

# Management of renal Stones for the non-specialist

**Abbreviations:** PUJ, pelvico-ureteric junction; AAA, abdominal aortic aneurysm; NSAIDS, non-steroidal anti-inflammatory; PCNL, percutaneous nephrolithotomy; SWL, shock-wave lithotripsy; URS, ureterorenoscopy

## Introduction

The incidence and prevalence of renal stones has increased significantly over the past decade, carrying an individual lifetime risk of 8-10%<sup>1</sup> and 83 000 UK hospital attendances annually.<sup>2</sup> With this trend likely to continue initial diagnosis, investigations and management of simple renal stones are increasingly performed by the non-specialist and so it is important for them to be aware of the latest evidence. We review the latest evidence for management below.

## Risk factors

Risk factors for stone formation are categorized into intrinsic and extrinsic causes. Intrinsic causes include age, family history and sex. The peak age of presentation is 40-60 years old. Patients with a first degree relative with renal stones have an increased risk (RR 2.5).<sup>3</sup> The relative risk between men and women has narrowed over the past decade from 3:1 to 1.3:1 (ibid). Obesity, fluid intake and diet are the most important extrinsic risk factors. There is a strong correlation between BMI and stone formation. A BMI of >27.5 doubles the relative risk compared with a BMI of 20-22.5.<sup>4</sup> Fluid intake is inversely correlated with stone formation. Consuming >2500 mls/day halves the relative risk compared with <1250 mls/day.<sup>5</sup> A low meat intake (<50g/day) halves the risk of stone formation compared with a high meat intake (>100g/day).<sup>4</sup> Perversely a low, rather than high, calcium diet predisposes to calcium stone formation.<sup>5</sup>

## Presentation

The majority of renal stones remain asymptomatic. Up to 5% of abdominal ultrasounds and CTs find incidental renal stones.<sup>6</sup> Small non-obstructing stones within the kidney are typically asymptomatic or have mild symptoms. The most common presentation of a renal stone is loin pain caused by ureteric obstruction. The classical presentation is severe colicky pain which reaches its peak within 1-2 hours and then becomes constant. Hospital presentation within 12 hours of onset of the pain is a significant predictor of renal colic.<sup>7</sup> The location of the stone within the ureter determines the nature of the pain. The most common sites are the pelvico-ureteric junction (PUJ), the pelvic brim and vesico-ureteric junction. PUJ stones typically present with a deep loin pain without radiation, pelvic brim stones with flank or lower quadrant pain radiating into the groin and vesico-ureteric stones with irritative voiding symptoms. Flank pain is not specific to renal stones with stones being demonstrated on CT in 34-73% of these patient.<sup>8</sup> Nausea, vomiting and a change in appetite are present in approximately 50% of cases.<sup>7</sup> Other less common symptoms of renal stones include visible haematuria, recurrent urinary tract infections and the painless passage of grit. On examination, loin tenderness may be present in up to 86% of patients.<sup>7</sup> Flank and iliac fossa tenderness may be palpated, but there should be no signs of peritonitis. A thorough examination

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of patient should be performed to rule out the red flags and other differentials mentioned below.

## Investigations

Detection of haematuria on urine dipstick is the most discriminating bedside investigation. It has a sensitivity for renal stones of 84%, specificity of 48%, PPV of 72% and NPV of 65%.<sup>8</sup> It should be noted that the sensitivity is 95% on day 0 from the onset of pain but decreases to 65% by day 3.<sup>9</sup> Low dose non-contrast-enhanced CT (CT KUB) is the gold-standard investigation for most adults, with a sensitivity and specificity of 95% and 98%.<sup>9,10</sup> All renal stone types are detectable by CT KUB except for Indinavir stones. These rare stones form as a consequence of the medication Indinavir Phosphate, used in HIV management.<sup>11</sup> Non-contrast-enhanced computed tomography can determine stone density, inner structure of the stone and the surrounding anatomy.<sup>8-11</sup> These parameters can affect the selection of treatment modality as we discuss later. Patients with a BMI >30 should have a standard-dose non-contrast-enhanced CT to maintain sensitivity and specificity at 95% and 98%.<sup>10</sup> Ultrasonography is the first line investigation for pregnant patients.<sup>8</sup> This has a sensitivity and specificity of 84% and 53%. It is important to be aware that normal pregnancy changes can mimic ureteric obstruction (ibid). Magnetic Resonance Imaging can be used as a second line investigation to visualise the level of obstruction and anatomical characteristics.<sup>8</sup> Ultrasonography should also be performed first line for patients under 16 years old.<sup>8</sup> This can be performed in conjunction with plain film KUB to increase the sensitivity and specificity. Cystine and Struvite stones, which together make up 10-16% of stones, are poorly visualised on a plain film and small stones are often missed.<sup>8</sup> Consequently, the sensitivity and specificity of plain KUB film is 57% and 76% (ibid). If ultrasonography and plain-film are inconclusive then low-dose non-contrast CT can be considered (ibid). Blood tests are useful to both rule out other differential diagnoses and complications of renal stones (highlighted below).

## Differential diagnosis

Other renal causes of acute flank pain include: pyelonephritis (typically fevers, rigors and vomiting with infection evident on urine dipstick); blood clot ureteric obstruction (secondary to frank

haematuria); pelvico-ureteric junction obstruction (classically after consuming large fluid volumes causing dilation of the renal pelvis); urological tumor (which more usually a chronic pain) and renal infarct (classically with fevers, vomiting and a history of atrial fibrillation). Non-renal pathologies attribute for approximately 10% of acute loin pain of these 37% are gynecological (with ovarian cysts being the most common), 24% diverticulitis and 15% appendicitis<sup>12</sup> which can also present with microscopic haematuria. Other pathologies include pancreatitis, biliary colic and cholecystitis. Symptomatic Abdominal Aortic Aneurysm (AAA) is a less common but a serious differential diagnosis. One case series reported 18% of symptomatic leaking AAA's being misdiagnosed as renal colic.<sup>13</sup> Clinically 80% of these cases had a palpable and expansile abdominal mass and all patients were >60 years old (ibid). Aortic dissection or rupture is poorly demonstrated by non-contrast CT and so early contrast CT or ultrasound is indicated. Musculoskeletal pain is commonly misdiagnosed as renal colic. This is most commonly mechanical back-pain but less-common pathologies include: thoracolumbar vertebral fractures, metastases, and multiple myeloma and psoas haematomas/ collections.

### Red flags - Urgent Urology Referral

The following are indications for an urgent admission:

#### I. Obstructed, infected kidney:

1. Sepsis must be ruled out both clinically and through investigations. Fever, rigors, deranged observations, a White Cell Count of >15,000/ $\mu$ L or leukocytes/nitrites on urine dipstick are suggestive.

#### II. Deranged Renal Function:

2. If the renal function is acutely impaired, it suggests renal obstruction with abnormal function of contralateral kidney.

#### III. Single functioning kidney:

3. Urgent decompression is required of an obstructed solitary normal functioning kidney.

#### IV. Uncontrolled pain:

4. Pain non controlled with oral/per rectal analgesics require admission for intravenous analgesia.

### Immediate (non-specialist) management

Analgesia and antiemetics are the first step of management for patients. Per-rectal non-steroidal anti-inflammatory (NSAIDS) medications (such as diclofenac 150mg/day 3-10 days) have the best efficacy and should be used as first line European Association of Urology, 2015). Contraindications for diclofenac include congestive heart failure, ischaemic heart disease and peripheral arterial- and cerebrovascular disease and poor renal function. Mild opioids should be used as second line (ibid). Parenteral analgesia and antiemetics should be used for rapid control of severe pain or nausea. Evidence of the use of alpha-blockers (such as tamsulosin) is controversial but European guidelines suggest using them to improve pain and ease passage (ibid). There is no clear evidence to support the use of antispasmodics for pain control (ibid).

### Emergency management of ureteric stones

The emergency decompression of the renal system for the indications above can be achieved by ureteric stenting or nephrostomy. A double-J ureteric stent is passed retrogradely under general anaesthetic and fluoroscopy to relieve the obstruction. General anaesthetic can be difficult if the patient is very unwell or has unfavourable co-morbidities. There is also a failure rate associated with an impacted ureteric stone.<sup>14</sup> Nephrostomy involves passing a drain through the skin under radiology guidance into the renal pelvis. A stent can then be introduced anterogradely if required. This requires a skilled interventional radiologist, but can be done under local anaesthetic. There is a risk of injury to adjacent organs and the requirement for a nephrostomy bag,<sup>15</sup> which can be difficult to manage in confused or uncooperative patients. These are temporizing measures, and the stone must then be dealt with definitely which often is attempted at a few weeks post acute admission.

### Patient advice with renal stones who do not need admission

- a. Seek medical advice urgently if your pain is not under control or you have a fever.
- b. Measures to reduce stone formation<sup>16-18</sup>
- c. Drink enough to produce a urine output of 2 to 2½ litres (4 to 5 pints) each day. It is best to drink continuously throughout the day, rather than going from periods of dehydration to drinking lots in one go.
- d. Do not restrict your calcium intake, as a low calcium diet actually increases your risk of stone formation.
- e. Reduce intake of animal protein (especially meat), refined sugar and salt.

### Non-emergency further management

The options for further management depend on the size, site, and composition of the stone. Options include conservative management, shock-wave lithotripsy (SWL), ureterorenoscopy (URS), or percutaneous nephrolithotomy (PCNL). SWL is a day-case procedure which focuses ultrasound waves from outside the body onto a stone to fragment the stone. It may be uncomfortable and analgesia is usually given beforehand. Common complications include pain, need for further therapy (which may be operative), failure, infection; bruising or blistering of the skin and precipitation of ureteric colic from stone fragments.<sup>17</sup> URS involves the insertion of ureteroscope under a general anaesthetic. The stone may then be retrieved using a variety of devices, or laser fragmented to smaller fragments or dust. A ureteric stent can also be inserted at the same time if required. Complications include: mucosal injury, false passage, ureteric perforation, bleeding, extra-ureteric stone migration, fever or sepsis, colic from haematuria and rarely ureteric avulsion.<sup>15</sup> PCNL uses a nephroscope under general anaesthetic to access the kidney through a loin incision. The stone is broken up with laser and pneumatic energy and usually removed through the nephroscopy tract. This usually necessitates a 2-5 day stay in hospital, a nephrostomy bag and a urethral catheter. These can be removed in the absence of complications when post-operative imaging shows adequate stone removal.<sup>18</sup> All patients can be expected to experience some haematuria with a risk of blood transfusion in up to 5% of cases. Other complications include UTI and urosepsis and

further auxiliary procedures if the stone clearance is inadequate. Open surgery is very rarely used with the advent of the minimally-invasive techniques described above, and is usually reserved for very large stones or abnormal renal anatomy.<sup>19</sup>

### Decision-making for surgical options

Stones less than 4mm have an 80% chance of passage.<sup>20</sup> Two thirds of stones less than 7mm can be expected to pass within four weeks.<sup>21</sup> A 2014 Cochrane review examined the efficacy of SWL against PCNL and URS for urinary tract stones in general requiring further management. It concluded, noting only five randomised controlled trials of low methodological quality, that SWL is less effective for renal stones than PCNL. This was based on success of treatment at three months (RR 0.46, 95% CI 0.35 to 0.62). One RCT found no significant difference between SWL and URS using the same outcome measure (RR 0.91, 95% CI 0.64 to 1.30).<sup>22</sup>

### Stones in the kidney

Factors affecting SWL success include size of stone, composition, anatomy and body habitus. It is contra-indicated in pregnant and anti-coagulated patients. In a meta-analysis covering 2927 patients in 13 centres, a 90% clearance rate was calculated for upper and mid-pole stones, and 59% clearance for lower pole stones. Of these, stones less than 10mm had a 74% clearance rate; those 11-20mm 56%; and those greater than 20mm 33%. Cystine stones generally do not respond well to lithotripsy. Infundibular length, width and infundibulopelvic angle have been shown to influence SWL success<sup>20</sup>, and obesity limits efficacy. Percussion, diuresis and inversion have been shown to increase its success.<sup>23</sup> Therefore, upper pole renal stones if less than 20mm deserve a trial of SWL as initial management. Stones greater than 20mm will usually require PCNL. Given the limitations of SWL with lower pole renal stones, it can be recommended as initial treatment in stones less than 10mm. It is unclear whether URS, SWL or PCNL is best for stones sized 10mm-20mm, but for lower pole stones 20mm and above, PCNL can be recommended (Raman JD, 2008). Staghorn calculi, which involve the renal pelvis and several or all of the calyces are best dealt with by PCNL.<sup>24</sup>

### Stones in the ureter

Treatment options are SWL or URS. European and American studies have agreed on success rates for SWL for ureteric stones, with a stone-free rate of 83.5%, and a retreatment rate of 10.7%.<sup>25</sup> Current guidance suggests that for proximal stones, SWL is slightly superior to URS for stones <10mm diameter. For mid-ureteric stones there is clinical equipoise. For distal stones, URS is favored.<sup>26</sup> These recommendations were based on an index patient: non-pregnant, with a unilateral non-cystine/non-uric acid radio-opaque stone in absence of renal stones needing treatment, with normal contralateral kidney and medical history, normal body habitus and favourable anatomy.<sup>27-30</sup>

### Conclusion and key points

Renal stones are common and an understanding of the basics of presentation, investigations and management is essential for the generalist. Whilst initial presentation is most commonly loin or flank pain with non-visible haematuria, alternate presentations are not uncommon and urine dipstick has its limitations. Low-dose non-contrast CT is the gold standard investigation for suspected

renal stones in an adult with a BMI<30. An obstructed kidney with deranged function or infection is an emergency requiring urgent decompression. Non-emergency management of renal stones includes conservative management, extra-corporeal shock-wave lithotripsy (SWL), ureterorenoscopy (URS), or percutaneous nephrolithotomy (PCNL). This choice depends on patient and stone factors with joint decision making after patient counseling.

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### Conflict of interest

The author declares there is no conflict of interest.

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