RECENT ADVANCES IN UROLOGY

EDITED BY
W. F. HENDRY

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NUMBER TWO

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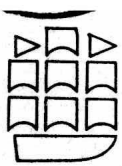

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PREFACE

The pervasive growth of urology as a precision branch of surgery has been largely due to three factors: consistent accuracy in preoperative diagnosis, improvements in operative surgical techniques, and increasingly effective interdisciplinary collaboration. Significant advances have been made in each of these aspects of urology in recent years.

Accurate diagnosis has always been the foundation of successful urology. Developments in radiological techniques (Chapter 1) now ensure that few patients need go for operation without a firm diagnosis, and careful biochemical studies (Chapter 2) can significantly reduce the incidence of recurrent disease after successful surgery. Many of the failures of surgical treatment in the past have been due to imperfect understanding of the dynamics of micturition, and the development of urodynamics as a precise diagnostic aid (Chapter 3) should improve the results of surgery for bladder outflow obstruction and incontinence. Recurrent urinary infection has always plagued the urologist, but again, increasing emphasis on accuracy in diagnosis in the management of urinary infection (Chapter 4) has produced striking improvements in the results of treatment. The application of these principles to urinary tract injuries (Chapter 5), and obstructive uropathy in childhood (Chapter 6), has produced better understanding of the disease processes involved and this in turn has led to better management of the patients.

Improvements in surgical techniques can now enable the urologist to conserve renal tissue instead of ablating it (Chapter 7), and spare the patient the life-long miseries of repeated urethral dilatations (Chapter 10).

Effective interdisciplinary collaboration has produced some spectacular advances. Cooperation with nephrologists has produced real hope for the patient suffering from hypertension (Chapter 8), or dying of renal failure (Chapter 9). By combining with endocrinological and gynaecological colleagues, the treatment of subfertility has become a stimulating challenge instead of a disappointing chore (Chapter 11). Finally, close collaboration with the pathologist, the radiotherapist and the chemotherapist now enables many young men with malignant testicular tumours to be cured (Chapter 14). The prospects for patients with prostatic or urothelial cancer (Chapters 12 and 13) are likely to be significantly improved by the application of the combined treatment policies which have proved so effective with testicular tumours.

I hope that the trainee-surgeon will find this book useful in studying for higher examinations. Many of the chapters have deliberately included much basic information, so that developments in diagnosis and treatment can be seen as integral parts of the management of disease as a whole, rather than as advances in isolation. In particular, I hope that practising surgeons will find something of interest, and as a result share in some of the excitement that has accompanied the advances which have occurred in urology in recent years.

I wish to thank Mr Howard G. Hanley, who edited the first edition of this book, for giving me the opportunity to edit this edition, and for his support and encouragement. I am indebted to the *British Journal of Urology* for permission to reproduce Figures 3 and 4 in Chapter 3, Figure 1 in Chapter 4, Figure 1 in Chapter 11, Figure 21 in Chapter 12, and Figures 7 and 8 in Chapter 13. I am particularly grateful to Miss Anthea Minchom, Librarian at the Institute of Urology, for her constant and untiring help in the preparation of the typescript, and to the Departments of Medical Art and Medical Photography at several hospitals who have helped the contributors with their illustrations.

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CONTENTS

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RADIOLOGICAL DIAGNOSIS

T. Sherwood

The past two decades have seen a much improved understanding of intravenous urography, great expansion in angiography, the establishment of radioisotope techniques, and exploration of ultrasound scanning. The development of rapid automatic film processing remains a particularly outstanding advance. The ability to view a dry radiograph a few minutes after its exposure has made the intravenous urogram (IVU) a highly flexible investigation, tailored to individual need rather than routine. The indications for intravenous urography have widened considerably, to include the field of renal failure where this is now the x-ray investigation of choice (Fry and Cattell, 1971; Sherwood et al, 1974a). An understanding of the physiology and pharmacology of the IVU has led to better examinations where more is seen, and retrograde pyelography has become less important. For interpretation of the 1970s IVU to be at all adequate, these advances must be appreciated in outline.

INTRAVENOUS UROGRAPHY

Current contrast media

These are often best known by their trade names, a fact that sometimes obscures rather than simplifies the choice of contrast medium and dosage. Current urographic agents are all benzoic acid derivatives with three iodine atoms. The diatrizoate, iothalamate or metrizoate so formed show only minor differences between them, and each anion can be linked to either or both of sodium or methylglucamine as cation. Nine combinations are therefore possible (Table 1), and most of these are available. Sodium agents appear preferable for the IVU since methylglucamine agents lead to a more intense diuresis, diluting the pyelogram (Benness, 1968). There are probably advantages in retaining the methylglucamine compounds for vascular studies, since

Table 1 Choices of urographic contrast media

Cation (radiolucent)	Anion (radiopaque)
Sodium Methylglucamine Sodium/methylglucamine	Diatrizoate Iothalamate Metrizoate

they appear less irritant to the vessel wall in high concentration (Penry and Livingston, 1972).

The standard urographic preparations contain about 300 mg iodine/ml, but more concentrated compounds are available.

Newer contrast media

The high osmolality of contrast media is generally a disadvantage. Linking two molecules to produce a larger *dimer* results in less fiercely hypertonic agents at no loss of radiopaque iodine atoms, and the use of these compounds is being investigated in uro-radiology (Benness and Glazer, 1973). The theoretical advantages of these compounds await extensive trial by experiment to see if the considerable cost of introducing them can be justified by improved IVUs. Non-ionic compounds are also under investigation (*Acta Radiologica*, 1973). Adherent gelatinous contrast media have been developed, and appear of greatest promise in angiography, where they make for safety and longer lasting images of vessels (Sovak et al, 1973).

Contrast medium dose

Although large doses of contrast media had been used successfully for at least a decade in cardio-angiography, it was only in the early 1960s that this was widely explored in intravenous urography. Following initial enthusiasm for drip infusion techniques it has become clear that it is the contrast medium dose that matters, rather than the method of its administration. A number of centres have arrived at 300 mg iodine/kg body weight, corresponding to 1 ml/kg of many currently available contrast medium preparations, as a good standard dose for patients with normal renal function (Saxton, 1969). In renal failure this dose should be doubled.

Contrast medium excretion

Glomerular filtration is the only important route of renal excretion for urographic contrast media. This was so even with the earlier agents that could be secreted by the renal tubular cell, because with the large doses used, the plasma level of these compounds is far above maximal tubular cell excretory capacity. In addition, present-day contrast media are not handled to any extent by the renal tubular cell (Cattell, 1970).

Glomerular filtration rate, plasma level of contrast medium, and urine flow rate are thus the only important variables bearing on urinary contrast medium concentration. In any IVU there is a close relationship between the contrast medium dose and plasma level (Cattell, 1970). The filtered load delivered to the kidneys is the product of plasma level and glomerular filtration rate. It will be clear that even in renal failure at much reduced filtration rates, it is possible to deliver more contrast medium into the nephron by raising the plasma level, i.e. the dose given. This is the basis of large dose IVU techniques in renal failure.

The diffuse opacification of the whole kidney occurring early in the investigation, the *nephrogram*, is therefore a functional event involving glomerular filtration. It is an *upper nephron event*, in contrast to the pyelogram, which is also determined by the activity of the lower nephron, particularly selective water reabsorption (Sherwood, 1971a).

As a non-reabsorbable solute, the contrast medium acts as an osmotic diuretic. Efficient distension of the upper urinary tract, brought about by this diuretic flood, is an important part of the improved IVUs possible with current contrast medium dosage. A short period of fluid deprivation before the IVU, however, is still to be recommended in *patients with normal renal function*, in order to encourage adequate urinary contrast medium concentration: on average a better IVU will result in this group (Fry et al, 1967; Sherwood et al, 1968). *It must be quite clear that patients in renal failure should never be deprived of fluid in preparation for an IVU.* These patients cannot concentrate their urine, and any misguided attempt in this direction is not only silly but dangerous. There is evidence that the properly conducted IVU presents no greater hazard to patients in renal failure than to the normal individual (Davidson et al, 1970). In reports of sudden further deterioration in renal function following the investigation, prior dehydration can usually be identified as the culprit (Talner, 1972). It is vital that this fact is appreciated by all medical and auxiliary staff concerned in the chain of arranging these examinations for patients in renal failure.

The 'Casualty Officer's IVU'

Before the present era of the IVU, there was little point in performing the investigation in a patient not deprived of fluid. With current techniques there is no need to delay the IVU on this account, when urgent information is required on a patient's urinary tract. The questions asked of such an immediate IVU are limited, and most commonly concern obstruction. For instance in the patient presenting with ureteric colic, a plain film followed by a second film taken 15 min after contrast medium injection (and with the bladder empty) will usually resolve the immediate diagnostic problems: the possibility of a ureteric stone, the severity of obstruction, and the normality of the contralateral kidney. The evidence may be limited, but it is enough for making reasoned plans on the patient's management. A further formal IVU can always be carried out later to investigate any other, less pressing problems not resolved on this two-film immediate examination (Turner Warwick, 1968).

Renal Failure

The IVU is no longer a useless or dangerous investigation in renal failure. Indeed, in acute renal failure it can be regarded as the radiological examination of choice (Fry and Cattell, 1971; Sherwood et al, 1974a). This is because the important questions to be asked of the IVU in renal failure are quite different

from those in the normal. A perfect pyelogram is not needed to make this an informative, valuable investigation. A nephrogram occurs in the great majority of these patients, however severe their renal failure (Fulton, Witten and Wagoner, 1969). It is the nephrogram which can be used for the major objectives of the IVU:

1. to demonstrate site and size of the kidneys,
2. to exclude obstruction,
3. to help with definitive diagnosis of the condition.

1. *Renal size* is generally of major importance to the management of the patient presenting in renal failure. The demonstration of small kidneys will point in the direction of end-stage renal failure and its management. This is a finding that may be seen even when the clinical presentation is of acute renal failure, revealing a perhaps unsuspected acute-on-chronic renal failure state.

Management will clearly be altogether different when kidneys of normal size are shown on the IVU. This should be the signal for a major investigative effort to discover the cause of a potentially reversible renal failure state. The effort may include renal biopsy, when exact knowledge of renal site shown on the IVU will be particularly valuable.

It may be noted that renal size will not discriminate absolutely between acute and chronic renal failure states. There are of course chronic renal failure conditions associated with enlarged kidneys, e.g. polycystic and amyloid disease. Severe chronic renal failure may be accompanied by normal renal size on other occasions, notably in glomerulonephritis, accelerated (malignant) hypertension, and diabetes.

2. The importance of accurate diagnosis of *urinary tract obstruction* can hardly be exaggerated. To miss this reversible cause of renal failure is a tragedy, and the diagnosis should be excluded in every patient. The IVU can do this since a pyelogram will eventually appear in the obstructed patient, outlining distended calices or ureters. It is most important to appreciate that late (at least 24 h) films will be needed for this, and that a nephrogram must have occurred earlier during the IVU. If enough contrast medium has entered the nephron to produce a nephrogram, then this will later outline some part of the obstructed urinary collecting system (Fry and Cattell, 1971; Sherwood et al, 1974a). As in all renal failure IVUs, proper contrast medium dosage and tomograms are essential to catch feeble contrast shadows reliably. The nephrogram itself may make the diagnosis of obstruction by showing the distended calices as regular, radiolucent spaces, or 'negative shadows', within the renal outline.

The exclusion of obstruction is a matter of such importance in renal failure that one should never hesitate to carry out retrograde ureterography (or pyelography) in order to refute or confirm the diagnosis in the doubtful case. It will also be clear that this must always be done in the unusual patient where no nephrogram has been seen at any stage of the IVU: failure to find

an obstructed pyelogram on late films cannot then be relied upon for the exclusion of obstruction. In general, the IVU carries so much more information than retrograde studies that it is the investigation of choice. However, the field is clearly too important to be burdened by fanatic championing of what are often complementary investigations.

3. On occasion a *definitive diagnosis* can be reached, as by the characteristic patchy nephrogram occurring in renal failure due to polycystic disease. Acute oliguric renal failure linked with the histological diagnosis of tubular necrosis is of particular interest here. The occurrence of an immediate dense nephrogram in this condition is a remarkable finding, pointing to persisting glomerular filtration in this state, and raising interesting questions on the mechanism of the oliguria. It is now clear that this is a characteristic but not pathognomonic finding, which may also be seen with other causes of acute renal failure (Sherwood et al, 1974a). However, it should still be a signal for regarding such a patient as suffering from a potentially recoverable acute renal failure state, till proven otherwise.

ANTEGRADE PYELOGRAPHY

There has been a revival of interest in the percutaneous techniques of needle pyelography and needle nephrostomy, first put forward some 25 years ago (Sherwood and Stevenson, 1972). The establishment of renal biopsy as a relatively safe investigation has helped to encourage these much less hazardous procedures. For antegrade pyelography in particular a fine needle can be used as for lumbar puncture, with very little risk.

The classical indication for antegrade pyelography is the combination of inadequate information from the IVU with an unsuccessful or impossible retrograde examination. With care the indications can be widened considerably, so that in selected cases antegrade pyelograms are performed electively, in preference to retrograde studies. Advantages are that these are quite short examinations under local anaesthesia, with sterility as good as in any lumbar puncture. They should always be done under fluoroscopy. In this way each step of the procedure can be monitored directly, making for consistent success and safety.

The antegrade pyelogram is of most obvious value in the accurate diagnosis of obstruction. The distended pelvi-caliceal system forms a ready target, and successful needling of an obstructed kidney is generally possible even in the absence of any helpful caliceal opacification following intravenous contrast medium injection. However, the procedure should not be undertaken 'blind' from surface markings alone, since careful fluoroscopy, particularly in conjunction with the plain film showing the renal outline, remains valuable even in this situation. In general, it is preferable to puncture a calix rather than the renal pelvis, since there will then be a better seal (by renal parenchyma) round the needle track, and less danger of puncturing large hilar vessels.

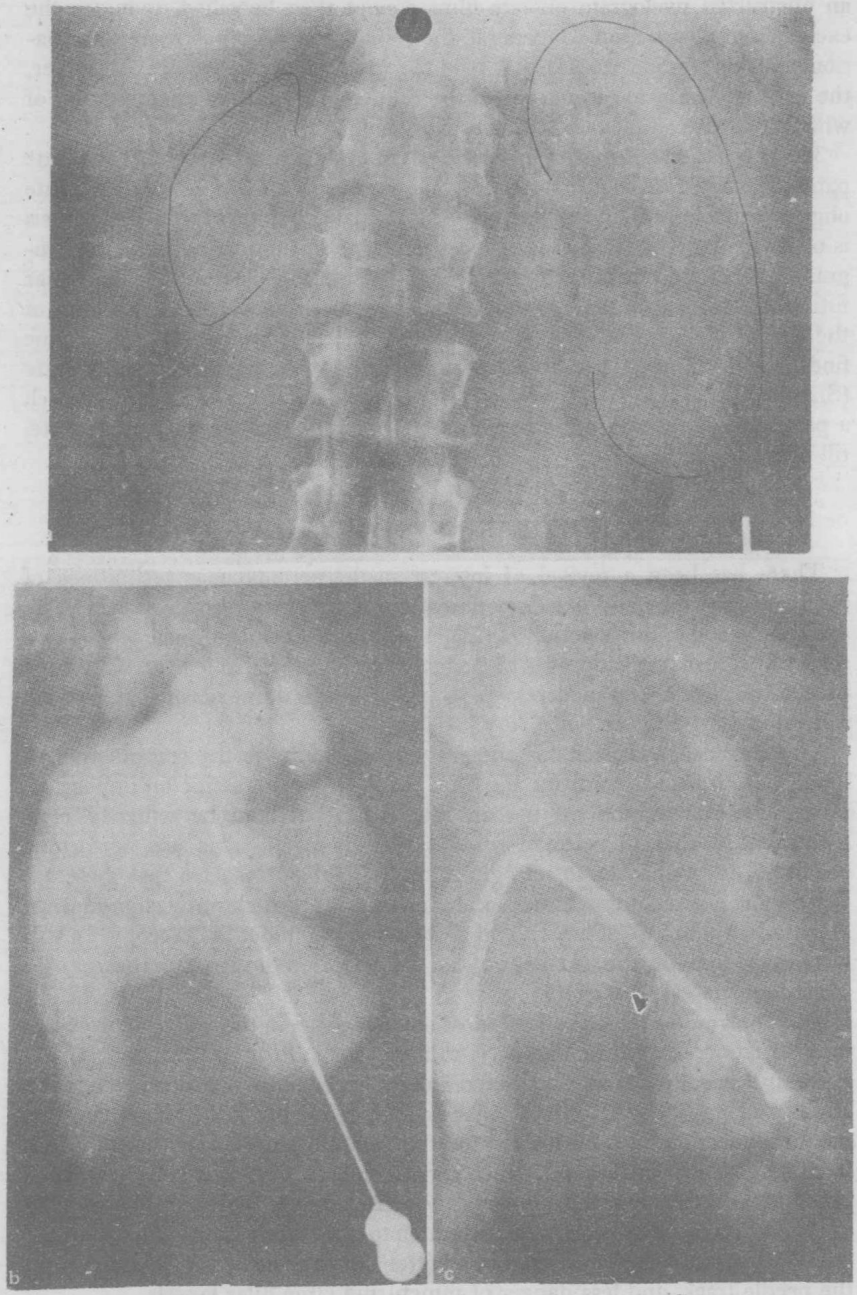

Figure 1

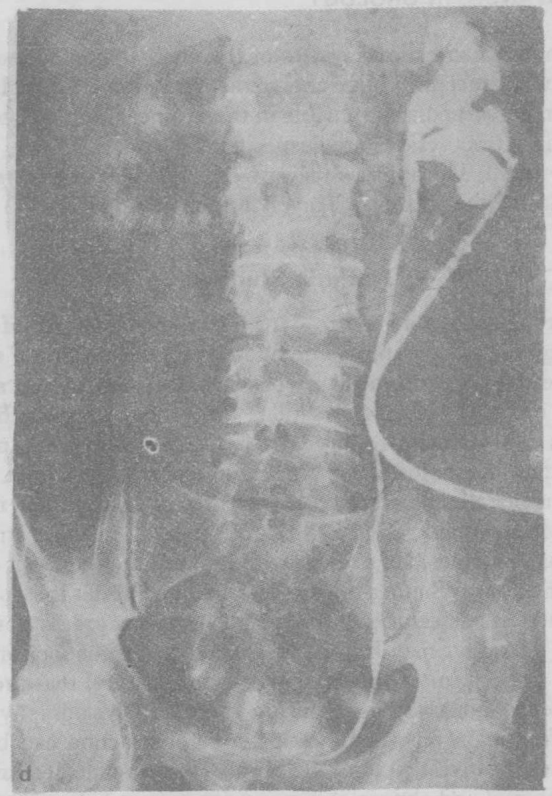

Figure 1a A patient admitted in acute renal failure shows a small right, and a large left kidney. There is a distant history of passing stones, but no radiopaque calculi can now be seen
Figure 1b Antegrade pyelogram: needling of the large left kidney shows the distended obstructed pelvi-caliceal system, with contrast medium arrested in the upper ureter. Note that the needle enters a calix, not the renal pelvis directly
Figure 1c A percutaneous teflon catheter has been inserted over the puncturing needle, and will be left here. The obstructed kidney can now drain freely—it is the patient's only serviceable one
Figure 1d Five days later the patient's uraemia has improved, and a preoperative nephrostogram through the same teflon drain shows the radiolucent material obstructing the left upper ureter. Note also contrast medium in the large gut, derived from extrarenal excretion in renal failure following the admission IVU. At operation uric acid stones were removed from the left ureter

A further attraction of this diagnostic approach to the obstructed kidney is that it can be combined with a temporary percutaneous drainage procedure (Saxton, Ogg and Cameron, 1972). For the sick patient, in severe renal failure because of his urinary tract obstruction, such a needle nephrostomy can be very helpful in allowing a recovery period of free urinary drainage. Definitive surgery can then be planned as an elective procedure in a more fit patient (Fig. 1).

The undistended pelvi-caliceal system of the unobstructed kidney can also be punctured with success. Such antegrade pyelograms are a little more difficult, but can be particularly valuable in the urothelial tumour field, where new upper urinary tract lesions are suspected (Sherwood, 1971b; Sherwood and Stevenson, 1972). The approach always calls for close clinico-radiological cooperation, with further teamwork involving the pathologist.

Dynamic Studies

The breakthrough into clinical uro-dynamic studies has been of particular promise in antegrade pyelography. The finding of a dilated ureter should not automatically lead to the diagnosis of obstruction, even in the absence of vesico-ureteric reflux. In simple situations the problem of whether an obstruction exists can often be resolved by a standard antegrade pyelogram, observing transport of a bolus of contrast medium down the ureter. However, simple situations not already resolved by the IVU are rare in this field. Even the definition of obstruction is complex, and generally involves structural as well as functional disarrays, i.e. a lesion with reduced flow across it and raised pressure proximal to it. Whether the cause of a dilated ureter is an obstruction or an intrinsic ureteric defect is clearly a question of great practical importance in surgery. An operation may be essential in the one situation, and of very doubtful value, at best, in the other. It is therefore natural that pressure and flow measurements should be used during antegrade pyelography to obtain quantitative information on which any possible obstruction can be gauged. Whilst this makes the investigation a little more cumbersome, it allows a much better view of normal and abnormal upper urinary tract behaviour. Whitaker (1973) has described a technique of stressing the ureteric transport mechanism by very high flow rates during the procedure. The normal pelvis and ureter can cope with this without abnormal pressure rises, in contrast to the obstructed upper urinary tract. This is work in progress, and part of the present task is still to define the range of normal in such techniques. Naturally there are problems and uncertainties at this stage, but there appears little doubt that dynamic antegrade pyelography studies open-up a new understanding of the upper urinary tract in health and disease (Sherwood, Doyle and Williams, 1974b).

THE RENAL MASS PROBLEM

As IVUs have improved, many more renal lesions are being discovered, often as chance findings. Two decades ago the advice that every renal mass should be explored was obviously wise and proper: the discovery of such lesions was usually prompted by relevant symptoms, and there were hardly any reliable preoperative criteria to lead to the diagnosis of an innocent mass. In the developed countries this situation is now altogether changed. The most

common reason for finding a renal mass is an IVU performed for other symptoms, in men most usually for bladder outflow obstruction. The prevalence of the innocent lesions so found, commonly renal cysts in the elderly, is very high, and needless morbidity and mortality are inevitable if all such lesions are to be explored. Examination by ultrasound scanning, angiography and renal puncture is establishing diagnostic grounds for well founded advice for or against surgery.

Diagnostic plan

When a renal mass is discovered on the IVU, appearances may rarely be highly characteristic, allowing a confident diagnosis at this stage. An example is diffuse central calcification in the mass, making a renal carcinoma extremely likely (Daniel et al, 1972). Further investigative steps may then still be indicated, e.g. angiography directed particularly at demonstrating a normal contralateral kidney and liver, lymphography, etc. A chest film must of course never be forgotten. However, there is no major diagnostic problem, and further investigation serves to delineate more accurately the surgical attack already demanded by the IVU.

Much more commonly, there is no more than a hint as to the likely nature of the lesion on the IVU. *Nephrotomograms* are particularly valuable to this end, and could be carried out in a further examination, if not done on first discovery of the mass.

Ultrasound examination is the next step (Table 2). The development of this non-invasive and harmless technique is making major contributions to this field (Barnett and Morley, 1972; Leopold et al, 1973). It is most important, however, to appreciate that, as in every other investigation, there is a diag-

Table 2 Investigation of renal masses