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Management of renal colic

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Urinary stone disease is increasingly prevalent, with a lifetime risk of about 12% in men and 6% in women.[1] Age of onset of a first stone episode for men rises from their 20s and peaks at age 40-60 years, with an incidence of three cases per 1000 population per year. Women appear to peak a little younger in their late 20s. The male to female ratio is narrowing, with one study showing a reduction from 1.7:1 to 1.3:1 over a five year period.[2] Presentation varies according to geographical and seasonal factors, with higher incidences in warmer climates and during the summer months.[3]

This review includes the latest information from meta-analyses, systematic reviews, randomised trials, current guidelines, and other peer reviewed evidence to provide a background on presentation, investigation, and medical and surgical management of patients with renal colic

SOURCES AND SELECTION CRITERIA

We performed a PubMed search to identify peer reviewed original articles, meta-analyses, and reviews using the search terms "renal colic" and "ureteric stone." We also reviewed national and international guidelines, and the Cochrane Collaboration and clinical evidence databases. We considered only papers written in English, with the emphasis on more recent articles if available or if we deemed the scientific validity to be sufficient.

What are urinary stones?

Urinary stones are formed by the aggregation of crystals with a non-crystalline protein (matrix) component.[3] These crystals clump together to form a stone and then move when they reach a certain size and pass down the ureter, frequently causing colic symptoms. Eighty per cent of stones contain calcium, most commonly in the form of calcium oxalate (60%). Calcium phosphate accounts for 20% of stones, with uric acid forming approximately 7%,[3] although this uric acid proportion may rise in obese patients. Another 7% are infection stones containing magnesium ammonium phosphate. Bladder stones usually have a different cause, often as a result of bladder outflow obstruction.

Who gets urinary stones?

The incidence of stones is higher in warmer climates, owing to a combination of dehydration and sun exposure (vitamin D). Obesity is also a risk factor, with large epidemiological studies showing both high body mass index and weight as independent risk factors for stones.[4] There is a 2.5 times greater risk if a patient has a family history of stone disease.[1] This increase is probably a genetic predisposition but may also be due to similar environmental factors such as dehydration and diet. Any anatomical abnormality of the urinary tract (such as a horseshoe kidney) indicates a higher risk of stone formation, as well as several medical disorders such as primary hyperparathyroidism, renal tubular acidosis, myeloproliferative disorders, all chronic diarrhoeal conditions (for example, Crohn's disease), and gout.[1] Occupations involving work in a hot environment (for example, kitchen workers) are also at risk due to dehydration.[3] Previous stone formation is a risk factor, with a 30-40% chance of forming a second stone within five years of the initial episode.[1] Both observational studies and a randomised trial (compared with control) have shown the importance of fluid intake—patients producing less than 1 L of urine per day are at highest risk of stone formation, while producing 2 L of urine per day substantially reduces the risk of stone episodes.[5]

SUMMARY POINTS

- Renal colic is a common presentation (lifetime risk 12% in men, 6% in women) causing pain and morbidity
- Non-contrast computed tomography is the imaging method of choice, owing to its high sensitivity and specificity
- Non-steroidal anti-inflammatory drugs offer the best initial analgesia, with opiates as a second line treatment
- Up to 80% of stones will pass spontaneously, and increasing evidence supports medical expulsive therapy
- Patients with coexistent obstruction and sepsis should have urgent relief of the obstruction with either percutaneous nephrostomy or retrograde stent
- Ureteroscopy and extracorporeal shockwave lithotripsy are highly successful treatments for ureteric stones

What is renal colic?

Renal colic describes the pain arising from obstruction of the ureter, although ureteric colic would be a more accurate term. The pain is caused by spasm of the ureter around the stone, causing obstruction and distension of the ureter, pelvicalyceal system, and renal capsule. Although the most common cause is a stone, the term "renal colic" actually refers to a collection of symptoms attributed to the kidney and ureter. There are other intrinsic or occasionally extrinsic causes such as lymphadenopathy, although extrinsic causes tend to present with milder and more chronic discomfort. Other common intrinsic causes are blood clots (from upper tract bleeding) or sloughed renal papilla (which can occur in sickle cell disease, diabetes, or long term use of analgesics).

What are the symptoms of renal colic?

The classic presentation of renal colic is the sudden onset of severe loin pain (in the costovertebral angle, lateral to the sacrospinus muscle, and beneath the 12th rib), often described as akin to labour pains. Depending on the site of obstruction, the pain will radiate to the flank, groin, and testes or labia majora. This pain can be a useful method of judging the level of obstruction. If a stone is at the vesicoureteric junction (VUJ), the patient may often complain of strangury (the urgent desire to pass urine with poor volumes, urinary frequency, and straining) due to irritation of the detrusor muscle from the stone. Nausea with vomiting is common. The pain is a colic, and thus comes in waves of varying intensity. Patients will often have completely pain

Differential diagnosis of renal colic	
Differential	**Features in history and examination**
Pyelonephritis	Fever and tender kidney (obstruction with sepsis is an emergency; if obstruction is suspected, immediate imaging is required)
Musculoskeletal pain	Worse with movement
Appendicitis	Tenderness or peritonism in right iliac fossa
Cholecystitis	Worse with eating fatty foods, tenderness in right upper quadrant
Diverticulitis	Associated bowel symptoms, usually tender in left iliac fossa
Leaking abdominal aortic aneurysm	Older age, vascular risk factors
Testicular torsion	Tender testis on examination
Gynaecological problems (for example, ovarian pathology, ruptured ectopic pregnancy)	Younger age, pelvic pain

free spells between attacks. Furthermore, they are often restless and cannot get comfortable, by contrast with peritonitic conditions in which patients remain still. Visible haematuria may occur, but in these cases it is important to ensure that the pain is not secondary to a clot as a result of other upper tract pathology. If concomitant urinary infection is present, the patient could complain of fevers and sweats. The table lists possible differential diagnoses

How should a person presenting with acute flank pain be assessed?

The underlying cause of acute flank pain is not always a urinary stone, and other important conditions can mimic this. A thorough history and examination are important to determine further management, with particular emphasis on eliciting the typical site and nature of the pain of renal colic, and exclusion of symptoms and signs suggesting that acute hospital admission is needed (boxes 1 and 2). In men, the testes must be examined because scrotal pathology may rarely present solely with abdominal pain. All patients must have their temperatures documented, and pyrexia should prompt immediate referral. A leaking abdominal aortic aneurysm can mimic left sided renal colic, and patients at high risk, such as those older than 60 years and with known arteriopathy (particularly if not previously a stone former), need immediate referral for imaging.

When can a patient be managed in a primary care or outpatient setting?

Patients with first presentation of renal colic are often seen in the emergency department, owing to both the severity of the pain and anxiety as to the cause. However, for patients in whom the diagnosis is clear, adequate pain relief can be achieved, and there are no complicating factors (box 1), it may be possible for a general practitioner to diagnose and manage patients with renal colic in the community and avoid acute hospital admission. This management is especially true for recurrent stone formers.

If the decision is taken to manage the patient in a community setting, urgent imaging must be arranged to confirm the diagnosis and assess the likelihood of spontaneous stone passage.[6] This confirmation could require liaison with radiology to ensure an appropriate timescale is achievable. Little evidence indicates what this timescale should be. Expert consensus has suggested that seven days is the maximum acceptable interval, and inability to achieve this could necessitate hospital admission. Urology outpatient assessment should occur within seven to 14 days.[6]

A common scenario is of a patient who is diagnosed in the emergency department with computed tomography (CT) and discharged home with conservative management. The patient should be advised that further episodes of pain are possible and that they may be caused by the stone passing. The patient should be supplied with nonsteroidal anti-inflammatory drugs (NSAIDs) for pain relief. Usually, these patients do not require readmission unless the pain is severe. A need for further scanning by CT would be rare, and second presentation to the emergency department would require referral to a urologist.

When does a patient with renal colic require hospital admission?

Inability to control pain and provide adequate analgesia are criteria for acute hospital referral.[6] Some clinical scenarios are of higher risk to the patient (box 1), and should suggest a lower threshold for referral into secondary care. In particular, any signs of urinary sepsis must be excluded (box 2); an obstructed infected kidney is an emergency because patients can rapidly deteriorate with overwhelming sepsis.

What investigations are needed when a stone is suspected?

Urine investigations

Expert guidelines from the British Association of Urological Surgeons (BAUS) and College of Emergency Medicine state that all patients should have a urine dipstick documented.[7 8] However, the sensitivity of haematuria in

Box 1 | Indications for acute hospital admission[6]

- Diagnostic uncertainty (consider admission for patients older than 60 years, because a leaking aortic aneurysm could present with similar symptoms)
- Inability to obtain or maintain adequate pain control
- Presence of significant fever (>37.5°C) in association with suspected renal colic
- Renal colic in patient with solitary or transplanted kidney
- Suspected bilateral obstructing stones
- Impending acute renal failure
- Inability to arrange early investigation or urological assessment

Box 2 | Signs of sepsis

- Fever (>37.5°C)
- Facial flushing
- Tachycardia (especially once pain relieved)
- Hypotension
- Loin tenderness

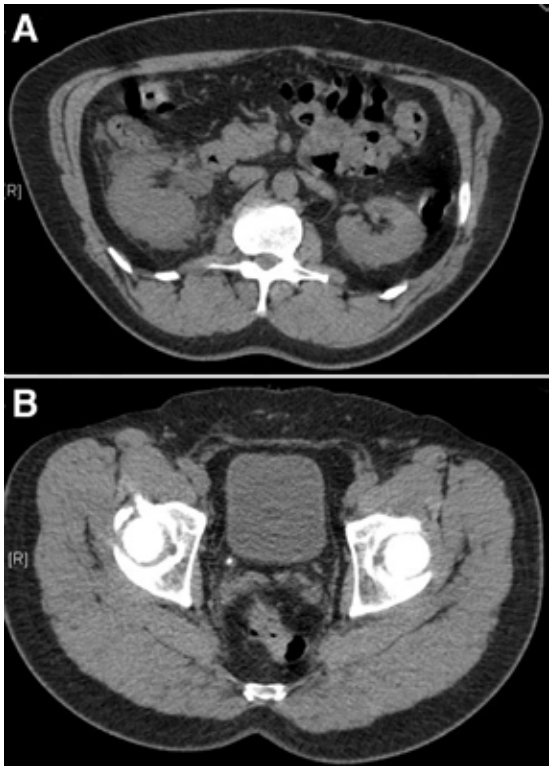

Fig 1 | Representative axial slices of the kidneys, ureter, and bladder for renal colic, using NCCT. (A) Normal contralateral (left) kidney, with hydronephrosis of the right kidney and peri-nephric fat stranding indicating obstruction.
(B) Distal ureteric stone (4 mm in diameter) with peri-ureteric oedema (rim sign) differentiating it from a phlebolith; the dilated ureter could also be traced down to the stone

Fig 2 | IVU, 1 h after contrast injection, showing a normal left kidney and dilated right pelvicalyceal system. The ureter is dilated all the way to the lower ureter (where a small calculus was visible on plain imaging). The image should be taken after micturition to allow the ureter to be traced to the bladder

patients with ureteric stones is about 90%, and 40% of patients presenting with acute flank pain and haematuria do not have urolithiasis.[9] Expert opinion suggests that the diagnosis and decision on whether to perform imaging should not be based solely on the presence or absence of haematuria.[10] The presence of leucocytes and nitrites would support a diagnosis of urine infection, and the expert guidelines state that a midstream urine sample should be sent for culture.[7 8]

Blood investigations

Expert guidelines state that determining full blood counts (for white cell counts) and renal function should be considered, which is mandatory in patients with pyrexia or a single functioning kidney.[7 8] Patients with proven stone formation should have basic metabolic studies measuring serum calcium and urate.[7]

Imaging

Most patients assessed in the emergency department will proceed to immediate imaging for a definitive diagnosis and management plan. However, if the pain has already resolved, there is no sepsis, and the patient has a normal contralateral kidney, immediate imaging is not mandatory and urgent imaging and review can be organised.[11] The exact timing of this approach will depend on local availability, but it is advantageous to make a firm diagnosis and management plan. In the only trial that analysed this, researchers arranged imaging within two to three weeks,[11] although other expert consensus opinion suggests a timeframe of seven days.[6]

Non-contrast CT

Non-contrast CT (NCCT) (fig 1) has become the imaging method of choice for investigating acute flank pain.[12 13] Several studies have shown consistently better results from NCCT than from intravenous urograms (IVUs; fig 2) (NCCT sensitivity 94-100% and specificity 92-100% *v* IVU 51-87% and 92-100%, respectively).[12] Radiation doses for NCCT can be reduced to similar levels as IVU by using a low dose protocol while maintaining diagnostic accuracy.[14] NCCT has other benefits over IVUs, including speed of the test, detection of other pathology, and eliminating risks of nephrotoxicity or of allergic or anaphylactic reactions from the intravenous contrast.[10] Guidelines from the BAUS, European Association of Urology (EAU), and American Urological Association recommend NCCT as the definitive investigation.[7 12 15] If the stone is visible on the scout film, a plain radiograph of the kidneys, ureter, and bladder is not required,[15] although such a radiograph would be needed if the stone was not visible, to assess visibility for directing the modality of follow-up imaging.[15]

Ultrasonography

Ultrasonography is a cheap alternative as a primary diagnostic screening tool,[12] particularly in thinner patients.[16] It is good at identifying stones (particularly those >5 mm in diameter) within the pelvicalyceal system. Patients should be scanned with a full bladder to identify stones at the VUJ. However, stones elsewhere in the ureter (between the pelvi-ureteric junction (PUJ) and VUJ) are unlikely to be seen. Secondary signs, such as dilatation, which may suggest an obstructing stone, improve the test's sensitivity. It is the first line test in pregnancy and children.[15]

Plain radiography of the kidneys, ureter, and bladder

Plain radiography of the kidneys, ureter, and bladder could be useful, with a sensitivity of 44-77% and specificity of 80-87%.[10] Detection rates of radiography and ultrasonography combined could approach those of CT if in the most experienced hands,[17] but a NCCT will be required if uncertainty remains. The combined approach is certainly reasonable if CT is not immediately available or if radiation dosing needs to be minimised.

A PATIENT'S PERSPECTIVE

My first experience of renal colic occurred when I was about 20 years old, and it was completely shocking as I had never experienced pain so severe. As well as the intense physical pain in my lower back, which came in waves, there was the added psychological aspect that I did not know what was going on, but knew that it was very serious. The intensity of the associated nausea and vomiting seemed to be amplified by this "fear factor." In the emergency department, the doctor gave me morphine, after which I fell asleep and the symptoms had passed when I awoke. When riding on my motorcycle the next day, I felt an urgent need to urinate and I passed a small stone.

Although this experience left me in fear of renal colic, the subsequent episodes have never had the intensity of the first; they were very unpleasant but I knew what was going on. As I have travelled a lot in the intervening period, including to some areas with poor healthcare, I always carry diclofenac and tramadol with me for emergencies, and I have learnt the importance of always drinking enough fluid.

Where are stones usually located?

Anatomically, the three narrowest parts of the ureter are at the PUJ, in the mid-ureter where the ureter crosses the iliac vessels, and at the VUJ. The most common site at presentation by far is at the VUJ; 60.6% of stones were found in this location by a retrospective review of 94 patients admitted to the emergency department with colic.[18] The study also found 23.4% of stones in the proximal ureter; 10.6% at the PUJ; and only 1.1% at the level of the iliac vessels.

What initial analgesia and advice should be given?

NSAIDs and opiates are the mainstay of treatment. Systematic reviews have shown that NSAIDs achieve a greater reduction in pain scores and that patients are less likely to require additional analgesia than those treated with opiates. Furthermore, opiates (particularly pethidine) are associated with higher rates of adverse effects such as vomiting.[19 20] Thus, NSAIDs should be used as first line analgesia unless a patient has a contraindication to their use (for example, history of peptic ulceration, known or suspected renal impairment, severe asthma). A Cochrane review of analgesia in renal colic was unable to determine which NSAID is best.[20] The BAUS guidelines suggest oral or parenteral diclofenac as first line treatment,[7] although choice will depend on local policies. If an opioid is used, it is recommended that pethidine is not used, owing to a high association with vomiting.[19]

Often patients are advised to increase oral fluid intake to accelerate stone passage, and some centres have used high volume intravenous fluid replacement or diuretics to achieve the same outcome. A Cochrane review found no convincing evidence to support these high volume strategies.[21] There is no guidance on what patients should be advised, but our personal opinion would be to advise 2 L of oral fluid per day to ensure hydration, especially if receiving nephrotoxic agents.

In one randomised trial, local warming using an electric blanket applied to the lateral abdomen and lower back was found to be an effective method of improving pain control (compared with controls (no warming)), particularly in a community setting.[22] Acupuncture is used extensively in some parts of the world, and one randomised study showed equivalent effect compared with an intramuscular analgesic.[23] There is low quality evidence for the use of anti-spasmodic drugs in renal colic, with no benefit observed in one randomised trial of hyoscine versus placebo. However, another randomised study suggested some benefit to intravenous papaverine in patients with ongoing pain after diclofenac.[24]

If a stone is passed and can be obtained from the urine, biochemical analysis can be performed (recommended in first time stone formers), which will avoid the need for any further imaging as long as symptoms have settled.[15] Therefore, asking the patient to sieve their urine may be beneficial.

What is the chance of stones passing spontaneously and how long does it take?

Whether a stone will pass spontaneously depends on its size and location. In one single centre study analysing 172 patients by stone location, the passage rates were 48%, 60%, 75%, and 79% for proximal, mid, distal ureteric, and VUJ stones, respectively.[25] When analysed by stone size, the rates were 76%, 60%, 48%, and 25% for 2-4 mm, 5-7 mm, 7-9 mm, and >9 mm diameters, respectively.

A meta-analysis of available studies (328 patients) showed an overall passage rate of 68% for stones at least 5 mm in diameter and 47% for stones of 5-10 mm.[26] A more recent report of 656 patients chosen to be managed conservatively, showed an overall passage rate of 86% (without medical expulsive therapy).[27] Of stones that passed, 55.3%, 73.7%, and 88.5% did so within seven, 14, and 28 days, respectively. The mean time to passage was 6.8, 12.6, 14.8, and 21.8 days for stone sizes of at least 2 mm, 2-4 mm, 4-6 mm, and 6-8 mm, respectively, although 42.5% of stones larger than 6 mm did not pass within two months. Intervention was significantly more likely for proximal stones larger than 6 mm in size. In a smaller but much quoted study (75 patients), the mean time to stone passage was similar although the intervention rates were higher (50% for stone diameter >4 mm).[28] Of stones up to 6 mm in diameter that did pass, 95% did so within four to six weeks.

What is the role of medical expulsive therapy?

Growing evidence indicates that treatments can increase the passage rates of stones by relaxing ureteric smooth muscle, either by α1 receptor blockade or calcium channel pump inhibition. Several studies have used nifedipine, while a range of α blockers have shown equivalent efficacy suggesting a class effect.[12] In a meta-analysis, patients given medical expulsive therapy had a 65% (relative) greater likelihood of stone passage than controls (no treatment), and the number needed to treat was four.[29] In another analysis, the absolute benefit with α blockers was 29% over controls, and only 9% with nifedipine.[26] Not only do α blockers increase expulsion rates, but they also reduce time to expulsion, pain episodes, perceived pain scale, and analgesic requirements.[24]

Most of these studies are for stones in the distal ureter and smaller than 10 mm in diameter. Since small stones (<5 mm) will probably pass anyway, the greatest treatment effect has been for sizes of 5-10 mm.[12] Only one

randomised study has specifically investigated upper ureteric stones.[30] Stones smaller than 5 mm had a higher passage rate with tamsulosin than no treatment (71.4% *v* 50%), while 5-10 mm stones showed a benefit in terms of relocating to the distal ureter. From these studies, it is not surprising that the guidelines advocate medical expulsive therapy.[7 12 26] Patients should be warned of the adverse effects of the drugs, and that it is an off-label indication. Women should be advised to use contraception to avoid pregnancy while taking the drug.

How long is it safe to leave a stone?

Existing evidence is weak. In old animal experiments with complete unilateral obstruction, irreversible loss did not occur before two weeks, although total renal loss can occur by six weeks.[31] Fortunately, stones usually only cause partial obstruction. The guidelines recommend periodic evaluation if a stone is treated conservatively,[26] with ultrasonography to check for hydronephrosis.[15] If a stone has not passed within four to six weeks, it is unlikely to do so and intervention will probably be required.

QUESTIONS FOR FUTURE RESEARCH

What is the role of medical expulsive therapy? (Ongoing trial by the National Institute for Health Research, SUSPEND (spontaneous urinary stone passage enabled by drugs))

What is the best surgical intervention for ureteric stones? (Future trial proposed by National Institute for Health Research trial to compare extracorporeal shockwave lithotripsy with ureteroscopy, TISU (therapeutic intervention for stones in the ureter))

Is retrograde stenting or insertion of percutaneous nephrostomy the best form of drainage in an obstructed infected kidney?

ADDITIONAL EDUCATIONAL RESOURCES

Resources for healthcare professionals

British Association of Urological Surgeons. Guidelines for acute management of first presentation of renal/ureteric lithiasis. 2012. www.baus.org.uk/NR/rdonlyres/3ABD2302-A13A-4650-B47C-2CDAB77DFCA8/0/RevisedAcuteStoneMgtGuidelines.pdf—provides brief overview of management of first presentation of renal or ureteric stone

European Association of Urology. Guidelines on urolithiasis. 2012. www.uroweb.org/gls/pdf/20_Urolithiasis_LR%20March%2013%202012.pdf—provides in depth, well referenced guidelines on all aspect of renal ureteric stone disease (translations also available in Greek, Russian, Spanish, Turkish, and Portuguese from association's website)

Information resources for patients

British Association of Urological Surgeons (www.baus.org.uk/patients/symptoms/calculi.htm)—Provides general information on kidney stones, including causes, treatment, and what to expect from a visit to a general practitioner

Patient.co.uk (www.patient.co.uk/health/Kidney-Stones.htm)—Provides information on kidney stones

Patient.co.uk (www.patient.co.uk/doctor/Loin-Pain.htm)—Provides details on causes of loin pain with factors in the history and examination that may help identify the cause

NHS Choices (www.nhs.uk/Conditions/Kidney-stones/Pages/Introduction.aspx)—Provides information on kidney stones through the NHS Choices Portal

When is urgent surgical intervention required?

Emergency surgical intervention is recommended in four situations: presence of an obstructed infected kidney, obstruction of a solitary kidney, bilateral obstruction, or uncontrolled pain. Infection in the presence of obstruction requires emergency surgery. Patients can deteriorate quickly with profound hypotension and septic shock, usually due to Gram negative organisms. Aggressive fluid resuscitation with broad spectrum intravenous antibiotics should be instituted and support from an intensive care unit may be required. Antibiotic delivery into the obstructed system is limited, and thus urgent decompression is indicated,[12] which can be achieved either with a percutaneous nephrostomy or a retrograde ureteric stent. A nephrostomy tube is typically inserted by interventional radiologists under local anaesthesia or sedation with direct needle puncture into the collecting system through the loin. A retrograde stent is inserted with a cystoscope via the bladder by urologists in the operating theatre using a cystoscopy. A randomised trial in this setting showed no significant difference in outcomes between the two interventions,[32] and consequently both the BAUS and EAU guidelines advocate the use of either.[7 12] The choice will depend on local preference and availability; stone characteristics; and patient factors such as obesity, coagulopathy, and suitability for anaesthesia.[32] Either way, only decompression of the collecting system should be obtained, and the stone must not be treated until the patient has fully recovered and the sepsis resolved.[12]

What follow-up imaging should be used?

If stones are managed conservatively, the evidence for timing and modality of follow-up imaging is limited. If a patient passes the stone, no further imaging is required.[15] If the stone was visible on the NCCT scout film, a radiograph of the kidneys, ureter, and bladder can be used to assess the stone's progress. If the stone was not visible at the time of NCCT, a radiograph should have been performed at that time, because 10% of stones will still be visible. For follow-up, the expert panel recommends a plain radiograph of the kidneys, ureter, and bladder to check for the stone as well as ultrasonography to assess the degree of hydronephrosis.[15] If the patient is symptomatic and those investigations are normal, low dose NCCT is recommended. Stones that are radiolucent will also need low dose NCCT.

What treatment options are available for the stone?

When to actively treat a stone will depend on size, location, ongoing symptoms, local availability, and patient preference. Most units will conservatively manage patients with stones smaller than 10 mm, controlled pain, normal renal function, and no signs of sepsis. If stones have not passed within four to six weeks, they are unlikely to do so,[28] and very few pass after eight weeks.[27] Patient preference is paramount, especially in situations where commitments necessitate a predictable clinical course or they intend on foreign travel. A patient's intention to travel would be an indication for prompt stone treatment, and patients with

TIPS FOR NON-SPECIALISTS

Exclude non-stone causes in patients presenting with renal colic

Evaluate for signs of sepsis in patients presenting with renal colic

Provide adequate analgesia using NSAIDs initially, and titrate up the analgesic ladder (avoiding pethidine) according to pain

Pain free patients without signs of sepsis or red flags for admission (boxes 1 and 2) can be managed in an outpatient setting

Liaison with local radiology department may be required to organise appropriate and timely imaging if patients are managed outside the hospital setting; based on the limited available evidence, our opinion is that this should be within seven days and ideally sooner

ureteric stones should be advised of the risks of developing colic during a flight. If the flight had to be diverted, patients could be liable for medical costs since their insurance policy would probably be invalidated.[33]

Indications for initial active treatment of stones are low chance of spontaneous passage, persistent pain, ongoing obstruction, and renal insufficiency.[12] If coexistent infection is present at admission for treatment, renal drainage only should be conducted.

The main treatment options are extracorporeal shockwave lithotripsy (ESWL) or ureteroscopy. ESWL is usually an outpatient procedure performed with analgesia or sedation. A shockwave is generated and focused on the stone. The procedure is generally well tolerated but is not available in all urology units, and could require more than one treatment. Ureteroscopy is typically done under general (or spinal) anaesthesia. Usually a rigid or semi-rigid ureteroscope is used, although evidence suggests that flexible ureteroscopy has better clearance rates for upper ureteric stones.[26] The vast majority of stones will be cleared in one treatment, but an indwelling stent may be required for some time afterwards.

Both procedures have high success rates for all ureteric stones. A meta-analysis of available studies has shown ESWL to have stone free rates of 82%, 73%, and 74% for proximal, mid, and distal ureteric stones, respectively.[12] Corresponding success rates for ureteroscopy were 82%, 87%, and 93%, respectively. In relation to stone diameter size, ureteroscopy obtained significantly better results than ESWL (distal ureteric stones, <10 mm 97% *v* 86%, >10 mm 93% *v* 74%; proximal ureteric stones, >10 mm 81% *v* 70%). However, since the success rates are so high, patients can opt for the less invasive option of ESWL if available. ESWL may be better for proximal stones smaller than 10 mm.[26] A recent Cochrane review concluded that ureteroscopy had a better stone free rate but a longer hospital stay and greater risk of complications than ESWL.[34] Only rarely would other more invasive surgical options be used, such as percutaneous antegrade ureteroscopy (involving direct puncture into the kidney) or laparoscopy, which is usually reserved for large stones (>15 mm), and only if other options have failed or are not suitable.[12]

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1 Curhan GC. Epidemiology of stone disease. *Urol Clin N Am* 2007;34:287-93.
2 Scales CD, Curtis LH, Norris RD, Springhart WP, Sur RL, Schulman KA, et al. Changing gender prevalence of stone disease. *J Urol* 2007;177:979-82.
3 Pearle MS, Lotan Y. Urinary lithiasis: etiology, epidemiology, and pathogenesis. In: Wein AJ, Kavoussi LR, Novick AC, Partin AW, Peters CA, eds. Campbell-Walsh Urology. 10th ed. Elsevier Saunders, 2012.
4 Taylor EN, Stampfer MJ, Curhan GC. Obesity, weight gain, and the risk of kidney stones. *JAMA* 2005;293:455-62.
5 Borghi L, Meschi T, Amato F, Briganti A, Novarini A, Giannini A. Urinary volume, water and recurrences in idiopathic calcium nephrolithiasis: a 5-year randomized prospective study. *J Urol* 1996;155:839-43.
6 Wright PJ, English PJ, Hungin APS, Marsden SNE. Managing renal colic across the primary-secondary care interface: a pathway of care based on evidence and consensus. *BMJ* 2002;325:1408-12.
7 BAUS section of endourology. Guidelines for acute management of first presentation of renal/ureteric lithiasis. 2012. www.baus.org.uk/Resources/BAUS/Documents/PDF%20Documents/Sections/Endourology/Revised%20Acute%20Stone%20Mgt%20Guidelines.pdf.
8 Clinical effectiveness committee of the College of Emergency Medicine. Clinical standards for emergency departments. 2010. www.collemergencymed.ac.uk/code/document.asp?ID=4688.
9 Argyropoulos A, Farmakis A, Doumas K, Lykourinas M. The presence of microscopic hematuria detected by urine dipstick test in the evaluation of patients with renal colic. *Urol Res* 2004;32:294-7.
10 Heidenreich A, Desgrandchamps F, Terrier F. Modern approach of diagnosis and management of acute flank pain: review of all imaging modalities. *Eur Urol* 2002;41:351-62.
11 Lindqvist K, Hellström M, Holmberg G, Peeker R, Grenabo L. Immediate versus deferred radiological investigation after acute renal colic: a prospective randomized study. *Scand J Urol Nephrol* 2006;40:119-24.
12 European Association of Urology Guidelines on urolithiasis. 2012. www.uroweb.org/gls/pdf/20_Urolithiasis_LR%20March%2013%202012.pdf.
13 Worster A, Preyra I, Weaver B, Haines T. The accuracy of non-contrast helical computed tomography versus intravenous pyelography in the diagnosis of suspected acute urolithiasis: a meta-analysis. *Ann Emerg Med* 2002;40:280-6.
14 Niemann T, Kollmann T, Bongartz G. Diagnostic performance of low-dose CT for the detection of urolithiasis: a meta-analysis. *Am J Roentgenol* 2008;191:396-401.
15 Fulgham PF, Assimos DG, Pearle MS, Preminger GM. Clinical effectiveness protocols for imaging in the management of ureteral calculus disease: AUA technology assessment (American Urological Association guideline). 2012. www.auanet.org/resources.cfm?ID=693.
16 Pichler R, Skradski V, Aigner F, Leonhartsberger N, Steiner H. In young adults with a low body mass index ultrasonography is sufficient as a diagnostic tool for ureteric stones. *BJU Int* 2012;109:770-4.
17 Catalano O, Nunziata A, Altei F, Siani A. Suspected ureteral colic: primary helical CT versus selective helical CT after unenhanced radiography and sonography. *Am J Roentgenol* 2002;178:379-87.
18 Eisner BH, Reese A, Sheth S, Stoller ML. Ureteral stone location at emergency room presentation with colic. *J Urol* 2009;182:165-8.
19 Holdgate A, Pollock T. Systematic review of the relative efficacy of non-steroidal anti-inflammatory drugs and opioids in the treatment of acute renal colic. *BMJ* 2004;328:1401.
20 Holdgate A, Pollock T. Non-steroidal anti-inflammatory drugs (NSAIDs) versus opioids for acute renal colic. *Cochrane Database Syst Rev* 2004:1;CD004137.
21 Worster AS, Bhanich Supapol W. Fluids and diuretics for acute ureteric colic. *Cochrane Database Syst Rev* 2012;2:CD004926.
22 Kober A, Dobrovits M, Djavan B, Marberger M, Barker R, Bertalanffy P, et al. Local active warming: an effective treatment for pain, anxiety and nausea caused by renal colic. *J Urol* 2003;170:741-4.
23 Lee YH, Lee WC, Chen MT, Huang JK, Chung C, Chang LS. Acupuncture in the treatment of renal colic. *J Urol* 1992;147:16-8.
24 Tseng TY, Preminger GM. Kidney stones. *Clin Evid* 2011;11:2003.
25 Coll DM, Varanelli MJ, Smith RC. Relationship of spontaneous passage of ureteral calculi to stone size and location as revealed by unenhanced helical CT. *Am J Roentgenol* 2002;178:101-3.
26 Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck AC, Gallucci M, et al. (American Urological Association Education and Research; European Association of Urology). 2007 Guideline for the management of ureteral calculi. *Eur Urol* 2007;52:1610-31.
27 Tchey DU, Ha YS, Kim WT, Yun SJ, Lee SC, Kim WJ. Expectant management of ureter stones: outcome and clinical factors of spontaneous passage in a single institution's experience. *Korean J Urol* 2011;52:847-51.
28 Miller OF, Kane CJ. Time to stone passage for observed ureteral calculi: a guide for patient education. *J Urol* 1999;162:688-90.
29 Hollingsworth JM, Rogers MA, Kaufman SR, Bradford TJ, Saint S, Wei JT, et al. Medical therapy to facilitate urinary stone passage: a meta-analysis. *Lancet* 2006;368:1171-9.
30 Yencilek F, Erturhan S, Canguven O, Koyuncu H, Erol B, Sarica K. Does tamsulosin change the management of proximally located ureteral stones? *Urol Res* 2010;38:195-9.
31 Vaughan ED Jr, Gillenwater JY. Recovery following complete chronic unilateral ureteral occlusion: functional, radiographic and pathologic alterations. *J Urol* 1971;106:27-35.
32 Pearle MS, Pierce HL, Miller GL, Summa JA, Mutz JM, Petty BA, et al. Optimal method of urgent decompression of the collecting system for obstruction and infection due to ureteral calculi. *J Urol* 1998;160:1260-4.
33 Borley NC, Rainford D, Anson KM, Watkin N. What activities are safe with kidney stones? A review of occupational and travel advice in the UK. *BJU Int* 2007;99:494-6.
34 Aboumarzouk OM, Kata SG, Keeley FX, McClinton S, Nabi G. Extracorporeal shock wave lithotripsy (ESWL) versus ureteroscopic management for ureteric calculi. *Cochrane Database Syst Rev* 2012;5:CD006029.