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IT becomes more and more evident with the increasing frequency of operations upon the kidney that serious errors in the diagnosis of renal calculus are often committed. Not infrequently a patient who has a persistent pain in the lumbar region, blood or pus in the urine, or a retroperitoneal lumbar tumor, is operated upon for calculus of the kidney, and the operation fails to demonstrate the existence of the stone.

I have seen repeated failures where all these signs existed in the same patient and had persisted for a long time.

The presence of pus in the urine is one of the most characteristic signs of calculus in the pelvis of the kidney, but from the mixed urines of the bladder it is impossible to say from which side the pus comes; or, if pain and swelling point distinctly to one side, it cannot be asserted after any ordinary examination that the other side is not affected too.

In so far as pus is diagnostic of the presence of a stone in the kidney, and it is one of the most characteristic factors, though by no means pathognomonic, I have been able to simplify the matter by my

method of catheterization of the ureter under a direct inspection, the bladder being distended with air by the posture of the patient. In order to secure a sufficient quantity of urine for satisfactory examination, it is necessary to leave the catheters in the ureters anywhere from a quarter of an hour to several hours. I found that flexible catheters were better for this purpose than the metallic ones that I had been previously using. I therefore had a series of catheters made, 2, 2¼, 2½ mm. in diameter, and 30 cm. (12 in.) long, constructed of woven silk, coated with many layers of shellac, and with a highly polished outer surface. The end of the catheter is blunt and conical, and has a large oval eye 2 cm. back of the extremity. In a warm room the catheter is often too flexible to be introduced into the ureter and it coils in the bladder; this difficulty is overcome by stiffening it with a wire stylet, when the point of the catheter is placed within the ureteral orifice, and then the catheter is simply pulled off the stylet, which is held rigidly as the catheter passes up the ureter. By means of catheters introduced one on either side the urines from the right and left kidneys are collected in separate test-tubes held in two auger-holes bored in a block of wood that is placed in the bed between the patient's legs. The right side must be carefully marked by a piece of string or some other device to prevent confusion.

An analysis of these urines, with the microscopic examination, then shows the presence of pus on one or both sides, and the amount of urea in each indicates the working coefficiency of the kidney.

FIG. 1.

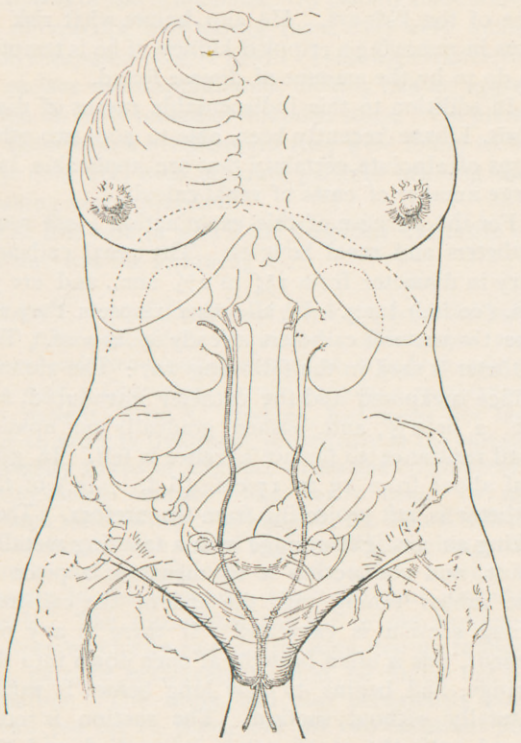


Diagram of ureters and kidneys, with a flexible ureteral catheter introduced just above the superior strait and draining the left kidney; on the right side a flexible renal catheter has been introduced and the extremity lies in the pelvis of the kidney. The ends of both catheters project from the urethra.

With the knowledge gained by this sort of examination of the two sides, the operator is posted

as to the amount of risk he incurs in operating upon one of the kidneys. He also knows what risk he runs in removing a crippled kidney, if he is tempted to do so by the amount of disease found.

In addition to this indispensable means of diagnosis, I have recently been able to add two other signs of absolute certainty that are applicable in a large number of cases of renal calculi.

For the purpose of this examination I use renal catheters and renal bougies. The renal catheters vary in diameter from 1¾ to 2½ mm., and are 50 cm. (20 in.) long. In all other respects they are like the ureteral catheters already spoken of. The catheter is used in the following way: The ureteral orifice is exposed and the catheter introduced, say No. 2 or 2¼, and pushed gradually on upward until resistance to further advance is felt. In general about from 13 to 17 cm. (6 to 7 in.) of the catheter is left projecting from the urethra. Then taking an air-tight syringe with a tapering metallic point, and connecting it by means of a piece of fine rubber tubing with the end of the catheter, strong suction is exercised. If there is any pus present, this is often brought at once down into the syringe, and begins to flow long before it would naturally without suction. The suction is continued until the renal pelvis is emptied, and the fluid obtained is placed in a conical graduate for careful examination.

In three cases I have been able to diagnosticate the presence of renal calculi by discovering in this fluid a minute, dark-brownish or blackish sediment consisting of little pieces of material about a half-

millimeter or less in diameter. On placing these under the microscope and testing them they were found to be composed of uric acid. Their appearance on the surface was mammillated, looking like an aggregation of little masses of rounded stone. On pressing them with a needle-point they were found to be quite coherent, each separate particle bending and breaking under pressure.

The first case in which the diagnosis was made in this way was the following:

CASE I. *Miss S.; several black specks withdrawn from pelvis of kidney by suction. Microscopic and microchemic examination showed them to be masses of uric acid. Operation; renal calculus; recovery.*— The patient, Miss S., aged 29, had spent not less than 10 years in treatment, principally at the various university towns of Europe, where she could secure distinguished counsel. She finally came to me through the courtesy of my friend, Dr. Max Koehler, of Cincinnati. She was of slight build, weighing 106 pounds, and complained of indigestion, a sense of pressure in the abdomen, headache, and irregular bowels. The discomfort she felt in the abdomen was located chiefly on the right side, but no tenderness, pain, or enlargement could be found out by palpation. The urine had also persistently contained pus for 10 years, and on two occasions she had passed some blood. Among others, she had seen Prof. Ultzmann and Prof. Czerny, of Heidelberg, who had diagnosticated a catarrhal pyelitis.

She dated her ailment from a chill taken at a ball, during menstruation, and stated that after this time the urine was affected.

On examination, I found the uterus and the pelvic organs normal in size and position. The urine con-

tained pus and a bacillus resembling the colon-bacillus. I placed the woman in the knee-breast position and passed a small speculum into the bladder, and distended it atmospherically, so that all of the bladder-wall could be well seen; this was found to be healthy. I found by catheterizing the uterers separately that the left side secreted normal, clear urine, entirely free from pus; but when the catheter was passed up to the pelvis of the right kidney, 3 or 4 cc. of turbid urine escaped, which under culture developed the colon-bacillus. The fact that there were several cubic centimeters of urine found in the pelvis of the kidney each time showed that there was a stoppage at the juncture of the ureter with the renal pelvis. Ordinarily, in two minutes' time 13 cc. of urine were discharged from the right

FIG. 2.

Stone found in the pelvis of the right kidney (Case I), diagnosticated by the flexible renal catheter and removed by lumbar section.

kidney, while under normal conditions the flow should not be more than 1 cc. I was never able at any time to trace the source of infection. The final result of the treatment showed that it was not due to any communication with the bowel.

I began treatment by introducing the renal catheter and washing out the pelvis of the kidney, and did this more than 100 times. At first there was some slight improvement, but later the trouble persistently grew worse, the pus increasing in quantity and becoming quite thick. The injections used were at first boric acid; a few times weak solutions

of silver nitrate, and, finally, solutions of mercuric chlorid, beginning with a strength of 1 : 100,000, and gradually reduced to 1 : 5000. This was kept up throughout the winter of 1894–95.

On two occasions upon emptying the pelvis of the kidney by strong suction, applied at the end of a catheter by means of an air-tight syringe connected with it by a short piece of thick, rubber tubing, I found in the bottom of the conical glass receiver several minute, black specks not over a half-millimeter in diameter. On putting these under a microscope, they turned out to be little masses of uric acid, holding firmly together, and only crushed with some difficulty by the point of a needle. At no time had any similar pieces been found in the urine passed in the usual way. On the basis of this find, associated with the fact that it was impossible to clear up the urine coming from the pelvis of the kidney, I concluded that the patient had a stone in the pelvis.

I operated March 30th, removing a small, black, rough, uric-acid calculus, 11 x 16 mm., shown in Fig. 2, natural size. The kidney was brought out through a lumbar incision, the renal pelvis opened posteriorly, and the stone was found lying in the lower part of the pelvis over the ureteral opening. After its removal, the pelvis was closed by suture with catgut. Before closing, the ureter was palpated and found normal down to the pelvic brim. The abdominal incision was closed down to a small opening in the loin left for a gauze-drain.

The patient recovered rapidly, and the urine cleared up completely. When she left my care early in June there was absolutely no pus in it, and, on catheterizing the kidney for a final examination through the bladder and ureter it was proved that clear urine was secreted in the normal manner, and

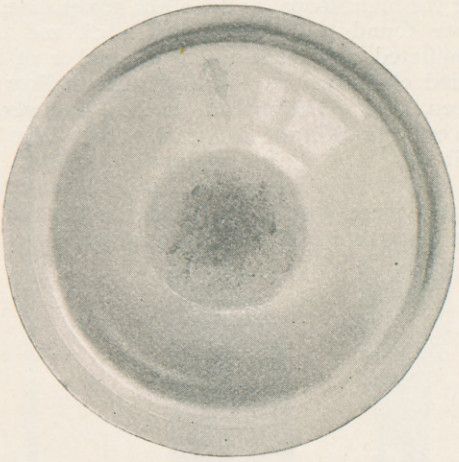
all trace of the stoppage at the junction of the ureter with the pelvis had disappeared.

CASE II. *Malignant disease of the right kidney; hydronephrosis of low grade; bits of renal calculus brought away by suction applied through the renal catheter.*—The patient had a large right kidney, either carcinomatous or sarcomatous. I found upon carrying the renal catheter up into the pelvis that about 10 cc. of clear urine escaped at once, and on putting on strong suction some fine, black granules were brought down which, under the microscope, appeared exactly like those just described in the case of Miss S. The percentage of urea, estimated from urine drawn from the sound side, was 1.7, while in the urine from the diseased side it was only 0.7. The patient's condition did not admit of any operative interference, and nothing was done.

CASE III. *Calculous pyonephrosis; diagnosis made by the renal catheter bringing away pieces of stone; a large piece caught in the eye of the catheter; scratch-marks on the end of the catheter.*—The third case came to me from Chicago, referred for diagnosis by the courtesy of my friends, Dr. N. S. Davis, Jr., and Dr. Fernand Henrotin. The patient was about 46 years of age, and suffered from a persistent pyuria of doubtful origin. I passed a renal catheter into the pelvis of the kidney, and by means of strong suction brought down at once a small quantity of urine mixed with abundant pus. A quantity of fine, granular, amorphous débris shown in the sediment in the figure came down with it, and interspersed with this were some small, blackish particles looking like grains of pepper. (See Fig. 3.) These under the microscope were found to be little, brownish masses of uric acid.

On withdrawing the catheter an irregular piece of stone, a millimeter in diameter, was found wedged

FIG. 3.



Sediment drawn down in Case III, August, 1895. The larger masses are tissue-débris. The minute granules are detritus of a calculus.

FIG. 4.

FIG. 5.

Fig. 4. Stone caught in eye of catheter. Natural size.
Fig. 5. Free broken-off surface of the same stone, magnified 18 times.

in the eye as shown in Fig. 4. On putting this under the microscope, under a low power, one surface was found to be discolored black and to be mammillated, and made up of a number of little rounded elevations set together with shallow sulci between them. The opposite surface, however, was of an entirely different color, being of a light buff, and it was broken, jagged, and crystalline, with sharp ridges. (See Fig. 5.) It was therefore evident that this piece had been freshly broken off and drawn into the eye of the catheter by the suction.

FIG. 6.

End of catheter hammered down and scratched. Magnified.

In addition to this conclusive evidence of the existence of a stone in the pelvis of the kidney, I found further confirmatory evidence of the most satisfactory sort upon withdrawing the catheter and putting the end under a weak magnifying power. The smooth, hard, varnished surface was chipped

off on one side, and the smooth, round end was hammered down and irregular, as shown in the an-

FIG. 7. FIG. 8. FIG. 9.

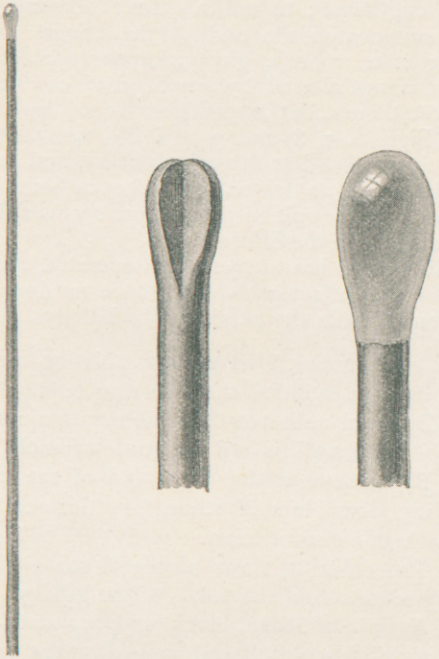


Fig. 7. Rubber bougie tipped with wax. Natural size.
Fig. 8. Hard-rubber bougie, showing groove. Enlarged four times.
Fig. 9. Rubber bougie tipped with dental wax. Enlarged four times. The clear spot is the reflection of a window on a smooth surface.

nexed figure, demonstrating that it had been brought into violent contact with a hard surface.

I had already thought of making a diagnosis in this way. I had made last spring a hard-rubber renal bougie, 2 mm. in diameter, with an olive point, 3 x 2 mm., notched on two sides, the notch running lengthwise; to use this, I melted some dental wax and coated the end of the bougie with it, giving it a smooth, glossy, impressionable point, which is not altered by any kind of contact with the soft tissues, but is easily scratched by a stone. (See Figs. 6, 7, 8, and 9.) I did not happen to have this at hand at this examination, and so made the diagnosis, as stated, with the catheter alone. I expect the bougie to prove more serviceable than the catheter in the future.

This patient has not yet been operated upon, but the diagnostic factors detailed leave no doubt as to the condition in the pelvis of the kidneys.

To recapitulate, I have been able by means of these cases to establish the following points:

1. By renal catheters to demonstrate a unilateral or a bilateral pyelitis and the grade of each.

2. By suction at the outer end of the catheter to bring down bits of stone for microscopic and microchemic examination.

3. The color of these pieces of stone signified a long retention in the pelvis of the kindey.

4. A piece of stone, black and rounded on one side, and light-colored and jagged on the opposite, was evidently broken off from a larger calculus and caught in the eye of the catheter by friction and suction.

5. The bruised end of the catheter was conclusive evidence of violent contact with a hard body.