Observations

ON

THE ROLE OF EXCRETION UROGRAPHY IN THE DIAGNOSIS OF DISEASE *

BY

HENRY WADE, C.M.G., D.S.O., M.D., F.R.C.S.ED.,
SURGEON, ROYAL INFIRMARY, EDINBURGH

(With Special Plate)

It is often said that in no branch of medicine is the diagnosis more accurate than in disease of the urinary system. This in truth is the case. It has been rendered possible by the various accurate methods of examination that are now available, of which urography probably is the most valuable. By its means a graphic picture of the urinary tract is obtained on *x*-ray examination, after the introduction of an opaque fluid. Until recently this was accomplished by injecting the media per urethram through a catheter—infusion urography, as it is now called, was thus carried out and a pyelogram, uterogram, cystogram, or urethrogram was obtained. This method of examination is neither difficult nor dangerous, nor should it be accompanied by any appreciable discomfort to the patient. It is, however, highly technical and highly intimate, as it is best carried out on the conscious patient. It thus has certain obvious disadvantages, more especially to those who are not expert in this branch of surgery.

Another method, known as excretion urography, is now available. This is accomplished by injecting into the circulating blood a chemical substance which is rapidly excreted in the urine. Its composition is such that if an *x*-ray examination is then conducted the passage of the fluid through the excretory channels can be observed and demonstrated, and not only can a pyelogram, ureterogram, or cystogram be obtained, but the kidneys also can be studied as the dye passes through their tubules. On these grounds some have advocated excretion urography as a substitute for infusion urography. It will be acknowledged that in certain cases it will serve this purpose, but it would be very regrettable if it were suggested that the chief claim of excretion urography was based on its employment as a substitute for the older method of examination, to the omission of the many advantages it possesses in itself. Excretion urography will never replace infusion urography. The two methods are both of extreme value—they are complementary and not in opposition. Infusion urography, by delineating the form and capacity of the urinary channels after injection, outlines their contour and demonstrates their normal or morbid anatomy. It is an anatomical demonstration. Excretion urography, on the other hand, gives a graphic picture of a physiological process. It is vital, and deals with life and activity. Infusion urography demonstrates form: excretion urography reveals function.

THE PROCESS OF EXCRETION

When excretion of urine takes place the urine is discharged into the minor calyces from tubules contained in the papillae. There it accumulates, and is ultimately discharged into a similar series of reservoirs of varying capacity, until it is ultimately voided per urethram. Each minor and major calyx is surrounded by plain muscle, which is condensed around its neck. As each calyx fills contraction occurs, the ring muscle at the neck relaxes, and the content is discharged into the major

calyces and pelvis. The pelvis also has a sheath of plain muscle and a ring of circular muscle at the pelvi-ureteral junction. In its turn the pelvis similarly fills until a certain degree of distension is reached. When peristalsis commences the pressure cone at the pelvi-ureteral junction relaxes and the contents are discharged down the ureter into the bladder, where they are stored in like manner and ultimately voided, the whole being a co-ordinated process accurately controlled by the autonomic nervous system.

By excretion urography the physiology of urinary excretion can be demonstrated graphically. The fluid can be observed passing from reservoir to reservoir, and a new field of observation is thus opened up. It may be laid down as a general principle that the indications of health may be based upon the time of the appearance of the dye and its rate of discharge. The functional activity of the two kidneys can thus be compared, and by estimating the amount of the chemical agent in the urine over a given period an accurate record of the renal functional activity of the entire renal tissue in the body can be determined. Von Lichtenberg estimated that 85 per cent. of uroselectan was eliminated from the body in the urine unchanged. He noted that 50 per cent. was eliminated in the first two hours, the highest concentration in the chemical agents then used being in a quarter to half an hour.

MEASUREMENT OF UROSELECTAN VOIDED

With the co-operation of Dr. C. P. Stewart of the biochemical department, Band and I investigated this question two years ago. We found that the average total excretion of uroselectan A in normal functional activity during the period of observation of six hours is 25 grams. Seventy per cent. of this is found in the urine passed in the first three hours of the period of observation, of which 15 to 20 per cent. appears in the first half-hour. The graphic representation of the figures thus obtained gives a normal uroselectan excretion curve. In cases of chronic interstitial nephritis we found a uniform low excretion of uroselectan. In a severe case of chronic interstitial nephritis the total amount of the drug excreted is extremely small—only about 3 grams—that is, 12 per cent. of that excreted in health. Thus an important factor in the establishment of this method for use in the estimation of functional activity is brought out—namely, a high level is reached where that is normal and a low level where function is grossly impaired. There is thus room for wide variation in the figures obtainable during a uroselectan investigation carried out on those cases which occupy an indefinite category between genuine health and well-established disease.

Various methods were employed in the biochemical laboratory of the Edinburgh Royal Infirmary to estimate the amount of drug excreted. Dr. C. P. Stewart has provided me with a short description of the simplest of these, which gives a satisfactory approximate estimate of the amount of the drug eliminated. He describes it as follows:

Our method is to precipitate the "drug" as the free acid (it is injected as the sodium salt), filter it off, dry, and weigh. The acid of uroselectan A is easily precipitated by adding dilute hydrochloric acid to the urine until maximum precipitation occurs. (In case of a diuresis, the urine may be evaporated to a specific gravity of about 1030.) The precipitate rapidly settles, and a drop of the supernatant fluid is tested with acid and with alkali for further precipitation. When as much as possible has been precipitated the mixture is filtered, and, without washing (since the precipitate dissolves somewhat in water), the uroselectan is dried at 100° C. and weighed. Uroselectan B is treated similarly, except that it is necessary to precipitate with concentrated acid—hydrochloric or nitric—and to use about 10 c.cm. acid for each 30 c.cm. of urine. (This is only a rough guide.) In both cases, of course, the

* Being an abstract of a British Medical Association Lecture delivered at a meeting of the Ayrshire Division on November 17th, 1932.

results are only approximate, since the uroselectan acids are not completely insoluble. With uroselectan A a very rough guide to the rate of excretion is given by simple measurement of the urinary specific gravity, which is very high when the urine contains considerable amounts of the drug—1030 and over.

INTERPRETATION OF FINDINGS

To determine these most valuable findings the co-operation of a biochemist is necessary. Band and I were singularly fortunate in having the co-operation of Dr. C. P. Stewart. He found it a very simple procedure to recover the drug in the urine and to estimate its amount. Those who are not so fortunate have, however, in the serial pictures a reasonably accurate method of determining the rate of the elimination of the drug and the amount discharged, by observing the density of the shadow in the serial cystograms, provided the patient is directed not to void urine and empty the bladder until after each photograph is taken. But as this method is liable to produce a shadow which may obscure the lower end of the ureter, it is more generally preferred to ask the patient to empty the bladder prior to the taking of each photograph, and this latter method has the great advantage in certain cases, such as prostatic enlargement, of demonstrating pictorially the amount of residual urine that remains.

In studying a series of skiagrams obtained by excretion urography, it is very important to remember that it is a running stream which is being observed—movements in a vital channel constantly emptying from one reservoir into another, and thus varying in contour from moment to moment. It may therefore be said that by excretion urography an accurate anatomical outline of the form and capacity of the pelvis and ureter is not obtainable, and only very exceptionally in disease is a clearly defined outline of these channels forthcoming. Thus a demonstration of the exact morbid anatomy of the pathological process cannot be depended on as is the case with infusion urography. This observation emphasizes again the fact that the two methods are entirely distinct in their sphere of application. In their own department each is extremely valuable. This is especially well illustrated when they are used in the diagnosis of tumours of the kidney. An accurate diagnosis of a tumour of the kidney by excretion urography cannot be relied upon. By infusion urography the presence of a tumour should always be demonstrated, and from the clinical history of the case and the state of the patient a fair estimate of the degree of malignancy is usually obtainable. There is, however, one group, the most malignant of all—alveolar carcinoma—where the findings observed by infusion urography may be seriously misinterpreted. Here, owing to the rapid growth of the tumour, a rapid flooding of the neighbouring renal tissue with malignant cells occurs, and the characteristic local destruction of the drainage system of the kidney at the site where the primary growth is situated, combined with the drawing out, flattening, and elongation of the adjacent calyces, may be absent, and in a pyelogram obtained by infusion urography only slight deformity may be observed. On the other hand, by excretion urography there may be an entire absence of shadow in this kidney, indicating an organ flooded with malignant disease and almost destroyed as a functioning gland. After having carried out a combined examination by infusion and excretion urography on a number of cases of tumours of the kidney of varying degrees of malignancy, the conclusion we came to was that the degree of malignancy varied inversely with the degree of demonstrable renal functional activity.

The outflow of urine may be obstructed by causes that are organic or functional. The necessity of surgical treatment in these cases will depend upon the extent to which the obstruction interferes with the functional activity of the organ above. A stone in the ureter may

lie quiescent, causing relatively little harm for seven years or longer. On the other hand, a similar stone producing complete impaction may lead to the destruction of the kidney above, as a functioning gland, in three or four weeks. In such cases excretion urography has proved the most valuable aid we possess in determining the degree of damage of the functional activity of the kidney above the site of the obstruction. Many cases of early hydronephrosis are met with which owe their origin to obstruction at the uretero-pelvic junction, and in many of these no local organic cause can be demonstrated. When examined by excretion urography it will usually be observed that the shadow appears as early on the diseased side as in the healthy kidney, but the fluid is retained within the renal pelvis in the former case long after it has disappeared from the other side. A fault in the neuro-muscular mechanism—an achalasia—probably accounts for this in certain cases.

VALUE OF THE METHOD

The primary value of excretion urography is therefore its service as a test of function. As a means of delineating the form and capacity of the renal pelvis, and thereby demonstrating the morbid anatomy of any lesion which may be present, it is unreliable. Not infrequently, however, especially where the disease has resulted in partial obstruction to the outflow of urine, an excellent anatomical demonstration may be obtained, and one sufficient to serve as a guide in determining the surgical treatment indicated. It has also to be borne in mind that occasionally it may be impossible to carry out infusion urography, or else such instrumentation of the urinary passages may be contraindicated. In the former class excretion urography has rendered it possible to demonstrate the structure and functional activity of the kidneys before and after transplantation of the ureters into the colon for vesical exstrophy, vesico-vaginal fistula, and malignant disease of the urinary bladder. In uretero-vaginal fistula the treatment indicated is determined by the degree of damage to the kidney above and the health of the other organ. Here excretion urography has proved of great value, for if it shows the kidney above to be functioning actively and not seriously damaged, reimplantation of the ureter into the bladder is the operation of choice; whereas if the kidney is seriously damaged and functionally impaired, and the other kidney is healthy, nephrectomy is to be preferred.

Excretion urography promises to prove of great assistance in treating the elderly person suffering from simple prostatic hypertrophy, and in helping to determine when operative treatment is indicated and what procedure to follow. Undoubtedly in very many cases of simple prostatic hypertrophy delay is too long before operative treatment is carried out. The fact that the ailment is met with in so many elderly men probably explains this in part. Of such patients undoubtedly a great number carry on for years handicapped, but apparently without their health being seriously damaged. The medical adviser is thus confronted with the serious problem of when to recommend operative treatment. Now the prostatic problem is essentially a renal problem, and the prognosis will almost solely depend on the functional activity of the kidneys. In a doubtful case excretion urography proves of great value here, as by its employment an accurate record of renal function can be obtained, the presence of hydronephrosis and hydro-ureter from backward pressure indicated, and a demonstration afforded, without discomfort or danger, of the amount of residual urine. The routine employment of excretion urography has enabled us to determine the very serious damage that the persistently systolic bladder produces by the backward pressure it exercises on the kidneys. Thus, where tuberculous

disease of one kidney exists with an associated tuberculous cystitis, the other kidney is frequently the site of hydronephrosis from this cause. During the convalescence of these patients after nephrectomy of the diseased organ, the functional activity of the remaining kidney should be examined at regular intervals and the degree of dilatation of the pelvis estimated, for it is possible for an apparent clinical cure of the tuberculous infection to be present years afterwards and the patient to be seriously ill with threatened uraemia from pronounced hydronephrosis of the remaining organ.

Infusion urography necessitates ureteral catheterization. A pervious channel is thus necessary. Organic stenosis may be present and render the examination impossible, but occasionally ureteral catheterization is impossible, although the orifice appears normal in appearance. The failure to introduce the instrument may be due to muscular spasm, a temporary stenosis, the kidney above being healthy, or, on the other hand, the kidney above may be a congenitally functionless organ, the patient possessing a single functioning kidney. Naturally, in this case operative treatment such as nephrectomy would inevitably prove fatal. Excretion urography provides a simple solution of this problem, which formerly was often so difficult to solve. In certain cases where infection exists in the lower urinary passages infusion urography, although technically easy, is contraindicated, and here the intravenous method may be substituted.

It is evident, therefore, that excretion urography is a valuable diagnostic aid. The technique of its use is simple and safe, but at the same time it is not one for general use. The interpretation of the appearances seen can only be made by one well trained in recognizing pyelographic appearances. In all cases a preliminary x -ray examination should be made, as otherwise the appearances of a dead kidney containing an arborescent renal calculus may be mistaken for a healthy organ with its pelvis filled with dye. The method should not be depended on as a routine means of demonstrating the cause of disease; its province is more to demonstrate the effect of disease. Thus, in most cases it is probably best employed at the stage of the examination when the presence of the disease has been determined and the most suitable method of treatment is under consideration.

PERURETHRAL OPERATIONS ON THE PROSTATE*

BY

KENNETH WALKER, F.R.C.S.

SURGEON TO GENITO-URINARY DEPARTMENT, ROYAL NORTHERN HOSPITAL; SURGEON TO ST. PAUL'S HOSPITAL

(With Special Plate)

Eleven years ago I stood on this very spot to deliver a Hunterian Lecture on the nature and causes of enlargement of the prostate in old age. My address, when stripped of its trimmings, was in reality a confession of ignorance, for we knew not the cause and were still in doubt as to the nature of the changes that are so apt to affect that gland in the later decades of life. But to-day I am in a more fortunate position, for, if we have not made any progress in the realm of the pathology of the prostate, we have at any rate advanced in that of its surgery.

It is with one aspect of this advance that I intend to speak to-day—namely, the effort to deal with the obstructing prostate by perurethral methods. The idea of

attacking obstruction situated in the neighbourhood of the bladder neck through the urethra is a hundred years old, for although Civealé's *Traité Pratique sur les Maladies des Organes Genito-urinaires* was published only in 1837, he states in it that he had been using a special instrument for the forcible dilatation of the vesical neck since the year 1824. But Civealé's writings had little effect on surgery, and are chiefly to be remembered for the bitter controversy they produced between him and his fellow urologist, Mercier, as to who could claim priority in the treatment of bladder-neck obstructions. Forty years later, when the petty squabble had been forgotten, Bottini brought out his galvano-cautery incisor, substituting cauterization for incision of the bladder neck in order to reduce the risk of haemorrhage. Bottini's operation attracted wider attention than had Civealé's, and workers in different countries adopted his instrument and modified it to meet their needs. But other methods of attack on the prostate soon appeared on the surgical horizon, and the successes of suprapubic and perineal prostatectomy deflected for a time the interest of the profession from the perurethral method of attack. Indeed, it may be said that it is only during the last decade that attention has once more returned to it, and that urologists have again begun to wonder whether, in spite of the success of total prostatectomy, there might not also be some place for methods that had almost been forgotten.

Two advances along other lines have been responsible for this renewed interest in perurethral surgery. The first of these is the perfecting of the cystoscope, with the power it gives of doing under visual control what Bottini could perform only blindly and with considerable risk. The second is the introduction of high-frequency currents into the realms of surgery. A third factor, of less importance but nevertheless having an influence on our attitude, is the realization that cases of obstruction occur in which there is to be found no massive enlargement of the prostate but only a minor deformity of the bladder neck. Whilst the two great discoveries of the cystoscope and the high-frequency current acted by furnishing us with weapons of which Bottini could only have dreamed, the realization that minor changes in the neighbourhood of the bladder neck may cause great difficulty in micturition has made us pause and consider whether it may not sometimes be possible to relieve our patients without subjecting them to so grave a procedure as total prostatectomy. Whether this is feasible or not is the question to which we must not try to find an answer.

FUNCTION OF THE BLADDER NECK

The question whether a partial operation on the prostate is sufficient to remove obstruction and restore the function of the bladder neck cannot be satisfactorily answered, owing to the fact that our knowledge of the physiology of micturition and of the mechanism of obstruction is incomplete. Clinical observations, however, show that micturition is associated with a backward movement of the posterior segment of the internal meatus and of the floor of the urethra. If during cysto-urethroscopy a patient is asked to micturate it will be seen that, whereas the anterior margin of the internal meatus remains stationary, the whole posterior segment of the bladder neck is pulled back, so that the angle made by the junction of the plane of the trigone with that of the floor of the urethra is straightened out. A similar phenomenon can be observed by making cysto-urethrograms of the bladder at rest and during micturition. This backward displacement of the posterior segment of the bladder neck and alignment of the planes of the trigone and urethra are brought about, according to Young and Wesson, by the contraction of the trigonal fibres having their origin in the trigone and their insertion in the

* Hunterian Lecture delivered before the Royal College of Surgeons of England on January 30th, 1933.

HENRY WADE: EXCRETION UROGRAPHY IN DIAGNOSIS

FIG. 1.—J. McD., aged 24. Bilateral ureteral transplantation 7 years ago for vesical exstrophy. Patient has normal health with complete rectal control. Excretion urography examination: photograph taken 15 minutes after injection of uroselectan B, showing kidneys, pelves, and ureters to be of normal contour and renal functional activity normal.

FIG. 2.—M. S., aged 28. Nephrectomy for tuberculous disease of the right kidney 7 years ago. Frequency of micturition has persisted, though patient has otherwise been in good health and no evidence now of active tuberculous disease. Excretion urography examination: photograph taken 30 minutes after injection of uroselectan B, showing pronounced degree of hydronephrosis and hydro-ureter in remaining kidney due to persistent vesical systole.

FIG. 3.—A. S., aged 12. Typical clinical history of pyonephrosis of left kidney. Excretion urography examination: photograph taken 15 minutes after injection of uroselectan B, showing right kidney to be healthy, left kidney non-functioning. Nephrectomy for pyonephrosis with normal convalescence.

FIG. 4.—A. F., aged 21. Right renal calculus. Preliminary X-rays showed calculus in region of right kidney with calculus in vicinity of left kidney. Catheterization of left ureter unsuccessful. Excretion urography examination: photograph 15 minutes after injection of uroselectan B, showing calculus in right renal pelvis with hydronephrosis of right kidney and left kidney normal. "Calculus" in vicinity demonstrated to be an extrarenal calcareous gland.