**Radiography of the kidneys inflated with air or gas / by Lewis Gregory Cole.**

# RADIOGRAPHY OF THE KIDNEYS

## Inflated with Air or Gas

BY

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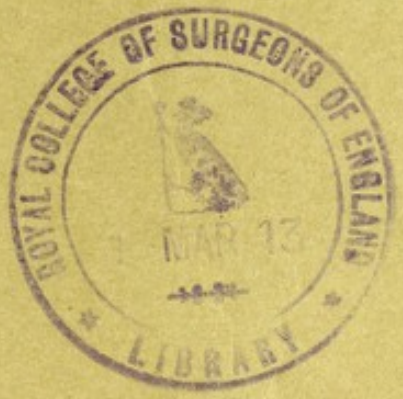

# Radiography of the Kidneys Inflated With Air or Gas.

By
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The main object of this paper is to describe a method of radiographic examination of the kidneys that eliminates some of the disadvantages and dangers of injecting the pelvis and calices with collargol or argyrol; but the case about to be reported also illustrates many of the fundamental principles of successful renal radiography.

When radiologists had temporarily ceased to make progress in differentiating soft tissues from each other, Rieder and other German radiologists suggested the use of food impregnated with bismuth to determine the size, shape, position and functional activity of the stomach and colon. Some time later Professor Voelcker of Heidelberg suggested radiography of the kidney after the pelvis and calices had been injected with collargol or argyrol. This method of examining the kidneys has been quite extensively used in this country by Doctors Braasch, Willie, Keys, Caldwell and McKee. It was at the suggestion of Dr. Willie of Rochester, Minn., that this method was used in the case about to be reported.

Before this method was used, radiologists were limited in their examinations of the kidneys, to the diagnosis of renal calculus, or some pathological condition which increased the density or changed the contour or position of the kidney. This was a very great aid, and when it was available, none of the careful surgeons operated for renal or ureteral calculus until such an examination had been made.

Injecting the pelvis and calices with collargol or argyrol increases the field of radiographic diagnosis by enabling one to show the size and shape of the pelvis and calices very accurately as in cases of hydronephrosis, deformity, or tumor of the kidney; also the relation of the pelvis and calices to a calculus in the cortex of the kidney may be definitely determined. There are, however, some disadvantages in this method of examination which are obviated by a method which, so far as the writer can ascertain, has not been previously described.

Men who have injected collargol or argyrol into the pelvis of the kidneys, differ in their opinions as to the necessity of having the catheter passed all the way to the kidney, but my experience in injecting sinuses leads me to believe that this is necessary. It is not always possible, however, to pass a catheter all the way to the kidney, especially where the ureter is tortuous or partially obstructed as it is likely to be in cases of hydronephrosis or deformity of the kidney. Patients usually complain of this procedure, and there are many physicians and some surgeons who object to ureteral catheterization on account of the danger of trauma or infection. But in skillful hands this is reduced to such a minimum that it may hardly be considered; however, the danger of irritation or obstruction from the injection of these silver solutions into the pelvis or calices of the kidneys, is a question which is open to discussion. So far as the writer has been able to ascertain, there has been no report of irritation of the kidneys from injecting argyrol or collargol into the pelvis and the detrimental effect on the case about to be reported does not seem to be due to the irritating effect of the solution, but rather to the precipitation of some of the ingredients of the urine, which with the collargol formed a thick pasty substance that might occlude the ureter. Where the pelvis

and calices are normal or drain readily, the evacuation of the collargol probably would be prompt, but in cases of extreme hydronephrosis, or where there is a high implantation of the ureter, retention of the solution might occur.

Although the relation of the pelvis and calices to a calculus in the *cortex* of the kidneys would be definitely determined by this method of examination, a calculus in the *pelvis* or *calices* would be obscured by the silver solution.

Having successfully radiographed the stomach and colon inflated with air it occurred to the writer that inflating the pelvis and calices with air or gas instead of injecting them with collargol or argyrol would have many advantages; and circumstances proved that it would eliminate some of the disadvantages and dangers of collargol or argyrol. The advantages of inflating the kidney with air or gas are as follows:

1.—The catheter does not have to be inserted all the way to the kidney. Indeed, I believe with a specially constructed catheter it would be necessary to insert it only two or three cm.

2.—Air or gas surrounding a calculus in the pelvis or calyx accentuates the shadow of the calculus instead of obscuring it.

3.—The air may readily be withdrawn after the radiograph has been made; if not withdrawn it will be absorbed.

4.—The sections between the calices are distinctly shown when the kidneys are inflated with air.

The technique of such an examination consists of a cystoscopic examination and complete or partial catheterization of the ureter. If there is a calcareous body near the course of the ureter complete catheterization of the ureter with a metal styleted catheter is advisable and radiographs should be made at angles to determine the relation of the calcareous body to the ureter. Where it is impossible or for any reason considered inadvisable to insert the catheter all the way to the kidney, the pelvis and calices may be inflated through the ureter by inserting the ureteral catheter only a few cm.

The air should be filtered through a wad of sterile cotton and then may be passed through a warm alkaline solution to heat it to the proper temperature; it is doubtful if this heating of the air is necessary. A catheter could be constructed so that its end might be expanded and the lumen of the ureter filled. The ureter, pelvis and calices may then be distended without passing the catheter more than two or three cm. into the ureter. A flask is used of about 300 c.c. capacity with a tightly fitting stopper, through which two glass tubes pass. One of these allows the air to pass through the cotton filter and alkaline solution into the ureteral catheter. The other is attached by a rubber tube to a flask containing 300 c.c. of sterile water. This flask of sterile water is then connected with the catheter through the flask containing the air. When placed on a level with the kidneys it will exert a neutral pressure and when raised the water will flow into the flask containing the air, displacing a corresponding amount of air through the catheter into the kidney. The amount of water passed into the flask indicates approximately the amount of air injected into the kidney and the distance that this flask of water is raised above the level of the kidney indicates accurately the amount of pressure exerted on the kidney. In this way over-distension of the kidney may be prevented, even when the patient is anesthetized. The amount of pressure which may be safely exerted on the kidneys as measured by the elevation of this flask of water remains to be determined.

A radiograph should be made of the region of the kidney immediately before it is inflated to ascertain if there is any gas in the intestines and to locate it if present.

After the kidney is inflated, radiographs are made with usual technique, except that one should not use much compression, as this flattens out the distended kidney giving a thin layer of air and therefore less contrast. Compression also may increase the pressure on the kidney. This point should be borne in mind,

whether using air, collargol or argyrol, particularly in cases of hydro-nephrotic kidney.

The following case deserves to be reported in full, not only because it demonstrates the relative value of inflation with air compared with the injection of collargol, but because it illustrates many of the fundamental principles of successful renal radiography.

The surgical history is compiled by Dr. E. M. Foote, who referred the case to me for radiographic examination and later performed the operation which is described in the latter part of the paper.

## SURGICAL HISTORY.

By Dr. E. M. Foote.

Mr. P., aged 34. Free from constitutional ailments. In July, 1895, an attack of pain in the right loin with fever, and pus in the urine, lasting about two weeks, was followed by three slighter recurrences, making the whole period of illness about eight weeks. The attack was considered by the physicians in the New York Hospital to be pyelitis, although the diagnosis was obscure.

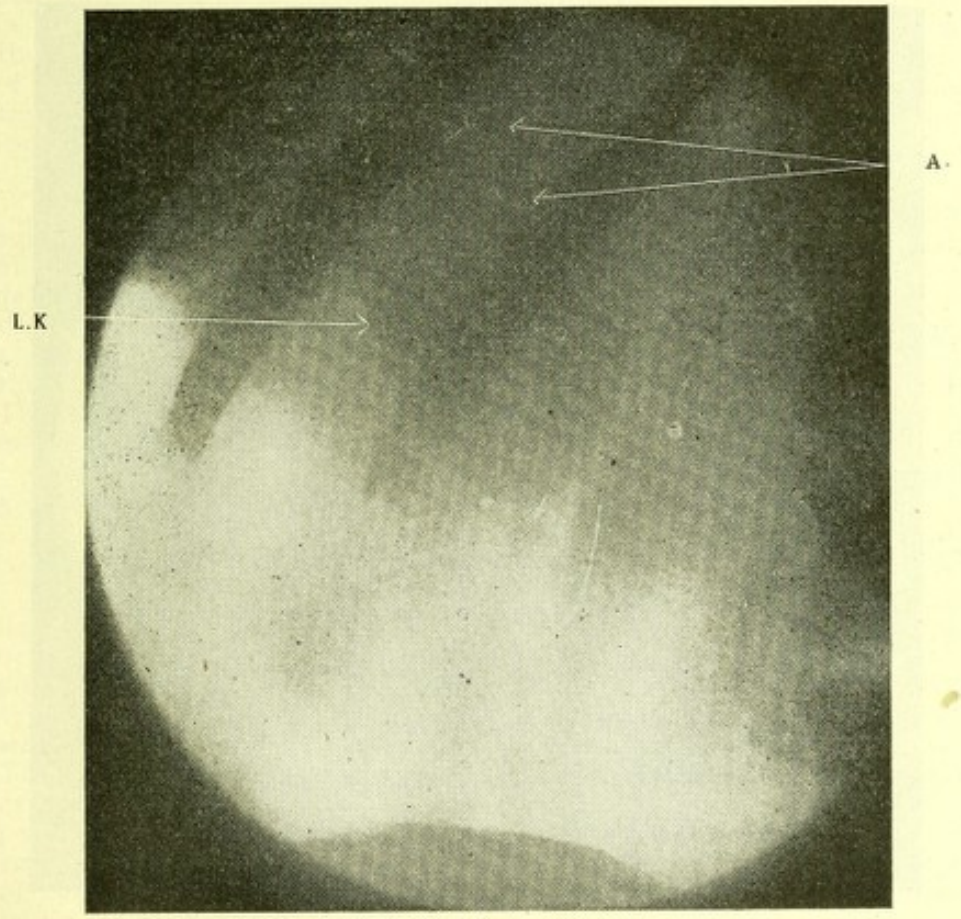


Fig. 1.

Left kidney normal in size, shape and position (L. K.). Two small areas of increased density which are absent in confirmatory plates are indicated by arrows marked "A."

Since that time there have been slighter attacks marked by pain on the right side, of a dull character, but so far as known, without alteration in the urine. Such an attack occurred in January, 1908. There was tenderness and a mass in the right hypochondrium, not moving with respiration. The urine at that time was free from albumen, the sediment contained amorphous phosphates, and an occasional leucocyte and cylindroid. He recovered in a few days. The diagnosis made at this time was colitis, probably not associated with the appendix. The stools were black, lumpy and sandy, but soon became normal after calomel and salts.

On December 4, 1909, following severe horseback exercise, to

which the patient had been unaccustomed for years, there was an attack of obstruction of the right kidney, marked with some pain, fever to 103° F., and pleurisy, with effusion on the right side. Fever and pain gradually subsided. There was a large rounded swelling on the right side. At the end of three and a half weeks there was a sudden increase in the quantity of the urine, 85 ounces being passed within twenty-five hours. It had a dark turbid appearance. Examination of the urine showed no marked change from the normal. The total quantity of the urine the first two days of the illness was 96 and 85 ounces. Then for two days about 48 ounces. For the next week it ranged from 24 to 32 ounces, excepting for three days, when it was 9, 11 and 13 ounces. After that it varied from 46 to 65 ounces, until the free discharge of dark urine mentioned above. The specific gravity of the urine varied from 1010 to 1030. It rarely contained any albumen. The urinary sediment consisted of a few epithelial cells, no blood, no pus, no casts. The frequent use of hot packs and the occurrence of watery stools, due to cathartics, might explain some of the variations of the urine.

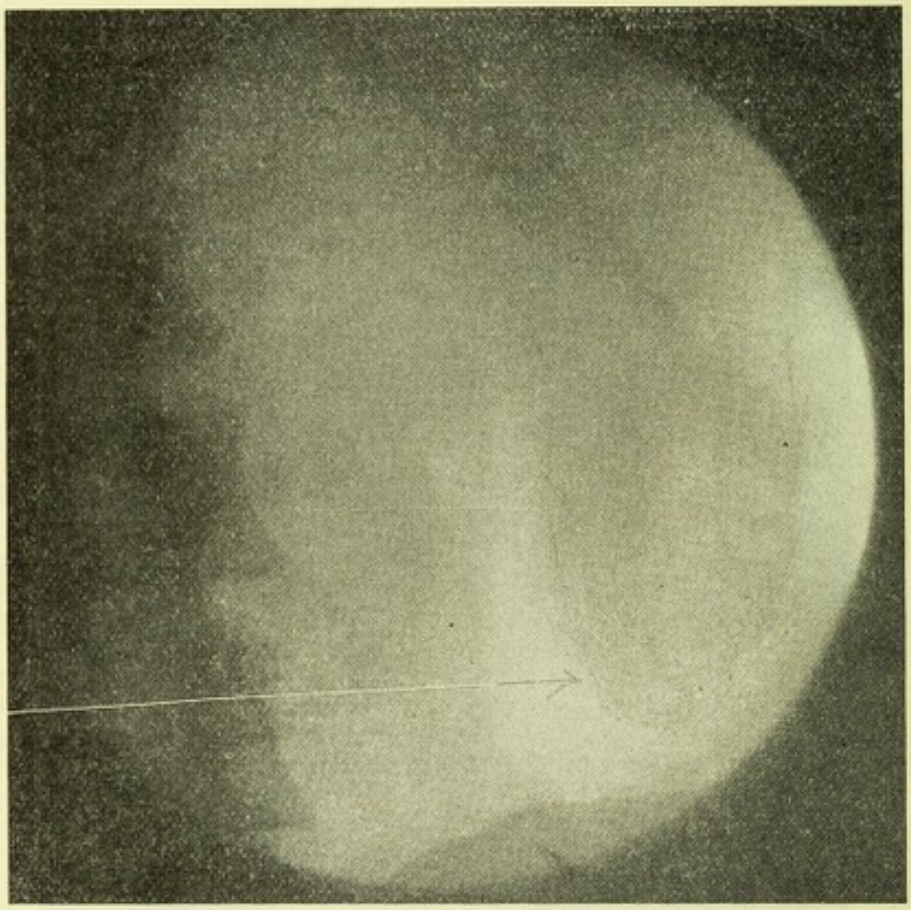


Fig. 2.
Right kidney enlarged and prolapsed, the lower pole indicated by the arrow (R. K.) is just above the crest of the ilium.

The urine and the fluid aspirated from the chest were injected into guinea pigs without producing tuberculosis. During this attack the patient was in Colorado Springs in charge of Dr. W. H. Swan. He was also seen by Dr. Chas. Powers, of Denver, who made a diagnosis of a possibly cystic enlarged right kidney. Under his direction a radiograph was taken which showed a large right kidney without calculus and a normal left kidney. Two attempts were made to catheterize the right ureter without success. The catheter failed to pass more than three inches into the right ureter while passing the full length of the left one.

When the patient came to New York in March, 1910, the right kidney was still very much enlarged, and its lower border reached

the rim of the pelvis. It could be easily pushed up as high as the umbilicus. It was free from tenderness. There was no clinical evidence of obstruction in the right ureter, nor had there been any since the free discharge of dark colored urine spoken of above.

Three separate and independent radiographic examinations were made by the writer and a copy of his radiographic findings and interpretation and diagnosis from these findings are incorporated in this report, and a careful study of these reports will show the necessity of making confirmatory examinations before operative procedure is advised.

March 21, 1910.

*First X-Ray Findings.*

Ribs, spine, transverse processes, spine of the ischium and tip of the coccyx show distinctly. Psoas muscle and left kidney show very distinctly. Right kidney indistinctly. The left kidney, Figure 1, is very much larger than the right, but is normal in shape and position. There are two or three small areas of increased density in the center of the left kidney. These are a little larger than a pea and irregular in shape. The right kidney shows no variation in density, although the pelvis is a little more dense than normal. In the median line of the pelvis, just opposite the first section of the coccyx, is a clear cut, well defined shadow half an inch long and one-sixteenth inch wide. This has the appearance of being a foreign body.

*Diagnosis.*

From a study of the plates one would be suspicious of small soft calculi in the body of the left kidney and also some substance of very great density in the region of the bladder. Although the detail in both of these plates is all that could be desired, they should be confirmed by subsequent radiographic examination after a thorough catharsis, the plates being made at different angles to show the relation of these shadows to the surrounding tissues. The shadow in the region of the bladder may possibly be a flaw in the plate.

Three days later, after a thorough catharsis, the second radiographic examination was made and following is the report:

March 24, 1910.

*X-Ray Findings.*

Ribs, spine, transverse processes, spine of the ischium show distinctly. Psoas muscle and left kidney show distinctly. Right kidney indistinctly. The left kidney is normal in size, shape and position, and although it shows more distinctly than it did in the original plates, the two or three small areas of increased density which were referred to in the original report, do not show in these plates. The right kidney, Figure 2, is large and soft with increased density of the upper pole. This increased density of the upper pole appeared as a small dense kidney at the original examination. The small clear cut, well defined shadow which was shown in the region of the bladder in front of the last portion of the sacrum, appears in the confirmatory plates to be near the spine of the ischium.

*Diagnosis.*

From a study of the plates one is justified in stating that the left kidney is normal in size, shape and position, and there is no calculus in this kidney. The right kidney appears to be large and soft, with increased density in the upper pole. The clear cut, well defined shadow which appears near the spine of the ischium cannot possibly be in any part of the genito-urinary tract.

Comparison of the original and confirmatory radiographic examinations illustrates the absolute necessity of making confirmatory plates. A complete radiographic examination with a styleted ureteral catheter and with the pelvis of the kidney inflated with air or injected with collargol was advised. Three days later, after a thorough preparation of the patient, this third examination was made. The following is a report of the radiographic findings, and the writer's interpretation and diagnosis from this examination.

*X-Ray Findings—Third Examination.*

Two stereoscopic plates were made after a catheter had been inserted thirty inches. The stylet in the catheter was distinctly seen in the ureter, and in the region of the fifth lumbar vertebra was nearer the median line than usual; after passing into the pelvis of the kidney it made several turns. The stylet was then removed, and there was no evidence of the catheter which remained *in situ*, and no evidence of air or gas in the intestines. About nine ounces of urine was then drawn from the pelvis of the kidney and the

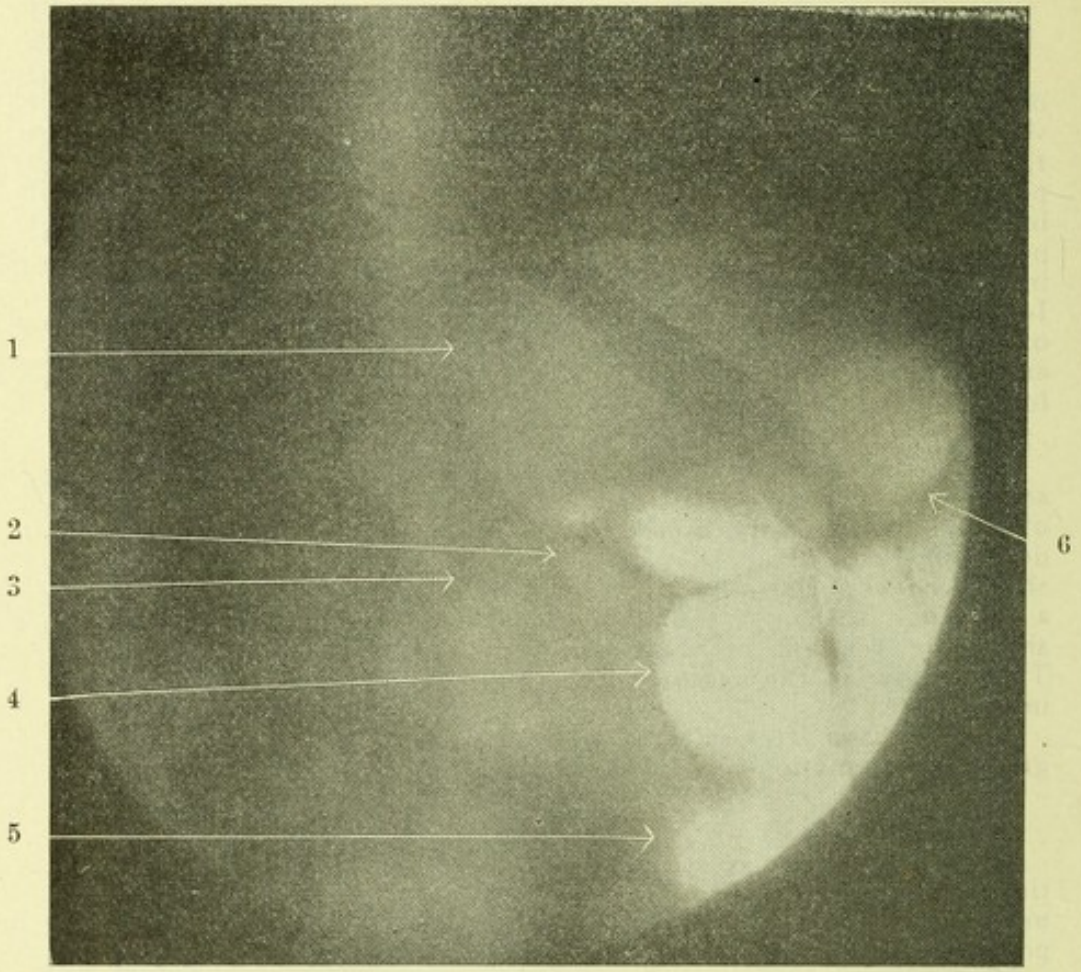


Fig. 3.

Right kidney inflated with air shows the immensely dilated pelvis and calices indicated by arrows 1, 2, 3, 4, 5 and 6. The sections between the calices show distinctly.

kidney was then inflated with air until the patient complained of a pain similar to that which he suffered during his attack. Stereoscopic radiograms were then made, one of which is shown in Figure 3. The dilated pelvis and calices and the sections between them show very distinctly, the pelvis and calices being dilated until the kidney was six inches long and four and three-quarter inches wide. When viewed stereoscopically the relation of these calices to each other is distinctly shown. The air was then removed by suction, and ten ounces of collargol solution injected into the pelvis of the kidney. This was not sufficient to completely distend it, and cause the pain which was characteristic of an attack. Stereoscopic radiograms were then made that showed the pelvis and calices of the kidney; one of these plates is shown in Figure 4. All of the calices were not filled with this solution, but those which were not were distended with air. These plates corroborated those in which air was used to dilate the kidney, and the arrows indicating the distended calices are similarly placed in Figures 3 and 4.

*Diagnosis.*

From a study of these plates one is justified in making a diagnosis of a very extreme case of hydronephrosis. The small, well-defined shadow which is shown in the pelvis in the first examination is seen opposite the tip of the transverse process of the fourth lumbar vertebra in the last examination. This shadow is caused by either a foreign substance in the same part of the intestine, or possibly by a calcareous area in the same part of the small intestine. I believe, however, that it is of no pathological significance.

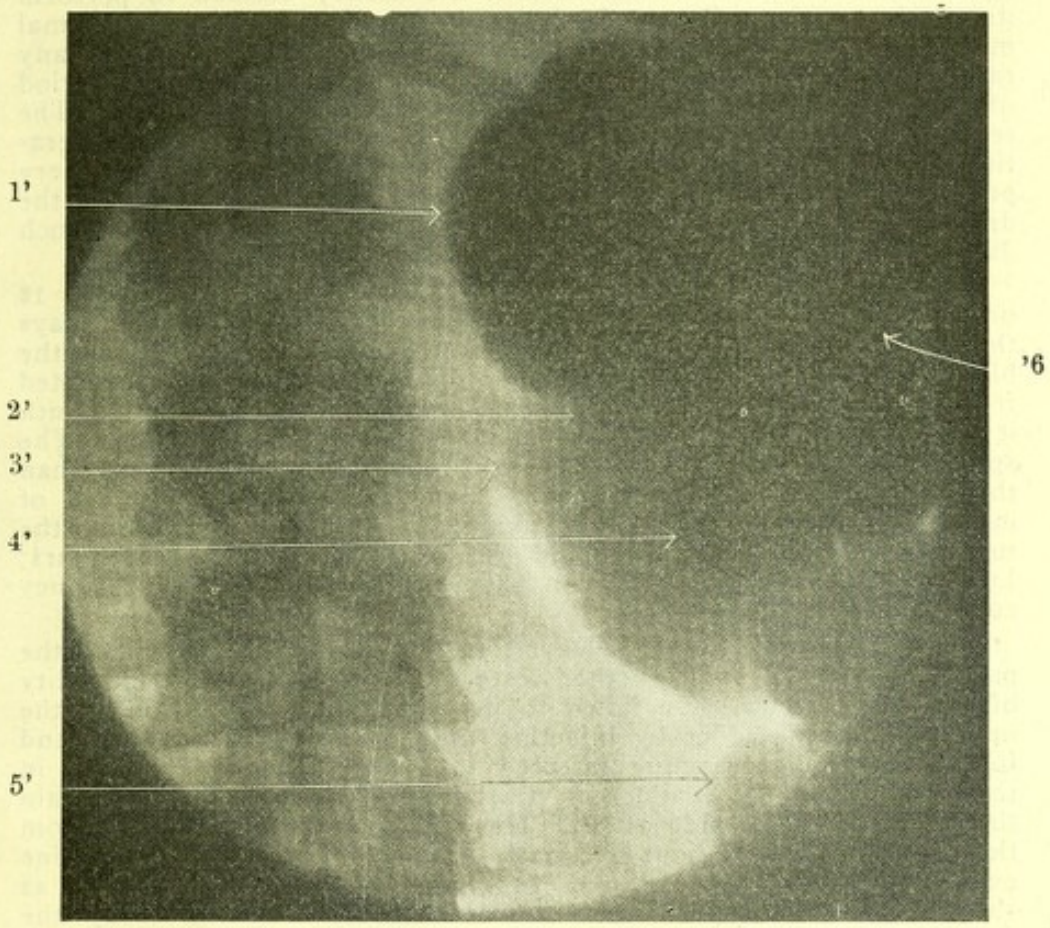


Fig. 4.

Right kidney with pelvis and calices filled with collargol indicated by arrows 1', 2', 3', 4', 5', 6',—similar in position to 1, 2, 3, 4, 5 and 6 in Figure 3,—implantation of the ureter was opposite the second transverse process, just above 2'.

*History of Operation.*

At my request, Doctor Cole made a very thorough and very successful X-ray examination which forms the basis of this article. Following the last examination, the one in which collargol was injected into the pelvis of the kidney by Doctor Kilbane, the patient was somewhat collapsed so that he was unable to return to his home. He suffered a good deal of pain, and that night and the following day there was evidence of obstruction to the right kidney. Doctor Kilbane again passed the catheter and succeeded in withdrawing several ounces of urine mixed with collargol; but the relief was only temporary, so that an immediate operation seemed indicated.

March 30th, 1910, I exposed the kidney through a lumbar incision. It was found to be greatly distended with brownish urine, in which there was a great deal of thick collargol. The pelvis of

the kidney was irrigated, repeated attempts being made to empty and wash clean every one of its much distended calices. The kidney substance was much thinned; it appeared otherwise normal. The capsule was not adherent. The bulk of the kidney was very great so that it would have been impossible to withdraw it for examination without extending the incision well into the abdomen.

It was evident that we had to deal with a greatly enlarged kidney, probably an instance of chronic intermittent hydronephrosis, and at the same time a displaced and movable organ. The infrequency of the attacks, the fact that they had come on after traumatism and that in the interval the kidney seemed to perform its work satisfactorily, made it seem possible that the abnormal mobility of the kidney might have caused the obstruction. At any rate, I determined to fix it in a correct position and give it a period of drainage through a large tube. This was accordingly done. The temperature which had been over 102 ° F. at the time of the operation, fell to normal in two days, and the patient made a very prompt recovery. For the first ten days after the operation the drainage from the wound averaged 15 ounces a day and was much discolored with collargol. The urine averaged 46 ounces.

For the next ten days the drainage from the side averaged 18 ounces and from the bladder 64 ounces. For the next ten days the drainage from the side averaged 8 ounces and that from the bladder 59 ounces. After that the proportion of the urine excreted from the side gradually fell until at the end of the second month it was only about ten per cent of the total urinary excretion. The specific gravity of the drainage was invariably a little less than the specific gravity of the urine from the bladder. Solution of methyl blue injected into the kidney and retained by corking the tube, appeared in the urine and the bladder within a few hours; but the possibility of absorption and excretion from the left kidney could not well be ruled out.

On May 24th, Dr. E. L. Keyes, Jr., at my request, examined the patient and made some further tests to determine the permeability of the right ureter. He failed to get any red discoloration of the urine from the bladder by injecting fluid into the right kidney, and found that indigo-carmine injected into the buttocks appeared in the urine from the bladder in twelve minutes, and did not stain the urine from the side at all. He also found that drainage from the side represented about one-sixth of the total amount of the urine excreted through the test and less than one-sixth of the work as shown by the ureter. While the left kidney was shown by the urine in the bladder to increase its work under the stimulus of excessive water drinking, the right kidney responded far less to this stimulant. Suspension of the kidney or its better drainage, or both, improved the patient's health and relieved him of the feeling of weight in the region of the caecum, which had been almost constant. He will be given a longer period of drainage since his general health is all the while improving, and if it is found at a later examination that the work done by the right kidney is still further decreased, the kidney will be exposed and the obstruction overcome by a plastic operation, or if this does not seem feasible, it will be removed.

*Resume.*

It was brought up in the discussion when this paper was presented that there might be a possibility of air embolism, but the genito-urinary surgeons differed in their opinions as to whether or not this was a real danger. The weight of opinion was against the possibility of such an occurrence. I believe that both air and collargol, or argyrol, dilation have their separate uses. In cases where the pelvis is not much dilated, as shown by the urine withdrawn by ureteral catheterization, collargol, or argyrol, may be used with no danger of its retention. On the other hand, if the pelvis is enlarged, particularly with a high implantation of the ureter, dilation with air is greatly to be preferred.