Kidney Stones: Diagnosis, Treatment and Prevention

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Objectives

- Epidemiology
- Etiology
- Stone types and characteristics
- Making the diagnosis
- Treatment options
- Prevention strategies

Epidemiology

- Increasing prevalence over the past four decades
- NHANES data: 10.6% in men, 7.1% in women
- Peaks in 4-6th decade of life
- Links to other disease:
  - HTN
  - Obesity
  - DM

Etiology – Disease States

- Primary hyperparathyroidism
- Increased PTH
- Resorptive hypercalciuria
- Parathyroidectomy
- Gout
- Hyperuricemia and hyperuricosuria
- Type 2 DM and obesity
- Insulin resistance leads to low urine pH and hypercalciuria
- Malabsorptive GI disorders
- Fat malabsorption, increased permeability, dehydration, acidosis

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Etiology – Genetic Diseases

- Primary Hyperoxaluria
  - Rare autosomal recessive disease
  - Early renal failure treated with K-L transplant

- Cystinuria
  - Autosomal recessive defect in renal transport of COLA
  - High cystine excretion leads to supersaturation

- Dent disease
  - X-linked disorder presenting mainly in males
  - Proteinuria, hypercalciuria, ESRD

- Distal RTA
  - Metabolic acidosis with setting of high urine pH
  - Hypocitraturia, hyperchloremia, hypokalemia

Etiology – Drugs

- Drugs that cause urinary changes:
  - Topiramate and acetazolamide
  - Carbonic anhydrase inhibitors
  - Acidosis, hypokalemia, hyperuricemia, hypocitraturia

- Drugs that can form crystals:
  - Triamterene
  - Ephedrine
  - Some protease inhibitors – Indinavir
  - Overuse of supplements
    - Vitamin C, calcium, Vitamin D

Etiology

- Chronic infection
  - Urease-producing organisms
  - High urine pH
  - Struvite stones

- SCI patients
  - Immobilization
  - Chronic indwelling catheters
  - Chronic colonization

Etiology

- Anatomic abnormalities
  - Ureteropelvic junction obstruction (UPJO)
  - Horseshoe kidney
  - Medullary sponge kidney

Etiology

- Diet
  - Low fluid intake
  - High intake of meat
  - Low or high calcium intake
  - Limited intake of fruits or vegetables
  - Excessive sodium intake
  - High oxalate intake with low calcium intake

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Types of Kidney Stones

- Calcium oxalate – 60%
- Calcium phosphate – 20%
- Struvite – 7%
- Uric Acid – 7%
- Cystine – 3%
- Drug-induced - <1%

Visible on KUB?

- Radio-opaque
  - Calcium oxalate
  - Calcium phosphate
  - Struvite
  - Cystine
- Radiolucent
  - Uric acid
  - Matrix
  - Triamterene
  - Indinavir (also invisible on CT)

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Making the Diagnosis

- Classic symptoms
  - Colicky flank pain
  - Nausea/vomiting
  - Hematuria
  - Irritative voiding symptoms

Making the Diagnosis

- Exam
  - Vitals
  - CVA tenderness
- Labs
  - CBC
  - BMP
  - U/A
- Imaging in the acute setting
  - CT stone protocol
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Treatment Options

- Observation
  - Pain controlled
  - Able to tolerate PO intake
  - No evidence of urinary tract infection
    - No fever
    - Negative urinalysis
    - Normal WBC count
    - Stone is passable

- Is stone passable?
  - Width of stone is most significant predictor
    - <4mm = 80%
    - 4-6mm = 59%
    - >6mm = 21%
  - Stone location at presentation is also important
    - Proximal = 22%
    - Middle = 46%
    - Distal = 71%
Treatment Options

- How long will it take to pass
  - 95% of stones ≤ 5mm will pass within 40 days
  - About 5% of stones < 2mm require surgical intervention
  - 50% of stones ≥ 5mm require surgical intervention

Treatment Options

- All criteria for observation are met
  - NSAIDs
  - Narcotics
  - Flomax – controversial after recent SUSPEND trial
  - Pickard et al, Lancet 2015
  - Strain urine
  - Follow-up with Urology in 2 weeks
  - Bring stone if collected
  - Stone needs to pass or be surgically removed in 6-8 weeks

Treatment Options

- Indications for immediate intervention
  - Uncontrolled pain, inability to tolerate PO, infection
  - Bilateral ureteral stones or stone in solitary kidney
  - Significantly elevated creatinine
  - Immunocompromised or diabetic patient
  - Size/location unlikely to pass

Treatment Options

- Immediate intervention
  - Ureteral stent placement under local or MAC anesthesia
  - Nephrostomy tube placement by Interventional Radiology
  - UTI suspected
  - Await culture results
  - Give 2 weeks of culture specific antibiotics
  - Definitive procedure after treatment of UTI
  - Procedure depends on size and location of stone

Treatment Options

- Extracorporeal Shock Wave Lithotripsy (ESWL)
  - General anesthesia
  - Non-invasive with no ureteral stent
  - Stone needs to be visible on KUB
  - Good candidate
    - Low BMI, smaller stone, softer stone
  - Most common complication is bleeding
  - May need second procedure for incomplete passage or obstructing ureteral fragments

Treatment Options

- Ureteroscopy with LASER lithotripsy
  - General anesthesia
  - Instrumentation can be done on anticoagulation
  - Can treat stones up to 2 cm and multiple stones
  - Holmium laser can break any type of stone
  - Often requires post-op ureteral stent which is quite symptomatic
  - Rare need for second procedure if ureter is too narrow
  - Stent for 2 weeks and then repeat procedure
  - 1-3% chance of ureteral injury
  - Requires prolonged stent
Treatment Options

- Percutaneous Nephrolithotomy (PCNL)
  - General anesthesia, 2 night hospital stay
  - Reserved for > 2 cm stones
  - Nephrostomy access done by IR
  - Increased risk of bleeding
  - Post-op CT done to check for stone clearance
  - May need second look for any retained stones

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Prevention Strategies - Diet

- Increase fluid – goal is 2L of urine per day (Borghi et al., 1996)
- Calcium intake 1000-1200mg per day
  - Preferably in food form
  - Supplements taken with meals, calcium citrate
- Low oxalate diet
- Moderate protein
  - 2-3 servings of animal per day
- Increase fruits and vegetables, especially citrus
- Low salt < 3000 mg/day
- Avoid Vitamin C supplements

Prevention Strategies - Medications

- Thiazide diuretics
  - Increases calcium reabsorption in the distal tubule
  - Volume depletion leads to calcium reabsorption in the proximal tubule
- Potassium citrate
  - Used in conjunction with thiazide to prevent hypokalemia and hypocitraturia
  - Goal is to alkalize urine to 6.5-7.0
- Allopurinol
  - Treats hyperuricemia and lowers urinary uric acid
  - Add if purine restriction is not adequate
  - Can reduce risk of both uric acid stones and calcium stones
In Summary

- Prevalence is increasing
- Stones are not an isolated disease
- Preferred imaging in the acute setting is a CT stone protocol
- Referral to urology for all stones
- Urgent referral for ureteral stone with uncontrolled symptoms, possible infection or large (> 6-7 mm) stone
- Treatment depends on size and location of stone
- Prevention strategies can decrease recurrence

References