Renal imaging

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Abstract

The renal tract is investigated in the assessment of abnormal renal function, hypertension, renal colic or haematuria. Increasing use of ultrasound (US) and computed tomography (CT) has limited the role of plain radiographs, but these are still used in the initial assessment of abdominal colic to evaluate potential renal or bowel abnormalities. Intravenous urography — radiological examination of the urinary tract performed following the intravenous injection of iodinated contrast — is the classical means by which to assess the kidneys and ureters. US is often the first imaging modality used to interrogate and follow up renal abnormalities. CT can be useful to evaluate renal masses and determine the site of ureteric obstruction by calculi. Magnetic resonance imaging (MRI) is primarily used to assess the renal arteries in patients with suspected renal artery stenosis. CT and MRI can provide images of exceptional detail and resolution beyond the capability of other modalities, and are thus often used to characterize and follow renal masses; in addition, images can be obtained in multiple planes. Radionuclide scans can be helpful in the evaluation of renal tract obstruction and provide a functional assessment of the renal tract.

Keywords computed tomography; KUB; magnetic resonance imaging; renal angiogram; renal biopsy; renal imaging

Indications

Abnormal renal function is the most common indication for renal imaging. Other indications include renal colic, haematuria and the investigation of hypertension where a renal vascular cause is suspected (renal artery stenosis).

Plain abdominal radiographs

The increasing use of ultrasound (US) and computed tomography (CT) has limited the use of plain radiographs, but they still have a role in the management of the acute abdomen. The kidney-ureter-bladder (KUB) radiograph may demonstrate urinary stones. However, approximately 10% of urinary stones are undetectable by plain radiography because they are not radio-opaque, and some urinary stones may also be obscured by overlying bowel gas. In the pelvis, phleboliths (calcified venous thrombosis) may be mistaken for ureteric stones. Phleboliths typically have a relatively radiolucent centre, which helps to differentiate them from urinary stones. If it is difficult to differentiate between a phlebolith and ureteric calculus, then an intravenous urogram (IVU) or a CT scan will help.

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Intravenous urography

IVU is performed following intravenous injection of iodinated contrast medium and serial radiographs are taken to follow the progress of contrast within the urinary tract. The initial nephrographic phase (when the contrast is in the renal parenchyma) confirms the glomeruli are filtering blood (and hence excreting contrast). This phase may help to confirm the intrarenal location of a calculus projected over the renal outline on the KUB. Focal lesions, such as cysts and tumours in the renal parenchyma, may be apparent during this phase. The subsequent urographic phase will identify calculi or urothelial tumours in the renal pelvis and ureters, and help in the assessment of urinary obstruction. The delay in passage of contrast into the renal pelvis and ureter (persistent nephrographic phase), if unilateral, is a sign of obstruction; bilateral delay implies a systemic cause, such as poor kidney perfusion or function. IVU will also aid in the detection of congenital abnormalities of the urinary system, such as horseshoe kidney, ureteric duplication and ureteroceles. IVU is contraindicated in patients with contrast allergy and in pregnant women. Adequate visualization of the renal pelvicalyceal system and upper ureters often requires abdominal compression during the IVU examination and this is contraindicated in patients with abdominal pain and abdominal aortic aneurysms.

Advantages: IVU can help to distinguish a collecting system dilated because of current obstruction from one showing residual dilatation as a result of previous obstruction.

Disadvantages: IVU requires intravenous contrast administration and the radiation dose is 2.5 times that of a chest radiograph. It may not be possible to delineate the specific nature of a space-occupying lesion of the renal tract demonstrated on IVU. Ultrasound may be required to differentiate a renal cyst from a tumour. A non-radio-opaque calculus can produce a negative filling defect within the contrast-filled collecting system similar to a urothelial tumour.

Ultrasound

The use of US in the assessment and follow-up of renal disease has become widespread chiefly because of the absence of exposure to radiation and its easy availability. An urgent US examination is indicated in the assessment of new-onset renal failure to exclude urinary obstruction, especially in the context of sepsis (Figure 1). If urinary obstruction is detected as hydronephrosis and/or hydroureter, an image-guided nephrostomy is often appropriate to relieve urinary obstruction and preserve renal function (Figure 2). In chronic renal failure, the kidneys may be small (normal size 10—12 cm) and hyperechoic. Asymmetry in renal size may suggest renal artery stenosis and Doppler interrogation of the renal artery may confirm this. Focal renal scarring could be evidence of previous pyelonephritis or focal renal ischaemia. Renal stones can be visualized, even if they are not radio-opaque. Simple renal cysts can be confidently diagnosed with US, whereas alternative imaging, such as CT or magnetic resonance imaging (MRI), will be required to exclude malignancy in atypical cysts (cysts other than thin-walled, unilocular fluid-filled cysts, such as multi-loculated cysts and cysts containing solid components). Further assessment of suspicious renal lesions is now also possible with contrast-enhanced renal US. In cases of renal trauma, a perinephric haematoma can be

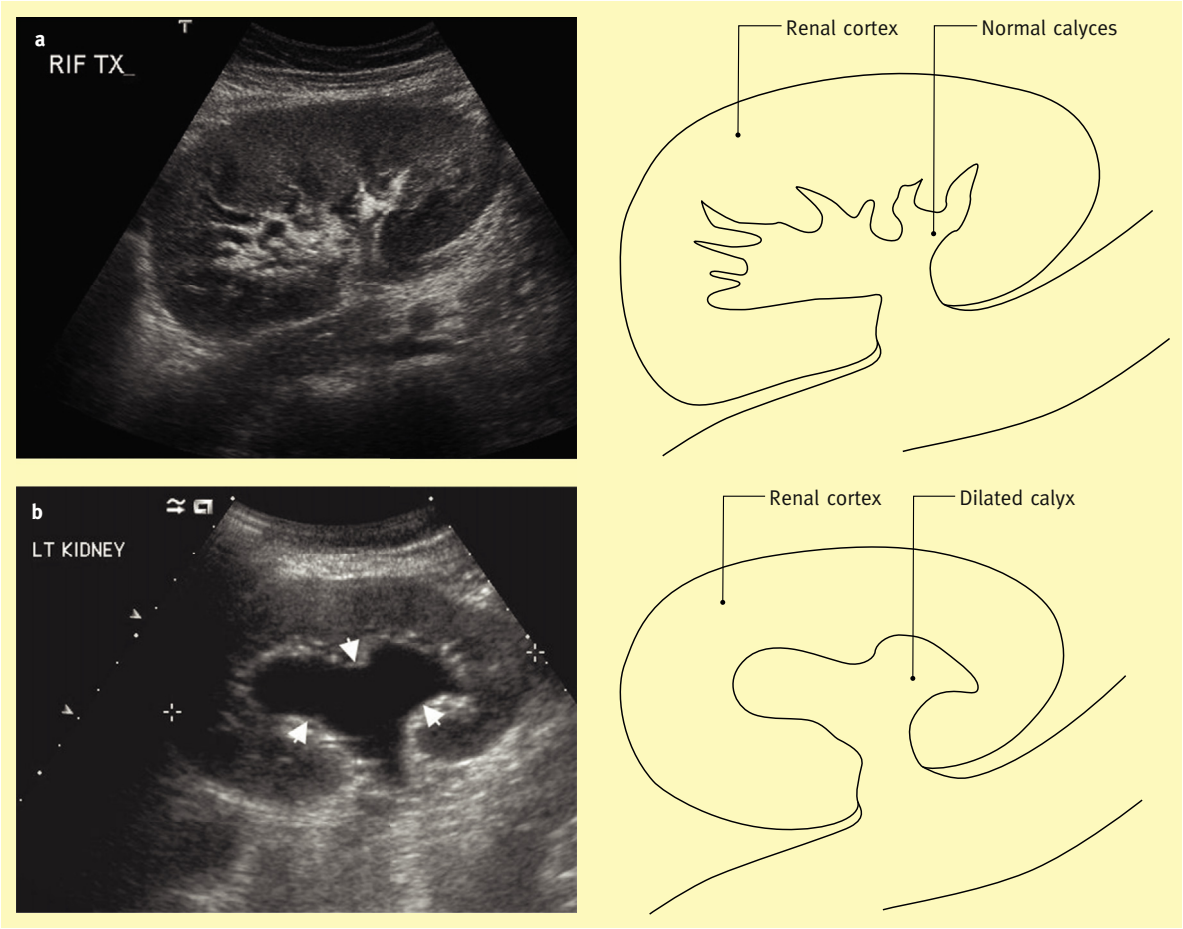

Figure 1 Ultrasound scans. (**a**) Normal appearance of kidney with undilated pelvi-calyceal systems. (**b**) Dilated pelvi-calyceal system in a kidney due to ureteric obstruction.

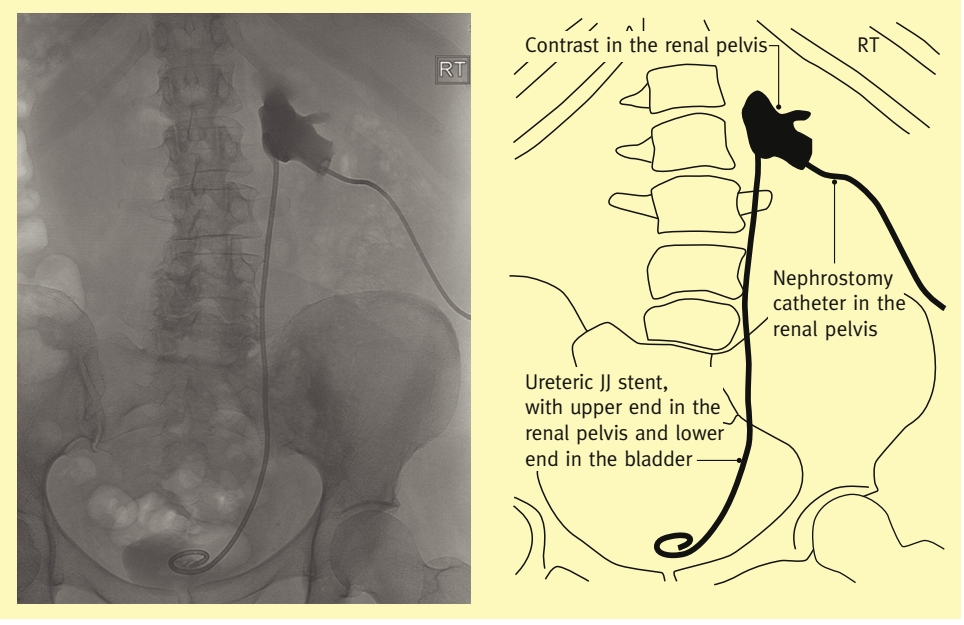

Figure 2 Nephrostogram performed by contrast injection through the nephrostomy catheter shows contrast reaching the bladder through the ureteric stent.