like to mention the only case in which I have undertaken an exploratory operation for a supposed calculus in the ureter. In 1935 I saw a patient who had had attacks of pain resembling colic for some months. She brought with her an inconclusive excretion pyelogram showing a solitary shadow in the pelvis in the line of the ureter. In spite of the combined persuasion of her doctor and myself, she refused to have any confirmatory examinations performed: The shadow was sufficiently like that of a calculus to convince me that an operation was justifiable, but I found when I did operate that the ureter was normal. A short search enabled me to find and remove a small phlebolith lying at a little distance from the ureter, so that I could have made the correct diagnosis easily, and without possibility of error, had I been allowed to use the diagnostic methods which I am going to describe.

It is my firm belief that the diagnosis of ureteric calculi can be exact, and I also believe that it should be possible for a urologist to say that he has never operated for a ureteric calculus and failed to find it. Perhaps it may require a little luck to avoid all such errors, but, even if it is difficult, it should be our aim to achieve it.

The basic principle of exact diagnosis is the avoidance of possible errors produced by coincidence, and it is possible, in the diagnosis of ureteric calculi, so to multiply the diagnostic tests or to have such a strict criterion of what constitutes diagnostic certainty, that the unfortunate coincidence can only very rarely lead us into error.

The first indication that a shadow is a calculus is that it lies on the line of the ureter down the tips of the transverse processes, over the sacro-iliac joint towards the ischial spine, and thence to the side of the coccyx. But this is a very weak diagnostic point, only strengthened when we find, in successive films, that the shadow has changed its position and still remains in the line of the ureter.

Although excretion pyelography is one of our most valuable diagnostic methods, I believe, nevertheless, that it has been responsible for more errors of diagnosis and unnecessary operations than any other method of urological examination. One of the fundamentals in the diagnosis of calculus is to realize that a dilated kidney and ureter above a shadow suspected of being that of a calculus does not by itself prove anything. There are only three appearances in the films of an excretion pyelogram that make the diagnosis of a calculus nearly certain: either the shadow of the dye must be in continuity with the suspected shadow, or the
suspended shadow must be seen within the shadow of the dye, or it must be obscured completely by the shadow of the dye (Figs. 1 and 2). *

Fig. 1. Shadow of dye in continuity with calculus.

The ureteric catheter must remain our most potent diagnostic weapon. If a ureteric catheter is passed on the side of the shadow it may stick at a point which corresponds roughly with the estimated distance of the calculus from the ureteric orifice. This may be as misleading as an inconclusive excretion pyelogram; it is a useful confirmatory sign if it fits the rest of the picture, but it may mean no more than any other failure to catheterize a ureter. The arrest of a ureteric catheter, even at the right distance, is not enough to justify a diagnosis of calculus; and it can be justified still less as an indication for an operation. The ureteric catheter that sticks is, however, part of two procedures of the greatest value. If a stereoscopic X-ray is taken while the catheter is being pressed into contact with the obstruction, a manipulation which requires either a visit to the radiological department or a cystoscopic X-ray table, those who are accustomed to the interpretation of stereoscopic X-rays will have no difficulty in making a certain diagnosis (Fig. 3). The second procedure also necessitates a visit to the radiological department in the case of calculi below the pelvic brim, because the catheter comes out so easily when perhaps no more than a few centimetres of it

* The figures, with the exception of Nos. 8 and 10, are drawings made from the X-rays used to illustrate the lecture.
are in the ureter. An opaque solution is injected through the catheter and will often pass beyond the impacted calculus and produce a shadow in continuity with the suspected shadow (Fig. 4).

If the ureteric catheter passes the site of the suspected shadow—and it often does—a stereoscopic X-ray will enable a certain diagnosis to be made (Fig. 5). In circumstances where no apparatus for viewing stereoscopic X-rays is available, almost equal certainty may be attained either by making two exposures on the same film, the tube being moved sideways between the two exposures, or by taking antero-posterior and oblique views (Fig. 6).

It is perhaps necessary to state that no grating sensation is felt as the catheter passes the calculus (this may be proved by a simple experiment with a ureteric catheter and a calculus). The catheter does, however, often stop at the calculus and then go on. This hitch can be seen and felt.

There is usually no doubt about the diagnosis of intra-mural calculi. The shadow will be seen in contact (Fig. 7), or nearly in contact, with the coccyx, and there will be oedema of the ureteric orifice. Calculi lying over the sacro-iliac joint, however, may present great difficulties owing to the density of the bone shadow. The shadow of the calculus can be thrown forward in the film, so that it is easily seen, by using the sitting position in conjunction with one of the methods already described (Figs. 8 and 9).
Although I have said that these diagnostic examinations make the chance of error so small that it may almost be disregarded, I have rarely operated to remove a calculus unless at least two of them have been positive. Up to the present time the rigidity of these methods has met with success, and my operation in 1935 on a patient who refused to have the appropriate diagnostic examinations performed remains the only one in which I did not find the calculus which I had diagnosed.

**Non-operative Management**

It is doubtful whether any arbitrary time now plays a part as an indication for operation, and, in the absence of infection and other complications, calculi may be left in the ureter for long periods in the hope that they will pass naturally. The indications for operation are as follows: persistent or increasing dilatation of the ureter; frequent and intolerable attacks of colic which do not cause the stone to progress down the ureter; the occurrence of infection (which is not common during the passage of a stone down the ureter); and rapid increase in the size of the stone (which is rare except possibly in the case of phosphatic calculi when infection is already present).

When there is no indication for operation the progress of the calculus and its effect on renal function may be observed in excretion pyelograms done at intervals of three months, or at shorter intervals if there have
Fig. 4. Dye has been injected and fills ureter above impacted calculus, the shadows of the dye and of the calculus being in continuity.

Fig. 5. The catheter has passed the calculus and a certain diagnosis can be made by a stereoscopic X-ray.
Fig. 6. Two exposures on the same film, a method which can be used when apparatus for viewing stereoscopic X-rays is not available.

Fig. 7. Intra-mural calculus nearly in contact with the coccyx.
been attacks of colic. There is little chance that irreparable harm will be done to the kidney if this procedure is followed. The indication for an operation may not always be entirely surgical, and I have removed a calculus 14 months after the onset of symptoms because the patient himself decided that he would like to have it done before his forthcoming marriage. There was very little dilatation of the kidney and ureter, both of which returned to normal soon after the operation.

Persistent or increasing dilatation of the kidney and ureter must be interpreted with care, especially if the stone is making progress, and it requires some experience to decide when an operation should be performed. The power of the kidney to return to normal will, from time to time, surprise even the most experienced observer.

It is not my intention to discuss in detail the many non-operative measures that have been recommended to hasten the passage of a calculus. It is possible that anti-spasmodic drugs may be of use, but the proof of their efficacy is difficult to establish. In most cases the stone will be found to have moved down the ureter only after an attack of colic, although it may move on, even into the bladder, without an attack of pain when it has reached the lowest part of the ureter.

Regular muscular exercises and gymnastics have been said to aid the passage of a stone by stimulating the movements of the ureter. This may be so; but on general principles it might have been thought that they would have the opposite effect. It is a common experience that exercise diminishes the output of urine, and the peristaltic activity of the ureter, which cannot be dissociated from the passage of a calculus, must also be diminished in these circumstances. The inactivity of the ureters when the urinary output is small cannot have failed to attract the attention of any surgeon doing many cystoscopies in a hot climate. On the other hand an increase in the urinary output increases the ureteric peristalsis, and it therefore seems reasonable to suggest that an increased fluid intake may be of some little help in hastening the passage of a calculus.

For some years it has been my practice to suggest no treatment during the weeks or months in which a calculus is passing except an increased fluid intake and the immediate relief of pain—by an injection of morphia, if necessary—when an attack of colic occurs. When a patient is away from home, and therefore not under the supervision of his own doctor, it is helpful to give him a note stating that he has a calculus and may have attacks of colic.

In tropical and sub-tropical countries, especially when the climate is dry, an attack of renal colic or the passage of a calculus gives rise to a problem of some importance—should a patient be advised after one attack to return if possible to a temperate climate? I have only a small experience of this problem in normal times, and the general attitude to it seems to be to accept it as an occupational risk. During the war, however, in Egypt, the problem was somewhat different—should a
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Fig. 8. Position for demonstrating calculi over sacro-iliac joint.

Fig. 9. Calculus which could not be seen in the ordinary position demonstrated in an excretion pyelogram by using the position shown in Fig. 8.
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soldier be invalided home after colic or the passage of a calculus? After a little trial it was found that a simple formula, if not interpreted too rigidly, worked well. After one attack of colic, or after the passage of one calculus (either after one attack of colic, or several attacks), invaliding was considered to be unnecessary, and many men had in fact no recurrence of symptoms. When many attacks of colic occurred, or when a second calculus was diagnosed, or when an operation had to be performed (even if it happened to be for the first calculus), the patient was considered to be fit for service only in a temperate climate and always left Egypt.

Treatment of Intra-Mural Calculi

Ureteric calculi often remain for a long time just outside the wall of the bladder in the lowest part of the ureter, and they also may remain for a long time in the intra-mural part of the ureter. I believe that it is necessary to treat these calculi in different ways—the extra-vesical by some method that is applicable to the ureter as a whole or by operation (if operation is indicated) and the intra-mural calculi by some intra-vesical method.

I have no experience of the ingenious methods by which a small percentage of movable stones in the lower part of the ureter may be extracted by wire spirals and baskets, nor have I often felt that experience of these techniques was necessary. I have an impression, but no figures or controls to prove it, that the mere passage of a ureteric catheter, especially when it goes past the stone, may precipitate an attack of colic and movement of the calculus; and I also consider that it is rational to inject sterile oil through the ureteric catheter, but only when the ureteric catheter has gone beyond the calculus. In the past I have injected oil below an impacted calculus, and I have seen others do it, but I have now felt for many years that it could not possibly have any effect.

Enlargement of the ureteric orifice through the operating cystoscope has been used for many years to hasten the passage of calculi in the lowest part of the ureter. I now perform this minor operation only when the stone is in the intra-mural part of the ureter; and since 1935 I have used only one method of enlargement—diathermy coagulation.

I was taught that enlargement of the ureteric orifice might be of some value even if the stone was just outside the wall of the bladder, and in cases of this sort it is easy to enlarge the orifice in many ways. In a few cases I used scissors or an electrode with a wire on top to cut a neat slit in the orifice, but I soon found that these methods were not applicable when the ureteric orifice was oedematous. It also seemed to me that it was useless to enlarge the ureteric orifice when it was not oedematous, because the absence of oedema was a clear indication that the stone was not in the intra-mural ureter, and it was difficult to believe that enlargement of the orifice would assist the passage of a calculus impacted just outside the wall of the bladder. A successful case of plain diathermy coagulation of the oedematous ureteric orifice in which the stone was
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passed on the seventh day made me use this method from time to time until about 1935. Since 1935 it is the only method which I have used, and I have used it in 38 cases (Table II). I usually use an ordinary electrode in an operating cystoscope, but I have on occasion used the Kidd diathermy cystoscope. If the oedema is moderate in degree, and the orifice can still be recognized, I coagulate backwards and outwards from the apex of the orifice. If the oedema is greater, I coagulate the whole oedematous area. Of the 38 cases I have no record of the result in 6: five in the years 1939-40 when the movement of the population in London prevented an accurate follow-up, and one in 1945 when I left the M.E.F. on the eleventh post-operative day. Of the 32 cases in which I know the

| Table II |
| --- |
| **Enlargement of Ureteric Orifice** |
| Diathermy enlargement | 38 |
| Other methods | 9 |
| **Diathermy Enlargement** |
| Stone passed | 27 |
| Stone not passed | 5 |
| Result unknown | 6 |
| **Average Time taken to Pass Stone** |
| All cases (27) | 11-0 days |
| Exact time known (17 cases) | 7-1 days |

result, 27 were successful and five were failures. In the 27 successful cases the average time taken to pass the stone after diathermy coagulation was 11-0 days. This figure is necessarily too big because it represents (in 10 cases) not the day on which the stone was passed but the day on which it was proved that it was no longer present. In the 17 cases in which I know the exact day on which the stone was passed the average time was 7-1 days (range: 3-18 days). I cannot believe that a stone in the intra-mural ureter will be passed in an average time of 7 days (or 11 days by a more unfavourable calculation) after a minor intravesical operation unless the operation has something to do with the result.

It is unfortunately impossible to estimate the length of time the stone has been intra-mural. Many of these patients had a history of several months’ duration.

The failures must now be considered. In two of them there was no oedema of the orifice and the calculus was not intra-mural, both, therefore, being cases in which I should not now use this method. In one of these, when the stone became intra-mural, a repetition was successful; and in the other I performed a ureterolithotomy. The third failure was in an Italian prisoner-of-war who had remained in hospital waiting for the stone to pass. He developed pneumonia a week after diathermy
coagulation and died five days later. This was on the twelfth post-operative day, when it was still possible that the stone might have passed. The stone was found to be present at the post-mortem examination, and there was no other lesion of the urinary tract. This stone was intra-mural. In the other two failures the stones were also intra-mural. In one a repetition was successful and in the other I do not know the result of the second diathermy coagulation which was done three weeks after the first. Thus, it will be seen that the only certain failures of the method itself were in two cases.

From the results it seems probable that an intra-mural calculus will be passed about a week after a diathermy coagulation of the ureteric orifice, and it is important to tell the patient that he must report at once if he begins to have bladder symptoms. In three of my patients it was necessary to perform a litholapaxy since the stone was too big to pass along the urethra. One of the three, who disregarded my instructions, had three weeks of great discomfort while he was trying to pass the calculus from his bladder.

Ureterolithotomy

Even after the most careful diagnostic examinations the patient should be X-rayed again on the way to the operating theatre. After months of recurrent attacks of colic without any progress, calculi have been known to slip quietly into the bladder in the 24 hours before an operation. In certain circumstances the immediate pre-operative X-ray examination may be omitted, but only if there has been no pain at all on the affected side between the last X-ray examination and the day of operation, and the difficulties of having the immediate pre-operative X-ray done are very great. If there has been any pain, however slight, in this period, it is unjustifiable to operate without having the patient X-rayed immediately before the operation.

I have performed 68 operations for the removal of calculi above the pelvic brim, and 109 for the removal of calculi below the brim. These figures suggest that it is more common for calculi to become impacted in the lower part of the ureter.

There are certain differences in operations above and below the pelvic brim, and it is convenient to discuss these operations separately.

For the exposure of the ureter above the brim I make the incision in the appropriate part of a line curving round from the renal angle to a point about one inch medial to the anterior superior spine. If the stone is high up in the ureter the lateral position with a cushion under the opposite loin gives the best exposure. When the stone is lower down, a semi-lateral posture is used; and when it is still lower, near the pelvic brim, the ordinary recumbent posture is used.

The muscles are divided in the line of the incision, and the peritoneum is swept forwards to expose the ureter lying on its posterior surface. Gentle dissection will free the ureter from the peritoneum, and it is
important to do this dissection first above the stone. As soon as a
short length of ureter above the stone is freed, a tape is passed round
the ureter and there is no longer any danger that the stone may slip back
through the dilated upper ureter into the kidney. A longitudinal incision
is then made directly over the stone, overlapping its upper end but not
extending to its lower end, the upper end of the calculus is gently elevated
with any suitable instrument (I use a Watson Cheyne dissector), grasped
in a pair of forceps (ordinary artery forceps will do), and removed.

After removal of the calculus a ureteric catheter is passed down to
the bladder and left in position while fine plain catgut sutures are inserted,
picking up the two edges of the wound, each suture passing superficial
to the catheter (Fig. 10). The catheter is then removed and the sutures
tied. With this technique of suture it is impossible, even in adverse
conditions, to pick up anything but the edges of the incision, and it is
therefore most unlikely that a stricture will occur.

For operations on calculi below the pelvic brim I prefer a spinal
anaesthetic, and it is my experience that no other anaesthetic gives such
good relaxation, enabling the operation to be done with speed and
certainty.

I now use a paramedian incision on the side of the calculus for all
cases. Before 1939 I occasionally used an oblique incision medial to
the anterior superior spine, extending it, if necessary, into the sheath
of the rectus.

I am convinced that it is unwise to tilt the table (head down) at the
start of the operation, or indeed at any time before a piece of tape has
been passed round the ureter above the stone. If the table is tilted, the
stone may slip back into the upper ureter or even into the kidney—a
troublesome accident necessitating a second incision. This accident
has not happened in any case in the present series, and I believe it is
impossible, or nearly impossible, if the table is not tilted and the
technique described below is followed.

There is rarely any difficulty in removing stones just below the pelvic
brim. When the stone is impacted in the last centimetre of the ureter
there may be difficulties in the exposure, and there are two methods of
trying to overcome these difficulties: the ureter may be identified at
or near the site of impaction; or it may be identified where it crosses
the bifurcation of the common iliac vessels and then followed down to
the bladder. I have no doubt at all that the second method is the better
of the two. In the first method a dissection, not always easy, and the
ligature of vessels lying in front of the ureter are always necessary. In
the second method it is often possible to remove a calculus without
ligaturing a single vessel after the incision has been carried through the
abdominal wall.

I am going to describe very briefly the technique which I have always
used since I had the opportunity of practising it frequently during the
war. After the incision has been made, the peritoneum is gently raised
with the finger from the external iliac vessels until the bifurcation is reached. The ureter is identified on the elevated peritoneum, gently dissected free, and secured in a loop of tape. The next stage is difficult to describe but easy to do. By a combination of slight traction on the tape and dissection—mostly with the index finger, but aided here and there with forceps—the ureter is freed down to the site of impaction, or to the bladder if necessary, in the majority of cases without ligaturing any vessels. Still with gentle traction on the tape by an assistant the ureter is supported at the site of impaction by the index finger and an incision is made directly over the stone, overlapping its upper end but not extending to its lower end. The upper end of the stone is then elevated as described above and removed. The method of suturing with a ureteric catheter in situ has already been described.

It will doubtless be noticed that in both upper and lower operations I always use incisions into the ureter directly over the stone at the site of impaction. It is my experience that it is usually impossible to move an impacted calculus without the use of undue pressure, which certainly causes more trauma than a clean incision. I have no evidence to suggest that incision at the site of impaction leads to fistula formation or stricture, and the supposed advantage of an incision in healthy tissue above the site of impaction has never appealed to me. When the stone is lying free in a localized dilatation of the lower ureter, as it sometimes does, it is obviously of advantage to milk it up as high as possible before incising the ureter.

In cases of bilateral calculi I prefer to operate first on the side showing the better renal function, postponing the second operation until partial or complete recovery can be seen on the first side in an excretion pyelogram.

**Complications of Ureterolithotomy**

I have already mentioned that a calculus may slip back into the dilated upper ureter, even as far as the kidney, during dissection and freeing of the ureter, and I have described the precautions necessary for the avoidance of this accident. It is less disconcerting for the surgeon if the stone moves down instead of up, an accident which is unlikely to occur often in cases of stones requiring operative treatment. I have had experience of this accident in two cases, included in “other operations” in Table II but not included in Table III because the operations were not in fact ureterolithotomies.

In the first of these cases the calculus was tightly impacted at the start of the intra-mural part of the ureter. I failed to extract it through an incision in the ureter just outside the wall of the bladder, and the manipulations broke it up. The fragments were pushed into the bladder with a bougie, and the ureter was sutured. No urinary fistula followed this unorthodox procedure. The second case was similar, but the stone slipped into the bladder during the manipulations. There were no complications after the operation.
The complications that have occurred in this series are set out in Table III, and they have been divided into those occurring after operations for calculi above and below the pelvic brim. No significant difference between the two operations has been revealed by this division, although there happened to be in proportion nearly twice as many cases of temporary fistula after operation above the brim (12 after 68 operations) as there were after operations below the brim (11 after 109 operations). It would be unwise to conclude that a fistula occurs more frequently after operations on the upper ureter.

The most common complication is a temporary urinary fistula, the average duration of the fistula being 11 days (range: 4-30 days) for the upper operation and 10-1 days (range: 3-28 days) for the lower. I have never had any real anxiety in the cases of temporary fistula that the fistula might become permanent, nor have I ever been certain, except in one case mentioned below, why there was a fistula or why it persisted for a certain number of days. The exceptional case was one in which I removed two calculi through two incisions 2.5 cm. apart in the ureter opposite the third and fourth lumbar vertebrae. The patient was X-rayed on the 29th day after operation, when he still had a fistula, and a tiny shadow, not seen in any previous X-ray was seen opposite the ischial spine. Next day, the 30th post-operative day, the fistula closed, and there was no shadow to be seen in an X-ray taken on the 31st day. It is probable that even the slightest obstruction in the ureter
### Table III

**COMPLICATIONS OF URETEROLITHOTOMY**

| Operations Performed       | Count |
|----------------------------|-------|
| Stone above pelvic brim    | 68    |
| Stone below pelvic brim    | 109   |
| **Total**                  | 177   |

| Temporary Urinary Fistula  | Count |
|----------------------------|-------|
| Stone above pelvic brim    | 12    |
| Stone below pelvic brim    | 11    |
| **Total**                  | 23    |

| Average duration (above)   | 10.4 days |
| Average duration (below)   | 10.7 days |

| Permanent Fistula: Nephrectomy | Count |
|-------------------------------|-------|
| Below pelvic brim              | 1     |

| Small Pulmonary Embolus        | Count |
|-------------------------------|-------|
| Stone above pelvic brim        | 1     |
| Stone below pelvic brim        | 1     |
| **Total**                      | 2     |

| Wound Infection: No Fistula   | Count |
|-------------------------------|-------|
| Stone below pelvic brim       | 1     |
| **Total**                     | 1     |

| Post-Operative Deaths         | Count |
|-------------------------------|-------|
| Stone above pelvic brim       | 2     |
| Stone below pelvic brim       | 2     |
| **Total**                     | 4     |

Below the site of the incision may cause delay in healing. In another case of temporary fistula I passed a ureteric catheter without difficulty on the 16th day and left it in the ureter for 24 hours. The fistula healed at once and did not recur.

In one case the fistula appeared to be permanent, and I removed the kidney on the 65th day. There are some points of interest in this case. The calculus was small but it had caused repeated attacks of colic for several months. It was lying free in a localized dilatation of the ureter. The incision in the ureter was rather less than 0.5 cm. in length, and one suture was inserted. There was no bleeding during the operation. Nevertheless there was a discharge of blood and clot along the corrugated rubber drain on the third and fourth days, and a day later urine began to leak from the wound. I think I must have pricked a vein during the suture of the abdominal wall or the insertion of the stab drain, and I believe that the permanence of the fistula was the result of organization of clot round the ureteric incision. This was my 117th case of ureterolithotomy.

There were two cases of minor pulmonary embolism and one case of wound infection without fistula formation.
URETERIC CALCULUS

It will be seen that there has been no complication in this series that could be attributed to dissection of the ureter from the pelvic brim to the bladder, although I have seen it stated that this dissection may interfere with the blood supply and cause sloughing of the ureter. I have often wondered whether the fear of this accident has arisen because it is known to occur in gynaecological practice after Wertheim's hysterectomy. It seems probable that infection from the carcinoma of the cervix is one of the factors in the gynaecological cases, and no infection is present, except to a limited degree as peri-ureteritis, in cases of calculus.

In this series of 177 ureterolithotomies there were four post-operative deaths (two after operations above the pelvic brim and two after operations below the brim), giving a mortality for the operation of 2·3 per cent. Brief summaries of the circumstance leading to these deaths are set out below:

1. Calculus opposite third lumbar transverse process. Urinary fistula and extravasation of urine into scrotum. Apparent recovery at end of second week. From 23rd day rigors and fever until 50th day, when he died. Blood urea rose to 168 mgm. per 100 cc. Probably ascending pylonephritis. No post-mortem examination. (15th case.)

2. Two calculi in lower ureter near bladder. Died suddenly in ward, 1½ hours after operation. No post-mortem examination. (51st case.)

3. Calculus just below sacro-iliac joint. Rigor during blood transfusion. Gradually increasing jaundice beginning 24 hours after operation. Died 60 hours after operation. Post-mortem examination: acute diffuse hepatitis. (84th case.)

4. Calculus at level of third lumbar vertebra. Apparently uninterrupted recovery from operation. Pulmonary embolus on 20th day. Died in less than 10 minutes. (150th case.)

Considering these deaths in retrospect I doubt whether any of them could have been prevented. The first death, an early case, might not have occurred if the antibiotics now available had been available in 1934. The second and fourth deaths must still be reckoned as occasional hazards of all major surgical operations. At the time of the second death it was unfortunately not obligatory to hold an inquest if death occurred within 24 hours of an operation, and permission for a post-mortem examination was not obtained. The third death was the result of a combination of the risks of war, surgery, and blood transfusion. The patient had previously had a deep stab wound in the groin and there was a great deal of haemorrhage as I tried, without success, to expose the ureter extraperitoneally. I had to remove the calculus transperitoneally. A blood transfusion was given after the operation, and a rigor occurred almost at once. Jaundice appeared at the end of 24 hours and it gradually deepened until death occurred 60 hours after the operation. The post-mortem examination showed changes in the liver and nothing else abnormal.

I have not yet seen a true stricture of the ureter following ureterolithotomy. I have, however, seen one case of extra-ureteric compression after the operation. In 1937 the patient had an uncomplicated ureterolithotomy, which is included in this series, and had no further trouble
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until he went to Egypt during the war. There he had a second ureterolithotomy on the same side. Following this operation he had a persistent sinus and a recurrent urinary fistula. For some months after his return to England I was able to observe by ureteric catheterization and intravenous pyelography a gradually increasing constriction of the ureter. I had arranged to explore the wound, but no exploration was necessary, for a swab discharged spontaneously 18 hours before the time at which I had intended to do the operation. After this fortunate termination the sinus healed, the urinary fistula did not recur, and the narrowing in the ureter slowly disappeared.

Conclusion

It has been my main endeavour to show that the diagnosis of ureteric calculus can be made with little possibility of error, and I have therefore described in detail the diagnostic methods which I have found to be most reliable. These methods were tested in a series of 177 ureterolithotomies in all of which the calculus was found and removed.

I have also described a method of treating intra-mural calculi and a technique for ureterolithotomy, to which I have added an analysis of the complications which may follow ureterolithotomy.

In addition I have made some observations, based on the records of 464 cases of ureteric calculus and 276 cases of renal colic, on the relationship between unexplained attacks of renal colic and ureteric calculi and on the non-operative management of cases of calculus.

ACKNOWLEDGMENTS

I am much indebted to the Director-General of the Army Medical Service for allowing me to use the records of my M.E.F. cases; to Dr. W. G. Scott Harden for his co-operation and skill in taking the X-rays used to illustrate this lecture; and to my colleagues at the London Hospital, Professor Clifford Wilson and Mr. G. C. Tresidder, for help and criticism.

COLLEGE TIE

Lord Webb-Johnson has kindly presented a number of ties, squares and scarves, for sale in aid of the Restoration and Development Fund.

These are now available on application to the Secretary. The price of the tie is one guinea, plus an additional sixpence to cover the cost of postage, and the design is a multiple College crest (an eagle proper holding a mace of gold) on a maroon background. The price of the square is 6s., and of the tubular silk scarf six guineas.

All these may be worn by the following: — (a) Fellows and Members of the College; (b) Fellows and Licentiates in Dental Surgery; (c) Fellows of the Faculty of Anaesthetists; (d) Holders of the special diplomas granted by the Royal Colleges through the Conjoint Board; (e) Donors of £50 and upwards to the Restoration Fund; (f) Any employee of the College whom the Council may from time to time permit; (g) Postgraduate students attending educational courses at the College.

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