

## URETERAL CALCULUS: ITS SYMPTOMS AND TREATMENT.

WITH A FEW ILLUSTRATIVE CASES.

BY  
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In the great majority of cases met with in practice, by means now at our disposal, little difficulty is experienced in discovering a stone in any part of the urinary tract, and in defining its size, shape, composition, and location. In some instances its presence may be detected by one method alone—by vaginal palpation (Case iv), by the cystoscope (Cases ii and iii), or by *x* rays (Cases v and vi); in others, and these are not few, on account of the absence of symptoms or physical signs, not one, but all our methods of investigation must be employed before a diagnosis is arrived at and the surgeon is placed in a position to advise for or against an operation.

The surgeon who has but a limited experience in renal work is often too readily convinced of the presence of stone. He is misled by what he believes to be clear evidence; he undertakes an operation; he exposes the kidney, opens the pelvis, and examines the ureter, but no stone is found. On the other hand, when the symptoms are atypical, a case of stone is liable to be mistaken for lumbago, appendicitis, perityphlitis, pleurisy, cystitis, lumbar abscess, or spinal disease. No one symptom or physical sign is free from fallacy.

At a time when the diagnosis of calculus in the ureter depended upon a consideration of symptoms, helped by a chemical and microscopic examination of the urine only, great difficulties and uncertainties presented themselves to the surgeon, but now, in almost all cases, with our modern physical methods of inquiry, the surgeon knows beforehand what he will require to do in operating.

Many other lesions of the urinary tract may present all the symptoms of calculus, so that when the surgeon had subjective phenomena as his guide, helped only by palpation and an examination of the urine, the cases were very rare where even an approximately correct diagnosis could be made, and he approached an operation with considerable solicitude, and his active intervention required some courage. The problem now is greatly simplified and the diagnosis reduced to a certainty. With the aid of *x* rays, the cystoscope, wax-tipped and metallic ureteral bougies, and palpation of the terminal portions of the ureters, exact information can be gained. But even with all these valuable physical aids, in a goodly number of cases patience and careful watching are necessary, and not one but frequent examinations may be required before a definite course of treatment can be determined.

Conversant with the recent advances both in scientific and practical urology, the surgeon knows how valuable all the physical corroborative evidence is in helping him to

gain a full knowledge of the lesion. It must, however, always be carefully borne in mind that the diagnosis of a case is not simply locating and understanding the nature of the local disease demanding the aid of the surgeon, but the possession of a full knowledge of the patient's general condition. The surgeon must be a physician, a physiologist, and a pathologist as well as an operator. The actual operation is the smallest part of his work. After knowing the patient and all about him the two problems to be solved are: (1) Are the symptoms due to a stone in the ureter, and, if so, where is it situated? (2) Is the function of the suspected kidney and its neighbour interfered with, and are there any secondary lesions?

These questions can only be answered by making a very complete examination involving the general clinical history (haematuria, pain, anuria), examination of the urine, palpation, cystoscopic inspection, ureteral catheterization, the use of wax-tipped bougies, and *x*-ray photography and the fluorescent screen. The symptoms depend upon whether the morbid processes involve one or both kidneys.

When one organ is free from disease, and a stone becomes embedded in the ureter of the other kidney, the phenomena are regulated by the amount of obstruction caused by the impacted body. If the plugging is complete the indications are generally acute but short in duration, and unless the obstruction is speedily relieved the corresponding kidney is rapidly destroyed. The blocking of the ureter is generally preceded by symptoms of stone in the corresponding kidney, renal colic on one side coincident with the presence of blood in the urine. The injury produced by an im-

packed calculus seldom causes much bleeding, but in some instances considerable haematuria may occur. The following case is an example of this, due to a stone impacted in the ureter at the point where it passes over the brim of the pelvis.

### CASE I.—Renal Colic on Three Occasions from Impaction of Renal Calculus in the Left Ureter: Transitory Hydronephrosis and Haematuria.

A lady, aged 28, who had suffered from two attacks of acute renal colic, consulted me during the third onset of the pain. The patient was thin and the abdomen extremely lax. On palpating the left kidney the renal pelvis was found to be occupied by a hydronephrosis, and on passing the hand along the tract of the left ureter on deep pressure a very painful spot was discovered, just at the point where the ureter passes over the brim of the pelvis (Fig. 3). The distended ureter could be traced down to the same point, and an examination per vaginam in the elbow-knee position showed the lower segment of the left ureter to be normal; the bladder and orifices of the ureters were also healthy. After the calculus had been impacted for five hours relief was obtained and 16 oz. of blood-stained urine was passed, the colour being like dark port wine. When a week had elapsed after the onset of the last attack the left ureter was carefully massaged three times daily, and nine days after this treatment had been instituted a smooth uric acid calculus, the size of a lentil seed, dropped into the bladder.

Sometimes the loss of blood is considerable, and the blood

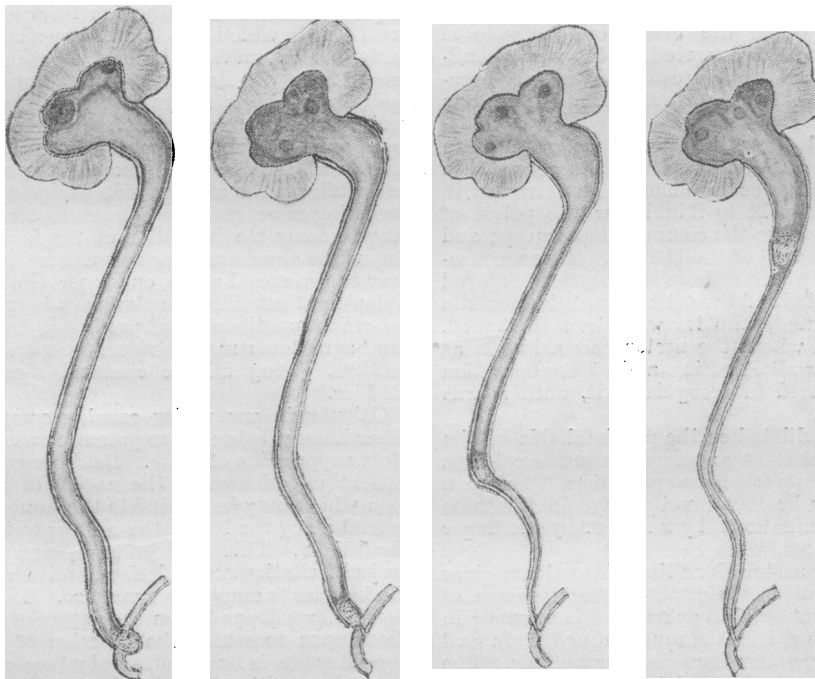


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1 shows distension of the renal pelvis and of the ureter throughout its whole course, from impaction of a calculus in the duct as it passes through the wall of the bladder. Fig. 2 shows the stone caught just outside the bladder; Fig. 3 at the brim of the bony pelvis, and Fig. 4 a little below the point where the renal pelvis contracts to form the ureter. The lumen of the ureter is smallest as the duct passes through the bladder wall.

comes away immediately after the relief from the acute colic (Case VI).

In other cases the quantity of blood present in the urine may be very small; this is generally so when the calculus is little and its surface smooth, and when it is impacted close to the orifice of the ureter. When the patient is suffering from an attack of renal colic there may be little or no blood in the urine, but if there is even a little it may be taken as evidence that the ureter is not completely obstructed by the stone, unless possibly the blood is escaping from the ureter of the unaffected side. When the attack passes off, either as a consequence of the escape, or from displacement of the calculus, a small quantity of blood is almost certain to be found in the urine if a careful watch is kept for it.

The dull and aching pain is for a time localized in the lumbar region only, but suddenly it shifts to the groin, and on pressure with the hand over the line of the ureter the suffering of the patient is markedly increased; at the same time it may be observed that the haematuria is suddenly stopped. Disappearance of blood from the urine coincident with sudden shifting of the locality and an increase in the severity of the pain are symptoms strongly in favour of the diagnosis of a stone fixed in and completely plugging the ureter. While the ureter on one side is blocked and no urine is being excreted by the corresponding kidney, the organ on the opposite side may be over-active and secreting a large quantity of urine of low specific gravity.

Figs. 1, 2, 3, and 4 show the ureter as seen when the stone is impacted in various parts of its course. In normal conditions the ureter is found to be narrowed in three places (1) at a point  $1\frac{1}{2}$  to 2 in. below the pelvis of the kidney; (2) as it crosses the common iliac artery; and (3) just as it enters the wall of the bladder. These, consequently, are the points where a stone is liable to be delayed in its descent or impacted. Above the impacted stone the duct is dilated, elongated, and its walls are thickened. I have seen instances where the ureter had a lumen as large as the normal small intestine, and at the operation difficulty was experienced in recognizing it, until it was traced to the kidney.

The duct is always dilated on the proximal side of the obstructing body, so that at an examination the calculus may be readily pushed up from the spot where it has been impacted, and so may be found not always in the same place at different examinations by *x* rays or by the finger (Figs. 1, 2, 3, 4).

With calculus in the ureter alone the urine seldom gives any significant indications. Certainly the presence of blood may attract attention, but as a rule it is so small in amount that as a sign it is not of much value. Pain and suppression of urine are the important symptoms. The conditions other than calculus which may cause obstruction to the ureter are numerous.

Table showing the Causes of Acquired Hydronephrosis in 665 Cases (from Newman: "Lectures on Surgical Diseases of the Kidney," p. 114).

	Hydronephrosis.	
	Double.	Single.
Simple or malignant tumours of pelvic organs causing pressure on ureters	143	41
Stricture of the urethra, enlarged prostate with hypertrophy of the bladder	195	39
Tumours or abscesses of pelvic organs leading to torsion of the ureters	23	9
Tumours or abscesses of abdominal organs ...	17	7
Displacement of pelvic organs, causing torsion of ureters	23	20
Bands and adhesions ... ..	7	5
Renal calculi ... ..	17	51
Displacements of the kidney ... ..	1	16
Tuberculous disease of the bladder ... ..	13	17
Tumours of the bladder ... ..	3	7
Ureter entering pelvis ... ..	6	5
	448	217
	665	

One important distinction between the course of events in calculous obstruction and that due to pressure from

without is that while the latter is gradual and almost always produces considerable dilatation of the pelvis of the kidneys, the former is sudden, and on one side at least is unassociated with hydronephrosis. It is unnecessary to discuss in detail the points of distinction between pressure symptoms as induced by the diseases above enumerated and the obstruction produced by calculus.

As a general rule, the disease causing pressure upon the ureters is itself so prominent that it is not likely to escape observation. But while a lesion may be discovered in one of the pelvic organs which may reasonably account for the obstruction, the surgeon must not conclude that a ureter is not also impacted by a calculus. A very striking example of this came under the observation of the writer. A woman with a large uterine fibroid complained of symptoms resembling renal colic, followed by suppression of urine, which lasted on several occasions for more than twenty-four hours, after which came relief with the escape of a large quantity of urine of low specific gravity. The conclusion came to was that the hydronephrosis and anuria were due to pressure of the tumour upon the ureters, but after death a calculus was found impacted in the left ureter as it passed over the brim of the pelvis. The most important cases to distinguish from calculous obstruction are those in which the flow is impeded by kinking of the ureter, as in movable kidney, or where the impediment arises from angular insertion of the ureter. Transitory hydronephrosis is met with in cases where the ureter is occluded only occasionally. Sudden accumulation and rapid subsidence of the swelling is an important characteristic of transitory hydronephrosis produced in this way, and while on the affected side the pelvis is still filling and becoming more and more tense, on the healthy side there may be complete inhibition of the function of the kidney. But while anuria may last sometimes for days, it is hardly ever so prolonged as to endanger the life of the patient. Calculus of considerable size may be present in the ureter for many months without producing any symptoms, or the local symptoms may be referred entirely to the bladder or urethra, giving all the classical signs of stone in the bladder.

Calculus in one ureter causing complete occlusion, the other kidney being incompetent, leads very soon to complete suppression of urine. Before suppression occurs the patient experiences in the region of the affected kidney pain which may be limited to the lumbar region, or it may extend along the line of the ureters to the bladder or down the thighs. This may be associated with considerable vesical irritation and a desire to micturate, even although the bladder is empty or nearly so. The course of events that follows depend upon the nature of the obstruction and the degree to which the function of the kidney on the opposite side is impaired. Calculous anuria may last for many days without the development of symptoms of toxic poisoning, and if the kidney has previously been the site of hydronephrosis the period will be more prolonged than if the organ is not so affected. This delay in the development of so-called "uraemic symptoms" is the feature which distinguishes obstructive anuria from suppression of urine due to disease of the renal parenchyma; indeed, in calculous anuria death may occur without the occurrence of any of the ordinary symptoms of uraemic poisoning. The early appearance of symptoms of toxic poisoning in the anuria of organic disease of the kidney is explained by the circumstance that during a long period prior to the actual suppression of urine there has been a steady impairment to the elimination of waste products and a gradual storing up of toxins in the system, so that when the kidneys stop working the poisoned state of the circulation cannot be relieved sufficiently by the complementary action of other organs, such as the skin, the lungs, or the alimentary tract.

In a few instances the employment of all the special methods may be necessary; in other cases one may suffice. Such easily diagnosed cases are not met with every day; it is only with very good fortune that an observer can have easy success, consequently all methods which throw light on the diagnosis are of use.

Considered in order of their relative value, they are:

#### I. Radiography.

For the detection of stone *x*-ray photography was first used in 1896 by Dr. John Macintyre in the Glasgow Royal

Infirmity, when calculous matter was discovered in the pelvis of the kidney of a patient under the charge of Dr. James A. Adams. When first employed many difficulties had to be met; the thickness of the parietes, the chances of the stone being overshadowed by bone, and the movement of the kidney during respiration are all difficulties which have been overcome by improvement in technique. The subject was carefully worked out by Albarran, Ringel, Braatz, Wagner, and others at an early stage in the development of this method, and they showed that even with the most careful attention to detail the results from radiography were valuable only in exceptional cases, where probably the diagnosis could have been made without the aid of the rays.

This was the general opinion and experience regarding the value of the Roentgen rays in the diagnosis of urinary calculi to begin with, and for a number of years after their general introduction. Now this method of investigating the urinary tract has been wonderfully improved and has become indispensable to the urologist, but it must not be allowed to exclude other methods of investigation. The danger is that it may become a short cut to diagnosis, and so lead to serious errors.

It is now so perfect that even a small uric acid stone in the lower segment of the ureter can easily be discovered. This field of diagnosis has been extended by the use of stilettered ureteral catheters, and by the injection into the ureter and kidneys of certain metallic salts which throw a shadow, and maps out for us the position of the renal pelvis and the line of the duct.

There are certain points the surgeon requires to attend to, and others should be looked after by the skiagrapher.

The surgeon should see that the bowels are clear of any substance likely to throw a shadow, and for this purpose a mild aperient should be given on two successive nights prior to the examination, and the patient should have only light diet the day before, and should fast on the morning of the examination.

In searching for ureteral calculus we use both the fluorescent screen and the photographic plate. These methods have the advantage that they not only demonstrate the presence of stones, but they also afford valuable information as regards their number, position, shape, and size.

There are many dangers of obtaining shadows which are liable to be mistaken for those of stone, and we must admit that the difficulties of obtaining a shadow of calculi *in situ* in the kidney or ureter are due to many causes. It is by recognizing these difficulties that we have practically overcome them, and steadily the percentage of our failures have become less and now are very few indeed. In each individual case the tension of the rays and the length of the exposure must be carefully considered, and before the shadow photograph is taken, or, better still, while it is being taken, the penetrating power of the rays must be observed through the fluorescent screen. Before taking a photograph the position of the stone as seen by the screen should be marked by cross wires which come out in the radiograph. The wire can then be removed and the relationship of the stone to the cutaneous surface fixed by marking with ink.

Errors in diagnosis may be considered in two divisions: (1) Those in which the shadow is given, and believed to be due to stone, but the surgeon fails to find one, and (2) those in which a stone is removed by the surgeon, but no shadow betrayed its presence. The most common causes of false shadows are the presence in the abdomen or in its walls of substances with a high absorptive index, such as faecal accumulations, fruit stones, the presence of bismuth salts, enlarged and calcified glands, old purulent accumulations, cicatrices, and phleboliths.

The most common and characteristic position for a stone is in the angular space formed by the eleventh rib and the spinal column. Very often the shadow of the stone is covered by the last rib. A clearly-defined shadow in this position is almost certainly due to calculus; it is when shadows are found in other regions that doubt arises. Those due to calculus may, of course, be found in any part of the urinary tract, and the more closely the situation of the shadow corresponds with the anatomical position of the pelvis of the kidney and the ureter the greater the suspicion of stone. It is therefore useful in doubtful cases to pass a soft metal bougie into the ureters and photograph

it along with the stone; but, on the other hand, a shadow well outside the line of the ureter may be caused by a calculus in a diverticulum (Cases VI and VII, Figs. 11 and 12).

The employment of bougies charged with metallic salts or injection of the pelvis and ureter with innocuous solutions of metallic salts furnish an additional shadow picture of the structures under examination, and afford valuable information in certain cases.

Ureter bougies made of fuse-wire are easily introduced and are superior in many ways to others. They mould themselves easily to the duct. On account of contortion of the duct causing variation in the course of the ureter it is difficult to judge from a skiagram whether a shadow is in the course of the ureter unless the x-ray picture is taken with a bougie in the ureter. In operations on the ureter, or on organs in close proximity to it, it is important to determine the topography of the ureter throughout its entire course.

By injecting a warm solution of collargol (10 per cent.) or an emulsion of silver iodide in mucilage of quince seed (5 per cent.) into the pelvis of the kidney through a ureteral catheter the urinary tract can be silhouetted on the x-ray plate. Great care is required in using this method, and it is not always free from danger, as shown by Rovsing of Copenhagen, Geraghty and Zachrisson. A very good review of this method is published by Lequeux, Papin, and Maingot.<sup>1</sup> As far as the diagnosis of stone in the ureter is concerned the ureter catheter fulfils all that is required. It is arrested by the stone and the radiogram shows the stone shadow at the tip of the bougie or in close relationship to it, whereas if the shadow is away from the line of the bougie the shadow is either caused by the stone being in a sac (Cases VI and VII and Figs. 11 and 12), or it is thrown by a foreign body outside the urinary tract.

An x-ray plate should be marked clearly with the patient's name, the date, and the *right* and *left* sides should be shown by L and R. This may seem a very elementary instruction, but it is an important one, and failure to carry it out gives rise to endless trouble. To avoid all possible error, metal letters R and L should be fixed to the patient's skin. The edge of the psoas muscle and the lower poles of both kidneys should be seen unless the liver is unusually dense or enlarged. The bones should be distinctly outlined, particularly the transverse processes of the lumbar vertebrae. A large plate should be taken showing the whole region of the urinary tract, and, if a shadow is seen anywhere, a smaller plate should be used to bring out detail.

## II. Sounding of the Ureters and the Use of Wax-tipped Bougies.

In cases of stone impacted at the lower end of the ureter the ureteral catheter may fail to pass more than a short distance into the duct, but on introducing a ureteral resonator the sound of the metal coming in contact with the stone can be detected by the ear, as well as by the hand, of the observer. The instrument consists of a probe which is fixed in a small flat handle and prolonged into a hollow brass globe or resonator. One end of an india rubber tube is fixed to the proximal end of the resonator; to the other end of the tube is fixed a wooden ear tube, made to fit the external auditory meatus of the observer. The probe is introduced into the ureter, and when an obstruction is met with the ear tube is fixed in position and the instrument is rotated slightly. If a calculus is present the sound produced by the probe grating upon it is easily heard.<sup>2</sup>

A method proposed by Kelly is to introduce a ureter catheter or sound coated with wax. When the smooth wax coating comes in contact with the rough stone its surface is scratched, and this, when carefully carried out, gives not only corroborative evidence of the presence of a calculus, but the distance of the stone from the urethral orifice can be measured. While this method may be employed with advantage in women through Kelly's speculum, it is not so easily employed when direct illumination cystoscopes are used. When the waxed catheter has to be introduced through the shaft of the cystoscope scratch marks may be made by the catheter canals, and consequently lead to erroneous conclusions. Kelly, in

<sup>1</sup> Made for the writer by Messrs. J. Gardner and Son, surgical instrument makers, Edinburgh.

referring to his own method, says: "There are three sources of error which must be borne in mind in order that they may be avoided. In the first place, the contact of the wax with the side of the speculum may produce a facet. This should never be taken for a scratch, and the wax need not touch the edge of the speculum if the catheter is introduced with a steady hand and the inner rim of the speculum utilized as a fulcrum. In the second place, the catheter should be introduced into the ureteral orifice with one direct forward movement; any to-and-fro movement near the vesical rim of the speculum is liable to produce scratches. In the third place, when withdrawing the catheter, the speculum having been already removed, the vulva must be held open, so that there is no contact with the genital hairs."

This method was employed with advantage prior to the introduction of  $x$  rays and even for a number of years thereafter, but now that the technique of skiagraphy is so thoroughly understood it is seldom used. All stones are discovered by the experienced skiagrapher.

Sounding the ureters also only marks an advance in physical diagnosis, but is a method I have not resorted to for many years.

### III. The Cystoscope.

The cystoscope may prove the existence of complete obstruction to the ureter by the fact that, even although the mouth is patent and the duct admits a catheter, no

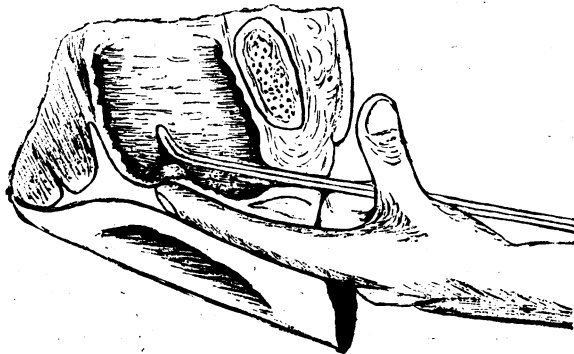


Fig. 5.—A sound in the bladder and the left index finger in the vagina, as seen when the stone is in the ureter outside the bladder wall.

fluid escapes. This is most accurately observed after a hypodermic injection of indigo-carmin or of aniline blue and the patient has taken a full drink of warm fluid. Coloured shoots are seen escaping from the patent ureter only.

When a stone is situated close to the orifice of the ureter it may appear in the bladder as a distinct projection of the mucous membrane, or it may protrude through the mouth of the ureter, exposing its surface.<sup>2</sup>

In some instances the calculus may pass along the ureter through the muscular portion of the bladder wall, and become gripped only by the mucous membrane at the orifice of the ureter, so in place of passing through into the cavity of the bladder, the calculus, by obstructing the flow of urine, leads to the mucous membrane being pushed away from the muscular portion of the bladder, and a rounded tumour-like mass presents itself in the bladder which may be mistaken for a tumour (Fig. 6).

From a number of cases two may be selected where I was fortunate in diagnosing the presence of a stone impacted at the orifice of the ureter by a cystoscopic examination only:

**CASE II.—Renal Calculus Impacted at Orifice of Ureter and pushing Mucous Membrane in front of it: Calculus Movable: Removal by Ilio-inguinal Operation.**

At the first examination the stone itself was not visible, being covered by the mucous membrane of the bladder, but the appearances were so exactly a replica of a view I got in a previous case<sup>3</sup> that I felt satisfied that I had to deal with a moderate-sized calculus included in the mucous membrane of the bladder; and after I had expressed my opinion to Dr. J. Souttar McKendrick, who sent the patient to me, he told me that he had an  $x$ -ray plate taken, and a shadow was found in the situation I had indicated (Figs. 1 and 6). The calculus was mobile, and was removed easily by the ilio-inguinal route.

**CASE III.—Repeated Attacks of Renal Colic from Ureteral Calculus, which ultimately became impacted in Orifice of Left Ureter and was clearly seen by Cystoscope: Removed by Suprapubic Route: Cure.**

A lady, aged 31 years, was suddenly and without any warning seized with a severe pain in the left lumbar region associated with suppression of urine, on November 10th, 1907. After twelve hours of agony the pain gradually passed off, and almost immediately she passed a few ounces of dark-coloured urine, but as no medical attendance was sought at the time it is not known that the coloration was due to blood. She enjoyed good health for over four months, when a second attack seized her, and I was asked to see the patient six hours after the onset of the pain, which had all the characteristics of renal colic. The attack lasted for eight hours but recurred the following day. A cystoscopic examination was made, when the bladder was found to be practically normal, but from the orifice of the left ureter the point of a phosphatic stone protruded, and by palpation through the vagina the stone was made out to be the shape of a horse bean but about one-half larger. It was removed by a suprapubic operation.

### IV. Abdominal Palpation and Palpation through the Vagina or Rectum.

By palpation through the abdominal parietes much information may be gained when the stone is situated above the brim of the pelvis, provided the walls are flaccid and the patient thin; but when the muscles are rigid, which is often the case, or the patient is corpulent, the detection of a stone in the upper part of the ureter is almost impossible. Pressure with the hand, however,

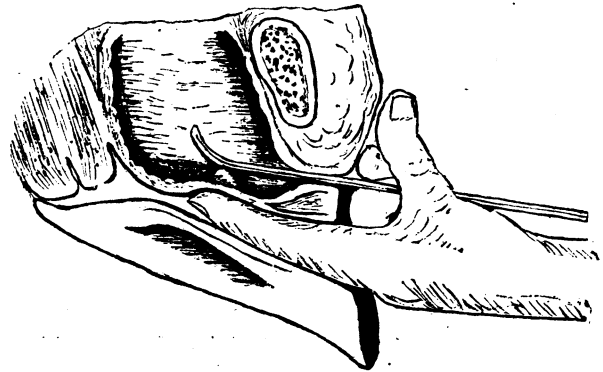


Fig. 6, when the stone is simply covered with mucous membrane of the bladder.

generally elicits tenderness in the locality of the stone, or may even induce acute pain.

When the calculus has passed to the lower third of the ureter, examination with the finger in the rectum or in the vagina, according to the sex, may lead to the detection of the stone and the exact situation occupied by it. A sound should be passed into the bladder, and, with the left index finger in the vagina or rectum, the back of the instrument is made to press upon the line of the ureters and their orifices (Figs. 5 and 6).

Simply by digital examination a stone may be found, as illustrated in Case iv. By palpating from the vagina or rectum the surgeon can, by pressing the point of the finger backwards against the pelvic wall, make out a hard body. During the examination the patient usually complains of pain and irritation of the bladder, with a desire to micturate.

**CASE IV.—Old History of Renal Colic from Calculus at Lower End of Ureter, the Movement of which was Limited: Removed by Ilio-inguinal Route: Ureter not Sutured: Good Recovery.**

Recently I was asked to see a lady who had suffered from symptoms of ureteral calculus for several years. Her husband, a doctor, suspected a stone, and on digital examination I found a hard body impacted just behind the cervix and a little to the left, which slipped upwards on pressure against the sacrum. I felt sure it was a stone, and the diagnosis was confirmed by a cystoscopic examination, the calculus causing a bulging at the orifice of the ureter (Fig. 1). On exploration the stone was found at the lower end of the ureter, but while movable it could not be pressed up more than 2 in. from the ureter orifice, and therefore could not be brought into view through the ilio-inguinal incision. I had therefore to make the incision through the ureter wall by touch, and press out the stone through the opening, and as no sutures could be applied, the wound was packed with gauze. The lumen of the ureter being large the urine

drained freely into the bladder, and the gauze packing was almost dry when removed on the fourth day. Uninterrupted recovery.

## REFERENCES.

<sup>1</sup> *Exploration radiographique de l'appareil urinaire*, Paris, 1913.  
<sup>2</sup> Newman: BRITISH MEDICAL JOURNAL, April 10th, 1900, and March 24th and 31st, 1906. <sup>3</sup> Newman: Calculi impacted in Ureters, *Lancet*, April 21st, 1900, Case III.

(To be continued.)

## REMOVAL OF A BULLET FROM THE RIGHT VENTRICLE OF THE HEART UNDER LOCAL ANAESTHESIA.

REPORTED BY

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With Remarks by

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PRIVATE A. was admitted to a general hospital on July 19th, 1915, having been wounded eight days previously. The bullet had passed through and killed a man in front of him. A. was knocked down, but did not lose consciousness, and had not had any discomfort other than slight pain from the wound. There was a small dirty wound ( $\frac{1}{2}$  in. diameter) just below and to the right of the xiphi-sternal junction, and also a painful swelling of the right parotid gland, which disappeared next day. The patient showed no other symptoms during the first few days. He was kept in bed. The heart appeared to be normal and regular. The pulse varied between 80 and 90. The evening temperatures rose to 100° to 101° F.

X-ray Report by CAPTAIN S. F. McDONALD, R.A.M.C.

July 21st, 1915.

"There was an entry wound in the right epigastrium, but on examination no shadow could be seen in the abdomen.

"The lungs and pleural cavities were normal. The diaphragm moved well and evenly on both sides. The heart was normally situated, but there was some slight increase of cardiac shadow on the right side. In the lower portion of the heart shadow was a very sharply defined dark shadow moving with the heart, and also apparently laterally in relation to the heart. This last movement suggested that the object was free in the pericardial cavity, but on turning the patient over it was seen to lie quite definitely in the substance of the heart. It had a distinct rocking movement. No antero-posterior movement was visible in relation to the heart.

"The object seemed to be in, or close to, the lowest portion of the wall of the right ventricle. Its shape and size, so far as could be made out, were those of a rifle bullet. Attempts to take radiograms were unsuccessful."

Colonel Gray, consulting surgeon, saw the patient first on July 25th, and again on July 26th, on which day a sharp pain developed suddenly in the left leg. As the pulse during the night of July 26th had shown some irregularity, rate 65 to 95, and the heart had occasionally dropped beats, an operation was decided on and performed on the morning of July 27th. Veronal, gr. v, was given on the evening before, and three doses of morphine, amounting in all to  $\frac{3}{4}$  gr., during the morning before operation. The patient was not unduly under the influence of morphine. He was screened again just before the operation and conversed, sat up, and turned himself smartly when asked to do so.

### Operation.

Under local anaesthesia (eucaïne 1 per cent., potassium sulphate  $\frac{1}{4}$  per cent., and adrenalin) Colonel Gray made a wide horseshoe-shaped incision, convexity upwards, extending along the sixth costal cartilage on each side and across the sternum at the level of the attachment of the fifth cartilage. This incision was used so as to make an

exposure of the track of the bullet in the depth. The perichondrium was separated from the left sixth cartilage, which was cut across at the costo-chondral junction and used as a lever to elevate the sternum while the triangularis sterni, pericardium, etc., were being separated off the posterior aspect of the flap. A small portion of the right sixth rib was removed close to the costo-chondral junction. The sternum, at the lower border of the fifth costal cartilages, was grooved deeply with a gouge and divided with bone forceps. The soft parts were then separated from the sternum and ribs so that the flap could be turned downwards and forwards. When the flap was pulled forwards a hole about an inch long appeared in the pleura on the right side, in the track of the bullet. The right lung collapsed. The respirations became laboured and quick, the patient coughed jerkily; he became anxious and complained that he was breathless. The colour remained good, and he settled down in about one minute, after being reassured by the surgeon. Except for this disturbance there was apparently no discomfort during the entire operation.

The flap was held forward by hooks, and the pericardium opened obliquely from the base to near the apex of the heart. About a drachm of slightly bloodstained fluid was noticed in the pericardial cavity. The heart looked normal. No wound could be seen. On digital exploration the bullet was felt to be lying, apparently fixed, at the back of the heart, either in the wall or cavity of the right ventricle. The point of the bullet was near the apex of the ventricle. During the manipulations the heart was noticed to miss a beat occasionally—when touched at the upper and back part of the interventricular septum.

The right ventricle was seized with a pair of catch forceps near the apex. When it was seen that this caused no disturbance a suture was passed through the muscle adjacent, and by these the heart was held forward. This in no way agitated the patient. On further exploration the bullet was definitely located by probing with a needle, and was thought to be fixed in the right ventricle near the posterior coronary vessels. After manipulation, the bullet was felt to change position and to be free inside the ventricle. It was worked away as far as possible from the coronary vessels and grasped between the thumb and finger. Two stitches were inserted into the muscle wall over the bullet. The wall of the ventricle was incised for half an inch, and the bullet removed with forceps. While the wall of the ventricle was still being held firmly between the finger and thumb the stitches were tied.

On removing the catch forceps there was brisk bleeding, which was stopped quickly by an under-running stitch. The pericardial cavity was wiped free of blood-clot and was filled with normal saline to expel the air; it was then sewn up. The right pleural cavity was next filled with saline and the injured pleura sewn up. While the wound was being closed the chest was aspirated to remove the saline. This aspiration was the only part of the operation which seemed to cause the patient any pain.

The patient was wonderfully comfortable on being taken back to bed, but about four hours after the operation the respirations rose suddenly to 48 a minute, and remained at about that level till he died, except for part of the day of July 29th and 30th, when, the patient being deeply under the influence of morphine, they dropped to 28 a minute.

He was much troubled after this occurred by mucus collecting in large quantity in the throat and the upper part of the trachea. Various remedies were tried for this, with little avail. He took nourishment fairly well. Cardiac stimulants were used after the first two days.

On July 29th his mind began to wander, and he was often delirious till the time of his death on July 31st. He lived nearly four and a half days after the operation.

There was never any indication that the operation on the heart had interfered with its action, which, though quick (average 120 to 130), was wonderfully strong up to within a few hours of his death. No dropping of beats was noticed after the operation.

### Necropsy.

At the *post-mortem* examination it was found that the external wound had healed well; there was no sign of any