Pyelo-radiography: A Clinical Study.

By Frank Kidd, F.R.C.S.

With Pathological Reports by Hubert M. Turnbull, M.D.; *Skiagrams by* S. Gilbert Scott; *and Experimental Studies by* E. C. Lindsay, F.R.C.S.

The progress of urology during the last thirty years has been marked by a succession of forward leaps, each of which has been due to the invention of a new method of investigation. The first was the invention of the cystoscope, then came the discovery of the Röntgen rays, and then the perfection of the catheterizing cystoscope which enabled the *physiological* and *pathological* value of each kidney to be determined with accuracy. There still remained to be surmounted the *anatomical problem.* Were two kidneys present or only one? And what was the shape, size and arrangement of each kidney and ureter? These were the questions that still exercised the minds of urologists. They knew how common mutations of the kidney and ureter are, they knew that the normal arrangement of ureters might appear in the bladder and be seen by the cystoscope and yet that a single kidney might be present.[1] This fear of the single kidney haunted every operation, and was so great that many surgeons advocated the exposure of both kidneys, either across the peritoneum or through each loin before resort was had to nephrectomy. It was true that in a thin patient, sufficiently purged, the outline of each kidney might be seen in the ordinary skiagram, but such a result was inconstant and unsatisfactory.

In the last few years, however, a fourth method of investigation of fundamental importance has seen the light, one which, to my mind, is as of great importance as any of the others mentioned above—namely, *Pyelo-radiography.* At length the expert cystoscopist can not only determine the physiological and pathological value of each kidney, but he can also determine the exact number of kidneys present, their size, their shape, and the exact arrangement of the ureters, pelvis and calices. Though this method has not by any means reached finality, but is still

[1] *See* p. 31 of author's book, "Urinary Surgery," 1910.

in the evolutionary stage, yet the fundamental idea underlying it is of such importance that it must continue to hold the field.

As we shall see later, collargol cannot be said to be wholly innocuous to the kidney, and although it does not appear to produce any changes in the kidney which cannot be quickly recovered from, and recovered from completely, I feel sure that as time goes on a solution opaque to the X-rays will be discovered which can be injected into the pelvis of the kidney without causing any changes whatever.

Method.

The fundamental idea is to pass a ureteric catheter, fill the pelvis of the kidney with a solution opaque to the X-rays, and obtain a shadow picture of the kidney and ureter. This method first saw the light at Czerny's clinic in Heidelberg, in 1905 and 1906, when it occurred to Voelcker and Lichtenberg to fill up the bladder, and later on the pelvis of the kidney, with a solution of 5 per cent. collargol, and then take skiagrams. At the time very little notice was taken of the papers of these workers; and it is due chiefly to Braasch, of the Mayo Clinic, that the method was taken up on a large scale and brought into its own. In its present state of development the method is as follows:—

Without an anæsthetic, one, or in exceptional cases, both ureters are catheterized with a catheter opaque to X-rays. The pelvis of each kidney is then filled up with a solution of collargol (5 per cent. being used for thin subjects, 7 per cent. for stout subjects). At one time this was usually affected by means of a graduated syringe; but it is perhaps better effected by means of gravity from a burette with a mercury manometer attached. A pressure of not more than 30 mm. of mercury is all that is necessary. The normal pelvis holds between 4 and 10 c.c. of fluid. The solution falls into the pelvis slowly and steadily, and when the pelvis is full it ceases to flow. The amount of fluid that has entered is read off on the scale. The patient is asked to say at once if the slightest feeling of fullness or discomfort is felt in the back of the loin, this being an additional sign that the renal pelvis is filled up to its fullest extent, and this is why it is imperative to carry out the method without an anæsthetic. If the patient were anæsthetized there would not be this additional guide as to when the pelvis was full. *One cannot therefore too strongly warn against the employment of an anæsthetic.*

As soon as the fluid ceases to fall in the burette a skiagram is taken of the kidney, pelvis and ureters. The quicker the exposure the better

for the patient, as the longer the solution remains in the pelvis under pressure, the more likely it is to penetrate to the cortex. The exposure is usually about fifteen seconds. One skiagram only is taken, and the catheter is at once removed so as to allow the solution to flow freely into the bladder.

Severe attacks of renal colic have been reported in certain cases as following the injections. Colic can only be caused by excessive irritation of the pelvic musculature by too strong a solution, by too rapid distension, or by over-distension.

When first I began this work in 1911, I used 50 per cent. colloid silver oxide supposed to resemble "cargentos" and on two occasions this produced renal colic. I have not had any complaint of colic since I used collargol (5 to 7 per cent.) and have taken pains to fill the pelvis slowly and with great gentleness.

As regards the nature of the injection fluid, some colloid preparation of silver seems to find most favour as being very opaque to the X-rays, and least likely to irritate. Personally, I find collargol less irritating than colloid silver oxide or "cargentos," and I find that strengths of 5 to 7 per cent. are quite sufficient to throw a good enough shadow for diagnostic purposes.

Kelly objects to collargol that it is expensive, dirty, and a proprietary preparation of unknown formula. He advises the use of silver iodide, which does not stain and is cheaper. He also states that it is non-irritating. The only evidence in his paper on this score is that he injected it into two cases. In one no trace could be found in a skiagram taken two days later. In the second no trace could be detected with the naked eye when the ureter was explored five days later. More searching tests than these are required (*vide infra*) before it is possible to state that silver iodide is non-irritating, and the question must be considered as still an open one.

The applications of the method will widen as time goes on; but at present it finds its chief field in the detection of malformations of the urinary tract, in the diagnosis of renal and abdominal neoplasms, in the diagnosis of early dilatation of the pelvis and ureters, and in the surgery of stone.

(*A*) Congenital Malformations.

Minor abnormalities of the urinary tract are of everyday occurrence, but it has not yet been adequately realized how common are gross abnormalities of the kidney that would influence urinary surgery. In

five years in the Mayo Clinic there were thirty-six instances of gross renal abnormalities. Out of the 649 operations on the kidney and ureter there were twenty-five cases operated on for gross abnormalities, that is to say, one operation in every twenty-six. Out of 171 autopsies, seven cases showed such abnormalities. The abnormalities were: Fused kidney, 11; single kidney, 6; atrophic kidney, 5; ectopic kidney, 3; duplication of pelvis and ureter, 8; division of ureter, 3.

So impressed was I with the importance of congenital malformations that in 1910 I devoted to their elucidation the second chapter of my book, "Urinary Surgery." Therein I outlined the embryology of the kidney and ureter, showing how easy it was to understand these anomalies, and gave a complete list of the possible mutations that may be encountered in practice. This list includes such things as reduplication of the pelvis and ureters; supernumerary kidneys, double or fused; the nine possible varieties of horse-shoe kidney; single kidney; ectopic kidney, atrophic kidney and cystic kidney.

That single kidney may be a practical clinical problem is evident from a case I am showing to-night of a woman who had a painful tumour in the left loin, which she asked me to remove. By means of pyelo-radiography I was able to show that it was a solitary kidney, and she was thus saved from an operation that must have been fatal. Practically all cases of hydronephrosis are due to congenital kinks or strictures of the ureter, or to pressure on the ureter by abnormal renal blood-vessels. In my own practice in the last year I have had five cases of aberrant renal artery causing hydronephrosis, a case of single kidney, a case of atrophic cystic kidney with ureter opening into the vagina, a case of double ureter, a case of double pelvis, four cases of congenital hydronephrosis, a case of kinked ureter, and finally, a man with double ureters and double fused kidneys on each side, and a tumour attached to the lower pole of one of them. Examples of these conditions are given below in the case records.

Dilatation of the Pelvis—(*B*) Mechanical, (*C*) Inflammatory.

One of the most important diagnoses that the urinary surgeon can make is that of dilatation of the pelvis, and the earlier it can be made the better for the life of the kidney. The earliest sign of dilating pelvis is an aching pain in the back of the loin. From time to time this may be accompanied by attacks of renal colic. Sooner or later suppuration will be superimposed. Our efforts should be

concentrated on making a diagnosis early, before the kidney has been destroyed by back-pressure or suppuration. *This can only be done by pyelo-radiography*, which should therefore be employed in cases of suspected renal pain for which no adequate or obvious cause can be found. Formerly the diagnosis was seldom made until it was too late, the kidney having been turned into a dilated and atrophic shell which could be felt as a large loin tumour.

Dilatation of the pelvis may be mechanical or inflammatory. *Mechanical dilatation* may be due to stone, to strictures of the ureter (congenital, Case V, or secondary to stone, tuberculosis or injury), to movable kidney (Cases VIII and IX), to the pressure of pelvic tumours, to the presence of aberrant blood-vessels (Case VII), or to congenital kinks (Case VI).

Inflammatory dilatation is seen in cases of tuberculosis of the ureter or in cases of stone attended by suppuration (Case X).

The signs of early mechanical dilatation are: (1) That the pelvis takes more than 8 to 10 c.c. of fluid; (2) a curved or kinked appearance of the uretero-pelvic junction; (3) a ballooning of the pelvis itself; (4) a flattening of the pyramids and a widening of the normal narrow necks of the calices. These changes can be well seen by comparing the plates of Cases VIII and IX with that of Case XI. If the diagnosis of early dilatation can thus be made the surgeon need have no hesitation in cutting down upon the kidney, as he is bound to find something which can be relieved by operation.

In late mechanical dilatation it is in the pelvis that the chief change occurs. The kidney, therefore, is seen slightly lobulated and not much enlarged, pushed out into the loin and riding on top of the balloon-like pelvis (Cases IV and V).

In inflammatory dilatation the pelvis and calices are shrunken and irregular and the dilatation takes place chiefly in the medullary and cortical portion of the kidney (Case X).

(*D*) Diagnosis between Abdominal and Renal Tumours.

The method will be found of great value in those cases where a loin tumour can be felt and the surgeon is in doubt whether he is dealing with a renal tumour or a tumour of some other viscus. If the kidney shadow is normal the tumour must be extra-renal. Excellent examples of this are exhibited in Case XI, where the tumour proved at the operation to be a large spleen; in Case XII,

where the tumour proved to be a hypernephroma lying between the suprarenal and kidney; and in Case XIII, where the tumour proved to be inflammatory lipomatosis of the peri-ureteric fat secondary to a perforating dysenteric ulcer.

(*E*) Diagnosis of Renal Tumours.

In a large hospital one is constantly coming across cases of hæmaturia in which one finds with the cystoscope that the blood is coming from one kidney only, yet in which it is possible to exclude all the other common causes of hæmaturia except neoplasm. Only a small number of these cases prove to be neoplasm, as there are still a great many cases of hæmaturia which it is impossible to explain, and yet one felt obliged to cut down on those kidneys for fear of losing a chance of removing an early neoplasm. Some of them proved to be cases in which a definite cause for the hæmaturia could be found at the operation, as for instance an abnormal renal artery. But in others nothing could be found, and the wound had to be closed again (*vide* Case XVI). A renal tumour of any size can hardly exist without causing some alteration in shape of the renal pelvis. A case of unilateral hæmaturia should therefore not be diagnosed as due to neoplasm unless a pyelo-radiogram has been taken and some change in the shape of the renal pelvis noted (*vide* Cases III, XIV, XV).

(*F*) Renal Pain.

Renal pain may be felt in many different situations, and it is therefore not always easy to say whether a pain that is complained of is due to some condition in the appendix, gall-bladder, stomach, or bowel. In doubtful cases I have found pyelo-radiography of value (Cases XVII, XVIII). If the shadows of the pelvis and ureter are normal in outline it is very unlikely that a pain is of renal origin and it is not wise to explore the kidney. If, on the other hand, there is evidence of dilatation of the pelvis an exploration can be safely advised as some congenital abnormality of the ureter is sure to be found (Case VII). For instance, abnormal renal arteries causing obstruction to the ureters are not at all uncommon, yet their only symptom may be pain. The method will show up the dilatation behind the obstructed ureter and lead to the necessary exploration and relief of the trouble.

(*G*) Stone in the Kidney and Ureter.

If the surgeon wishes for the best results in the surgery of stone it is of vital importance for him to know before he starts operating the exact position of the stones, whether in the pelvis or in the calices or in the ureter, and whether the kidney is shrunken and fixed, or dilated and movable. An ordinary skiagram will often suffice to tell him all he needs to know, but pyelo-radiography has made it possible for him to make certain of these facts in cases that still remain doubtful. If the stone is in the pelvis he will proceed forthwith with the operation of pyelolithotomy; but if the stone is in the neck of a calyx and there is dilatation of the calyx with thinning of the cortex he knows exactly in which calyx the stone is, which part of the kidney to clear, and through which small area of thinned cortex to enter the kidney and extract the stone with a minimum of damage and bleeding and a maximum of quick healing. Instances in which the method proved useful are given in Cases XIX and XX.

(*H*) Dilatation of the Ureter.

The ureter may be blocked by stone, by stricture (inflammatory or congenital), or by pelvic tumour.

In a great number of cases of suspected stone in the ureter the nature of the shadow in the region of the ureter cannot be exactly determined even by passing an opaque bougie up the ureter and taking a stereoscopic X-ray picture. According to Braasch, unless a suspected shadow is at least 1 cm. away from the ureteric bougie it cannot be said that it is not in the ureter. It is hardly possible for a stone to be long present in the pelvic ureter without its causing some dilatation of the ureter above. If, therefore, there is a shadow in the neighbourhood of the pelvic ureter the nature of which is uncertain the ureter should be filled up with collargol and only if the ureter shows signs of dilatation above the shadow should it be accepted as due to a stone.

(*I*) Infections of the Kidney.

In many cases it is difficult to say whether a patient is suffering from pyelitis, pyonephrosis, or perinephric abscess, but by pyelography the diagnosis is made easy (Case XIII). For instance, in one case I drew off purulent urine from the right kidney and clear urine

from the left kidney. There was a big swelling in the right loin, and the patient was suffering from fever and rapid wasting. Having no doubt that I was dealing with a pyonephrosis I cut down and removed the right kidney, which was lying in a large perinephric abscess. When the kidney came to be examined it was found to contain nothing abnormal save two or three tiny microbic infarcts and probably it need not have been sacrificed. If only I had used the method in this case I should not have been led astray. I know that it is not uncommon for such a mistake to be made, and indeed I remember one case where the surgeon actually removed the whole of a perinephric abscess in its surrounding sac under the impression that he was removing a large pyonephrosis, the kidney itself being practically healthy.

Finally, the method can be used for bladder conditions, but it can show very little that cannot be discerned with the cystoscope. Still it would undoubtedly prove of value in cases of bladder pouches. I append below a list of some of the most striking cases I have met with, which serve to illustrate most of the conditions I have mentioned. By far the most striking case is, I think, the woman with the solitary kidney. Had I not made it an absolute rule of practice on no pretence whatever to remove a kidney until I had completely satisfied myself as to the condition of the other one I should certainly have removed the solitary kidney and sacrificed the woman's life.

Experimental Considerations.

Little attention seems to have been paid to finding out what exactly happens when a fluid such as a solution of collargol is injected into the kidney pelvis. This has been a mistake, as unless the method is proved to be harmless it remains open to criticism. When I came to cut down on the kidneys, which I had injected with collargol a day or two before, in a few of them I found that the cortical substance of the kidney might show patches of brown staining and that the perirenal fat might be slightly œdematous and might also appear brown.

Dr. Turnbull, Director of the Pathological Institute, London Hospital, has cut sections of some of these kidneys, and has furnished me with the following report for insertion in this paper.

REPORT ON KIDNEYS INTO THE URETERS OF WHICH COLLARGOL HAD BEEN INJECTED DURING LIFE.

(1) I. G., aged 26. S. D. 1731, 1913 [*vide infra* Case XXI].

Macroscopic Examination.—Kidney measuring 10 cm. by 6 cm. by 3·5 cm. The pelvis was contracted and its mucous membrane was scarred. There was a considerable quantity of inspissated, yellow, purulent material upon the pelvic mucous membrane. There was some swelling of the cortex. The cortical pattern was straight. There was no evidence of purulent infiltration of the renal substance.

Microscopic Examination.—A section was taken of the pelvis, peripelvic lipomatous tissue and a portion of the renal substance. The pelvis is lined by transitional epithelium. The majority of the cells are rounded and are greatly swollen by perinuclear vacuolation. In the lipomatous tissue of the pelvis there is much fibrosis, hæmorrhage, and proliferation of fibroblasts and fat cells. There is also infiltration by lymphocytes, plasma cells and cells filled by granules of brownish-yellow pigment. The infiltration is less marked in the muscular and inner fibrous layers of the pelvic tissues. The fibrosis, hæmorrhage and infiltration is continued in the interlobar septa up to the arcuate vessels. In this extension the cells containing pigment are very numerous, and there are extracellular collections of pigment. From the sheaths of the interlobar and arcuate vessels a lymphocytic infiltration, and in places a fibrosis, spread for a short distance into the interstitial tissue of the adjacent renal substance, enclosing some tubules and glomeruli. In this infiltration there are cells containing similar granules of pigment. The glomeruli are engorged. The cells lining the first convoluted tubules are swollen and granular. In many cells there is no nucleus; in others the nucleus is pyknotic or very pale. The lumina contain shreds or granules of substance resembling the protoplasm of the cells, or they contain a few desquamated cells. Similar but severer degenerations and necrosis are present in the cells lining the ascending loops of Henle. The cells lining the second convoluted tubules are desquamated; one tubule close to the infiltrated sheath of an arcuate vessel contains neutrophile leucocytes. There is much catarrhal desquamation of the epithelium of the small collecting tubules. The nuclei of the desquamated cells are pyknotic and their protoplasm is deeply stained. The cells lining the large collecting and discharging tubules are swollen by perinuclear vacuolation. The tubules contain casts of epithelial cells which have a deeply stained protoplasm and pyknotic nuclei. The contrast between the pale, vacuolated cells lining the tubules and the deeply stained cells of the casts is very striking. Finely granular albuminous casts are also present. Within the vacuolated cells lining the discharging tubules there are frequently globules of yellow pigment. Some of the granules of pigment in the cells in the peripelvic and perivascular tissue, and in the infiltration spreading therefrom, give the Prussian blue reaction. The pigment in the epithelium of the discharging tubules is not altered by ammonium sulphide. It does not give the Prussian blue or Turnbull's blue reactions for free iron, or Gmelin's reaction for bile. It appears to become a darker yellow when treated with strong sulphuric acid. Treated with polychrome methylene blue and tannic acid it is stained a very dark blue.

(2) F. P., aged 34. S. D. 1880, 1913 [*vide infra* Case IX].

Macroscopic Examination.—A kidney from which the capsule had been stripped. The subcapsular surface was slightly uneven. The patterns of the cortex and of the medulla were straight. The demarcation between the cortex and medulla was sharp. There was no dilatation of the pelvis. There was a little recent hæmorrhage in the tissues of the hilum.

Microscopic Examination.—The capsule is absent. The pelvis is lined by transitional epithelium. There is a slight infiltration by lymphocytes of the retropelvic and interlobar connective tissue. There is no pigment in this tissue. There is no increase of interstitial tissue within the cortex or medulla. There is a slight hypertrophy of the intima of the

interlobular arteries, but no hypertrophy of the media. In one glomerulus the tuft is shrunken and fibrotic, and is fused with a sclerotic, thickened capsule. The interstitial tissue of the other glomeruli is swollen. The cells lining the first convoluted tubules are swollen and granular; many of their nuclei are absent, many show pyknosis or karyolysis. The lumina contain nuclear fragments and granules of a substance which resembles the protoplasm of the epithelium. The epithelium of the ascending limbs of the loops of Henle shows similar changes; some of the cells contain granules of yellow pigment. There is much desquamation of the epithelium of the second convoluted tubules, and the majority of the nuclei are pyknotic. The cells of the discharging tubules are swollen by perinuclear vacuolation. Many contain large globules of pale yellow pigment. In places the collecting and discharging tubules contain epithelial casts. The cells of these casts have a deeply stained protoplasm and pyknotic nuclei; they thus contrast sharply with the pale, vacuolar cells which line the lumina. The pigment in the epithelium of the tubules of Henle and the discharging tubules is not stained by ammonium sulphide, and does not give the reactions of iron or bile. It becomes brown-yellow when treated with sulphuric acid, and is stained deep blue or green, or green stippled with deep blue, when stained with polychrome methylene-blue and tannic acid.

(3) A. K., aged 32. S. D. 922, 1913 [*vide infra* Case X].

Macroscopic Examination.—A kidney measuring 14 cm. by 6 cm. by 3·5 cm. The subcapsular surface showed fœtal lobation and was smooth. On section the pattern of the cortex and medulla was normal. The pelvis was slightly dilated and showed a few petechiæ.

Microscopic Examination.—The capsule is absent. There is extreme swelling and perinuclear vacuolation of the cells of the transitional epithelium which lines the pelvis. In the peripelvic and interlobar connective tissue there is a very slight perivascular infiltration by plasma cells, lymphocytes, and eosinophile leucocytes. There is no increase in the interstitial tissue of the cortex and medulla. The capillaries are engorged. The glomeruli fill Bowman's capsule; their interstitial substance is swollen. The cells lining the first convoluted tubules are swollen and ill-defined or fragmented. Their protoplasm is granular or vesicular, or contains hyaline droplets, or is diffusely hyaline. Many cells have no nuclei; in the remaining cells many of the nuclei show pyknosis or karyolysis, or karyorrhexis. The lumina are almost completely filled by the swollen cells and fragments thereof, or by a fusion of cellular fragments with albumin. The cells of the ascending loops of Henle exhibit similar degenerations and necrosis; in a few cells there are lumps of a pale yellow pigment. The tubules of the descending loops of Henle contain albuminous casts. In the second convoluted tubules the cells are granular, and many of the nuclei are pyknotic. A little albumin and a few desquamated, necrosed cells are frequently present in the lumina. The cells lining the majority of the large collecting and discharging tubules are swollen and rounded by perinuclear vacuolation. The nuclei are frequently shrivelled and occasionally fragmented. A few of these tubules contain albumin and one or two red corpuscles. In one portion of a pyramid the majority of the discharging tubules contain clumps of epithelial cells. These cells have an eosinophile protoplasm and pyknotic nucleus; the cells contrast, therefore, sharply with the pale, vacuolar cells which line the tubes. The pigment in the epithelium of the tubules of Henle does not give the reactions of iron or bile; it is not stained by ammonium sulphide; it has a greenish colour in sections stained by polychrome methylene blue and differentiated with tannic acid.

Remarks by Dr. Turnbull.

In all three cases there is a severe, general parenchymatous degeneration of the kidney. A striking feature is the presence of epithelial casts within localized groups of collecting and discharging tubules. Albuminous casts are

also present. There is also a greater or less amount of infiltration of the peripelvic and interlobar connective tissue. Exactly similar changes were found in kidneys which had been removed for similar surgical conditions, but which had not been injected previously with collargol. It is clear, therefore, that these changes are effects of the underlying surgical conditions for which the kidneys were removed, and of the operative interference; they cannot be considered to be effects of the injection of collargol.

In all three cases pale yellow pigment was found within the epithelial cells, lining the discharging tubules, or the ascending tubules of the loops of Henle. The exact nature of this pigment is uncertain. It did not give the reactions of iron or bile, it was not blackened by ammonium sulphide, it appeared to become a darker yellow in strong sulphuric acid, and it was stained either a deep blue or a pale green, or a pale green stippled with dark blue, by polychrome methylene-blue differentiated by tannic acid. Similar pigment is found, in similar positions, not only in kidneys which have been removed for corresponding surgical conditions without previous injections of collargol, but in the majority of cases of parenchymatous degeneration. Thus, numerous large droplets may be present in vacuolated cells lining the discharging tubules in puerperal eclampsia. The deposit of this pigment is evidently independent of the injection of collargol.

In Case I granules of pigment are present within the inflamed peripelvic and interlobar connective tissues. Many of the granules give the Prussian blue reaction for iron. This pigment is doubtless derived from disintegrated red corpuscles, and merely indicates that the chronic inflammation of the peripelvic tissue was hæmorrhagic.

It may therefore be concluded, that Cases II and III afford evidence that collargol may be injected into the ureter without causing damage to the renal substance.

That collargol may pass into the renal substance, and remain there, is shown by a kidney examined in the Institute (S. D. 1158, 1913). On macroscopic examination a few faint brown streaks were noticed in both the cortex and medulla. In a section there are in the cortex patches in which the pigment is present. The pigment is extra- and intra-cellular. It is partly black and partly brown-yellow. The intracellular pigment is chiefly brown-yellow; it became stippled with black when treated with ammonium sulphide. In the patches there is a marked increase of interstitial tissue, and the bulk of the pigment lies within cells of the interstitial tissue. Some of it lies within the lumen or epithelium of tubules which lie within the patches of interstitial proliferation. There are giant cells round a few larger masses of pigment. There are also in the cortex patches in which there is interstitial proliferation, together with infiltration by plasma cells and eosinophile leucocytes, but in which there is no pigment. The pigment may therefore have been retained in areas which were inflamed before injection.

It is impossible to determine from this section the mode of entrance of the collargol. That it has reached the interstitial tissue from the tubules is

indicated by the following specimens. In a kidney (S. D. 1032, 1911) in which there was severe purulent nephritis with the formation of abscesses, silver nitrate had been injected at considerable pressure into the ureter four days before operation. In microscopic sections quantities of black and yellow pigment are present in many of the discharging, collecting, and second convoluted tubules; there is also a little pigment in some of the abscesses. In sections taken from sheep's kidneys which had been injected, after removal, by Mr. E. C. Lindsay with collargol, at pressures of 35 and 70 mm. of mercury, the collargol has passed into the kidneys along many discharging tubules, and has extended along collecting tubules in the pyramids of Ferrein, ultimately to fill the second convoluted tubules. The pigment extends to some second convoluted tubules which lie immediately beneath the capsule. There is no pigment in the interstitial tissue.

Having noted these facts I proceeded to the next step. Immediately after the removal of the kidney of Case III, I filled up the pelvis with collargol under a high pressure and tied off the ureter. Within twenty minutes collargol began to drip out of the hilum from the cut lymphatics; a skiagram was then taken which showed admirably the distribution of collargol throughout the cortex.

I then determined to initiate some experiments on fresh sheep's kidneys. These were conducted for me by Mr. E. C. Lindsay. The sheep's kidneys were removed immediately on the death of the animal and placed in warm sterile salt solution. They were used within the next hour so as to obtain conditions as like as possible to the living conditions. Nine kidneys were filled with collargol, 7 per cent., by gravity from a burette at varying pressures measured by a mercury manometer, the feeding cannula being tied firmly into the ureter, and the pelvis being kept filled for varying times. Two kidneys were filled by means of a syringe, the pressure being likewise measured. A complete schedule of the experiments, prepared by Mr. Lindsay, is appended below. Briefly stated the results were as follows:—

In nearly every case the collargol appeared on the surface of the cortex in patches under the capsule within a short time. It always appeared first at the poles, and only later in the middle portions of the kidney. The collargol made its way to the cortex just as constantly under quite low pressures (e.g., 15 mm. Hg) as under high pressures (e.g., 70 mm. Hg). The only difference was that it appeared on the surface more quickly under the higher than under the lower pressures. For instance, fig. 1 shows a kidney infiltrated in thirty minutes at a pressure of 15 mm. Hg, and differs little from fig. 4, when the fluid was

delivered at a pressure of 70 mm. Hg, continued for half a minute. In all the cases injected with gravity, however low the pressure and short the time, the collargol completely infiltrated the medullary portion of the kidney and caused an appearance of slight œdema, but it only infiltrated the cortex in streaks and patches, and that chiefly at the pole. In other words, at whatever pressure the collargol is supplied it is bound to infiltrate the medulla in every case, and it will only fail to infiltrate the cortex if the pressure is not too high and is released before one minute has elapsed. In the two kidneys (10 and 11) injected by means of a syringe, though the pressure used was higher than in any of the "gravity" injections, yet the high pressure was only maintained for a second or two, and, consequently, the cortex was not infiltrated at all. Time is therefore equally as important a factor as pressure, a fact that has not so far been recognized. Collargol should be injected at a maximum pressure of 30 mm. of mercury, skiagrams should be taken, and the catheter removed from the ureter, all within less than one minute, if we are to avoid infiltrating the cortex. Tennant, in a recent paper,[1] has published a case where the case was infiltrated, and asserts that the severe pain experienced by his patient was due to this fact. The cortex must be infiltrated in a large number of cases, yet pain is not experienced. I do not believe you can get severe renal pain apart from sudden over-distension of the pelvis itself, or of the true capsule. Where severe colics have occurred it must have been due to too sudden filling of the pelvis, or to using too strong a solution, as in Tennant's case (25 per cent.), which must have irritated the pelvic muscular tissue into painful spasms.

These experiments are very severe tests, as the cannula was tied tightly into the ureter, and the conditions were therefore not quite like those obtaining in pyelo-radiography, when the injecting fluid is free to escape into the bladder round the injecting catheter. We therefore repeated the experiments, using a ureteric catheter inserted into the pelvis and not tied in. These showed that the cortex is not likely to be infiltrated under such conditions, but that the medulla does not escape infiltration. (Schedule appended below.)

[1] *Ann. of Surg.*, 1913, lvii, p. 888.

SCHEDULE OF EXPERIMENTS BY MR. LINDSAY.

Injection of Sheep's Kidney with Collargol.

The kidneys were obtained from sheep within a quarter of an hour of slaughter under personal supervision, and transferred immediately to warm saline solution from which they were removed direct to be injected within one and a half hours at the outside, after killing, some as early as half an hour after killing. In most cases the injection was performed about three-quarters of an hour after the death of the animal. In all cases 7 per cent. collargol was used.

The apparatus used consisted of a graduated burette of 50-c.c. capacity, connected to a fine glass cannula with rubber, in the course of which was inserted a glass T-piece, the vertical

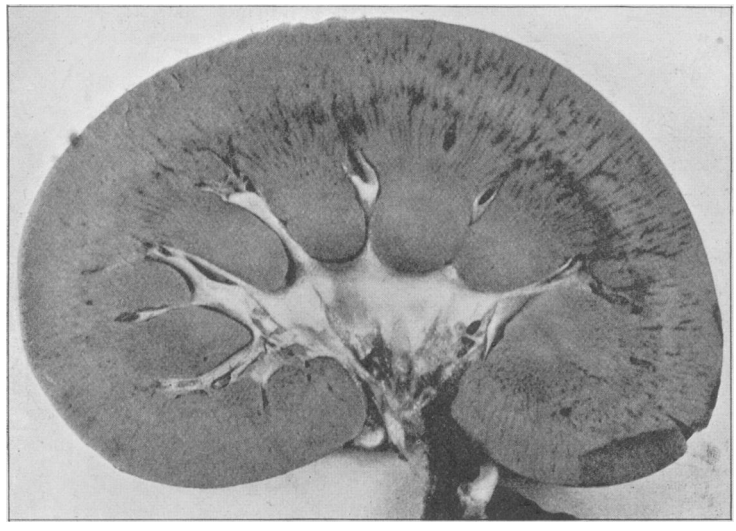


Fig. 1.

Sheep's kidney. Collargol injected into pelvis, ureter tied around catheter. Pressure, 15 mm. Hg. Time, thirty minutes. Mottling could be seen under capsule in fifteen minutes.

limb being connected to a mercury manometer. The collargol was prevented from running up into the manometer by having a sufficiently long air pad in the tubing. The fluid was delivered by means of a glass cannula with a small fusiform nozzle which could be tied into the ureter. Time measurements were made by means of a clamp fixed on the rubber just short of the cannula.

In all eleven injections were made at gradually increasing pressures for varying times. It was found that the ordinary pressure quoted by Tennant as being approximately the correct pressure for injection—namely, 80 mm.—was excessive, judging by the time at which the collargol reached the cortex as noted by the appearance of mottling under the capsule. Injections were therefore tried at various increasing pressures, beginning at 15 mm. Hg.

During the delivery of the fluid the following observations were made: (1) The amount of collargol required to fill the pelvis concurrently with the fall of pressure while this took

place (at high pressures practically instantaneous); (2) the time at which mottling appeared under the capsule; (3) the total time during which pressure was maintained.

It was found that (1) was fairly constant, provided the nozzle was tied into the ureter at the same distance from the pelvis; the only variation noted between low and high pressures was that, at high pressures, the level of the fluid continued to fall rapidly for a few seconds after the pelvis became full, the whole kidney becoming turgid and erect as the collargol was driven into it; at low pressures the level of the fluid in the burette tended to become stationary as soon as the pelvis was filled and the kidney showed no signs of turgidity. A fall of 2 to 3 c.c. of fluid was noted before the pelvis became full, and with this was noted a fall of 2 to 4 mm. of Hg in the manometer. This was in all cases of course followed by a further fall in the level in the burette as the collargol worked out to the cortex; as noted above, at high pressures, a rapid fall, at lower pressures so slow as to be almost imperceptible.

Records of Injections.

(1) (Kidney L.) Pressure, 15 mm. Hg. Fig. 1. Time, half an hour. Mottling appeared at poles fifteen minutes after commencement of injection and spread very slowly.

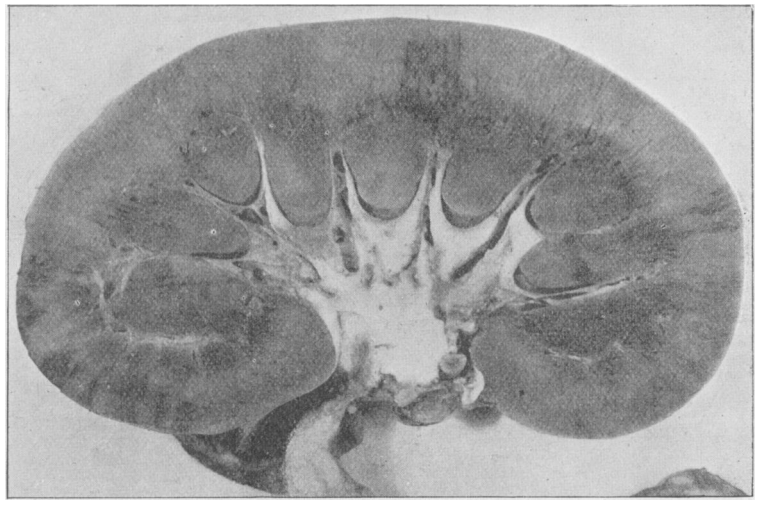


FIG. 2.

Pressure 35 mm. Hg. Time, two minutes. No mottling appeared under capsule.

Section, ordinary post-mortem incision (made immediately on conclusion of injection) showed diffuse injection of both medulla and cortex extending right out to capsule. The whole surface oozed collargol, and collargol staining was well marked at junction of cortex and medulla, the poles were more deeply injected than the rest of the kidney substance at one pole, greenish-black staining suggestive of a coagulative necrosis was evident, and this was to be seen later in many kidneys injected at a higher pressure.

(2) (H.) Pressure, 20 mm. Hg. Time, five minutes. No mottling seen at all under capsule. Cortex showed indefinite streaks of collargol, the medulla, however, being injected diffusely all over. This kidney, although apparently showing a negative result as far as the cortex injection goes, is instructive by comparison with Nos. 1 and 3 from a time point of view.

(3) (G.) Pressure, 25 mm. Hg. Time, five minutes. Mottling appeared three minutes

after injection commenced—at one pole first, as usual—spread fairly quickly. On section, injection of cortex—mainly at both poles. The injection appeared in wedge form extending from the apex of a pyramid.

(4) (E.) Pressure, 30 mm. Hg. Time, five minutes. Mottling appeared at poles in three minutes—as injection of cortex in wedge manner, mainly at poles, the middle of cortex being (naked eye) uninjected.

(5) (C.) Pressure, 35 mm. Hg. Time, two minutes. Fig. 2. Very little obvious mottling, but on stripping capsule, fine points were observable, which section showed to be due to faint lines of collargol. Wedge-shaped injections again marked, but in this case base of wedge extending only to junction of cortex and medulla. (D.) Further injection at 35 mm. Hg in a second kidney. Time, five minutes. Mottling appeared in two and a half minutes, and section showed usual injection of cortex and medulla.

(6) (B.) Pressure, 40 mm. Time, five minutes. Mottling appeared in two minutes at poles. Cortex and medulla again injected in wedge fashion—most intense at poles—central third very slightly affected.

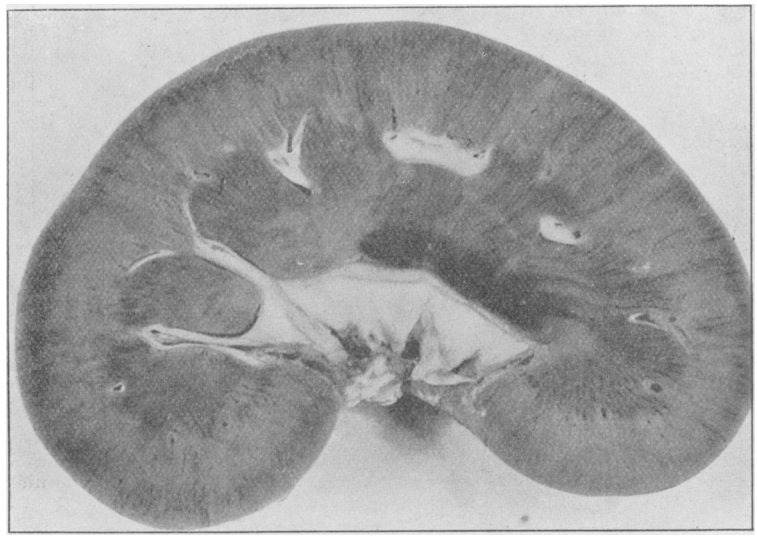


FIG. 3.

Pressure, 55 mm. Hg. Time, fifteen minutes. Mottling appeared under capsule in one minute.

(7) (D.) Pressure, 45 mm. Hg. Time, three minutes. Mottling appeared in one minute and spread rapidly. Injection of both cortex and medulla, mainly at poles, usual wedge shapes, in some parts of cortex deep injection lines about 1 mm. in width with separating width of 1 mm. uninjected.

(8) (A.) Pressure, 55 mm. Hg. Time, fifteen minutes. Fig. 3. This was the *first* kidney injected as a test of a moderate pressure. Mottling appeared in one minute and spread rapidly. Streaks were seen on section running out into capsule. Collargol oozed freely from surface and at poles, the medulla presented the gelatinous appearance already noted.

(9) Pressure, 70 mm. Hg. Time, thirty seconds. Fig. 4. This was the highest maintained pressure used, further high pressures being only momentary, such as would be

produced by injection with syringe. Mottling appeared as early as ten seconds, and before its appearance the whole kidney became tinged and erect like the filling of a sponge with water. Mottling spread rapidly, poles becoming quite black at the end of thirty seconds; appearances as seen in photograph IV.

(10, 11) Syringe injection with nozzle tied into under pressure not maintained. Pressure rose in ten seconds to 80 mm., in eleven seconds to 90 mm. Pressure rose gradually, being maintained at maximum pressure only about one second and pressure then released, manometer dropping at once to zero. Whole time, twenty seconds. In neither case was mottling observed under capsule. In both, the medulla was diffusely injected, but neither showed evidence of cortical injection.

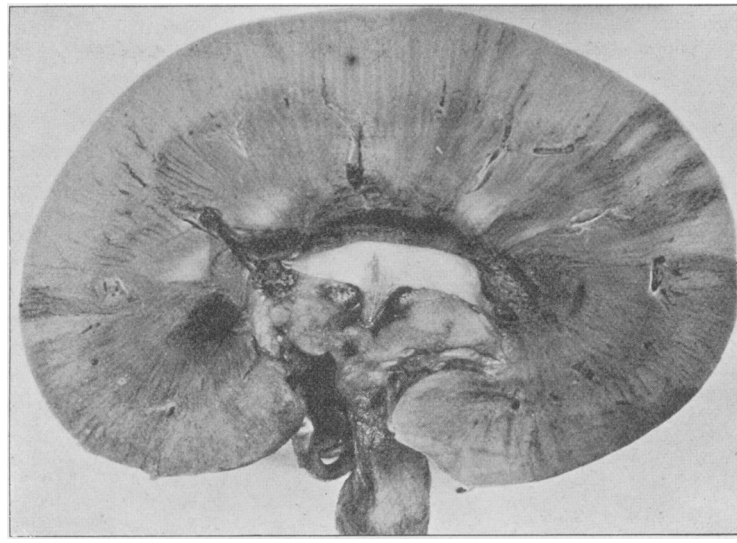


FIG. 4.

Pressure, 70 mm. Hg. Time, thirty seconds. Mottling appeared under capsule in ten seconds.

The times of penetration, then, of the injection at the different pressures may be arranged in order, thus:—

	Penetration Time.
15 mm.	Fifteen minutes
20 ,, ...	Mottling not seen in five minutes
25 ,, ...	Three minutes
30 ,, ...	Three minutes
35 ,, ...	Mottling not seen in two minutes
40 ,, ...	Two and a half minutes
45 ,, ...	Two minutes
55 ,, ...	One minute
70 ,, ...	One minute
80 ,, ...	Ten seconds
90 ,, ...	Mottlings not seen, but pressure maintained at these levels only momentarily

INJECTIONS OF KIDNEYS BY MEANS OF URETERIC CATHETERS.

A very fine ureteric catheter was used (No. 5), the length of ureter into which it was introduced was 7 in., the opening of the catheter lying in the pelvis. Pressure was maintained by the same method as in earlier experiments—namely, fluid pressure of collargol in a burette with manometer inserted in the tube.

(1) Pressure, 18 mm. Hg. Collargol took five minutes to return round the catheter, and then very slowly. Pressure dropped to 13 mm. during the time (ten minutes) that the injection was continued. On section no mottling seen; medulla again diffusely injected and (naked eye) few fine streaks of collargol at junction of cortex and medulla. Wedge-shaped injection not present.

(2) Pressure, 26 mm. Hg. Time, four minutes. Fall of pressure, 5 mm. Collargol returned round the catheter in one and a half minutes. No mottling was observed. On section infiltration of the medulla and a few faint streaks in cortex, but no wedge-shaped infiltration.

(3) Pressure, 30 mm. Hg. Collargol returned round the catheter in one minute and the pressure dropped to 23 mm. during the three minutes that the injection was continued. In this case, of course, there was considerable loss of collargol. On section diffuse infiltration of medulla, few very fine streaks of collargol extending out into cortex, but not reaching as far as capsule. No mottling seen.

The three experiments support the former contention that even at low pressures infiltration of the medulla takes place. There is, of course, no evidence that the pressure in the pelvis rose to that at which the fluid was delivered, but only to a pressure sufficient to distend the pelvis and orifice of ureter and allow of the escape of fluid. It is certain that this distension pressure would be less in the sheep's kidney than in the human kidney in the body owing to loss of tone of the pelvis and ureter, and therefore we may take it that the infiltration in the human would be not less than in the experimental specimens.

How does the collargol travel to the cortex? Is it by way of the collecting tubules or by way of the lymphatics? To determine this point Dr. Turnbull very kindly made sections of some of these infiltrated sheep's kidneys, and also of two infiltrated human kidneys. From his report it appears that the path is by way of the collecting tubules. These experiments seem to show that the cortex is more likely to be infiltrated by the gravity method than by the syringe method, unless care is taken to measure the pressure at which the fluid is delivered by gravity, so as to keep it below 30 mm. of mercury (the method of injecting recommended by Thomas, of the Mayo Clinic, does not therefore appear to be ideal). They also show the importance of keeping the fluid in the pelvis under pressure for as short a time as possible, a time that is represented by a few seconds only.

Evidence that collargol, 7 per cent., does no permanent damage to the kidney that can be recognized by clinical methods: In many of the cases injected with collargol I have had the urine tested afterwards at intervals of days and weeks, not only the whole urine, but in some cases the urine drawn off by catheter from the injected kidney itself.

These urines were reported on by Dr. Panton and Dr. Tidy, of the London Hospital Clinical Laboratory, to whom I am much indebted for their care and trouble. Some of these cases had received three or more injections of collargol, 5 per cent., for the purpose of washing them out and freeing them, in all cases successfully, from the *Bacterium coli*. In no case have I been able to find evidence of permanent pathological change in the urine. In the majority of cases, for a few days after the injection, though the urine appeared clear to the naked eye, of good colour, normal specific gravity and urea content, yet there was found the smallest trace of albumin, and microscopically a few leucocytes and red blood corpuscles. In not a single case, however, were any "casts" observed. For instance, in the case of W. H., with obscure pains in the right loin, 4 c.c. of collargol (5 per cent.) were injected into the right kidney. The urine tested by Dr. Tidy on the day following the injection contained a trace of albumin, and the centrifugalized deposit contained pus cells in microscopical amounts (*vide* Cases VII and XIII). In some of the cases no change whatever could be detected in the urine immediately after the injections (e.g., Cases XV, XVIII). On the other hand, when the urines were tested some week later, no changes of this nature could usually be detected and often the condition of the urines was found to be much improved (e.g., Cases VIII, XVI, XIX). This line of evidence, therefore, seems to show that in some cases there are no changes in the urine following the injection, but that in others slight changes are caused in the urine at first, but that these changes soon disappear. Presumably these changes are not of a permanent nature, and are soon recovered from by repair of the kidney cells. These urinary changes are not nearly so marked as are the changes found in the urine after a kidney has been exposed and handled at an exploratory operation. After such an operation the appearance of albumin and a large amount of blood with pus in the urine are not uncommon. Those who condemn the use of the ureteric catheters and the injection of collargol are just those who do not hesitate to recommend exploration of a kidney in a doubtful case. My argument, then, is that a collargol injection is safer and does less harm than an exploratory operation. Those who advocate exploratory operation cannot, therefore, in fairness criticize the method on this score.

Conclusions.

(1) The gaining of the knowledge of the exact anatomical state of the kidney and ureter before operation is of such vital importance that a method must be found which will give this information.

(2) The most feasible method is to fill the renal pelvis with a solution opaque to the X-rays and take a skiagram, which has now been done in a large number of cases with excellent results.

(3) The solutions so far employed (collargol, cargentos, &c.) do seem to irritate the kidney a little, though the irritation is only a passing one and is recovered from completely.

(4) It remains for future research to find a solution that will not irritate the kidney.

(5) Meantime, collargol can be used in weak solutions (5 to 7 per cent.) under low pressure (30 mm.), and with as short an exposure as possible (less than fifteen seconds).

(6) Caution is still necessary in advising pyelo-radiography. It should only be employed by those who are in a position to practise it assiduously in carefully selected cases, that is to say, cases in which otherwise an exploratory operation would seem to be necessary. The risk is far less than that of an exploratory operation.

(7) It is probably not wise to inject more than one kidney unless the conditions are very exceptional. It is certainly not advisable to fill the same kidney on three or four different occasions with strong solutions (15 to 50 per cent.) as has been reported by certain authors.

CASES.

Group A.—Congenital Abnormalities.

Case I: Single Kidney.—K. T., aged 36. Five years' left renal ache, especially on exertion; getting worse. Large, low, tender kidney felt in left loin. Urine clear, 40 oz. *per diem*, 1·3 per cent. urea. Ureteric catheterization twice. No urine came from the right ureter, which was normally placed. Left ureter, 1·7 per cent. urea; indigo carmine appeared in ten minutes. Collargogram shows single large kidney on left side. Ureter ending abruptly where kidney ought to be on right side.

Case II: Double Pelvis.—J. D., aged 28. Some months' right renal pain, vomiting, functional anuria for two days at a time. No X-ray evidence of calculus. Collargogram shows double pelvis.

Case III: Double Ureter and Double Kidneys on each side, with Neoplasm of Right Lower Kidney.—F. L., aged 51. Hæmaturia some months. Cystoscopy: Double ureters on each side with blood and growth issuing from mouth of right lower ureter. Collargograms: Left size double ureters and double fused kidney. Right side double ureters and double fused kidney; tumour shadow at lower pole obliterating the pelvis of the right lower kidney. Operation: Right nephrectomy. Ureters of specimen filled with collargol after removal. Collargogram taken to show spread of collargol in human kidney.

Case IV: Hydronephrosis.—C. P., aged 37. Five years' intermittent attacks of pain in right loin, accompanied by tumour and oliguria; as the attack passes off the tumour disappears and there is polyuria; able to work. No lump to be felt. Urine, 60 oz., alkaline, pale, specific gravity 1010, no albumin, urea 0·2 per cent. Left ureter catheterized, functional tests not satisfactory. Right ureter catheterized, 40 c.c. of 7 per cent. collargol injected easily; no pain. Collargogram: High hydronephrosis. Operation not advised owing to state of left kidney.

Case V: Congenital Hydronephrosis.—I. S., aged 32. Ill one month; attacks of pain in right loin, vomiting; increased frequency, three or four times at night; never noticed any hæmaturia. On examination, tumour in right loin with characteristics of kidney tumour. Urine acid, albumin and pus; on culture showing *Bacillus coli*. Radiogram: Right kidney enlarged, group shadows visible in kidney area; elongated shadow made up of a group of small shadows in line of right ureter in pelvis. Four days after admission passed small grey, facetted stone, and the following day three more stones were passed. Collargogram, 20 c.c. injected: Large dilated pelvis; kidney itself decreased in size and calculi lying in it. Nephrectomy two days later. Collargol diagnosis confirmed and an abnormal artery found at operation running to lower pole behind ureter. Calculi oxalates with trace of phosphates. Patient made uninterrupted recovery. Cystoscoped two weeks later and bladder found clear.

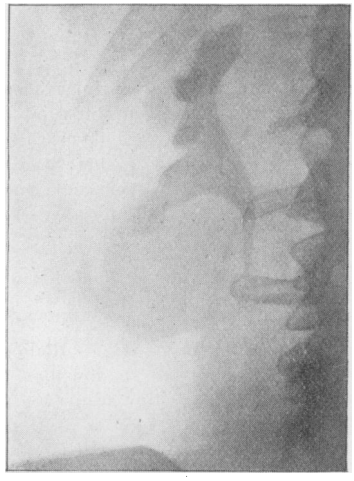
Case VI: Congenital Kinked Ureter.—H. S., aged 23. Three years' severe right-sided colics accompanied by oliguria and followed by polyuria lasting twenty-four hours; he has to go to bed. Collargogram, February 20, 1913: Well-marked kink in middle portion of ureter. April 24, 1913: Right ureter explored through muscle-splitting incision. It was found bound to the spine at the fifth lumbar vertebra and crossing the origin of the right common iliac artery. It was released from its attachments, and thereby the kink was relieved. After this urine could be seen to pass easily throughout the tube. Healed well; no further attacks.

Case VII.—Mrs. G., aged 34. Nurse in scarlet fever hospital. Scarlet fever three times. In April had a bad fall; a few days later, while lifting a child, was seized with severe right-sided renal colic. Severe aching pain in right loin ever since, especially on exertion. Soon after severe attack in April the legs swelled and albuminuria was discovered in the urine. Urine acid, specific gravity 1003, albumin $\frac{1}{3}$, oxalates and leucocytes. No œdema. Blood-pressure, 105 mm. Hg. September 11, 1913: Both ureters catheterized; a similar amount of albumin in urine from each kidney. Collargogram of right kidney shows a stricture of the ureter at the pelvic junction, and that the kidney is too low in the loin; pelvis slightly ballooned. September 16, 1913: Urine acid, specific gravity 1015, urea 1·3 per cent., albumin $\frac{1}{6}$, clear, amber, to the naked eye, but centrifugalized deposit shows a few pus cells and red cells. September 16, 1913: Operation. No trace of collargol seen. A large abnormal vein found running behind the ureter and causing the obstruction. This was divided and the obstruction relieved, and the kidney anchored in proper position.

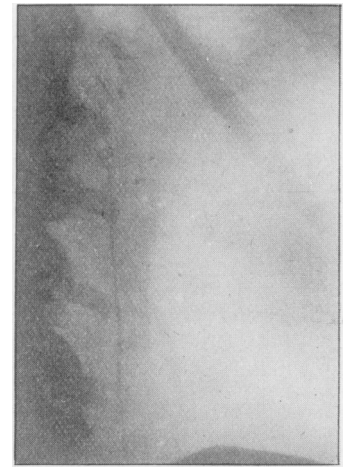
Group B.—Mechanical Dilatation of the Renal Pelvis.

Case VIII: Movable Kidney.—Mrs. S., aged 38. Eleven years attacks of pain in right loin; very movable right kidney. Urine acid, smoky, specific gravity 1026, 2 per cent. urea, albumin $\frac{1}{3}$, sugar 1·6 per cent., pus cells, red cells in deposit. Collargogram: Early dilatation of pelvis (ballooning). Operation two days later: No trace of collargol; nephropexy. Excellent healing. Urine at exit acid, specific gravity 1020; no albuminuria, trace of sugar.

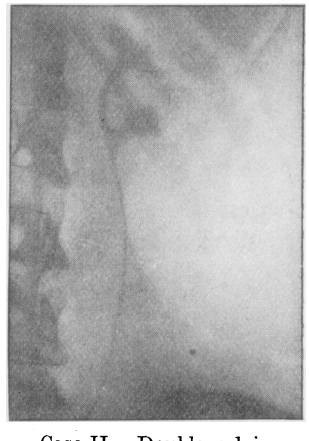
Case IX: Movable Kidney fixed too low at a previous Operation.—F. P., aged 34. Seven years ago right renal pain. Right kidney fixed in the provinces. Ever since then constant throbbing pain in the right loin, which has got so bad that she has given up work and taken to her bed. Urine acid, specific gravity 1030, no albumin or sugar, urea 3·3 per



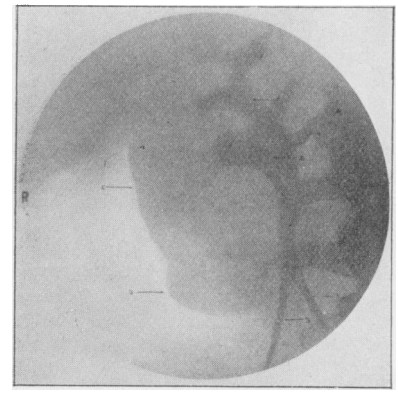
Case I.—Solitary left kidney.



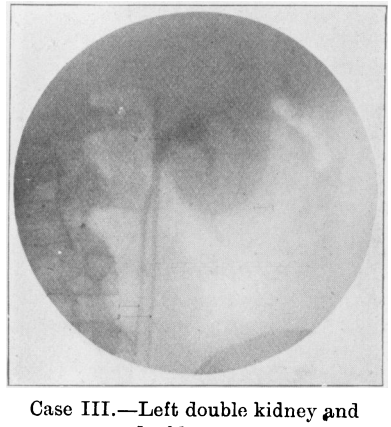
Case I.—Absence of right kidney.



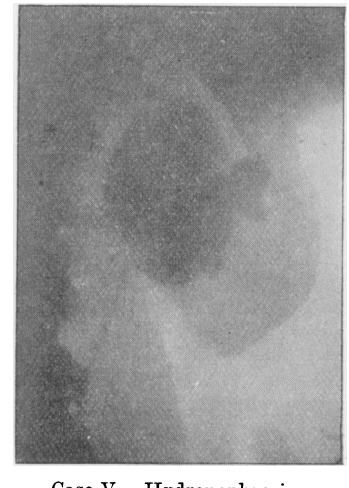
Case II.—Double pelvis.



Case III.—Right double kidney and double ureter with tumour at lower pole.



Case III.—Left double kidney and double ureter.



Case V.—Hydronephrosis.

cent., no pus. August 15, 1913: Collargogram shows ballooned pelvis from kinked ureter; kidney fixed too low down. August 20, 1913: Right kidney explored. Set in a dense membrane which rendered reposition in a higher position impossible. Kidney removed. No trace of collargol. Sections made (*see* Dr. Turnbull's report). Pain completely relieved.

Group C.—Inflammatory Dilatation.

Case X.—A. K., aged 33. Two years' pain in right loin, hæmaturia. X-ray at King's College, *nil* found; also at St. Bartholomew's and Hampstead Hospitals. Skiagram shows *nil*. Urine: Albumin, pus, blood. April 19, 1913: Collargogram shows shrunken pelvis, dilated ureter below. March 23, 1913: Urine—albumin, blood, pus, specific gravity 1020. April 24, 1913: Operation. Dilated ureter; very adherent kidney. Nephrectomy. After nephrectomy a stone found buried at the uretero-pelvic junction was the cause of the whole trouble. Sections (*see* Dr. Turnbull's report).

Group D.—Diagnosis between Renal and other Abdominal Tumours.

Case XI.—E. R., aged 57. Six months' pain in left loin. Six weeks ago sudden severe attack with high fever. Large tumour to be felt in left loin of doubtful nature. Collargogram shows normal kidney. Tumour explored and proved to be a hypertrophied and adherent spleen which was successfully removed and the patient relieved. Patient quite well, 1913.

Case XII.—Mrs. D., aged 34. Fifteen months' lump in left loin which gave all the usual signs of a renal enlargement. April 3, 1913: Collargogram shows normal kidney. Operation: Hypernephroma weighing 5¾ lb. removed, lying between the left kidney and the left suprarenal. Did well.

Case XIII.—J. G., aged 56. Dysentery five years ago. During the last two years tumour of right loin, intermittent rigors, wasting. Large tumour in right loin of uncertain nature. Urine acid, specific gravity 1017, urea 1·8 per cent., no albumin, no sugar, no deposit. Cultures: No pathological bacteria present. Collargogram shows normal kidney shadow. Tumour explored; found to be inflammatory lipomatosis of the peri-ureteric fat below the right kidney, set up by chronic ulcer of ascending colon. After collargol injection, urine acid, specific gravity 1024, trace of albumin, a few pus cells in centrifugalized urine. No naked-eye deposit.

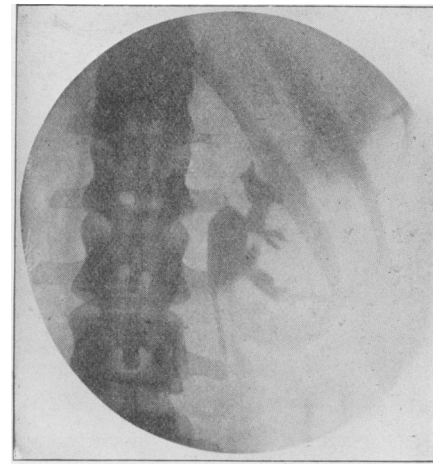
Group E.—Diagnosis of Renal Tumour (*vide also Case III*).

Case XIV.—H. L., aged 60. Six months' hæmaturia, pain in left loin, œdema of both legs. Collargogram (plate broken). Inoperable tumour of left kidney.

Case XV.—J. C., aged 32. Syphilis ten years ago. One month pain in right loin; wasting. Wassermann reaction plus. Large right renal tumour to be felt. Urine acid, specific gravity 1015, heavy cloud of albumin, pus cells in deposit. Collargogram: Very large right kidney, no deformity of pelvis. Diagnosis: Syphilitic kidney. Urine tested a week later: No additional changes. Cleared up after three injections of neo-salvarsan.

Case XVI.—B. G., aged 10. Three weeks' wasting; hæmaturia. Large right kidney. Urine acid, trace of albumin, pus cells, *Staphylococcus albus*. Collargogram shows a large right kidney, but normal in outline. Right kidney explored: No trace of collargol seen, nor anything abnormal; wound stitched up again. Urine: No changes except that pus disappeared; tested afterwards frequently. Patient quite well at exit.

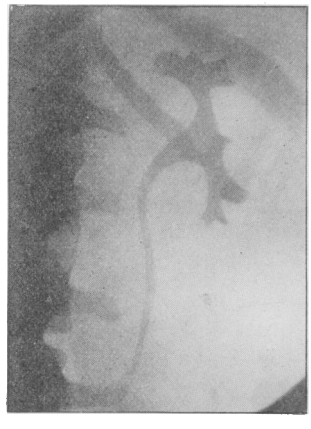
Case VII.—Obstruction of upper end of ureter by abnormal blood-vessel.



Case VIII.—Movable kidney. Early mechanical obstruction.

Case IX.—Kidney fixed too low at operation. Kinked ureter.

Case XI.—Diagnosis from splenic tumour. Normal kidney.



Case XV.—Large syphilitic kidney. Normal arrangement of pelvis and calices (upper, middle, and lower group).

Case XX.—Shadows of calcareous glands, not stone shadows, because stones always lie in a calyx and not in the cortex.

GROUP F.—RENAL PAIN (*see also Cases I, II, IV, V, VI, VII, VIII, IX, X*).

Case XVII.—C. H., aged 20. Seven months' right-sided pain; appendix removed elsewhere. Increased frequency at times. Urine, specific gravity 1032, 3·4 per cent. urea, calcium oxalate crystals, no pus. Skiagram, *nil*. Collargogram: Normal shadow, therefore pain probably not renal.

Case XVIII.—C. C., aged 40. Eighteen months' pain in left loin, increased frequency of micturition. March 18, 1913: Collargogram shows normal kidney. March 19: Urine—amount normal, acid, amber, clear, no albumin; specific gravity 1025; urea 0·9 per cent.; no deposit, no pus, no blood; cultures sterile.

GROUP G.—TO SHOW UP STONES IN THE KIDNEY AND THEIR POSITION.

Case XIX.—C. T., aged 55. Eighteen months' pain in left loin, hæmaturia. Skiagram, nothing definite. Urine alkaline, specific gravity 1011, trace albumin, pus. Collargogram shows up two stones, one in an upper calyx, the other in a lower calyx. Urine alkaline, specific gravity 1020, no albumin; occasional pus cells microscopically, cultures sterile.

Case XX.—F. S., aged 28. Four months' pain in left loin. X-ray group of shadows opposite second and third T.V. process, right side. Six cubic centimetres 7 per cent. collargol. Rather a large kidney; no dilatation of pelvis; abnormal shadows lie in lower pole of kidney apart from ureter.

Case XXI.—I. G., aged 26. Two years ago passed two small stones. One year ago, diagnosis of appendicitis and appendicectomy performed. Since, dull aching pain in right loin—similar to that before operation. Increased frequency, usually once at night. Never hæmaturia. Radiogram: No shadows seen in kidney, ureter or bladder. Ureteric catheterization: Hazy urine from right, left clear and well pigmented. Collargol: 25 c.c. injected into right pelvis; enlarged right pelvis. Exploration of right kidney: Kidney found to be enlarged, much peri-ureteritis; pelvis opened and explored, *nil* beyond dilatation found; sutured after freeing of adhesions. One month later the wound in the loin broke down and a urinary fistula became established. Second operation, nephrectomy. Diagnosis, constricting peri-ureteritis secondary to passage of stones, causing inflammatory pelvic dilatation. Sections (*see* Dr. Turnbull's Report).

BIBLIOGRAPHY.

BRAASCH, W. F. *Ann. of Surg.*, Philad., 1910, li, p. 534; 1912, lvi, pp. 726-37; *Surg., Gyn., and Obst.*, Chicago, 1911, xii, p. 374; *Old Dominion Journ. of Med. and Surg.*, Richmond, 1911-12, xiii, p. 269.

BRUCE, W. IRONSIDE. *Brit. Med. Journ.*, 1911, ii, p. 908.

FOWLER, O. S. *Surg., Gyn., and Obst.*, 1912, xiv, p. 137.

KELLY, HOWARD, and LEWIS, R. M. *Surg., Gyn., and Obst.*, 1913, xvi, p. 707.

TENNANT, C. E. *Ann. of Surg.*, 1913, lvii, p. 888.

THOMAS, J. G. *Journ. Amer. Med. Assoc.*, 1913, lx, p. 184.

UHLE, PFAHLER, MACKENNEY, MILLER. *Ann. of Surg.*, 1910, li, p. 546.

VOELCKER und LICHTENBERG. *Münch. med. Wochenschr.*, 1905, lii, p. 1576; 1906, liii, p. 105.

WALKER, J. W. THOMSON. *Lancet*, 1911, i, p. 1627.

(The discussion on this paper was adjourned until the next meeting.)