Evaluation & Management of Urolithiasis

大林慈濟醫院
翁慧鈴

Outline

- Etiology of stone urolithiasis
- Risk factors for stone disease
- Various types of stones
- Symptomatology
- Evaluation
- Management of urolithiasis
- Preventions of urolithiasis

Etiology of urolithiasis

1. Supersaturation: Urine becomes oversaturated with a type of solute, which then comes out of solution (crystallization)
2. Inhibitor deficiency: Urine normally has substances which block crystallization (eg: citrate, magnesium, pyrophosphate, sulfate)
   - Dietary deficiencies
3. Neucleation theory:process by which free ions in solution associate into microscopic particles. Crystallization can occur in solution micro-environments

Risk factors

- Dehydration
  - Majority of the stones formation
  - Occupations: high temperature
  - Geographic location: high temperature, summer
- Anatomic obstruction and urinary stasis
- Metabolic / Urine composition
  - Urinary pH
  - Increased stone formation substances: Ca, oxalate, uric acid
  - Decreased stone inhibiting substances: citrate, Mg
- Diet: fatty acid, animal protein

- Urinary tract infection
  - Urease producing organisms: Proteus, Klebsiella, Pseudomonas, Serratia
- Sedentary lifestyle/ immobilization
  - Increased bone reabsorption→ high Ca level in urine
- Related diseases:
  - Sarcoidosis
  - Hyperparathyroidism
  - Inflammatory bowel disease
  - Chronic diarrhea
  - s/p Gastric bypass
  - Cystinuria
  - Gout
- Medications: HIV Protease inhibitors: Indinavir and Nelfinavir, Topiramate, vitamin C, vitamin D, triamterene, furosemide, acetazolamide, probenicid

Types of stones

1. Calcium-based: ~80% of all stones
   I. Calcium oxalate
      - Most common stone formed in industralized nations
      - Most common type of bladder stone
      - Radio-opaque
      - Very difficult to dissolve
      - dehydration: common influential factor
   II. Calcium phosphate
      - ~10% of calcium stones
      - Influential factors: hyperparathyroidism, UTI, dehydration

2. Non-calcium-based

I. Uric acid ~8%

- Pure form→ radiolucent
- Form in acidic urine (pH< 6.0)
- Dissolves with alkalization of urine
- Common influential factor: dehydration
- Patients usually have normal plasma and urine uric acid level

II. Struvite stone (10%)

- infectious stones: Proteus, Pseudomonas, Providencia, Klebsiella and Staphylococcus infection
- Associated with UTI
- Majority with staghorn calculi
- Form in alkaline urine
- Radio-opaque

III. Cystine (1%)

- Caused by cystinuria: homozygous recessive disorder
- Formes in acidic urine
- Dissolves with urinary alkalization
- Radio-opaque
- Resistant to Extracorporeal Shock Wave Lithotripsy (ESWL)
- May forms staghons

IV. Indinavir, protease inhibitor

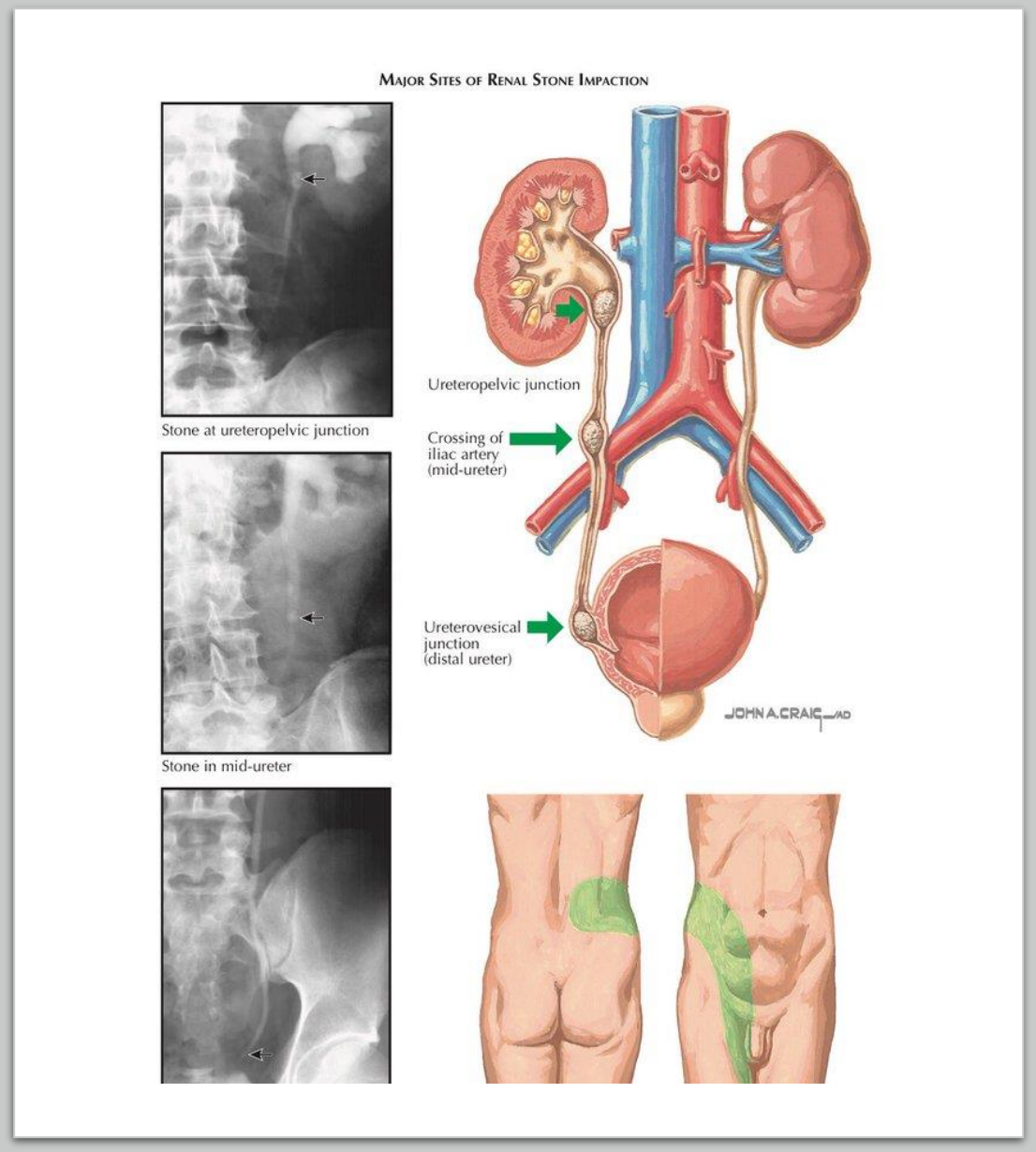
- Medication for HIV
- Radio-lucent in non-contrast CT

Types of Kidney Stones

- Cystine Stones
- Calcium Stones
- Uric Acid Stones
- Struvite Stones

Symptoms

- NOT all the patients with stones have symptoms
- Stone become symptomatic when:
  - Cause obstruction and irritation
    - Typical sites of obstructions:
      1. Ureteral pelvic junction (UPJ)
      2. Ureter cross over internal iliac vessels
      3. Ureteral vesical junction (UVJ)
  - Associated with infection



Classic symptoms:

- Obstruction→ acute, colicky pain
  - Can be severe
  - May have associated with nausea vomiting
  - Location of pain suggested location of stone impaction
    - Flank
    - Abdomen
    - Radiate to groin or testicle
- Irritation urothelial lining→ hematuria
  - Gross or microscopic
- Irritation of bladder lining → lower urinary tract symptoms
  - Frequency, urgency, dysuria
- If associated with infection→ fever

Evaluation:

1. Laboratory tests:
   - CBC, BUN, Creatinine, urine analysis (urine culture: if UTI), blood culture if febrile
2. Imaging:
   - Non-contrast CT
     - First line diagnostic test
       - Location of stone
       - Stone size
       - Identify signs of obstruction: hydronephrosis and hydroureter
   - KUB, intravenous pyelogram (IVP), ultrasound

Management

1. Conservative treatment
   - Candidates:
     - Afebrile, pain controlled, no overt signs of infection or renal compromise
   - Medical management
     - **Oral hydration**
     - **analgesics: NSAIDS**
     - **Alpha-blockers: Silodosin, Tamsulosin**
       - relaxes ureteral smooth muscle
       - Increase stone passage rates up to ~44%
       - Decreases time to stone passage by 2-4 days
       - Decreases pain associated with stone passage
   - Re-evaluate with imaging ~4-6 weeks
     - If still obstruction→ intervention becomes necessary

Table 3: Chance of Passing Ureteral Stones

Stone size (mm)	Number 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%

- Patients with active infection
  - Initial treatment
    - Antibiotics
    - Drainage of kidney
      - Ureteral stent
      - Percutaneous nephrostomy tube
  - Proceed to surgical intervention of stone removal after infection is resolved

Double J ureteral stents

Percutaneous nephrostomy tube

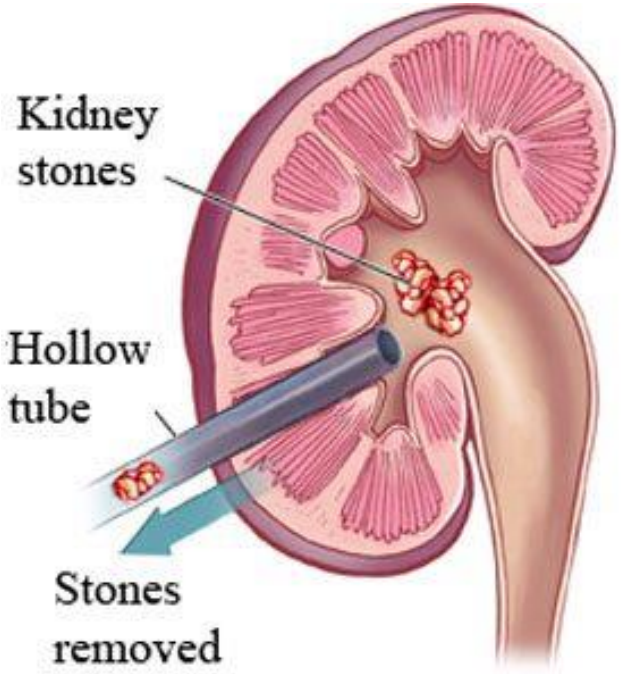
- Treatment strategy based on: stone size and location
- Kidney and ureteral stones:
  - Extracorporeal Shock Wave Lithotripsy (ESWL)
  - Percutaneous nephrolithotomy with lithotripsy (PCNL)
  - Retrograde (flexible) URS stone (RIRS)
  - Ureteroscopy with lithotripsy/ extraction
  - Open surgery (rare)
- Bladder stones:
  - Cystolitholapaxy
  - Cystolithotomy (open surgery)

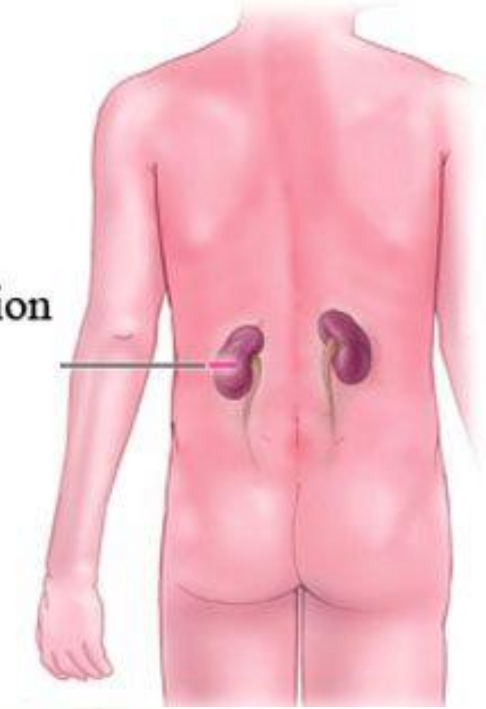
Extracorporeal Shock Wave Lithotripsy (ESWL)

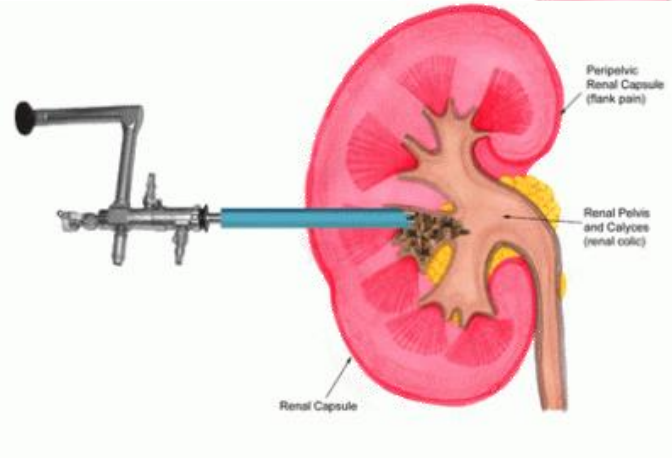
- Most common first line treatment for renal stone
- Indication: renal or ureteral stone <1.5-2.0cm
- Contraindiction:
  - Pregnancy
  - Coagulopathy
  - AAA(>4cm)
  - Cystine, infection stones (relative contraindication)
- Advantages:
  - Non-invasive
  - Outpatient intervention
- Diadvantages:
  - Self-passage stone fragments
- Complications
  - Steinstrasse 4-9%: may require 2nd intervention
  - Hematoma: renal or retroperitoneal

Percutaneous nephrolithotomy with lithotripsy (PCNL)

- Indications:
  - Renal pelvic calculi
  - Staghorn stone
  - Proximal ureteral stone >1cm
  - UPJ obstruction
- Contraindication:
  - Coagulopathy
- Advantages
  - High stone free rate
  - Renal stones 95%
  - Ureteral stones 75%
- Disadvantages:
  - Anesthesia
  - Overnight hopsital stay
  - Ureteral stent and/or nephrostomy tube in perioperative period





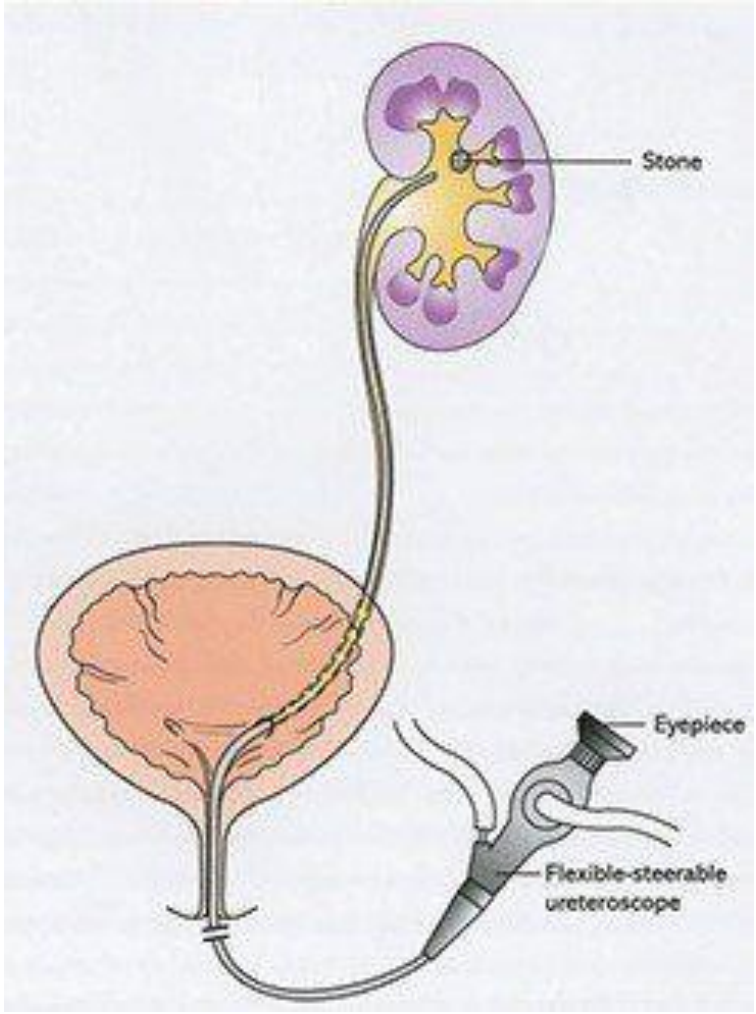


- Complications with PCNL
  - Bleeding
    - Transfusion rate: 3%
    - Hemodynamically unstable: back to OR
    - Hemodynamically stable:
      - Clamp PCN tube for tamponade bleeding
      - Angiography and embolization
  - Pneumothorax/ hydrothorax
    - Percutaneous access
    - Signs: pleuritic chest/flank pain, loss of breath sounds, respiratory distress/ desaturiation

- Bowel injury
  - ~0.2% risk
  - Colonic injury more common
  - Intraoperative detection: contrast in colon with nephrostogram
  - Postoperative signs: fecaluria, pneumaturia, peritoneal signs, fever, ileus, leukocytosis
- Renal pelvis laceration/ perforation
  - occur during dilatation of percutaneous tract
  - Post-operatively: placement of large bore nephrostomy tube until tract closes

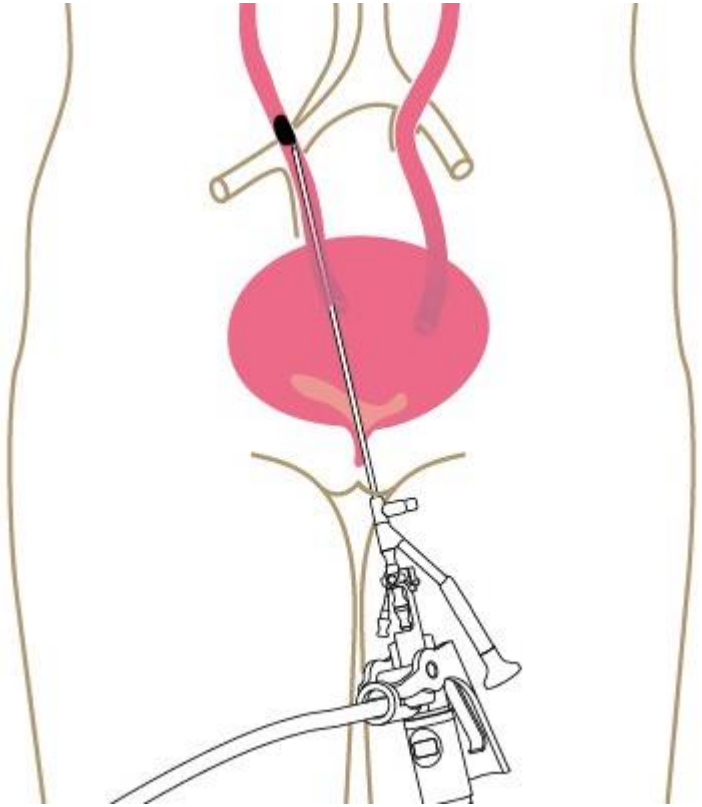
Retrograde (flexible) URS stone (RIRS)

- Indications:
  - Renal stones <2cm
  - Lower calyx stone
  - Anticoagulated patient
  - Morbid obesity
  - Ectopic or horseshoe kidney
  - Evaluation of upper urinary tract malignancy
- Contraindications:
  - Infection
  - Relative: coagulopathy

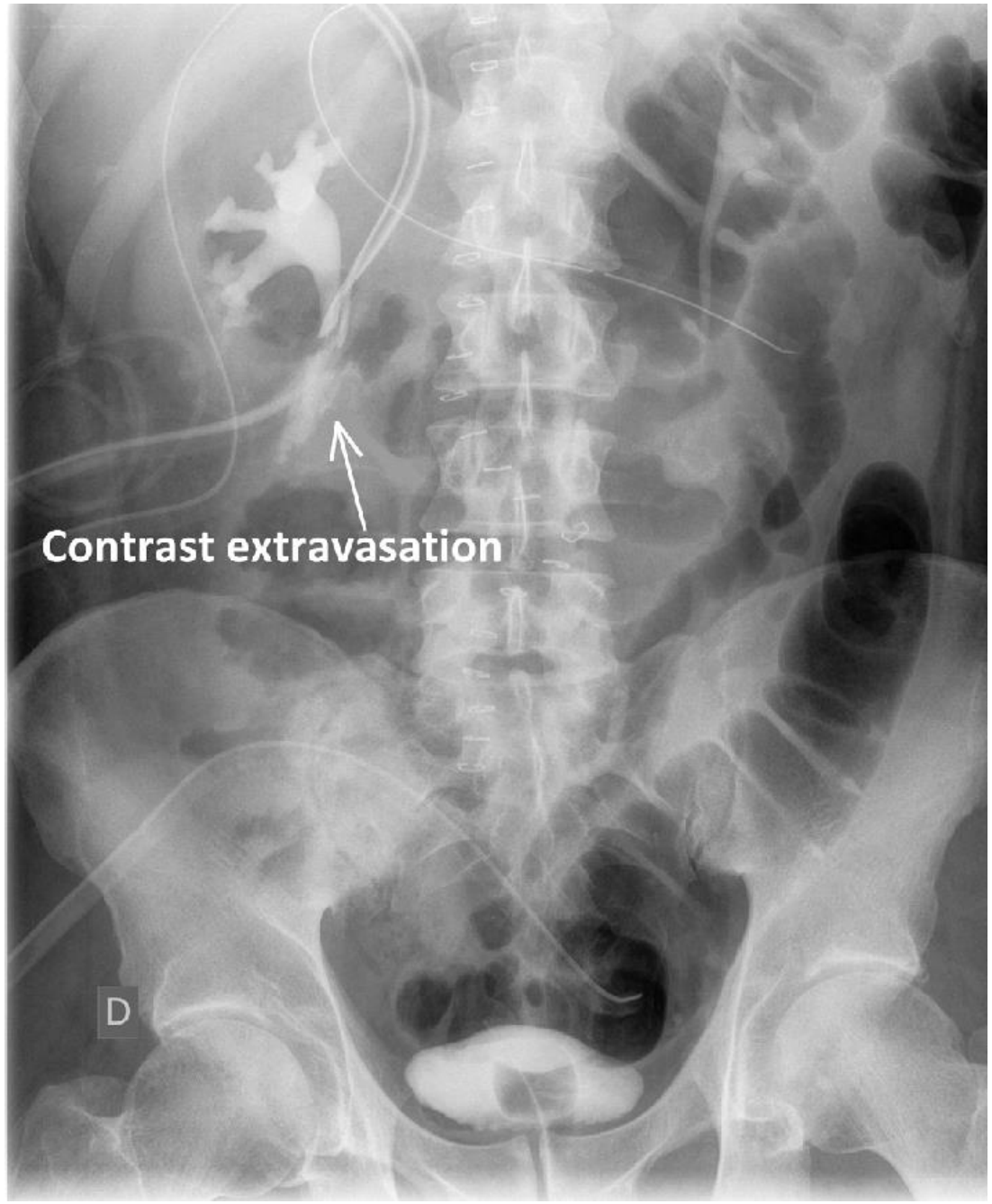


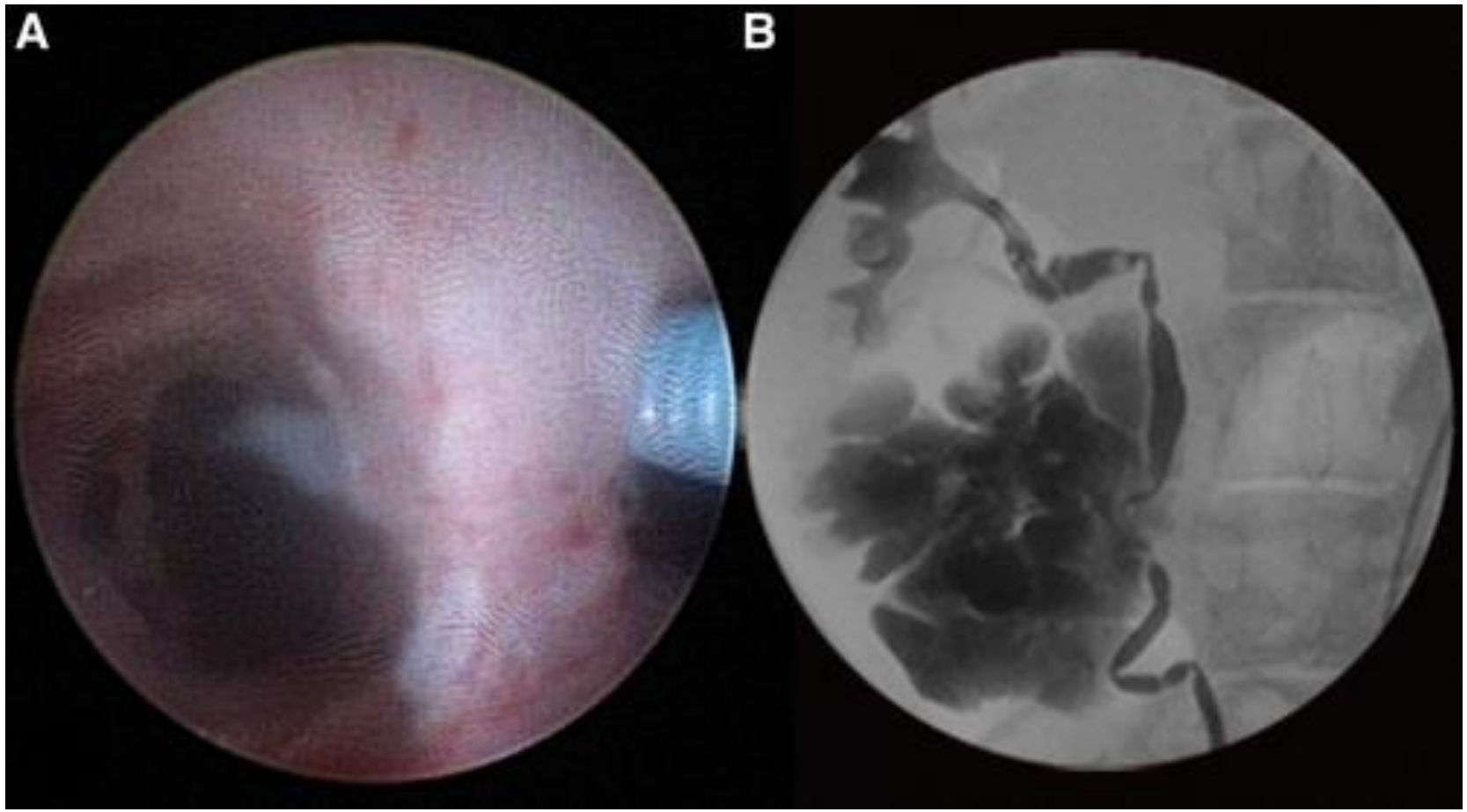
Ureteroscopy with lithotripsy/ extraction

- Indications:
  - Ureteral stones <8mm stone
- Advantages:
  - short hospital stay
  - High success rate of stone removal66-100%
- Disadvantages
  - Anesthesia
  - possible need for ureteral stent placement

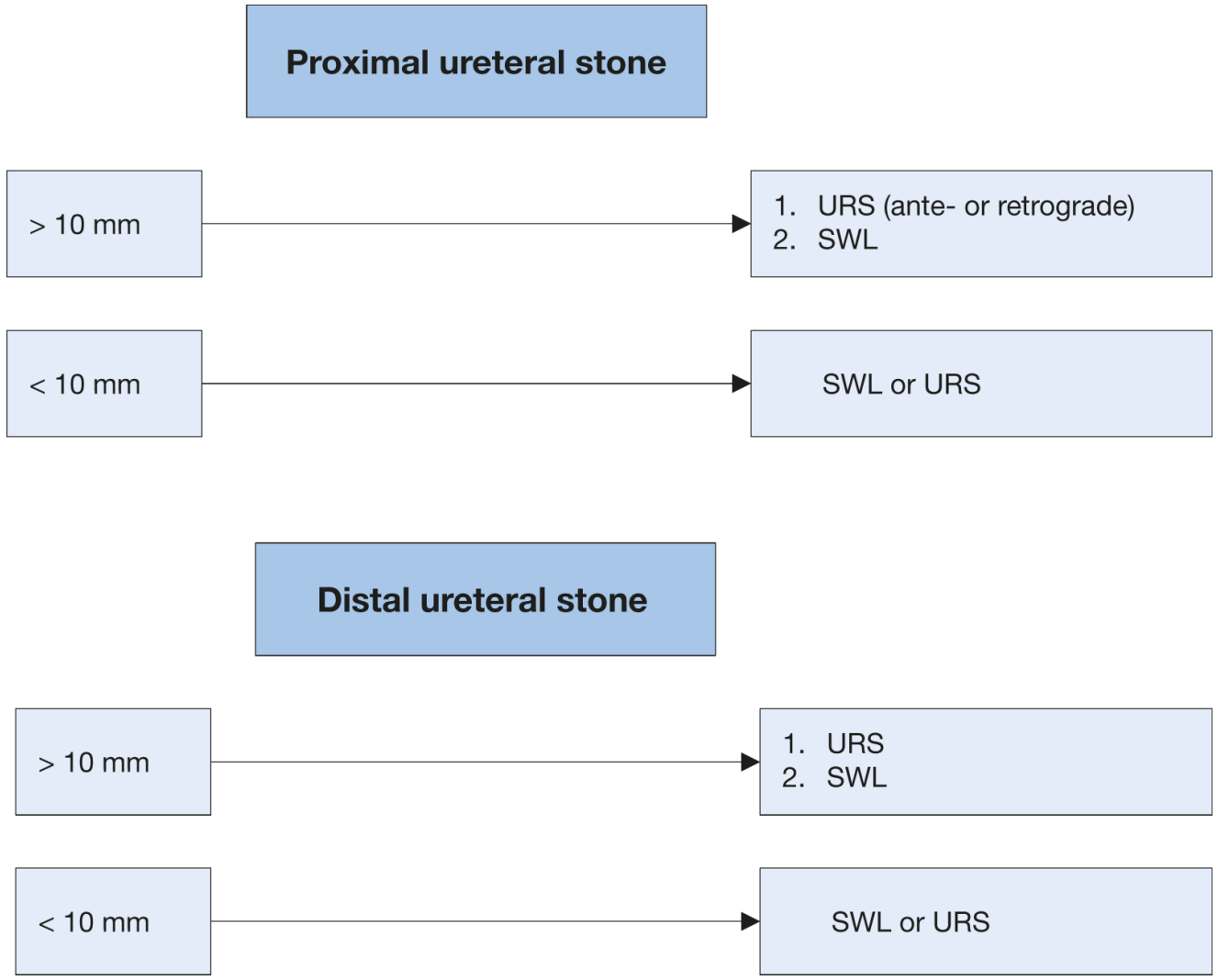


- Complications:
  - Ureteral false passage 0.4-0.9%
  - Ureteral perforation 1-15%
  - Avulsion ~0.3%
  - Ureteral stricture 0-4%

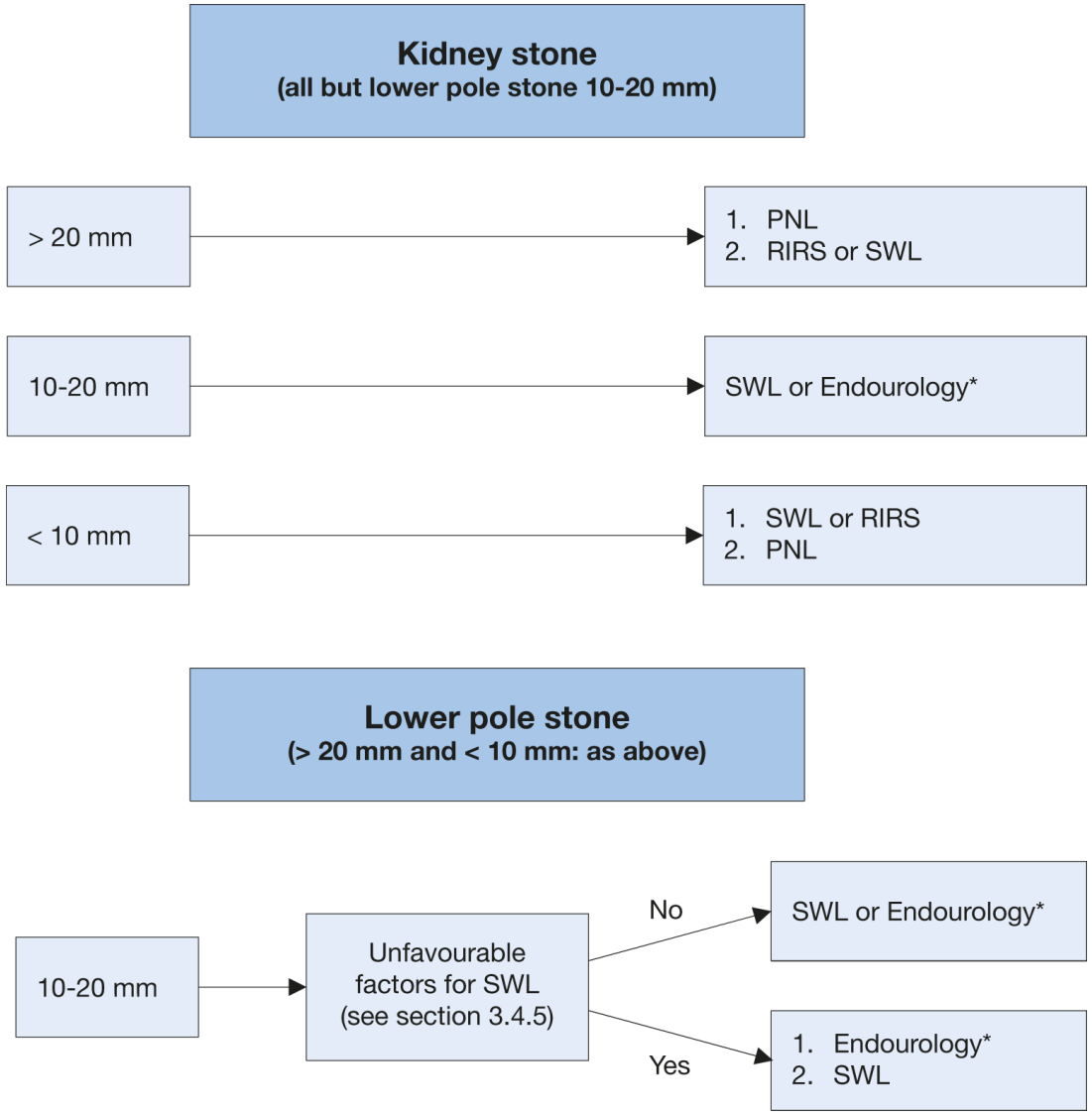



A
B

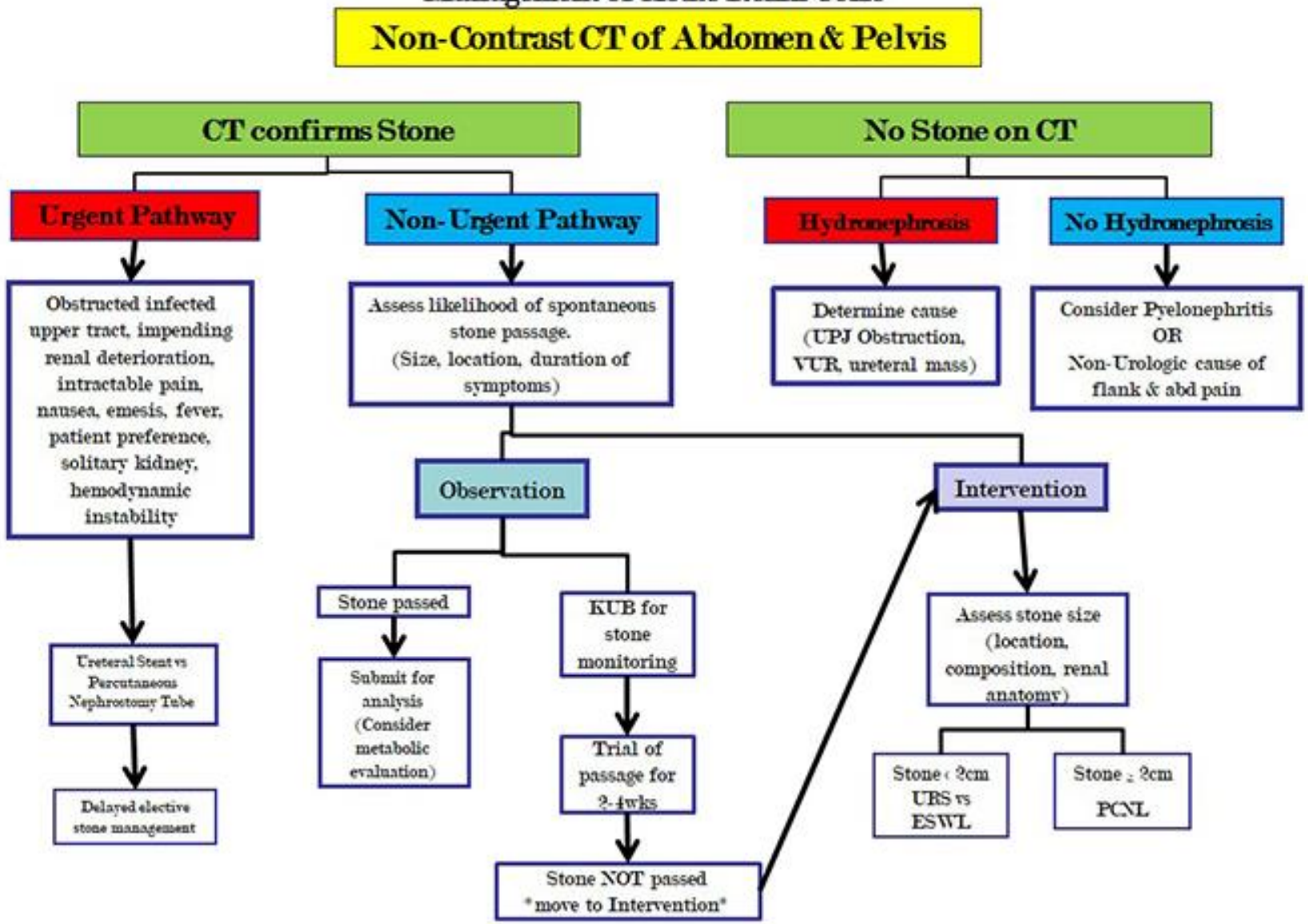
Treatment algorithm for ureteral stones (if active stone removal is indicated)



Treatment algorithm for renal stones (if/when active treatment is indicated)



Management of Acute Renal Colic



Preventions:

- Oral fluid intake
  - Keep urine volume 2-3L/day
- low sodium diet
- Low animal protein diet
- low oxalate diet
  - Chocolate, tea, spinachm rhubarb, nuts, beets
- Moderate calcium intake
  - 800-1000mg/day
- Specific recommendations based on metabolic evaluation

- Oral medication
  - Alkalinizing pH agent: phophate citrate
  - GI absorption inhibitor: Cellulose phosphate
  - Phosphate supplementation
  - Diuretics: Thiazide
  - Calcium supplementation: calcium gluconate
  - Uric acid-lowering medication: allopurinol
  - Urease inhibitor: acetohydroxamic acid prevent struvite stone

Take home message

1. Stone formation theory: supersaturation, nucleation, crystal inhibitor
2. Most common types of stone: calcium based 80%→ calcium oxalate
3. Urinary calculi typically symtomps: renal colic and hematuria frequently accompanied by nausea and vomiting
4. The unenhanced CT is the single best initial diagnostic imaging test.
5. Clinicians should initially assess the need for urgent intervention as well as the likelihood of spontaneous stone passage.
6. Urologic intervention must be individualized
7. Metabolic risk of stone recurrences should be addressed in repeat stone formers, children and in some motivated first-time stone formers