

# Kidney Stones

## Medical Student Case-based Learning



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**A 46 YEAR OLD OBESE MAN PRESENTS TO THE ER  
WITH SUDDEN ONSET RIGHT FLANK PAIN  
RADIATING TO THE GROIN. NO AGGRAVATING  
OR ALLEVIATING FACTORS. VITAL SIGNS ARE  
NORMAL.**

What are the clinical symptoms associated with renal colic?



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# Renal Colic Clinical Symptoms

- Episodic flank pain radiating to the groin or scrotum
- May localize to the abdomen overlying stone
- Intense pain
- Irritative voiding symptoms
  - Urgency
  - Frequency, dysuria



# What Is The Burden Of Kidney Stones On The US Population?



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# Epidemiology

- Estimated prevalence of 3% in all individuals
- Affects up to 12% of the population during their lifetime
- Stone recurrence rates approach 50% at 10 years
- Caucasian males have the highest incidence in the US
- Incidence highest in the “Stone Belt,” ie southeastern and central southern US



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# **The Patient Reports Significant Dysuria, Low Grade Fever, Gross Hematuria, And Nausea And Vomiting.**

What is the differential diagnosis?



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# Differential Diagnosis

- Obstructing renal or ureteral stone
- Hydronephrosis (ureteropelvic junction obstruction, stricture, ureteral/ renal malignancy)
- Bacterial cystitis or pyelonephritis
- Acute abdomen (bowel, biliary, pancreas, or aortic abdominal aneurysm)
- Radicular pain (L1 herpes zoster, sciatica)
- Depending on the patient gender, primary gonadal pathology
  - Women: ectopic pregnancy, ovarian torsion
  - Men: testicular torsion, orchitis



# What Are Some Common Types Of Kidney Stones?



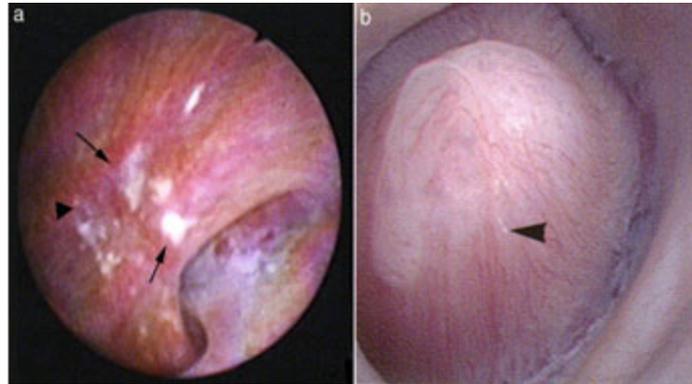
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# Calcium oxalate

- Calcium phosphate concretion (called a Randall's plaque- highlighted by the arrows below), erodes through the urothelium and is a nidus for CaOx deposition.



- Risk factors: Dehydration, hypercalciuria, hyperoxaluria, hypernatrituria, hyperuricosuria.
- Urinary citrate is an important inhibitor of CaOx deposition.



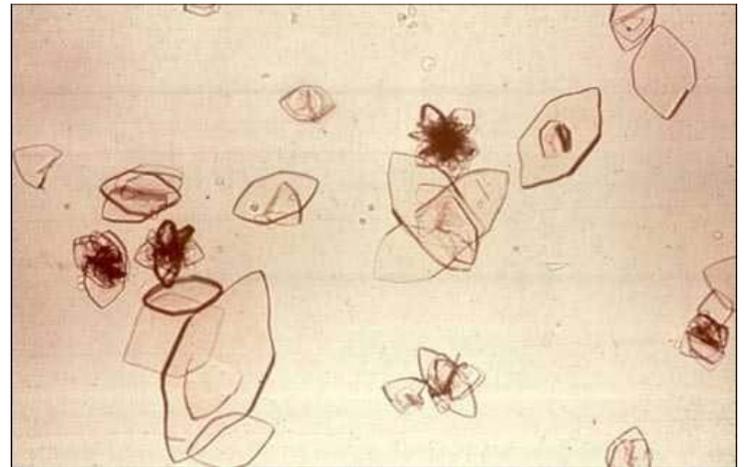
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# Uric Acid Stones

- Persistently acidic urine
- Persistent metabolic acidosis (eg renal tubular acidosis)
- Hyperuricosuria due to a variety of causes
  - Lymphoma/ leukemia treated with chemotherapy
  - Hyperuricemia (gout)



Parallelogram shape

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# Struvite Stones

- Also called magnesium ammonium phosphate stone
- Caused by UTIs with urease-producing organisms
  - Commonly Proteus
  - E. Coli is not urease-producing
- Urea  $\rightarrow$   $\text{NH}_4 + \text{OH}^-$  (raises urine pH)
- Can form staghorn calculi which occupy the calyceal spaces/  
internal renal volumetric capacity



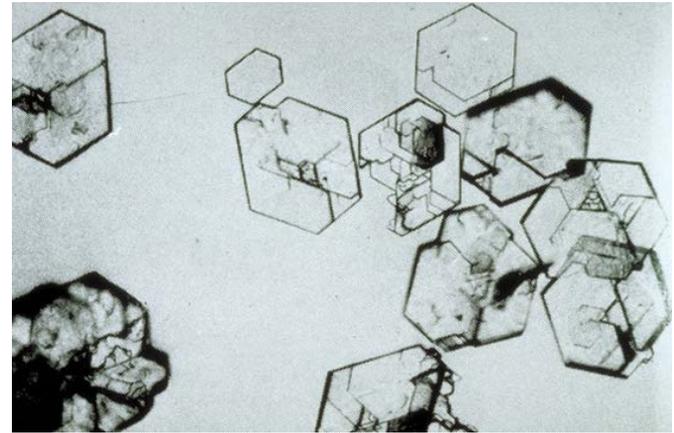
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# Cystine Stones

- Amino acid of cysteineS-S-cysteine
- One of the 4 dibasic amino acids including ornithine, lysine, and arginine (COLA)
- Cystine stones produced in patients homozygous for recessive cystine transport gene
- Forms in acidic urine



Hexagonal shape



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# HOW WOULD YOU DIAGNOSE A KIDNEY STONE?



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# Diagnosis of a Kidney Stone

- Gold standard is a CT of the abdomen and pelvis without IV contrast
- Ultrasound is not sensitive for ureteral calculi, but is the test of choice in pregnant women
- A plain abdominal radiograph (KUB) can diagnose 75-90% of stones
  - Uric acid stones are radiolucent and cannot be seen on KUB



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# HOW ARE STONES MANAGED AND WHEN ARE THEY AN EMERGENCY?



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# Situations where Stones Require Urgent Intervention

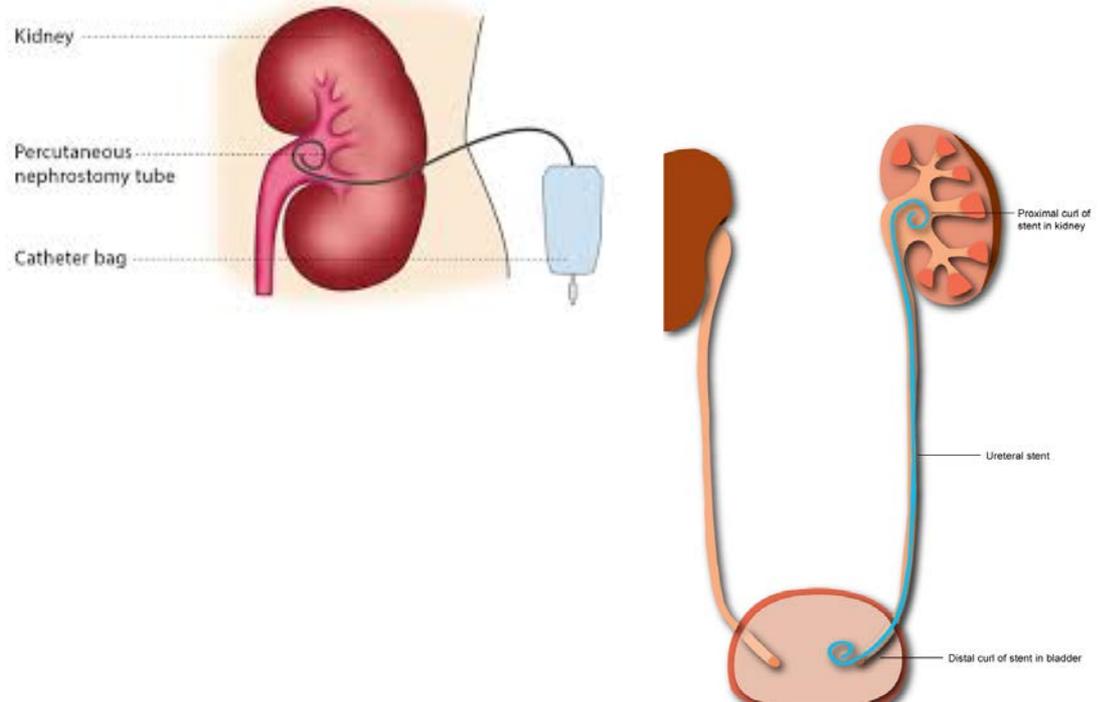
- Obstructed upper tract with infection (fever, elevated WBC, signs of infection on urine analysis and microscopy)
- Impending renal deterioration (as in a solitary kidney)
- Pain refractory to analgesics
- Intractable nausea/ vomiting



# Management in the acute setting

- Placement of a ureteral stent/ percutaneous nephrostomy tube to decompress the kidney
- Does not involve breaking up the stone, as bacteria are often housed within the stone and this could worsen urosepsis

Percutaneous nephrostomy



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# WHAT SIZE STONES ARE LIKELY TO PASS AND WHAT ARE NON-SURGICAL TREATMENTS FOR STONES?



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# Chance of Passing Ureteral stones

Stone Size (mm)	# of days to pass stone (mean)	% Likelihood of eventual need for intervention
2 or less	8	3
3	12	14
4-6	22	50
>6	--	99%



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# Medical Expulsion Therapy (MET)

- MET shortens the duration of stone passage and increases the likelihood of stone passage
- Includes alpha-blockers and calcium channel blockers in combination with NSAIDs
- Encourage hydration up to 2L/ day of fluid intake and ask the patient to strain their urine to catch and submit their stone for analysis



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# WHAT ARE SURGICAL AND NON-SURGICAL OPTIONS FOR STONE INTERVENTION?



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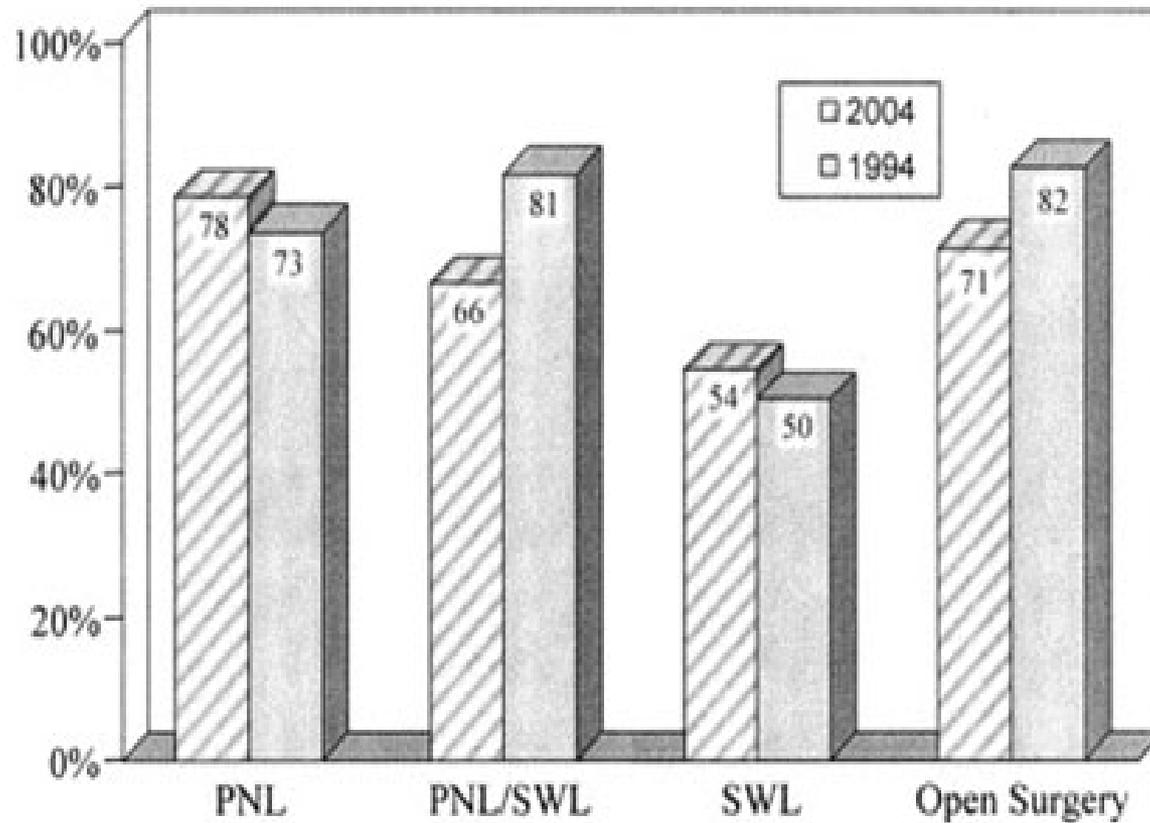
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# Stone Intervention Options

- Oral Stone Dissolution
  - Specific to uric acid stones (5-10% of all urinary calculi), can be managed with urine alkalinization with potassium citrate
- Extracorporeal shock wave lithotripsy (ESWL)
  - External shock waves are concentrated over the area of the stone
  - Many variables at play to determine likelihood of stone clearance, but ideal for stones <3cm and not in the lower pole
- Ureteroscopy and Laser Lithotripsy
  - Direct visualization and fragmentation of the stone with a laser
- Percutaneous Nephrolithotomy
  - Percutaneous removal of large stones or staghorn calculi





Stone-free rates after various urological procedures. Note: PNL- percutaneous nephrolithomy; SWL-shock wave lithotripsy. (From: Preminger et al, J Urol 2005;173:1991-2000).

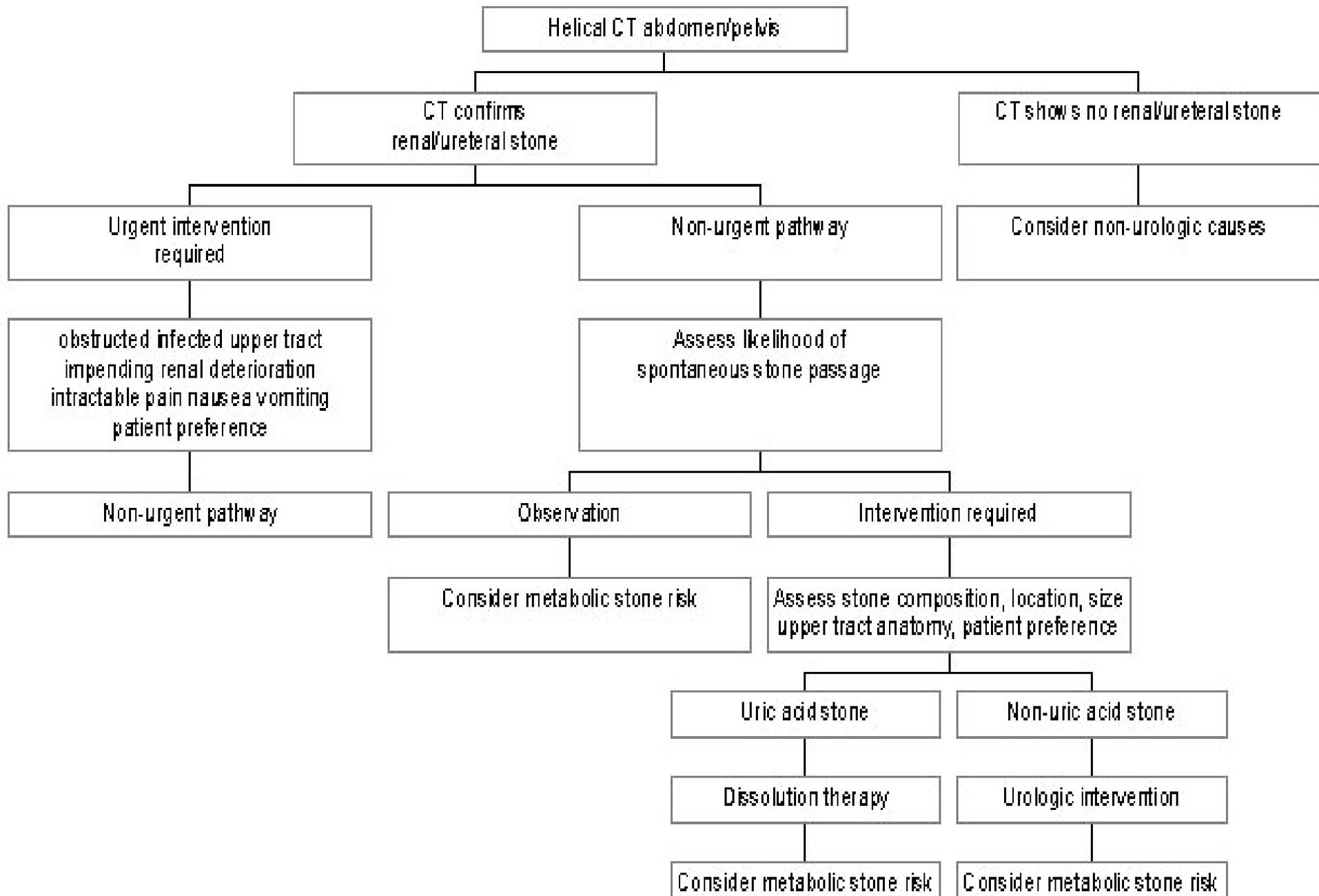


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# Management of acute renal colic



WHAT ARE MEASURES TAKEN TO  
PREVENT STONE RE-FORMATION?  
WHAT IS THE ROLE OF DIET?



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# Metabolic Stone Evaluation

- To be undertaken chiefly among patients with recurrent stone episodes and when the patient does not have an obstructing stone
- 24 hour urine collection for total volume, calcium, oxalate, sodium, uric acid, citrate, phosphate, magnesium, sulfate, & creatinine
- Serum calcium, phosphorous, uric acid,  $\text{HCO}_3$ , BUN, creatinine, albumin, alkaline phosphate, intact PTH (optional), 1, 25-di-OH-vitamin D2 (optional)
- Stone composition analysis



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# General Dietary Guidelines

- Increase fluid intake & low salt diet – reduces the likelihood of stone supersaturation
- Moderate animal protein – regulates uric acid
- Moderate calcium – a certain amount of calcium is needed in the diet to bind oxalate and prevent hyperoxaluria
- Increased dietary citrate- found in lemons and oranges; a major buffer for urinary pH



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# Summary

- Urinary calculi typically present with renal colic and hematuria.
- A non-contrast CT scan of the abdomen and pelvis is the best initial diagnostic test.
- Clinicians must assess the need for urgent intervention and the likelihood of stone passage.
- Metabolic risk of stone recurrences should be addressed most commonly in repeat stone formers.



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