Clinical applications of renal arteriography

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Introduction

THE FIELD OF UROLOGY is unique in that practically every part of the urinary system usually can be adequately visualised, either by direct instrumentation or X-ray contrast studies. Intravenous urography, however, is often limited in that it outlines only the pelvi-calyceal system, and lesions in the renal parenchyma must be inferred from it. When the kidney is not functioning, intravenous urography may contribute little to the precise diagnosis of the lesion. Retrograde pyelography usually does not add much to what can be seen on intravenous urogram and in obstructive conditions may be contraindicated. Renal arteriography is an invaluable addition to the radiodiagnostic techniques in urology, as a study of the vascular pattern in the renal parenchyma may contribute to a more precise and confident diagnosis beyond what is usually possible by intravenous urography.

Technique

The technique used is that of percutaneous transfemoral catheterisation. The procedure is performed under local anaesthesia on the sedated patient. The use of image-intensifier-television control provides the improved visualisation required for selective arteriography, and also minimises total screening time. Rapid serial filming of adequate duration permits detailed sequential study of the entire renal circulation, including the venous phase which is of particular interest in the angiographic evaluation of renal tumours.

In general, two methods are available:

(1) Selective renal arteriography

(2) Aortography.

(1) Selective Renal Arteriography

This provides the best demonstration of the intrarenal vascular pattern, unobscured by overlying branches of the abdominal aorta. It is therefore the preferred method.

(2) Aortography

Preliminary aortography has the following advantages:

(a) Demonstration of multiple renal arteries will require the selective injection of each artery, in turn or simultaneously, for complete visualisation of the intrarenal vascular pattern.

(b) Demonstration of displacement and distortion of the renal artery by a large tumour mass will influence the choice of a suitable catheter shape.

(c) Where doubt exists as to the renal origin of a retroperitoneal tumour, demonstration of its vascular supply by an aortic injection will ascertain the appropriate artery to catheterise.

(d) Demonstration of an unsuspected lesion in the contralateral kidney.

We do not feel, however, that these advantages justify the routine performance of preliminary aortography in all patients. With few exceptions, our own practice has been to proceed with initial selective renal arteriography, followed by aortography only where indicated, or occasionally when attempted selective catheterisation of the renal artery has been unsuccessful.

There is little place for aortography alone.

Arteriographic Findings

The value of arteriography lies in:

(1) demonstrating the presence, or otherwise, of a space-occupying lesion when evidence on plain abdominal film and on excretory urography is inconclusive;

(2) determining whether a tumour, already demonstrated on urography, is benign or malignant;

(3) assessing the operability of an established malignant lesion;

(4) eliciting the nature of a kidney lesion, the diagnosis of which may be totally unexpected, and

(5) delineating a retroperitoneal mass when there is doubt as to whether it is renal or extrarenal.

The following cases are presented to illustrate the applications of renal arteriography.

(1) Tumour Or No Tumour?

Case 1 (Figure 1)

A 33-year-old male Chinese presented with right loin pain, dysuria and hematuria of one week's duration. Physical examination revealed no abnormal findings. Intravenous urography showed a definite bulge of the upper outer quadrant of the left renal contour. The underlying calyces, however, did not appear to be displaced or distorted. A superficial subcapsular tumour was considered. On selective left renal arterio-

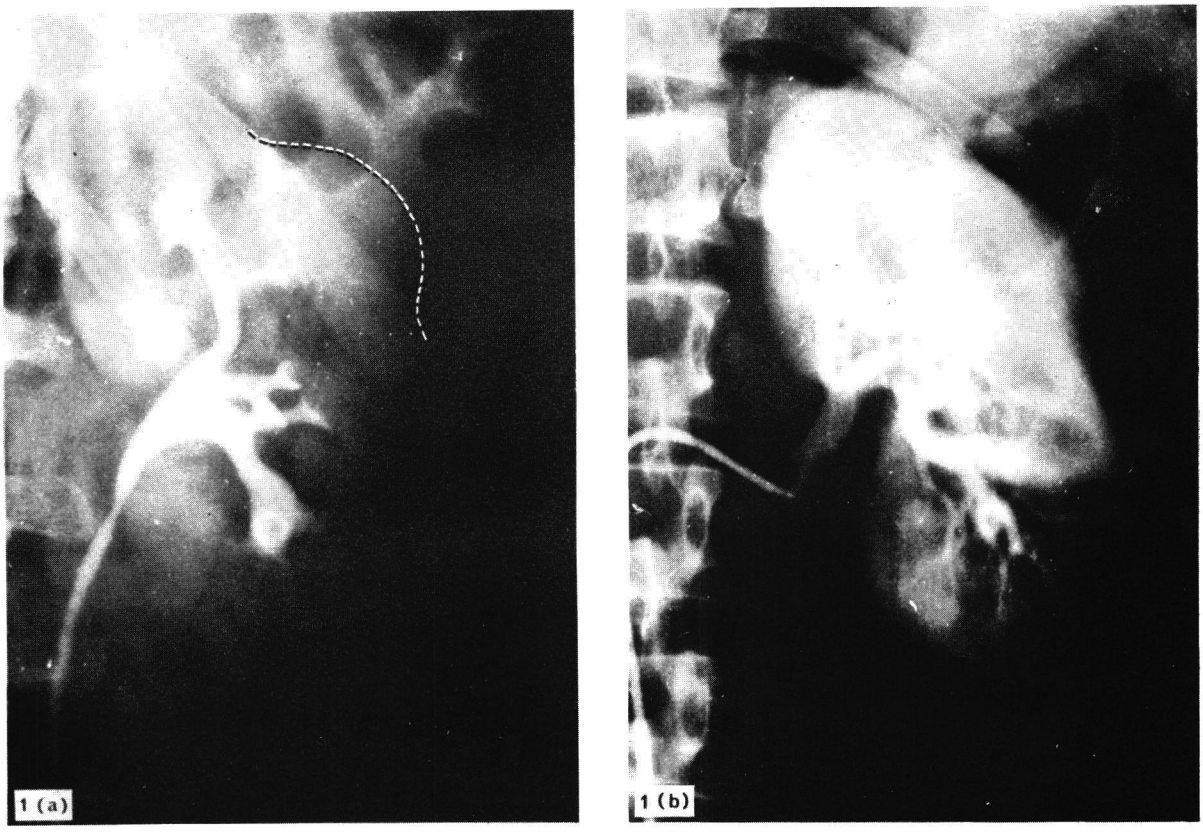


Fig. 1: (a) Intravenous pyelogram shows bulge of upper outer quadrant of left renal contour with normal pelvi-calyceal pattern, suggesting a superficial subcapsular tumour. (b) Renal arteriogram demonstrates normal left kidney with unusually prominent cortical lobulation.

gram, there was no evidence of tumour. The abnormal outline of the left kidney was seen to be due to an unusually prominent cortical lobulation. Subsequently, the patient's urine cleared and his symptoms subsided. The final diagnosis was urinary tract infection. In the absence of renal arteriography, surgical exploration of the right kidney would have had to be undertaken on the basis of his initial symptoms, urinary findings and intravenous pyelogram.

(2) Benign Or Malignant?

Case 2 (Figure 2)

A 69-year-old male patient was admitted with prostatomegaly. An intravenous urogram, carried out as part of his preoperative evaluation, showed stretching and displacement of the upper calyces of the left kidney suggesting the presence of a mass. Selective left renal arteriogram showed an avascular, round mass, measuring 4 cm. in diameter, in the middle third of the left kidney. This was sharply demarcated from the surrounding normal parenchyma and had the typical appearance of a benign renal cyst. A similar lesion was present in the lower pole. No operation on the kidney was required. The management of this patient was thus simplified.

Case 3 (Figure 3)

A 51-year-old male Chinese complained of intermittent left loin pain of seven months' duration, not associated with hematuria. Plain abdominal film and intravenous urography showed a left renal calculus and a mass in the upper pole of the left kidney. Selective left renal arteriogram demonstrated this to be a large avascular mass. The sharp demarcation between the renal parenchyma and the mass gave the 'shoulder' appearance typical of a benign renal cyst. At operation for the left renal calculus, the diagnosis of renal cyst was confirmed. Pyelolithotomy afforded the opportunity to confirm the arteriographic findings. Surgery would not have been undertaken for the mass alone, as the diagnosis of renal cyst was firmly established on arteriography.

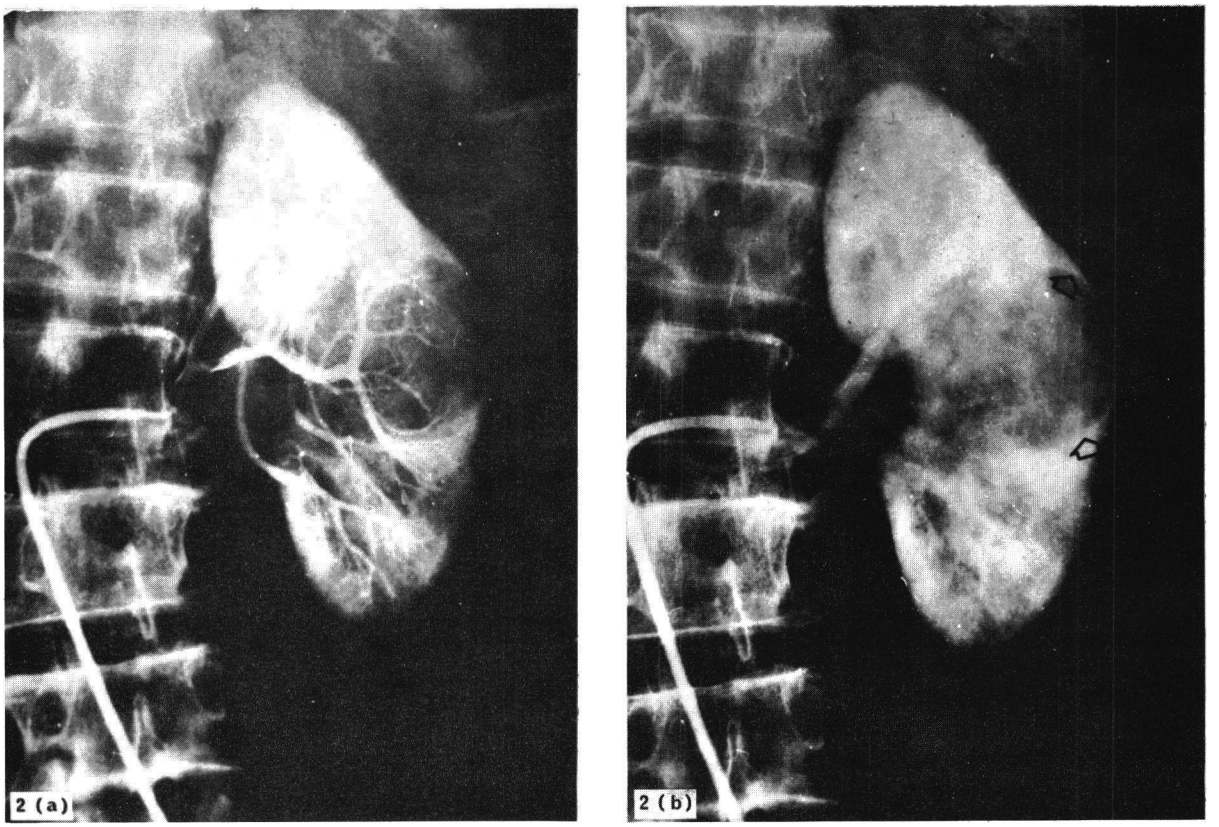
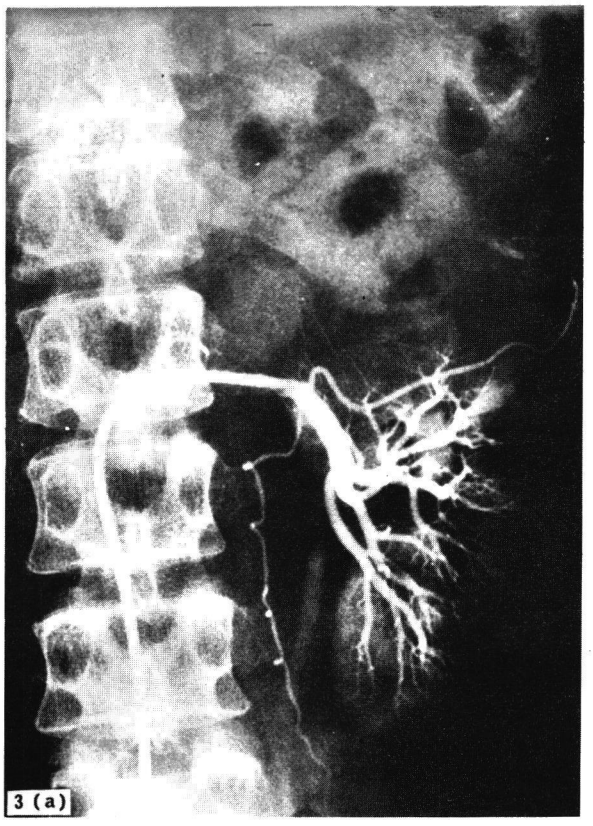


Fig. 2: Left renal arteriogram: (a) arterial, and (b) nephrogram phases showing typical appearance of renal cyst. (arrows)



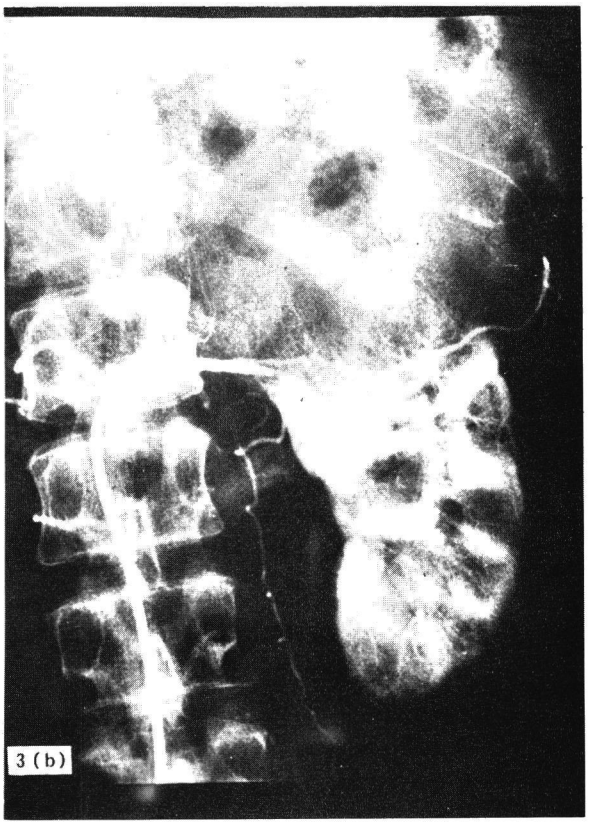


Fig. 3: Left renal arteriogram: (a) arterial, and (b) nephrogram phases showing avascular mass in upper pole of left kidney. Diagnosis of renal cyst was confirmed at pyelo-lithotomy.

Case 4 (Figure 4)

A 16-year-old Indian boy complained of swelling in the left side of his abdomen since childhood and intermittent left loin pain for the past four years. There was no dysuria nor hematuria. Physical examination revealed a smooth, cystic, non-tender mass in the left flank. On intravenous urography, there was a large mass in the lower half of the left kidney causing displacement, deformity and dilatation of the left pelvicalyceal system. Renal arteriography showed this to be an avascular mass, suggestive of a large renal cyst. At laparotomy, a complete duplex left kidney was found. The upper segment was normal, but the lower half consisted of a large hydronephrotic sac, filled with infected urine. The cause of the hydronephrosis was not apparent. Excision of the hydronephrotic portion was carried out. In this case, arteriography did not significantly contribute to the diagnosis or influence the management.

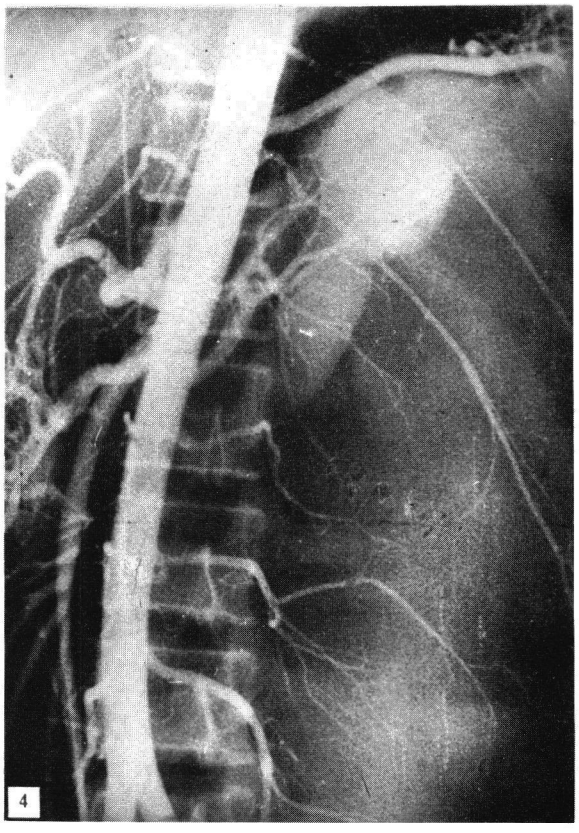


Fig. 4: Aortogram shows large avascular mass in lower pole of left kidney, causing displacement of aorta and left renal artery. Excreted contrast material delineates upper collecting system which is also displaced. Laparotomy revealed duplex left kidney, with normal upper segment and hydronephrotic lower segment.

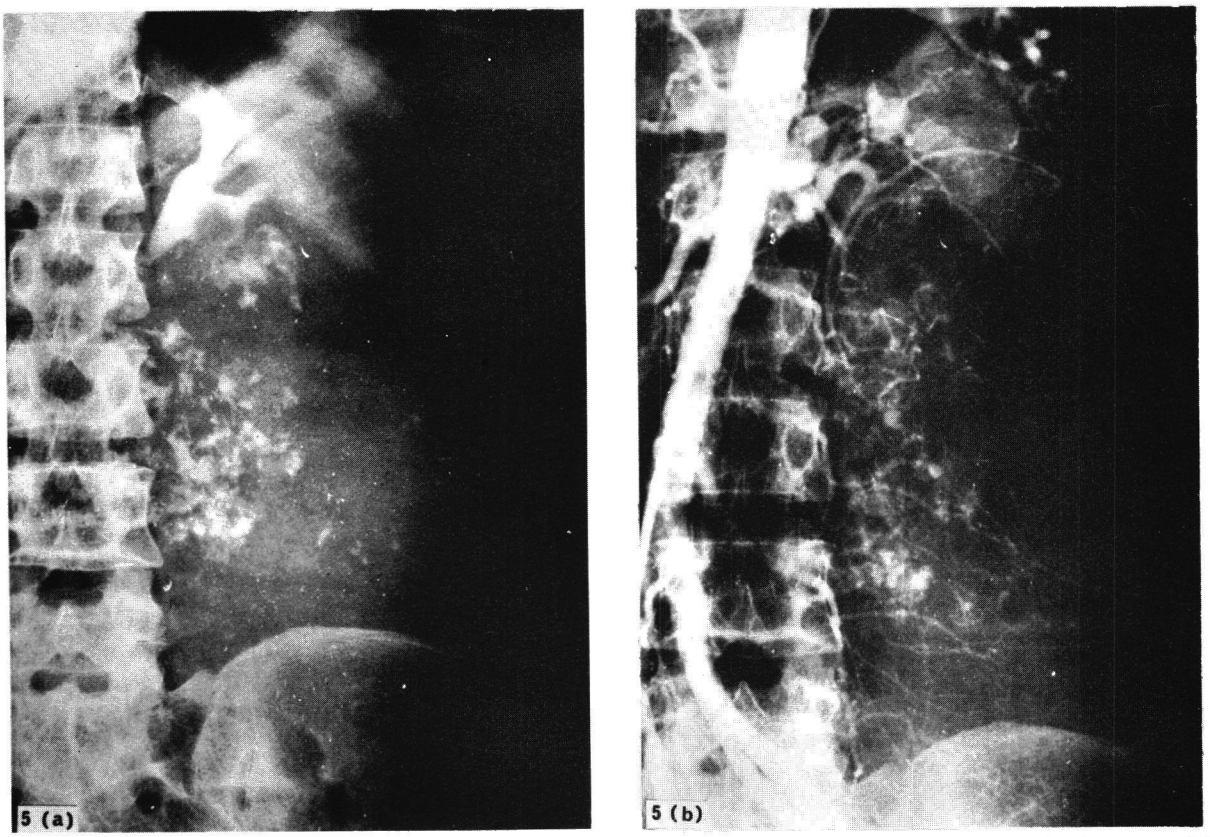


Fig. 5: (a) Intravenous pyelogram shows large mass with irregular calcification occupying lower half of left kidney. (b) Aortogram shows relatively avascular lesion, but presence of numerous abnormal tortuous vessels suggests malignancy. Histopathology of nephrectomy specimen was that of clear cell carcinoma.

Case 5 (Figure 5)

A 41-year-old Malay housewife complained of a mass in the left side of her abdomen for the past 12 years, which had progressively increased in size. In the past four months, she had had four episodes of painless hematuria. Physical examination disclosed a left upper quadrant mass which was hard, non-tender and ballotable. Plain abdominal film and intravenous urogram showed a large mass in the lower half of the left kidney, containing areas of irregular calcification. Aortography showed a large partially calcified mass in the lower pole of the left kidney, displacing the abdominal aorta and its branches across the mid-line and distorting the left renal artery. The intrarenal arterial branches supplying the lower pole were markedly stretched. The mass was relatively avascular and well-demarcated from the adjoining normal parenchyma, but the presence of numerous abnormal tortuous vessels in some areas suggested malignancy. At laparotomy, there was a large tumor of the lower pole of the left kidney, easily separated from the retroperitoneal tissues. Left nephrectomy with partial adrenalectomy was performed. Histological examination showed it was a clear cell carcinoma of the kidney.

(3) Operable or Inoperable?

Case 6 (Figure 6)

A 58-year-old male Chinese presented with pain and swelling of the right flank of one-and-a-half months' duration, not associated with hematuria. He had noticed marked weight loss for the past four months. On physical examination, he was emaciated and ill-looking. There was a firm mass in his right flank, measuring about 8 ins x 4 ins. Intravenous urography showed a non-functioning right kidney, with a mass in its lower pole. Selective renal arteriography showed a vascular tumour, with distinctly abnormal vessels, occupying the upper pole and mid-portion of the right kidney, highly suggestive of a carcinoma.

There was early filling of the inferior vena cava which was occluded at the level of the renal hilum. Collateral flow through the lumbar veins was noted. Aortogram showed tumor vessels in the suprarenal area displacing the aorta towards the left side and stretching the right renal artery. Invasion of the inferior vena cava indicated that the tumor was inoperable. The patient subsequently left the hospital against medical advice.

(4) Unsuspected Diagnosis

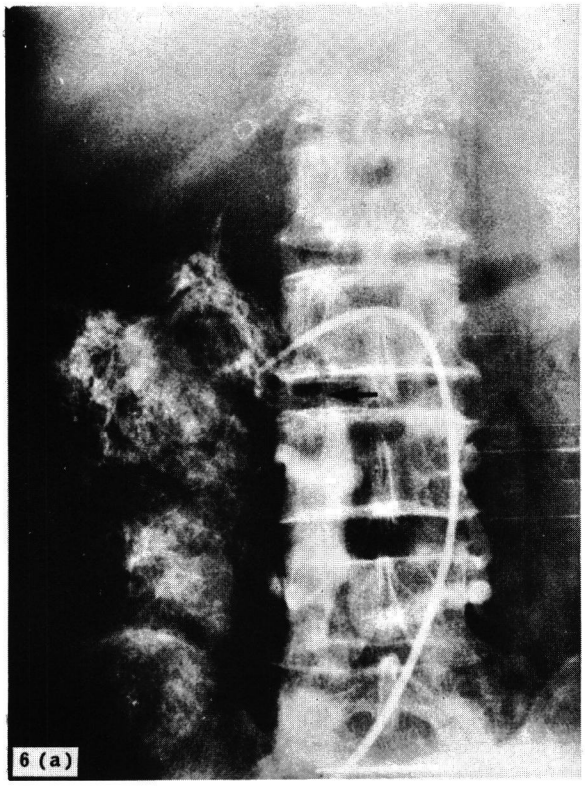
Case 7 (Figure 7)

A 24-year-old Chinese housewife presented with a 4-week history of intermittent right loin pain, not associated with dysuria or hematuria. On physical examination, the right kidney was palpable and markedly tender. Intravenous urography showed enlargement of the right renal contour, with displacement and compression of the pelvi-ureteric junction. Selective renal arteriography was undertaken with the diagnosis of renal tumor in mind. This revealed a fracture of the right renal cortex, extending from the margin of the upper pole to one of the superior minor calyces. There was a large non-opacified mass surrounding the posterior and lateral aspects of the lower half of the right kidney due to a subcapsular hematoma. The renal parenchyma was displaced medially with some kinking at the pelvi-ureteric junction. Direct questioning of the patient elicited the reluctant admission that she had injured her right flank four weeks previously as a result of an accidental fall down a staircase. In view of the localised extent of the renal injury and continuing clinical improvement while being investigated in the ward, conservative management with treatment of urinary tract infection was carried out. The patient was well when discharged.

(5) Renal Or Extrarenal?

Case 8 (Figure 8)

An 18-year-old Chinese girl presented with right upper quadrant pain of two years' duration. There



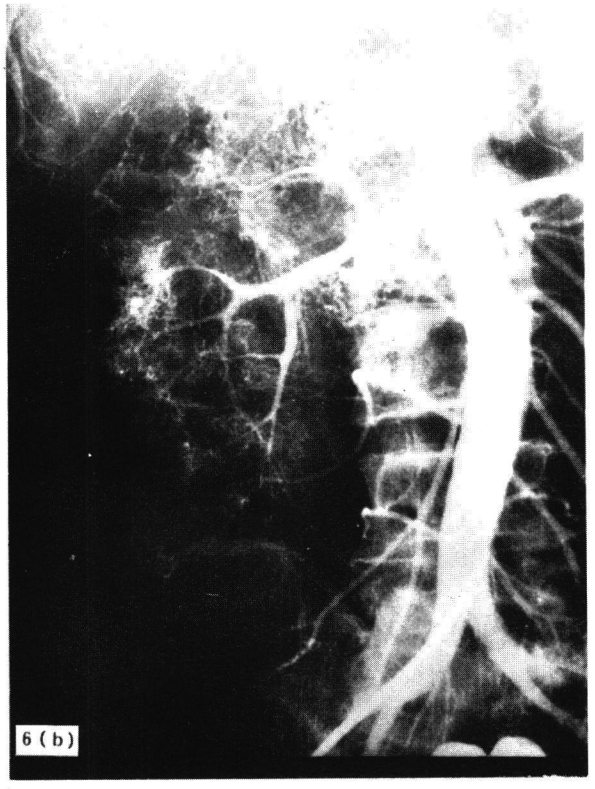


Fig. 6: (a) Selective renal arteriogram shows highly vascular tumour in upper pole and mid-portion of right kidney. Appearances are consistent with renal carcinoma. Invasion of inferior vena cava (arrow) indicates that lesion is inoperable. (b) Aortogram shows extensive involvement of suprarenal area.

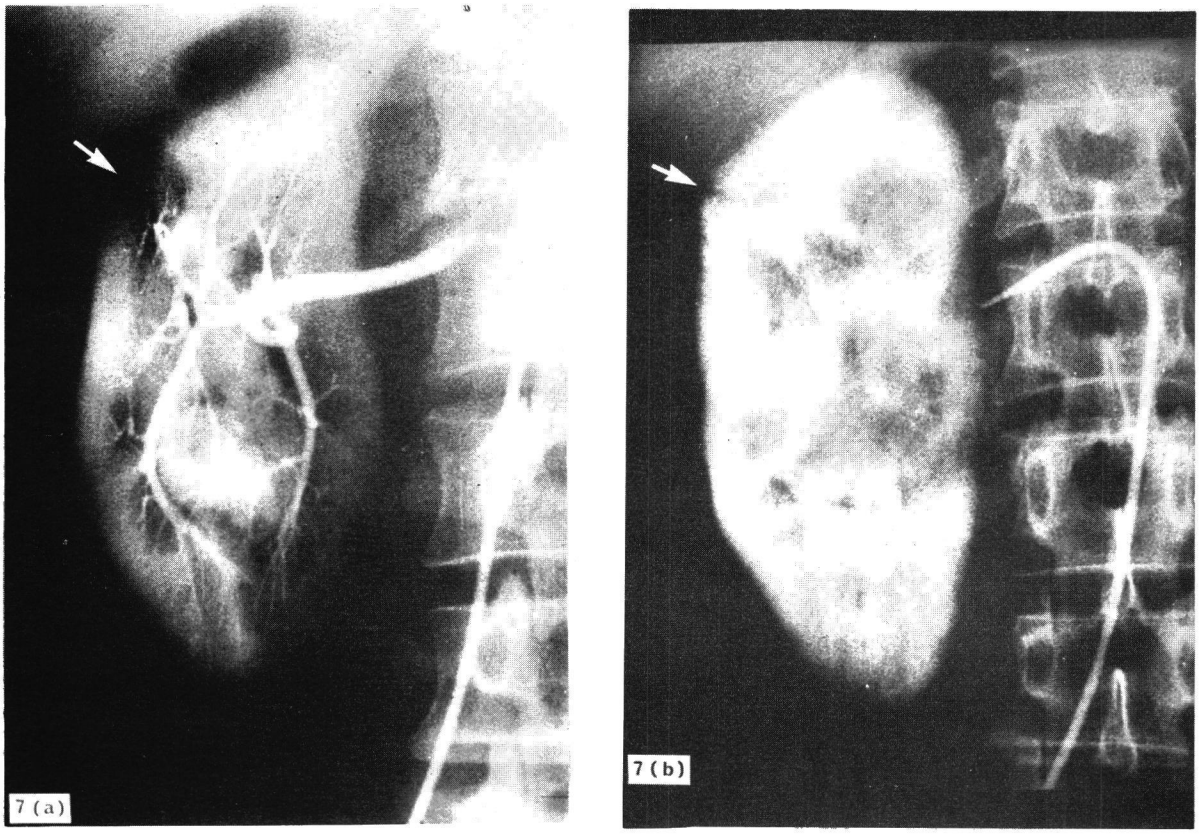


Fig. 7: Right renal arteriogram: (a) arterial and (b) nephrogram phases showing renal fracture (arrow) extending from outer margin of upper pole to superior minor calyx. The diagnosis was not suspected on intravenous pyelography.

was no dysuria or hematuria. Physical examination revealed a tender right abdominal mass. An abdominal film and intravenous urogram showed a mass in relation to the lower pole of the right kidney, containing areas of irregular calcification. A selective right renal arteriogram demonstrated that the mass was extra-parenchymal, and derived its blood supply mainly from tortuous capsular branches of the ventral division of the main renal artery. The aortographic appearance suggested that this was either a capsular tumor or a retroperitoneal tumor, involving the renal capsule. Although no tumor circulation was shown, the vascular pattern was that of a solid lesion, and malignancy could not therefore be excluded. Laparotomy revealed a discoid mass, measuring 8 x 6 x 2 cm., adherent to the posterior abdominal wall and the posterior surface of the right kidney. The renal capsule was involved in the mass, but the kidney itself was normal. The lesion was not resected. A biopsy revealed benign fibrous adipose tissue with focal chronic non-specific inflammatory changes, and no evidence of neoplasia. The histopathology was thought to be consistent with retroperitoneal fibroma or retroperitoneal fasciitis.

Discussion

The majority of urological conditions can be accurately diagnosed on the basis of history, physical examination, common laboratory tests, cystoscopy and the usual radiological studies. In the case of renal lesions, however, in many instances the clinician is left with considerable doubt as to the precise diagnosis or as to whether operative treatment is indicated. It is in these doubtful situations that renal arteriography finds its place. The renal arteries down to the fine branches can normally be outlined, or the renal parenchyma may be rendered opacified so that a non-functioning area, such as might be caused by a cyst, stands out in clear contrast.

The diagnosis of space-occupying lesion in the kidney is usually made with assurance when it is possible to demonstrate enlargement and deformity of the re-

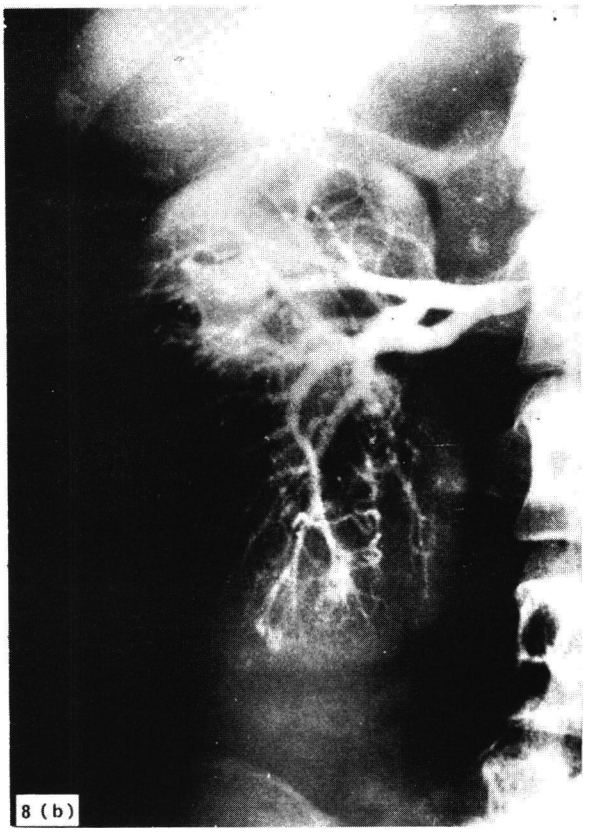


Fig. 8: (a) Intravenous pyelogram shows irregularly calcified mass in relation to lower pole of right kidney. (b) Renal arteriogram demonstrates that tumour is extraparenchymal.

(c) Selective injection of ventral division of main renal artery demonstrates that blood supply of tumour is derived from tortuous capsular branches.

Histopathology was thought to be consistent with retroperitoneal fibroma or retroperitoneal fasciitis.

nal contour in addition to displacement and distortion of the pelvi-calyceal system on intravenous urography. Nevertheless, the pelvi-calyceal system may not be affected by a superficial subcapsular lesion, and on the other hand, a small central lesion may cause no deformity of the renal contour. In these situations, the plaguing question of whether to operate or not to operate can be resolved by arteriography. This point is illustrated by Case 1, where a bulge of the renal contour proved to be a prominent cortical lobulation. Pseudotumours such as this may result from focal hypertrophy of residual tissue in diseased kidneys which have suffered extensive parenchymal damage from trauma, pyelonephritis or in-

farction , or they may be caused by developmental variations.

When the diagnosis of a space-occupying renal lesion is established, the question of immediate concern to both the clinician and the patient is whether it is benign or malignant. There is no difficulty in the differential diagnosis when evidence of calyceal destruction is apparent on intravenous urogram or when metastases are obvious clinically or radiologically. In many instances, however, the diagnosis of malignancy can be established or excluded only by recourse to arteriography. Cases 2, 3, 4 and 5 clearly illustrate this point.

In a recent review of 100 patients with renal carcinoma who had been submitted to arteriography, Watson and his colleagues reported a diagnostic accuracy rate of 97%. High diagnostic accuracy rates by arteriography have previously been reported by Edsman, Boijsen and Folin. The arteriographic diagnosis of renal carcinoma depends upon the finding of abnormal tumor or 'pathological' vessels, in addition to vessel displacement and distortion. These abnormal vessels are dilated, irregular and tortuous, and may be associated with a diffuse tumor 'blush', contrast pooling, microaneurysms, and arterio-venous fistulae resulting in early venous filling. Difficulty in diagnosis may arise in the small group of poorly vascular or avascular lesions, many of which appear to be cystic. Suspicious features include: (1) the presence of poorly defined marginal lips where the mass, if peripheral, protrudes through the cortex, and (2) thickness of the wall which, in benign cysts, is paper-thin. The technique of cyst puncture has been advocated as being of value in these cases. We have had no experience with this procedure.

Occasionally, renal arteriography carried out to further delineate a presumed condition reveals a totally unsuspected diagnosis. This is illustrated in the case of renal fracture (Case 7). A kidney mass adherent to or infiltrating the surrounding retroperitoneal tissues may not move with respiration on physical examination. Where there is doubt as to the exact location of a retroperitoneal mass in the kidney region, renal arteriography can be of help (Case 8).

Summary

(1) The technique of renal arteriography is briefly described. Cases are presented to illustrate the various clinical applications of renal arteriography.

(2) The place of renal arteriography in urological diagnosis is discussed.

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