The diagnosis of urinary tract obstruction depends on showing increased resistance to flow along the urinary tract. Such increased resistance causes proximal dilatation (obstructive uropathy) and secondary functional effects on the kidney (obstructive nephropathy) with associated nephron damage and parenchymal atrophy (obstructive atrophy) [1]. Ultrasonography (US), intravenous urography (IVU), computed tomography (CT) and magnetic resonance imaging (MR) diagnose obstruction largely by showing the anatomical consequences of obstruction, namely the dilatation of the pelvicalyceal system and ureter proximal to the obstructing lesion. Some limited functional information may be obtained from the pattern of contrast medium excretion with IVU, CT and MR and from Doppler US examination. Scintigraphy, however, provides direct functional evidence of obstruction.

Pelvicalyceal dilatation is often described as “hydronephrosis” and this term may be used as if it is synonymous with obstruction. It is very important to recognise that pelvicalyceal and ureteric dilatation do not always indicate obstruction. Nonobstructive causes of pelvicalyceal dilatation include vesicoureteric reflux, normal anatomical variants (e.g. large extrarenal pelvis) and congenital anomalies (e.g. megacalycce). Also, following relief of obstruction, mild dilatation of the pelvicalyceal system and ureter may persist. Once dilatation has been shown by an “anatomical” method, its significance may need to be assessed either by scintigraphy or by other anatomical methods which give a more detailed assessment.

Another important concept is that the functional severity of obstruction is unrelated to the degree of dilatation of the pelvicalyceal system and ureter. Mild dilatation occurs in some types of severe obstruction, particularly obstruction caused by ureteric stones, retroperitoneal fibrosis and retroperitoneal malignancy.

**Acute Obstruction**

Acute ureteric obstruction is most commonly caused by a calculus. Less common causes of obstruction are blood clots, sloughed papillae, or acute idiopathic pelviureteric junction (PUJ) obstruction.

**Intravenous Urography**

IVU is the investigation of choice in most suspected acute ureteric obstruction [2]. It should be performed while the patient is in pain.

**Technique**

A full-length plain film on inspiration and a coned renal area view on expiration are used to check for renal and ureteric calculi. They may need to be supplemented by oblique films or plain tomography to check for intrarenal calcification.

After intravenous contrast medium administration a limited series of films is used, with the first film being a full-length film at 15 min. A full-length film following bladder emptying may be necessary to show hold-up at the vesicoureteric junction. Delayed films will be necessary in acute obstruction to show ureteric filling to the level of obstruction.

**Findings**

In complete ureteric obstruction there is an immediate nephrogram which becomes denser with time (Fig. 1). There is delayed filling of the pelvicalyceal system and ureter on the affected side, and they are usually mildly dilated to the level of obstruction. Where obstruction is incomplete, the typical nephrogram pattern does not occur but delayed pelvicalyceal filling with dilatation to the level of obstruction is seen. If the urogram is normal when the patient has pain, ureteric colic can be confidently excluded.

Clot colic is suspected if the patient has heavy haematuria. The clot is seen as a lucent filling defect which has usually resolved by 10-14 days. A sloughed papilla is suspected when the changes of papillary necrosis are seen in the kidneys. In acute PUJ obstruction the round-
ed, soft tissue density of dilated pelvis may be appreciated on the plain film and will fill with contrast medium on delayed films.

**Ultrasonography**

US is generally considered less satisfactory than IVU in the diagnosis of ureteric colic [3]. It may fail to demonstrate the mild pelvicalyceal dilatation which occurs. It does not show most of the ureter and cannot assess ureteric drainage. It may be used if IVU is contraindicated (e.g. by pregnancy or allergy to contrast medium).

**Technique**

The patient must be hydrated (at least 500 ml orally or IV) [4]. Mild pelvicalyceal dilatation is the expected finding in ureteric obstruction. Attempts should be made to visualise the upper ureter and the lower ureter through the bladder. US is good at showing calculi at the vesicoureteric junction. US must always be combined with plain films to check for opaque calculi.

Supplementary techniques include Doppler US:
1. Colour or pulsed Doppler US can differentiate dilated renal vessels, particularly veins, from a dilated pelvicalyceal system [5].
2. Ureteric jets are seen with colour Doppler in the bladder of normally hydrated subjects. They may be absent or reduced in ureteric obstruction [6].
3. Measurement of the resistance index (RI) in the intrarenal vessels

   \[ RI = \frac{\text{Systolic velocity} - \text{diastolic velocity}}{\text{Systolic velocity}} \]

   RI is elevated (>0.7) in obstruction. An inter-renal RI greater than 0.08 is a particularly helpful sign [7].

**Chronic Obstruction**

**Anatomical Investigation**

The first investigation of choice depends on the clinical setting. If there is pain, and stone disease or pelviureteric junction (PUJ) obstruction are possible, IVU is best. If there is impaired renal function, prostatism, or pelvic or retroperitoneal neoplasm, US and plain radiography should be used first.

Rare cases are recognised in which obstruction is present without pelvicalyceal dilatation [8, 9]. If this is suspected, the diagnosis may only be achieved when renal function improves after either antegrade or retrograde renal drainage.

**Intravenous Urography**

On the IVU films obtained immediately after administration of contrast medium, the dilated pelvicalyceal sys-

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Fig. 1 a, b. Acute obstruction of the right ureter by a calculus at the vesicoureteric junction. a Note increasingly dense right nephrogram, delayed pelvicalyceal filling, and opacity at right vesicoureteric junction (arrow). b Delayed film shows pelvicalyceal system and ureter filled to the level of the calculus.