

# Urolithiasis – Ten things every general practitioner should know



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## Background

Upper urinary tract stones are a common problem in Australia, with an incidence of 0.13% per year, and a lifetime prevalence of up to 15% in males and 8% in females. Many of these patients first present to general practitioners (GPs), so a thorough understanding of the diagnosis, treatment and prevention of stone disease is an important part of any GP's arsenal.

## Objectives

In this article, we present evidence-based guidelines regarding urolithiasis, from diagnosis, through to conservative and operative management, and prevention, as a reference for GPs and other primary care physicians.

## Discussion

The majority of urolithiasis cases can be conservatively managed. However, prior to conservative management, adequate imaging must be obtained and emergent conditions must be excluded. Conservative management should not be initiated without a plan in the event the management fails, and adequate analgesia and medical expulsive therapy should be prescribed. Should surgery be necessary, the majority of operations can be performed as minimally invasive day procedures.

**U**rolithiasis, or urinary tract stones, is the aggregation of crystals in the urine, most commonly composed of calcium oxalate.<sup>1</sup> Urinary tract stones are responsible for renal colic, which is the most common symptomatic presentation of urolithiasis.

The formation of calculi in the upper urinary tract is a problem that places a considerable burden on primary care physicians. The lifetime prevalence of urolithiasis is up to 15% in males and 8% in females, with a yearly incidence of roughly 131 per 100,000.<sup>2,3</sup> The lifetime recurrence rate in patients with known urolithiasis approaches 50%.<sup>4</sup> Many of these patients present first to general practitioners (GPs), and often require investigation. Not all patients with urolithiasis require referral to urology, so it is important to be able to determine which patients can be safely managed conservatively. Renal colic is frequently said to be one of the most painful conditions one can experience, so knowing which medications to give and why can make the difference between a successful consultation and an unhappy patient.

Renal colic classically presents as colicky, unilateral pain in the 'loin-to-groin' distribution, with vomiting, flank or renal angle tenderness and, occasionally, macroscopic haematuria. However, this clinical presentation is not always sufficient to make the diagnosis and, more importantly, does not provide enough information to guide management. Presentations can also include unilateral flank or groin pain without a colicky character, or intermittent flank pain that worsens with micturition. Pain may occasionally refer to the testes or the penis, and distal calculi may present with slow, painful micturition (stranguria).

## What tests should I order when I suspect renal colic?

While the patient is in the consulting room, collect urine for testing. This provides the following important information:

- Urine dipstick may detect blood – haematuria is present in roughly 85% of renal colic cases.<sup>5</sup>

- Dipstick may reveal nitrites, and urine microscopy and culture may suggest urinary tract infection (UTI) – this is a vital differentiator and significantly alters management.

Imaging is important for confirming diagnosis and guiding treatment. Computed tomography (CT) and X-rays of the kidneys, ureters and bladder (KUB) should be ordered and performed on the same day. Many radiology centres now offer low-dose CT scanning. Often, follow-up imaging is needed and thus, performing a simultaneous X-ray of the KUB allows for a potential decrease in exposure to subsequent ionising radiation and provides a clue to the composition of the stone. Approximately 50% of renal calculi are seen on X-ray.<sup>6</sup> Given that nearly 50% of patients will go on to have further episodes of renal colic, minimising radiation is desirable.<sup>4</sup>

Ultrasonography may be useful in patients in whom avoiding radiation is necessary (eg young people, women who are pregnant), but CT is still the preferred imaging modality of urologists as it allows better decision-making for further management. Ultrasonography can be useful for following calyceal stones, but is much less accurate than CT at detecting ureteric stones and at measuring stone size (a key determinant of further management).<sup>7</sup>

Finally, it is useful to order renal function tests, as severe renal failure may alter management decisions. A moderate degree of renal failure in many patients with renal colic usually relates to dehydration rather than the obstruction, as the unobstructed kidney's function is not compromised.

### What is the difference between CT KUB, CT intravenous pyelogram and CT abdomen? Which type of imaging should I order?

CT KUB is a non-contrast scan that is performed with the patient prone on the CT table. The ureters pass obliquely through the posterior wall of the bladder, opening at the upper corners of the trigone. This produces a valve-like action at the vesicoureteric junction (VUJ), which is the narrowest point of the ureter and the most common site for ureteric obstruction.<sup>8</sup> Calculi that are in the bladder will lie on the posterior bladder wall when the patient is supine. Scanning in the prone position lets bladder calculi fall to the anterior wall of the bladder, differentiating them from VUJ calculi. This scan is primarily used for diagnosis of urolithiasis.

A CT intravenous pyelogram (CT IVP), also known as a CT intravenous urogram (CT IVU), is a contrast scan, usually in two or three phases, and usually performed with the patient lying in the prone position. An initial CT KUB is performed and is sometimes followed by a nephrogenic phase-contrast scan for characterisation of renal masses. The delayed phase is performed approximately 10 minutes after contrast injection, by which time the kidneys should usually have excreted contrast down the ureters into the bladder, outlining the ureters and bladder. This scan can be useful in the work-up of renal masses, painless

haematuria and causes of obstruction (eg pyeloureteric junction [PUJ] obstruction). It is not a recommended test for initial investigation of suspected renal colic.

CT of the abdomen is a portal venous phase-contrast CT performed while the patient is supine. The uses of this imaging modality are beyond the scope of this article and should not routinely be requested for renal colic. This is because the patient is supine, and because contrast in blood vessels and in the kidneys can mask the appearance of calculi.

### Red flags to initiate urgent surgical management

Most ureteric stones cause a partial obstruction to the urinary tract. This usually results in an initial increase in blood flow through the affected kidney, followed by a decrease if the obstruction remains in place.<sup>9</sup> In patients with normal renal function, the contralateral kidney will usually compensate for any temporary decrease in function of the affected kidney. Urolithiasis can be an emergency in certain circumstances, necessitating immediate hospital treatment.

When obstruction and UTI are concurrent, high-pressure pus can build up in the obstructed urinary system (pyonephrosis) and cause bacteraemia via the renal vasculature (pyelovenous backflow). This can result in catastrophic gram-negative sepsis, often requiring intensive care admission and occasionally causing death.<sup>10</sup> Early recognition is key to effective treatment, hence the necessity to perform urine dipstick analysis in all patients with suspected renal colic. Occasionally, urine dipstick may be negative because of complete obstruction of infected urine. In any patient with fevers, tachycardia or hypotension, the diagnosis of infection must be considered.

Patients with evidence of complete urinary obstruction – those with a single kidney (ie congenitally, postoperatively), bilateral obstructive stones or anuria – should not trial conservative management. Patients with minimal renal reserve – those with pre-existing kidney disease – should also be sent to hospital for treatment.<sup>11</sup>

### Which stones should pass?

Most urolithiasis, even symptomatic, can initially be managed conservatively. The majority of stones will pass within six weeks.<sup>12</sup> However, the reason imaging should be performed at the first visit is to allow confident stratification between cases where the stones can be conservatively managed safely and those that should be referred onwards.

For stones 5–7 mm, about 60% should pass with conservative management, whereas the minority of stones >7 mm will pass. The likelihood of spontaneous passage decreases with increasing size and with more proximal stones. The likelihood of a stone >10 mm passing spontaneously is very low.<sup>13</sup> Patients should be made aware of the likelihood of passage as some patients will opt for expedited surgical treatment to avoid the possibility of further

episodes of renal colic, even though the stone may be of a size that should pass spontaneously.

### What should I do for a patient who is being managed conservatively?

All patients undergoing conservative management should be told to present to the emergency department if they develop symptoms of a UTI, or if the pain is unbearable despite analgesia.

Renal colic can be intensely painful, as ureteric peristalsis increases back pressure behind an obstructing stone and dilates the renal capsule. Effective analgesia is important. Nonsteroidal anti-inflammatory drugs (NSAIDs) provide the most effective available pain relief in renal colic. NSAIDs reduce the prostaglandin-mediated pain response, and decrease the transient increase in glomerular blood flow that accompanies acute urinary obstruction. NSAIDs can be given by oral, rectal, intramuscular and intravenous routes, with the latter providing the most rapid onset of analgesia in renal colic. For outpatient management, oral and rectal routes provide equivalent analgesia; however, given the nausea that frequently accompanies renal colic pain, many patients find it beneficial to have NSAID suppositories available.<sup>14</sup>

Despite recent controversy with a large randomised control trial showing that alpha-adrenoceptor antagonists have no benefit<sup>15</sup> as an expulsive therapy, many other studies, including meta-analyses, have shown benefit, specifically with the alpha-1a-selective antagonist tamsulosin.<sup>16</sup> As this drug generally has minimal side effects (unlike the non-selective prazosin), we recommend the routine use of 400 µg daily in conservatively managed renal colic. Tamsulosin is not available on the Pharmaceutical Benefits Scheme (PBS) for the treatment of urolithiasis. Alpha-1a antagonists are contraindicated in patients with end-stage hepatic or renal failure, and patients with severe orthostatic hypotension.

Patients who are trialling conservative management should be advised to strain urine, to avoid unnecessary imaging if the stone has passed. Patients should be given a specimen jar and asked to bring the stone in to be verified; the stone should then be sent for analysis. The stone should be palpated as, occasionally, small blood clots may appear to be calculi on cursory inspection.

Follow-up scans (X-ray KUB if the stone is definitely seen on initial X-ray, or CT KUB if it is not seen) should be organised for four weeks after the initial visit, unless a stone has been collected and verified by the GP or urologist.

### Who needs referral to a urologist?

Some patients with urolithiasis do not require emergency treatment, but are likely to experience ongoing pain and potentially have kidney damage if they are not offered surgical management. These patients should be referred to a urologist at diagnosis, rather than conservatively managed or sent straight to hospital.

Stones >7 mm are less likely to pass, so the patient should be referred to a urologist.<sup>17</sup> Patients who have been trialling

conservative management for three weeks and have not passed their stone should also be referred to a urologist, as renal damage becomes more likely after six weeks of failed passage. Patients who have ongoing pain despite adequate oral analgesia should also be referred to a urologist, and those with unbearable pain despite oral analgesia should be sent to the emergency department.

Lastly, patients who have passed stones but have ongoing blood in the urine should be referred to a urologist for investigation of haematuria, preferably with three urine cytology tests and a CT IVP.

### What are the surgical options? What should I tell patients if they ask?

In Australia, there are three main surgical options for the management of urolithiasis. Availability varies, particularly in more remote areas. All procedures except percutaneous nephrolithotomy (PCNL) are usually performed as day cases.

#### Laser lithotripsy

Laser lithotripsy can be used to treat calculi anywhere in the urinary tract, and is the most commonly performed procedure for the management of urolithiasis. A rigid or flexible scope is passed perurethraly into the ureter and then a flexible laser fibre is used for fragmentation of the stone. Stone fragments may be removed with a basket or allowed to pass spontaneously. A ureteric stent is usually left in situ for a short time (usually 1–14 days) following the procedure.

The advantages of laser lithotripsy are that it has good access to the whole urinary tract, can deal with most stones <20 mm in size, allows objective clearance of stone and retrieval for biochemical analysis, and has widespread availability. The risks of laser lithotripsy include stent symptoms and, rarely, ureteric injury. The disadvantages of laser lithotripsy are that it sometimes requires multiple procedures and the stent can be very bothersome for some patients.

#### Extracorporeal shock wave lithotripsy

Extracorporeal shock wave lithotripsy (ESWL) is an option, usually for stones in the renal calyces or renal pelvis that are 5–10 mm in size. A lithotripter is used with ultrasonography or X-ray guidance, under general anaesthetic, to deliver a series of shocks to one or more stones to fracture them, allowing them to spontaneously pass with urine. ESWL is rarely used in the acute setting in Australia.

The advantages of ESWL are that it is minimally invasive, usually well tolerated, and a stent is not usually required. The risks of ESWL include bruising, pain or urinary obstruction from fragments of stone, haematuria and, rarely, perinephric haematoma or significant bleeding requiring further management. The disadvantages of ESWL are that effectiveness decreases with increasing body mass index, it requires expensive machinery

and trained technicians to perform the procedure, there is poor clearance of lower pole and larger stones, it is not suitable in pregnancy and is not widely available.

### Percutaneous nephrolithotomy

PCNL is a surgical procedure where the renal calyces are accessed via a 2 cm incision over the kidney, and a nephroscope is passed directly into the kidney. The stone is fragmented with a combination of mechanical force and direct application of ultrasound or laser. This procedure usually requires two days in hospital.

The advantages of PCNL are that it provides excellent access to large stones and has a high rate of stone clearance. The risks of PCNL include bleeding, renal damage and pneumothorax. The disadvantages of PCNL are that it usually cannot access ureteric stones, it is a higher morbidity procedure, and not every urologist performs this procedure.

### What should I expect if a patient sees me after stone surgery?

**Stent-related symptoms** are the most common cause of re-presentation to primary care after stone surgery. Through irritation of the bladder wall, ureteric stents commonly cause **haematuria**, which is not of concern unless it is causing urinary retention. Stents frequently cause dysuria and urinary frequency, with a constant feeling of **urgency**. Unless a urine culture is also positive, this is unlikely to represent a UTI. Finally, due to urine reflux up the stent, **flank pain** during micturition or abdominal straining is common. Patients presenting with these symptoms should receive reassurance. Occasionally, tamsulosin and anticholinergic medications can help with the urinary symptoms. Fever or persistent and severe flank pain are not to be expected and in their presence, a UTI or stent misplacement or migration should be suspected.

A patient who presents with recurrent renal colic after stent removal should usually be worked up as a new presentation of renal colic, with urinary dipstick and imaging, and managed as per previous suggestions. Half of the patients will go on to have recurrent stones at some point in their lives after the first treatment.<sup>4</sup>

### What can I advise patients with recurrent stones to do?

Specific advice for each composition of renal stones is beyond the scope of this article. However, the majority of stones are calcium-based, and common advice can be given for all.

Renal calculi precipitate from concentrated urine, so good hydration is key to stone prevention. We generally advise our patients to drink to a level where the urine produced is clear, rather than targeting a specific volume of fluid per day, as this provides feedback for the patient.

There is a common misconception that dietary calcium is a risk factor for renal colic. In fact, studies have shown that a normal

dietary calcium can reduce the risk of calcium stone formation (compared with a low-calcium diet).<sup>18</sup> However, increased dietary sodium causes increased urinary calcium excretion by reducing calcium reabsorption from urine. Therefore, a low-sodium diet can be beneficial for patients with recurrent stone. Dietary oxalate also has an impact on stone formation, so low oxalate diets have been shown to help.

Finally, most stones form in acidic urine, which is primarily related to protein in the diet. Vegetarians have much lower rates of urolithiasis than the general population. A low-protein diet can help reduce recurrence of urolithiasis.<sup>19</sup>

Metabolic screening for patients who are at high risk or have recurrent stones is important but is beyond the scope of this article. It will usually be performed during postoperative follow-up by the treating urologist. GPs can also perform these tests and refer to the relevant specialist (usually a nephrologist) if the metabolic screening is abnormal. For patients who pass stones with conservative management, those who are at high risk of recurrence (briefly outlined below) should have further metabolic work-up. Serum calcium and uric acid levels, parathyroid hormone level, 24-hour urinary calcium, citrate and oxalate may all be performed, in addition to other specialised tests dependent on stone composition.<sup>20</sup>

### High risk of recurrence

Patients who are at high risk of recurrent stones include those with:

- early onset of urolithiasis (younger than 20 years of age)
- a family history of stones
- disease-associated stones (eg hyperparathyroidism, genetic conditions)
- anatomical abnormalities (eg single kidney, PUJ obstruction)
- previous or concurrent renal calculi.

### What about asymptomatic stones?

Asymptomatic renal calculi are most frequently incidentally found in the calyces of the kidney, but can occasionally present in a chronically obstructed and atrophic kidney, and may be a focus of recurrent urinary tract infection.

Renal stones that are >5 mm may cause obstruction and pain should they pass into the ureter, hence prophylactic treatment of stones of this size is recommended. For certain subgroups of patients (eg those with single kidneys, airline pilots), being stone-free is mandatory. Patients with recurrent UTIs with no other cause may benefit from stone clearance. For patients with small (<5 mm) asymptomatic calculi, follow-up imaging should be performed after six months and then yearly (usually ultrasonography is adequate).<sup>20</sup> Indications for referral of asymptomatic renal stones include:

- stone size >5 mm
- single kidney (congenital or postoperative)
- occupational need to be stone-free (eg airline pilot, military)

- chronic obstruction
- recurrent urinary infections.

## Key points

- Urolithiasis with concurrent UTI is a potentially life-threatening emergency. These patients should go straight to the emergency department for treatment.
- Patients with a single kidney, bilateral obstruction, anuria or severe pre-morbid renal failure should be sent to the emergency department and/or promptly discussed with a urologist.
- Specify CT KUB for investigation of urolithiasis, and perform a simultaneous X-ray KUB.
- Patients with uncomplicated stones <7 mm in size should be considered for conservative management, but this depends on patient preference and clinical scenario.
- NSAIDs provide the most effective analgesia in renal colic, and regular tamsulosin improves stone passage rates.
- Large stones or patients who have failed conservative management can be referred to a urologist as an outpatient.
- Ureteric stents cause dysuria and urgency, haematuria and flank pain. Although these symptoms overlap with those of a UTI, midstream urine is rarely indicated in otherwise well patients, and urine dipstick is not useful in patients with stents.
- Stent symptoms may be improved by tamsulosin and/or anticholinergic medications.
- Patients with urolithiasis should be well hydrated, and have a diet low in salt, oxalate and protein.

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