Diagnosis and management of renal (ureteric) colic

Renal (ureteric) colic is a common surgical emergency. It is usually caused by calculi obstructing the ureter, but about 15% of patients have other causes, e.g. extrinsic compression, intramural neoplasia or an anatomical abnormality. This review will focus on calculus-related renal or ureteric colic, its assessment and subsequent management.

Renal (ureteric) colic affects approximately 1.2 million people each year and accounts for approximately 1% of all hospital admissions in the USA (Leslie, 2006). Renal colic, secondary to stones, occurs as a result of obstruction of the urinary tract by calculi at the narrowest anatomical areas of the ureter: the pelviureteric junction (PUJ), near the pelvic brim at the crossing of the iliac vessels and the narrowest area, the vesicoureteric junction (VUJ). Calcium stones (calcium oxalate, calcium phosphate, mixed calcium oxalate and phosphate) are the commonest type of stone, while up to 20% of cases present with struvite, uric acid and cystine stones.

Clinical features

Classically, renal colic presents with a sudden onset of acute loin or abdominal flank pain. The pain is colicky in nature and radiates across the abdomen to the groin and sometimes to the scrotum in men and the labia majora in women. Associated symptoms of nausea and vomiting are frequent, while some patients mention intermittent frank haematuria. The differential diagnosis includes appendicitis, pancreatitis, cholecystitis and in women salpingitis and tubal pathology. There are several reports of ruptured or leaking abdominal aneurysms presenting in a similar manner as renal colic (Eckford and Gillatt, 1992) and this should be suspected in patients >50 years old with loin pain. This differential should be kept in mind when taking the history and examining patients (e.g. Murphy's sign, rebound or guarding) as well as when ordering relevant investigations (e.g. chest radiograph for air under diaphragm). Doctors should remain vigilant to those who feign the symptoms of renal colic because they have an underlying opiate dependency. A previous history of episodes treated in different distant hospitals is usually key to identifying these patients.

On examination, the patient is usually unable to remain still – this is a classic feature of colic as opposed to the 'still' peritonitic patient. There is tachycardia and a pyrexia may indicate a concurrent urinary tract infection. Tachycardia and hypotension should alert the clinician to peritonitis from ruptured viscus or aneurym. Otherwise, examination reveals little else with only a minority of patients exhibiting tenderness in the loin and at the site of the calculus.

Investigations

Urinalysis is mandatory since renal colic causes dipstick-positive haematuria in over 90% of patients (Ooi et al, 1998). A few patients have macroscopic haematuria. It is prudent to send a sample of urine for microscopy, culture and sensitivity to ascertain presence of bacteria.

A blood sample is routinely sent for full blood count, electrolytes, urea and creatinine, amylase, serum calcium and urate. If appropriate, C-reactive protein and liver function tests may help if intraperitoneal pathology is suspected, and pregnancy testing is mandatory in all premenopausal women.

A plain radiograph of the kidney-ureter-bladder (KUB) will identify radio-opaque calculi (*Figure 1*). A KUB also shows pelvic phleboliths and faecoliths which can cause diagnostic uncertainty to the untrained eye. Pure uric acid-, xanthine- and triamterene-containing calculi are radiolucent, whereas cystine calculi are radiodense because of their sulphur content.

The intravenous urogram (IVU) is regarded as the gold standard for the diagnosis of renal and ureteric stones although this is being challenged by other imaging modalities (Mutazindwa and Husseini, 1996). The test is performed with intravenous injection of iodine-based contrast (e.g. Urografin, Schering Health Care Ltd, Burgess Hill, West Sussex, or Niopam, Bracco UK Ltd, High Wycombe, Bucks) after the plain KUB is taken, with subsequent serial radiographs usually at 20 minutes and post-micturition, with delayed films if necessary where obstruction is demonstrated. This is apparent where there is delay in appearance of contrast material in the kidney and ureter. Comparison with control plain KUB will help in identifying the location of the stone and its size (*Figures 2a* and *b*).

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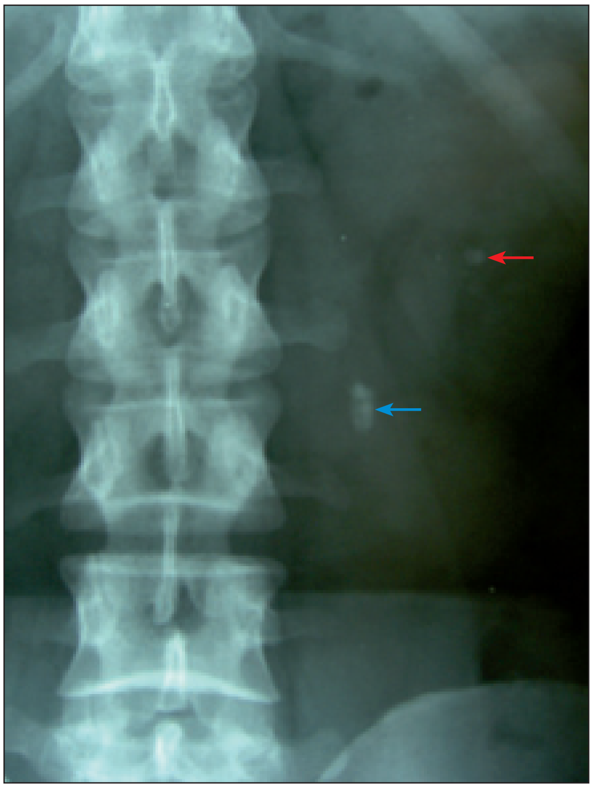

***Figure 1.** Kidney-ureter-bladder X-ray showing a radio-opacity (blue arrow) between the transverse processes of the second and third lumbar (L2–L3) vertebrae in the line of the left ureter. Also note a radio-opacity in the lower pole of the left kidney (red arrow) in this patient who had recurrent episodes of renal (ureteric) colic.*

One must be aware of the risks of sensitivity to intravenous contrast agents as well as excluding renal failure before performing this investigation. The latter will not only risk increased damage to the renal parenchyma, but also give a poor quality IVU. In diabetic patients taking metformin the iodine-based contrast reacts with the metformin causing a lactic acidosis, therefore the anti-glycaemic drug needs to be stopped 24–48 hours before and after the IVU.

In recent years, unenhanced helical computed tomography (CT) has been shown to be more sensitive and specific than IVU and ultrasound scan (USS) in detecting ureteric calculi (Greenwell et al, 2000). CT is useful in detecting radiodense as well as radiolucent calculi. Secondary signs of an obstructive process such as hydronephrosis as well as perinephric and periureteric stranding are readily identified (*Figures 3* and *4*). CT also provides significant alternative or additional diagnoses in 6–12% of cases (Ahmad et al, 2003). These advantages should be balanced against a two-fold increase in radiation exposure when compared to conventional three-film IVU, but as no contrast is used it is safe in those where IVU is contraindicated. Furthermore, CT has now become the first-line investigation in a number of centres.

Other investigative modalities have been studied. For example, the combination of a KUB and USS was found to be sensitive although not as specific for ureteric calculi as an IVU (Dalla-Palma et al, 1993). Isotope

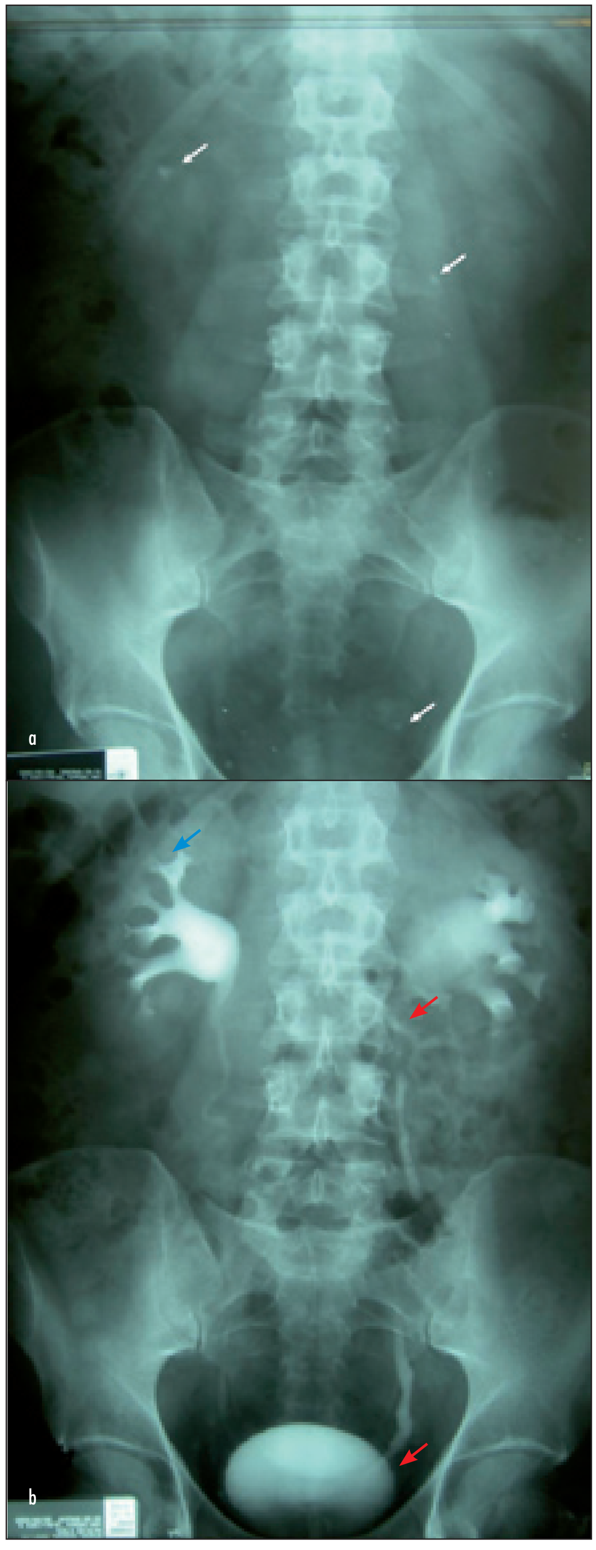

***Figure 2.** a. Kidney-ureter-bladder X-ray which reveals multiple bilateral radio-opacities (white arrows), which (b) after intravenous contrast, were found to be renal (blue arrow) and ureteric (red arrows) stones.*

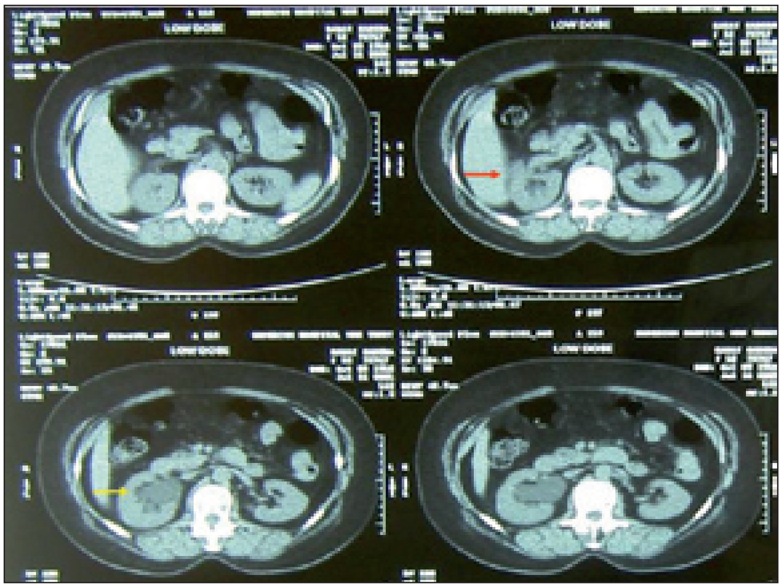

Figure 3. Unenhanced computed tomography scan revealing hydronephrosis (yellow arrow) and perinephric stranding (red arrow) which are secondary signs of an obstructive process from ureteric stones.

renography (e.g. mercaptoacetyltriglycine, also called MAG-3) has been used in conjunction with CT to assess anatomy as well as function (German et al, 2002) – if there is no evidence of obstruction a CT is adequate, but isotope renography helps in distinguishing different degrees of obstruction when present. These findings in conjunction with the clinical situation, size and site of the stone identifies those patients who would benefit from earlier intervention. More recently, magnetic resonance imaging has been evaluated and studies have shown it to have certain advantages over CT, especially in detecting obstruction (Regan et al, 2005). It is of particular importance in evaluating renal colic in pregnant women.

Initial management

This involves basic resuscitation as well as the specific measures of intravenous fluids, analgesia and antiemetics where necessary. Much debate has centred around whether non-steroidal anti-inflammatory drugs (NSAIDs) or opiate-based analgesia should be used. Meta-analysis of trials which compared these two groups concluded that NSAIDs are more effective in pain relief, require less rescue medication, induce less side effects (such as nausea and vomiting), and are useful in stone expulsion by reducing ureteric inflammation (Holdgate and Pollack, 2005). If opiates are to be used it is recommended that pethidine is avoided as it causes more nausea and vomiting.

The discovery of α-1 adrenergic receptors in the distal ureter lead to studies looking at tamsulosin, a selective α-1 antagonist normally used in the treatment of benign prostatic hyperplasia to relax prostatic smooth muscle. It has been shown that tamsulosin aids in the early expulsion of distal small ureteric stones, reducing the need for endoscopic intervention, hospitalization and analgesic use (Resim et al, 2005).

Patients with infection and obstructing calculus need to be treated vigorously with intravenous fluids and antibiotics. If renal USS confirms the presence of hydronephrosis urgent renal decompression with a nephrostomy is mandatory to prevent irreversible renal damage and septicaemia. Uroseptic patients tend to be very unwell and therefore need intensive clinical monitoring, ideally with management in a high dependency unit.

Patients with stones causing significant obstruction and pain will need ureteric stenting pending definitive treatment (*Figures 5a* and *b*). This can have a failure rate of up to 20% and require subsequent percutaneous drainage and antegrade stenting via a nephrostomy. Some urologists institute definitive treatment with ure-

Figure 4. Reconstruction of unenhanced computed tomography (CT) scan which shows a proximal ureteric stone (white arrow) resulting in hydronephrosis (red arrow) and proximal hydroureter (yellow arrow). Note that the size of the stone is easily measurable on CT scan and is 2.9mm

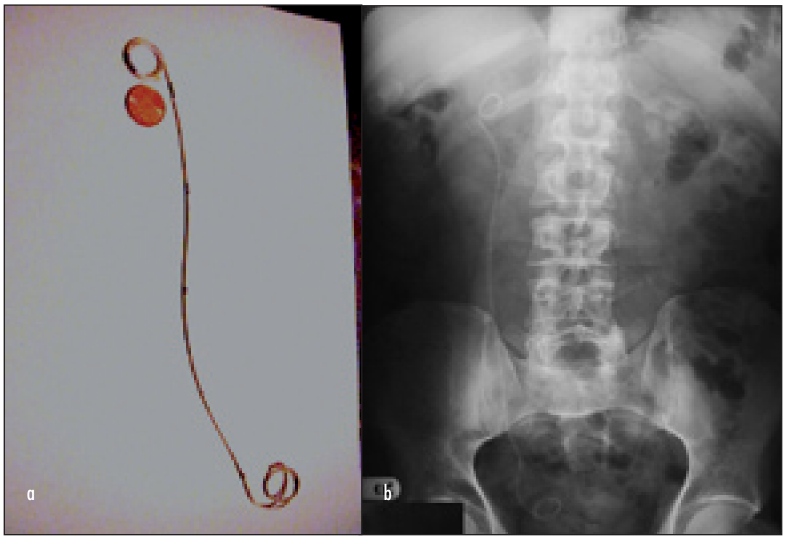

Figure 5. a. A typical ureteric stent. b. A kidney-ureter-bladder X-ray showing the stent correctly in situ, with proximal coils in the kidney, the main length of the stent in the ureter and the distal coils in the bladder.

teroscopic stone fragmentation and extraction. This may be followed with insertion of a temporary ureteric stent if there is significant inflammation or damage to the ureter.

Definitive treatment

Definitive treatment of the ureteric calculus depends on its size and site (Tiselius et al, 2001). Calculi less than 4 mm in size are likely to pass spontaneously in the majority of cases (80%). Patients with stones of this size, who have good pain control and no evidence of infection, are discharged from the hospital with follow-up imaging after 2–3 weeks. The probability of spontaneous passage of stones is not only dependent on size, but also on site. Overall spontaneous ureteral stone passage rate is 25% for the proximal ureter, 45% for the mid-ureter and in the distal ureter approximately 70% of stones will pass spontaneously. Spontaneous passage rates dependent on site and size are detailed in *Table 1*.

Patients are encouraged to sieve urine in order to recover calculi as this allows chemical analysis of the stone, especially those with recurrent stone formation (*Figure 6*). Not all patients with renal colic need hospital admission (Morris et al, 1995). Hospital admission is necessary when pain is not controlled with oral analgesics; in the presence of anuria and risk of renal failure (patients with an obstructing calculus in a solitary kidney or rarely, bilateral obstruction); or in the presence of concomitant infection. These are also obvious indications for intervention.

Table 1. Probability of stone passage

	Probability of passage (%)		
	Size of stone (mm)		
Stone location	>5	5	<5
Proximal ureter	0	57	53
Mid ureter	0	20	38
Distal ureter	25	45	74

From Morse and Resnick (1991); Glowacki et al (1992)

Proximal ureteric non-obstructing stones can be treated by extra-corporeal shockwave lithotripsy (ESWL) with stone-free rates above 80% (Drach et al, 1986). Contraindications to ESWL are pregnancy, uncontrolled coagulopathy, uncontrolled hypertension and febrile urinary tract infection. Endoscopic treatment is reserved for large (>1 cm) stones, multiple stones, hard stones (e.g. cystine) or impacted stones causing significant obstruction.

Mid-ureteric calculi may either be treated with ESWL or ureteroscopy. Although good results have been obtained with ESWL localization of the stones radiographically may be difficult in this region because of the presence of the pelvic bones. The flexible ureteroscope is useful to access the stones in this area.

Lower ureteric calculi can be treated successfully with ureteroscopy (Chang et al, 1993) under general anaesthesia as a day case procedure. Rarely, a ureteric stent may need to be inserted at the end of the procedure where there is traumatic extraction or uncertainity about ureteric injury. ESWL has satisfactory results as first-line treatment for smaller calculi (<1 cm) where facilities are available.

Further management

The underlying abnormality predisposing to stone formation remains after surgical stone removal, and therefore identifiable causes in calcium metabolism (hyperparathyroidism, sarcoidosis) or oxalate metabolism (primary oxaluria) need to be ascertained in recurrent stone formers and treated appropriately. Similarly uric acid and cystine stone formers will need appropriate therapy for the underlying problem. Adequate fluid intake to maintain a urine output in the region of 3 litres for an aver-

Figure 6. Typical size of stone which passes spontaneously in a patient with recurrent stone formation. The stone was caught while the patient sieved his own urine and biochemical analysis revealed it to be a calcium phosphate stone.

age-sized person per day reduces stone recurrence: this is the main guidance provided to the majority of patients to prevent recurrence of idiopathic urinary tract calculi.

Conclusions

Calculus-related renal colic is a common presenting complaint and early recognition of aetiology with the use of appropriate imaging such as IVU, CT or USS is vital. NSAIDs are the most appropriate analgesic agent to use and with adequate hydration most stones will pass spontaneously. There is at present a shift towards using cross-sectional imaging (CT, MRI) in evaluating renal colic and the use of tamsulosin as a new therapy for conservative management of ureteric calculi has been proven effective. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Renal (ureteric) colic is common and most cases are caused by calculi.
- Imaging in the form of plain abdominal radiograph plus intravenous urography, non-contrast computed tomography or ultrasound are needed.
- Management is with hydration and analgesia, usually with non-steroidal anti-inflammatory agents.
- Where a stone does not pass spontaneously definitive treatment is dependent on the size and site of stone, and the presence of infection.