Investigation and Management of Renal Colic

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Nephrolithiasis

- Majority (approx 80%) are calcium stones
- Others include uric acid, struvite and cystine
Risk Factors

- Past Medical Hx of renal calculi
- Family Hx of renal calculi
  - consider hereditary diseases associated with stones
- Enhanced enteric oxalate absorption
  - Gastric bypass, short bowel syndrome
- Patient factors
  - HTN, obesity, gout, DM, extreme exercise, poor oral fluid intake
- Persistantly acidic urine
  - Chronic diarrhoea, metabolic disorders (gout, DM, obesity)
- Recurrent upper UTIs
- UTI due urease-producing organisms (Protease, Klebsiella) increases risk of struvite stones
Renal Colic

- Symptoms most at passage of stone from renal pelvis into ureter
- Thought to be due to obstruction and distention of the renal capsule
- Colicky (due to ureteric spasm) and migratory as the stone travels down the ureter
- Passage of a stone usually associated with haematuria
- Other Symptoms may include N&V, dysuria and urgency
- Significant complications include obstruction, infection and ARF
Differential Diagnosis

- Renal cell carcinoma
- Pyelonephritis
- Gynae - ectopic pregnancy/cyst accident, dymenorrhoea
- Surgical - bowel obstruction, mesenteric ischaemia, appendicitis, diverticulitis
- Biliary colic/cholecystitis
- Herpes zoster
- AAA
Diagnosis

- **Non-con helical CT**
  - 3-5mm cuts
  - May identify alternative diagnosis
  - Some information regarding stone composition
  - **Radiation dose**
    - Low dose CT have similar sensitivity and specificity except with small (<2mm) stones and in obese patients

- **Ultrasound**
  - No radiation
  - Sensitive for obstruction
  - May be able to identify radiolucent stones
  - Harder to detect smaller stones and distal ureteric stones
  - Useful if patient is pregnant or unsure
CT scan shows a calculus in the proximal left ureter causing delayed excretion of contrast material from the left kidney (long arrow). All the contrast has been excreted from the normal functioning right kidney and is in the nondilated right ureter (small arrow).

CT scan: computed tomographic scan.

Courtesy of Jonathan Kruskal, MD.
Kidney stone detected by ultrasonography

The sagittal view of the right kidney reveals a 7 mm shadowing stone in mid-portion of the kidney, characteristic of a non-obstructing stone. The echogenic focus (white arrow) represents the stone. The calcified stone inhibits transmission of sound waves, resulting in a shadow behind the stone (red arrows).
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**USS v CT in the ED**


- Pts with clinical suspicion of renal colic randomised to non-contrast CT, USS by radiologist, bedside US by trained ED physician
- Sensitivity
  - USS 57% (radiologist), 54% (ED physician)
  - CT 88%
- Radiation dose higher in CT group
- Significant missed diagnoses similar
  - USS 0.5%, CT 0.3%
- Adverse events & repeat visits to ED similar
- Length of stay in ED longer when US performed by Radiologist
Other imaging modalities

- **AXR/XRay KUB**
  - Will detect large radiopaque stones
  - Potential to miss uric acid stones, smaller stones and stones overlying bone
  - Does not detect signs of obstruction

- **IVP**
  - More specific and sensitive than plain XR
  - Detects obstruction
  - Potential for contrast reactions, significant radiation dose

- **MRI**
  - Some role in pregnancy
Intravenous pyelogram showing ureteral stone

An image obtained during the excretory phase of an intravenous pyelogram shows contrast material in the right renal pelvis and ureter extending down to the mid-ureter where a small calculus is obstructing the lumen (arrow).

Courtesy of Jonathan Kruskal, MD.
The plain film of the abdomen in the anteroposterior projection reveals a staghorn calculus. Note calcifications (arrows) in the opposite kidney as well.
## Radiologic procedures in evaluating renal stones

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>KUB</td>
<td>Readily available</td>
<td>Requires skilled radiologist to interpret</td>
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<tr>
<td></td>
<td>Inexpensive</td>
<td>Limited sensitivity and specificity</td>
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<td>Limited radiation</td>
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<td></td>
<td>Useful in acute setting</td>
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<tr>
<td>Ultrasound</td>
<td>Readily available</td>
<td>Moderately expensive</td>
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<td>Roughly equivalent to IVP as a diagnostic test</td>
<td>Poor performance with small stones</td>
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<td>Improved sensitivity with use of color Doppler</td>
<td>Requires skilled technician and radiologist</td>
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<td></td>
<td>No radiation exposure</td>
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<td></td>
<td>Good for hydronephrosis</td>
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<tr>
<td>Excretory urography (IVP)</td>
<td>Useful in planning therapy and confirming diagnosis</td>
<td>Moderately expensive</td>
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<td></td>
<td>Long established history as gold standard</td>
<td>Intravenous contrast required</td>
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<td></td>
<td></td>
<td>Moderate x-ray exposure</td>
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<tr>
<td>CT scan (including spiral CT)</td>
<td>Probably new gold standard</td>
<td>Expensive</td>
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<tr>
<td></td>
<td>Can distinguish radiolucent stones from blood or tumor</td>
<td>Moderate x-ray exposure</td>
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<td></td>
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<td>Not uniformly available</td>
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<tr>
<td>MRI</td>
<td>Great potential for localizing site of stone in ureter</td>
<td>Very expensive</td>
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<td></td>
<td>Largely investigational so far except in certain centers</td>
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<td></td>
<td>Poorly tolerated by many patients</td>
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<td>Stones are not affected by magnet and may be missed</td>
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Further investigation

- **Bloods**
  - FBE, UECreatinine, LFT’s, Inflammatory markers, calcium, urate

- **Urine**
  - pH, crystals, oxalate
  - Straining urine for stones
  - Cytology and Culture

- **Genetic testing**
  - Dent’s disease, adenine phosphoribosyltransferase deficiency, cystinuria
Management

- Analgesia and hydration
  - NSAIDs v opiates
    - NSAIDs can reduce smooth muscle tone in the ureter
    - Possibly best in combination
    - NSAIDs should be avoided/used with care in severe dehydration and impaired renal function
Passing a stone

- <5mm likely to pass without intervention
- >10mm unlikely to pass without intervention
- Increased intervention requirements with larger stones
- Likelihood of stone passing also affected by position
  - Stones at the vesicoureteric junction more likely to be passed than those in the proximal ureter
Medical Expulsive Therapy

- **Alpha-blockers** - prazosin, tamsulosin (tamsulosin is a selective $\alpha_{1A}$ receptor blocker so less Side Effects than with prazosin but cost implications as not on PBS)

- The randomized control trials have shown no benefit in stones less than 5mm and some questionable benefit in stones larger than 10mm


Medical Expulsive Therapy for Ureterolithiasis: The EAU Recommendations in 2016. Türk C¹, Knoll T², Seitz C³, Skolarikos A⁴, Chapple C⁵, McClinton S⁶; European Association of Urology.

- **Calcium channel blockers** – (nifedipine)- decreases human ureteral peristalsis and has limited use in renal colic management
Urological referral

- Urosepsis
- Acute Renal Failure (ARF)
- Anuria
- Uncontrolled pain
- Stones not passed after trial of medical therapy (usually about 4 weeks)
Intervention

- **Emergency**
  - Infected obstructed kidney, bilateral obstruction with AKI or obstructed single kidney with AKI requires urgent decompression via percutaneous drainage or ureteric stenting

- **Shock wave lithotripsy**

- **Ureteroscopic lithotripsy**

- **Percutaneous nephrolithotomy with endoscopic stone removal**

- **Open surgical removal**
Prevention of stone recurrence

- Stone analysis
- Increased fluid intake
- Dietary and lifestyle factors
  - Obesity, diabetes, exercise
  - Low sodium diet for calcium stones
  - Low purine diet for uric acid stones
  - Avoidance of muscle building supplements which are high in purines
### Major risk factors for calcium stones

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<tr>
<th>Urinary</th>
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<tr>
<td>Lower volume</td>
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<tr>
<td>Higher calcium</td>
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<td>Higher oxalate (CaOx stones)</td>
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<td>Lower citrate</td>
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<td>Higher pH (CaP stones)</td>
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<th>Anatomic</th>
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<td>Medullary sponge kidney</td>
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<td>Horseshoe kidney</td>
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<table>
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<th>Diet</th>
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<td>Lower fluid intake</td>
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<tr>
<td>Lower dietary calcium</td>
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<td>Higher oxalate</td>
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<td>Lower potassium</td>
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<td>Higher animal protein</td>
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<td>Higher sodium</td>
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<td>Higher sucrose</td>
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<td>Higher fructose</td>
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<td>Lower phytate</td>
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<td>Higher vitamin C</td>
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<th>Other medical conditions</th>
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<td>Primary hyperparathyroidism</td>
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<td>Gout</td>
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<td>Obesity</td>
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<td>Diabetes mellitus</td>
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Additional treatments

- Thiazide diuretics in combination with low sodium diet for calcium stones
- Potassium citrate for hypocitraturia and to alkalinise the urine in uric acids stones (also some role for allopurinol in uric acid stone prevention)
- Increased fluid intake, urinary alkalinisation and tiopronin (thiol drug which decreases the precipitation of cystine in the urine) and D-Pencillamine for cystine stones
Penicillamine is a first-generation chelating agent that combines with cystine to form a soluble disulfide complex (50 times more soluble than cystine), thus preventing stone formation and possibly even dissolving existing cystine stones.
In summary

- Renal colic usually presents as unilateral, colicky, loin/flank pain
- Haematuria present in majority of cases
- 1st line imaging either CT or US
- Smaller (<10mm) stones usually managed conservatively
  - Fluids, analgesia & MET (Medical Expulsive Therapy)
- Surgical options include ESWL and ureteroscopy
  - Emergency decompression indicated for infected obstructed kidney, bilateral obstruction with AKI & obstructed single kidney with AKI