Canadian Undergraduate Urology Curriculum (CanUUC): Urinary Calculus Disease

Last reviewed June 2014

Urinary Calculus Disease: Objectives

1. List the signs/symptoms and differential diagnoses of an acute stone episode
2. Describe the imaging studies available to diagnose renal or ureteral calculi.
3. List the classes of medications effective for treating the pain of renal colic.
4. Outline the basic treatment options for renal and ureteral calculi

Urinary Calculus Disease: Objectives (cont'd)

5. Describe the clinical scenarios requiring urgent decompression of a ureteral stone.
6. List the basic principles of stone formation and prevention.

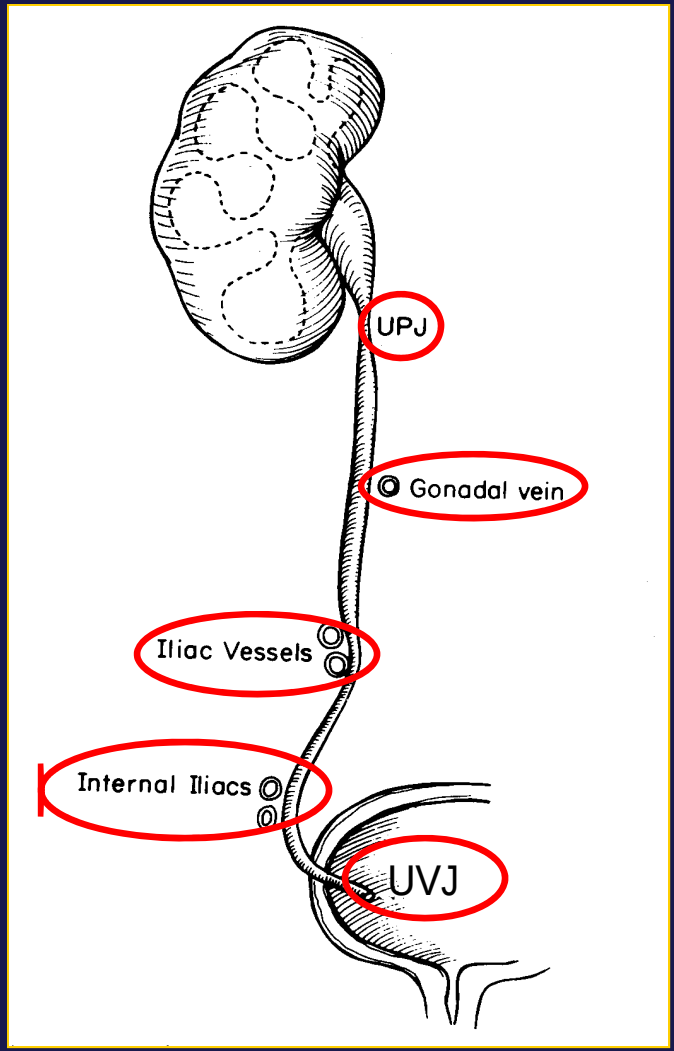
Urinary Calculus Disease: Why care?

- Lifetime prevalence
  - Males - 6-12%
  - Females - 4-5%
- Recurrence rates are 7-10% per year
- First presentation usually in young adults
  - Age 20-40
- Estimated $2 billion dollars spent on the diagnosis and management of urolithiasis in the US in 2001

Urinary Calculus Disease: Signs and Symptoms:

- Colic nature of the pain
  - Rapid onset
  - Unable to achieve comfortable position
- Radiates from flank to groin
  - Testis/labia
- Associated nausea/emesis
  - May develop ileus
- Hematuria
  - Gross, microscopic
- Irritative LUTS
  - May indicate stone near the UVJ/distal ureter
- BEWARE OF FEVER

Urinary Calculus Disease: Where do stones get stuck?



Urinary Calculus Disease: Differential Diagnosis

- Vascular:
  - AAA
- Bowel:
  - Inflammatory bowel disease, appendicitis, diverticulitis
- Gynecologic:
  - PID, ruptured ovarian cyst, ectopic pregnancy
- Neurologic:
  - Radicular pain, herpes zoster
- Genito-urinary:
  - Cystitis, pyelonephritis, torsion, UPJ obstruction

Urinary Calculus Disease: Investigations

- AFTER CAREFUL History and Physical
- Labs:
  - Urinalysis
  - Consider Pregnancy Test (HCG) in females
  - CBC&diff, creatinine
- Imaging:
  - KUB
  - Non-contrast CT abdopelvis (NCCT)
  - IVP - more or less historical or in remote settings
  - Other:
    - Ultrasound - first line in pregnancy
    - Retrograde pyelogram

Urinary Calculus Disease: Urinalysis

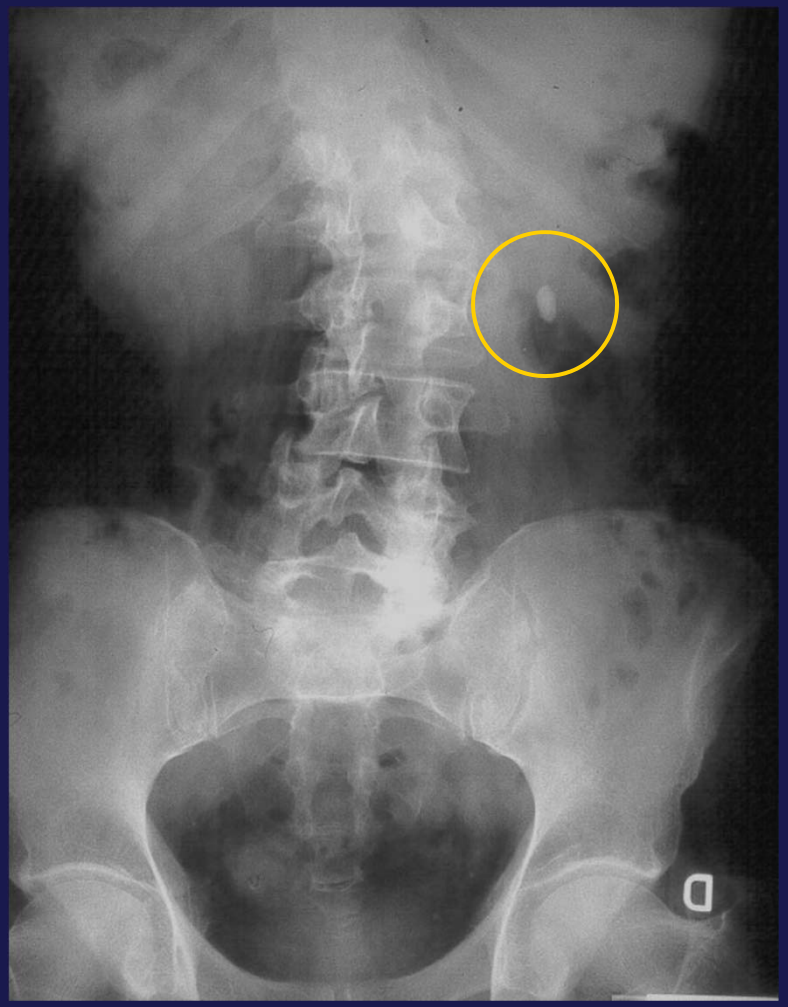
- 85% will have at least microhematuria
- May have some pyuria
  - May not indicate UTI
- May have crystals
  - Not specific for stone disease

Urinary Calculus Disease: Diagnosis - Imaging

- KUB:
  - 80-90% of stones are radio-opaque
  - Phleboliths
- IVP:
  - Demonstrates stone location & degree of obstruction
  - Time consuming & contrast risk
- CT (Non-contrast)
  - Quick, sensitive
  - Concurrent intra-abdominal pathology

Diagnosis: KUB

- Advantages:
  - 80-90% of stones are radio-opaque
  - Minimal radiation
- Disadvantages:
  - No detection of concurrent pathology
  - Bowel gas



Diagnosis: Non-Contrast "Renal Colic" CT

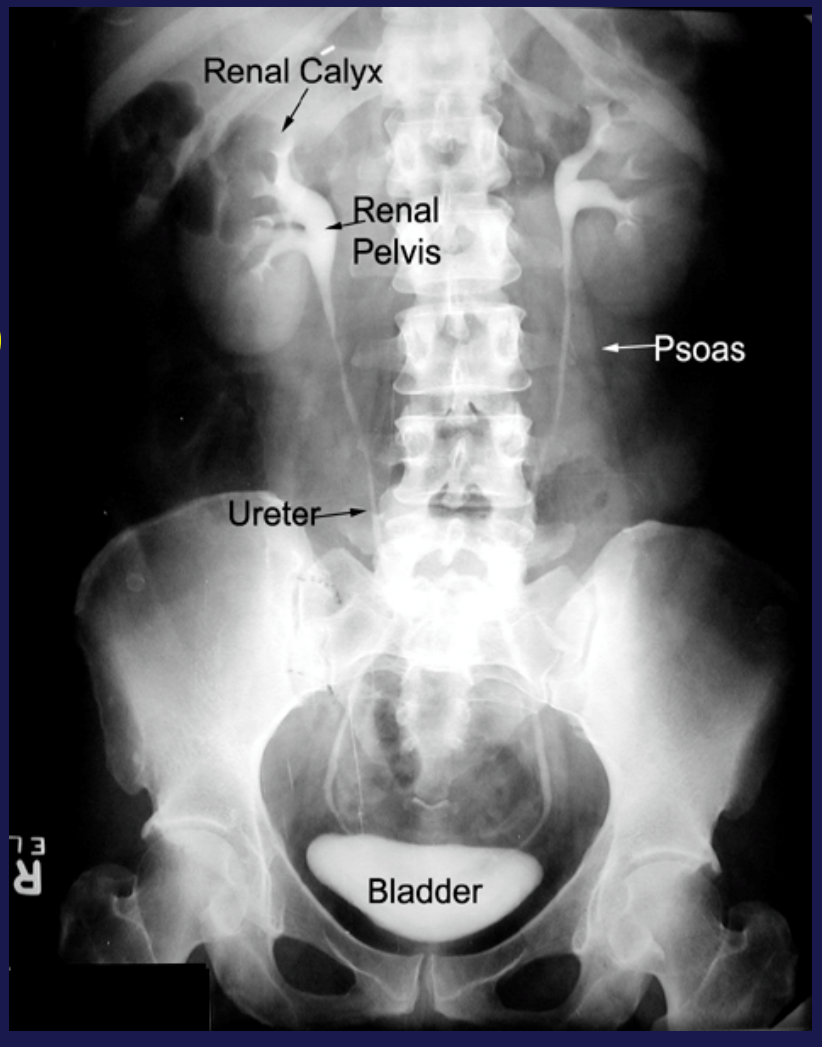
- Advantages:
  - All stone types visible except indinivir
    - SN - 97%; SP - 96%
  - Rapid
  - Readily available
  - Does not require contrast
  - Other pathology identified
  - Information about stone and collecting system obtained

Diagnosis: Non-Contrast "Renal Colic" CT

- Disadvantages:
  - Cost?
  - No physiologic information
    - Obstruction
  - Increased radiation dose compared with KUB but low dose radiation protocols being utilized
  - Has supplanted the KUB
    - KUB useful for following stones managed medically and determining suitability for SWL

Diagnosis:
Intravenous Pyelogram (IVP)

- Scout film
- Intravenous contrast
- Serial xrays
  - Nephrogram phase (1min)
  - Pyelogram phase (5 min)
  - Delayed views (ureter)
  - Post void
- Time consuming
- Contrast reaction risk

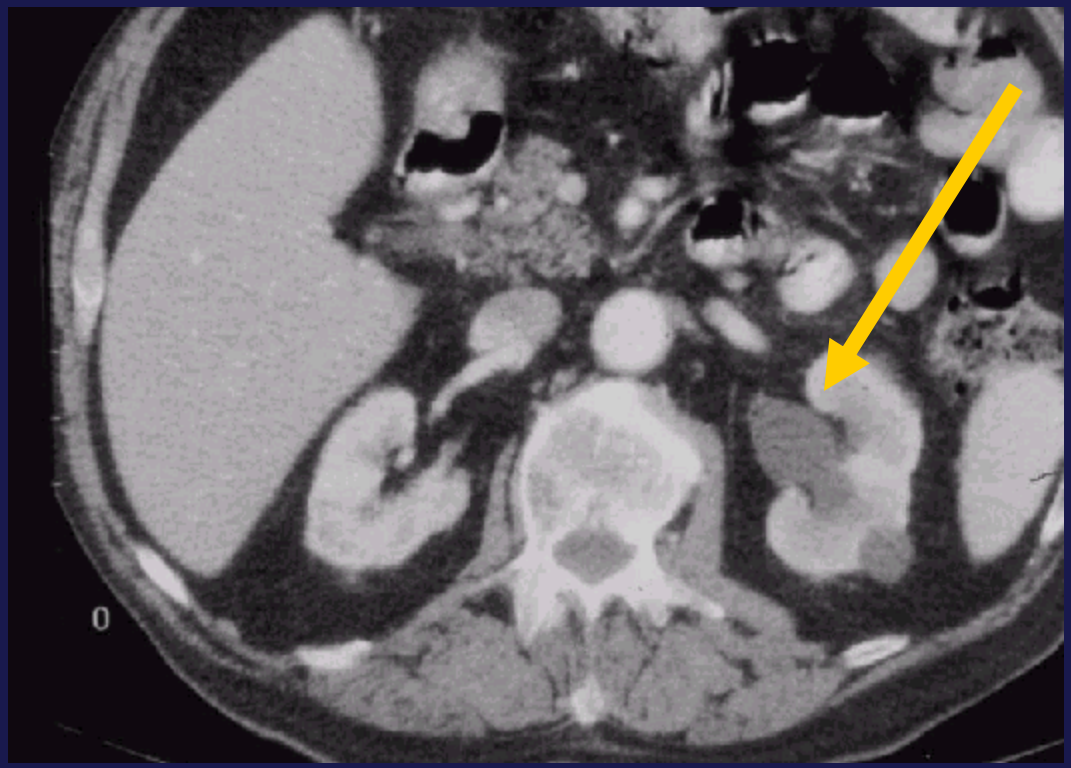


Diagnosis: Non-contrast CT (NCCT) What are you looking for?

- Stone size
- Location
  - Renal
    - Lower pole
  - Ureteral
- Presence of hydronephrosis or hydroureter
- Evidence of stranding
- Gas in the collecting system
  - Emphysematous (necrotizing) infection
  - Rare but important

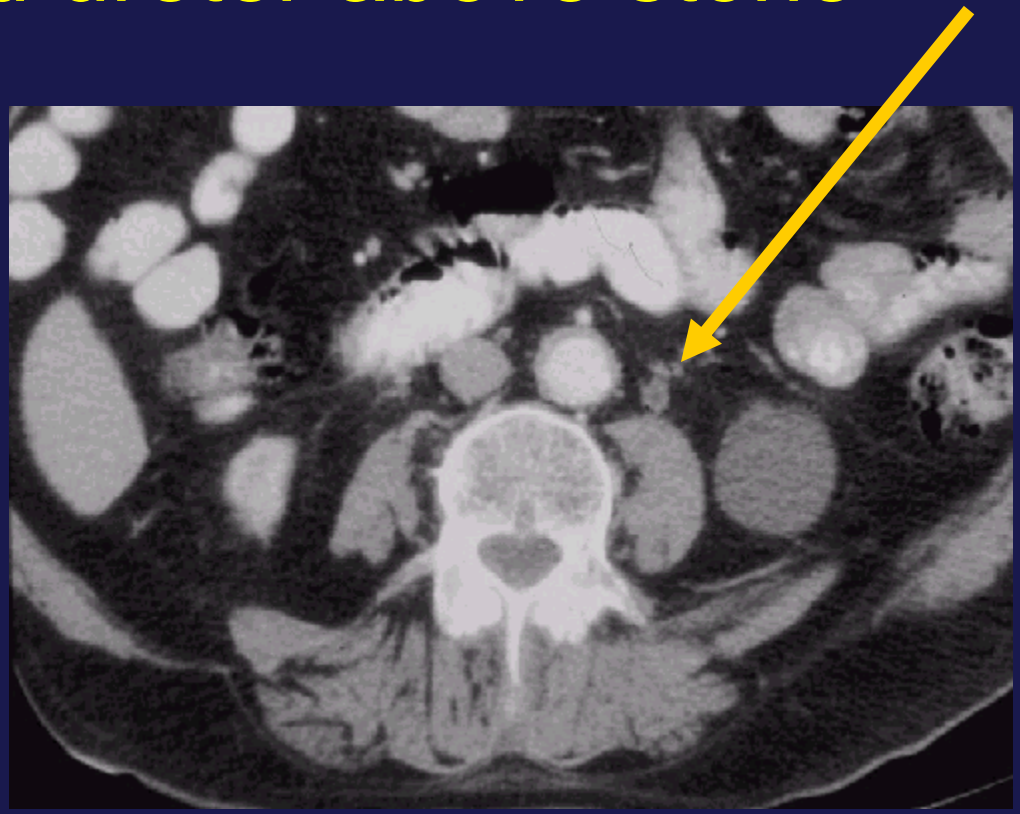
Diagnosis:
Non-contrast CT

- Hydronephrosis, perinephric stranding



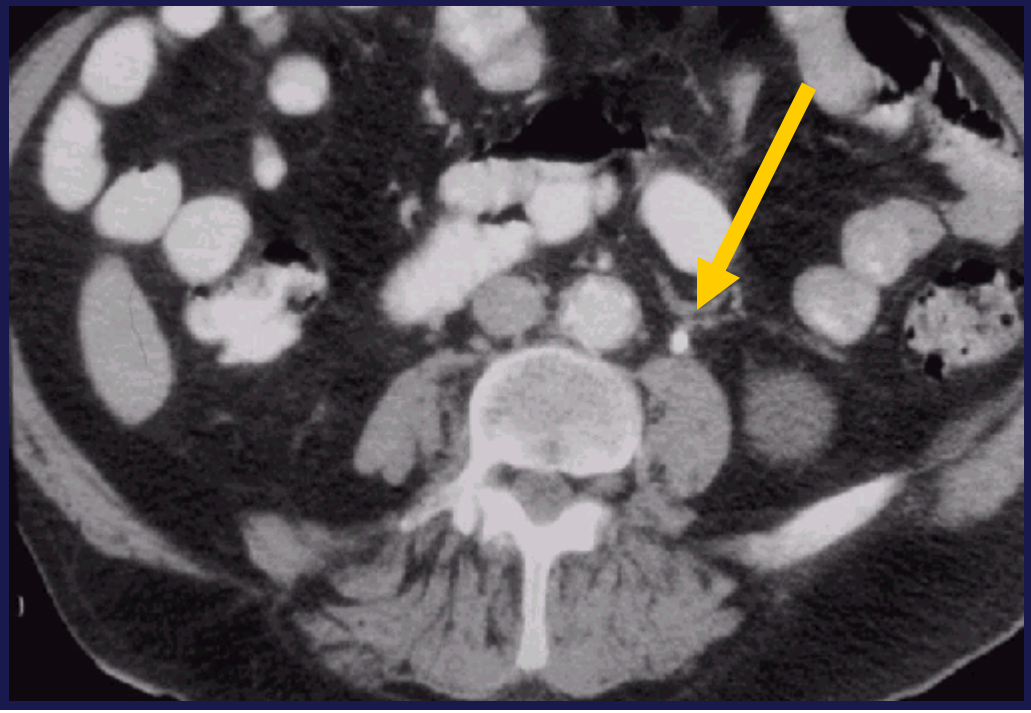
Non-contrast CT: Ureteral Calculus

- Dilated ureter above stone



Ureteral Calculus: Non-contrast CT

- Stone visualization & location
- All stones are “radio-opaque” on CT
- “Tissue ring” sign



Calculus Disease: Initial Management of Renal Colic

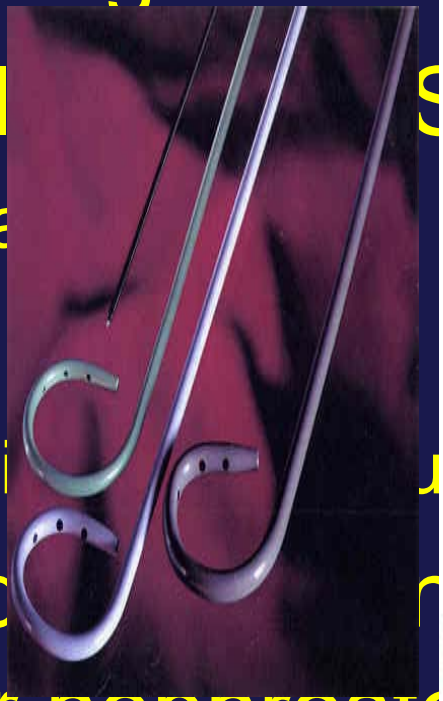
- Pain control
  - Narcotics
    - Oral/IM/IV
  - NSAIDS (renal function)
    - Oral/rectal/IV
  - Acetaminophen
  - Anti-emetics
- IV hydration prn
- IF FEVER - CONSULT UROLOGY
  - DISCUSS ANTIBIOTICS
- Alpha-blockers as medical expulsive therapy (MET)
  - tamsulosin

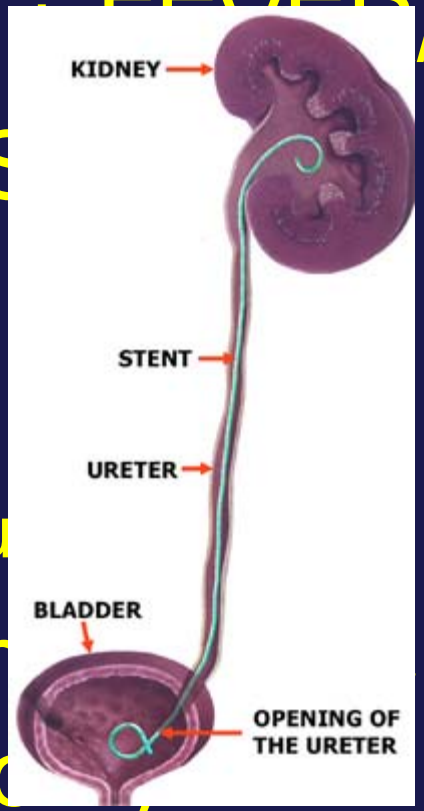
Calculus Disease: Initial Management Based on Size

- <5mm (renal or ureteral)
  - Discharge home
  - Tamsulosin for ureteral stones
  - Most will pass
  - Should at least f/u with GP if not urology
    - Fear is silent obstruction -> renal loss
- >5mm or signs of obstruction
  - Discuss with urology
  - +/- tamsulosin

Urinary Calculus Disease: RED FLAGS

- Obstructing stone + FEVER/Infection
- Bilateral S
  - Renal fa
- Solitary
  - Impendi
- These rec attention (stent or nephrosto





Urinary Calculi: Treatment

1. Extracorporal shock wave lithotripsy (ESWL)
   - Upper ureter or renal stones <2cm
2. Ureteroscopic laser lithotripsy (URS)
   - Ureteral stones or ESWL failures
3. Percutaneous nephrolithotripsy (PNL)
   - Large >2cm renal stones

Renal Calculi: Clinical Points

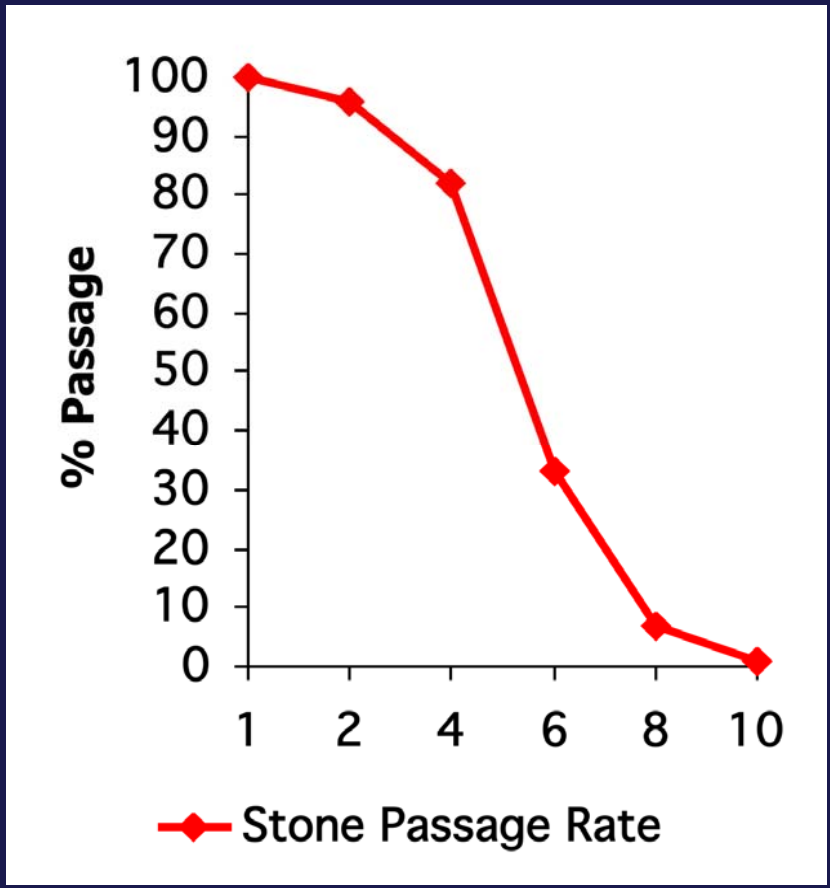
- Spontaneous stone passage depends on:

1) Location: Proximal vs. distal (distal stones more likely to pass)

2) Size: ~80% of stones <5mm will pass

1) Time since onset: Most stones pass by ~3weeks

Stone Size: Probability of Stone Passage



- Probability of passage:
  - <4mm- ~90%
  - 4-7mm- ~50%
  - >7mm- <10%

Ueno et al. Urol, 1977

Urinary Calculus Disease Treatment: Extra-corporal Shockwave Lithotripsy (ESWL)

- Least invasive
- Conscious sedation
- Fragments stones that the patient then passes
- High patient satisfaction
- May require more time to become stone free
- Renal calculi or proximal ureteral calculi

ESWL:
Absolute Contra-indications

- Pregnancy
- Bleeding Disorder/anticoagulation
- Febrile UTI
- Distal obstruction to the stone being treated

ESWL:
Relative Contra-indications

- Radiolucent stones - can give contrast
- Pacemaker
- Calcified renal artery/AAA
- Severe orthopedic deformities

Post ESWL follow-up:

- Patients may be d/c on tamsulosin
- KUB in 2-4 weeks post treatment
- May continue to pass fragments for several weeks
- ? Need for U/S to rule out silent obstruction

ESWL success depends on:

- Stone Size
- Stone Location
- Stone Composition
  - Hounsfield unit density of NCCT
- Patient Habitus
- Drainage anomaly of the kidneys
  - UPJO
  - Horseshoe kidney

Complications of ESWL

- Hematuria
- Hematochezia
- Ureteral obstruction - 5-30%
  - Depends on size of initial stone
  - “steinstrasse”
  - Intervention as per other ureteral stones
- Sepsis - 1%
- Perinephric Hematoma - <1%
- Hypertension - no evidence that SWL leads to long term htn
- No convincing evidence that SWL leads to DM

When do we not use ESWL?

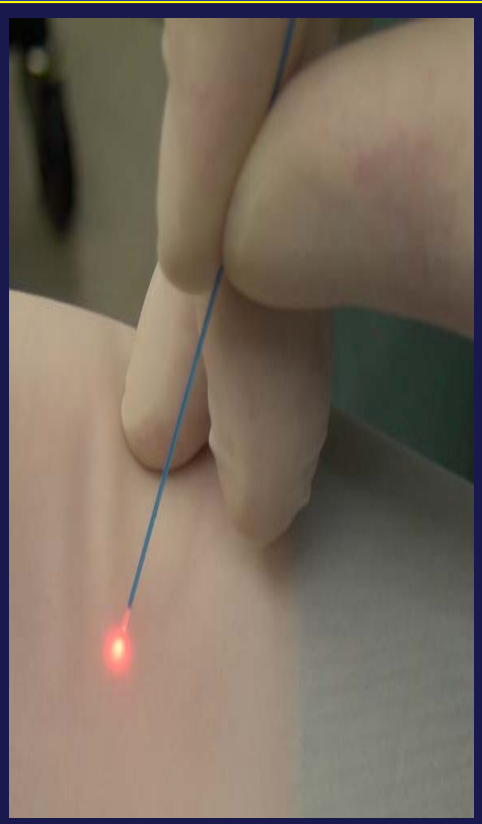
- Stone Burden
  - >2cm in largest diameter or multiple stones
- Stone composition
  - Particularly cystine
- Patient needs to be stone free
  - Or stone free faster
- Patient habitus precludes SWL
- Failed SWL
  - 2nd treatment reasonable
  - Diminishing returns of 3 or more treatments

URS for Ureteral Stones

- Advantages:
  - Near 100% stone free rate
  - Low retreatment rates
  - Treatment available in most centres
    - SWL tends to be in regional centres only
- Disadvantages:
  - General anaesthesia is usually required
  - Urinary stent may be left
    - Stent symptoms are bothersome to patients
  - Lower patient satisfaction
- Typically for ureteral calculi and ESWL failures

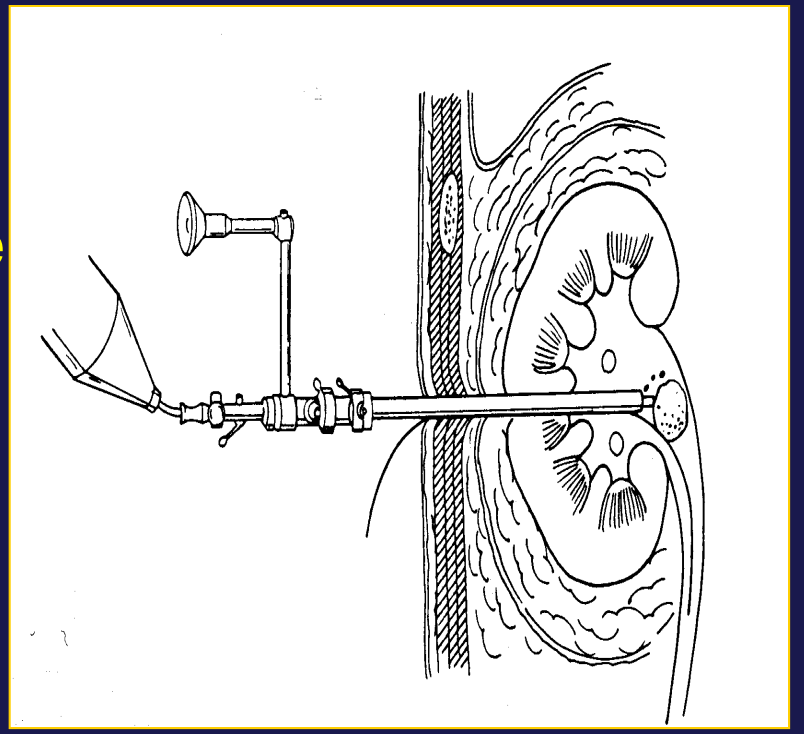
Ureteroscopic Equipment:

- Scopes:
  - Flexible
  - “semi” rigid
- Stone Fragmentation
  - Holmium laser
  - Pneumatic lithotriptor
- Stone Retrieval
  - Baskets
  - Graspers
- One of the largest innovations in urology in the last 2 decades



Urinary Calculus Disease: Percutaneous Nephrolithotripsy

- Typically for large (>2cm) renal calculi
- Advantages:
  - Ability to remove large or multiple stone burden with high success rate (>95%)
- Disadvantages:
  - General anesthesia
  - More invasive than URS
  - Risk of bleeding - <2% require transfusion
  - Injury to surrounding organs
  - Risk of hydropneumothorax



Percutaneous Nephrolithotripsy: Complications

- Perforation of the renal pelvis
- Stricture
  - UPJ or infundibulum
- Sepsis
- Residual stone fragments
- Hemothorax/pleural effusion (<10%)
- Adjacent organ injury
- Bleeding

STONE PREVENTION

Stone Prevention: Basic Stone Former Work-Up

- Urinalysis and culture
  - Urea splitting organisms (Proteus, Pseudomonas, Klebsiella, mycoplasma, Serratia, Staph Aureus)
  - Acidic urine - uric acid stones/cystine
  - Alkaline urine - struvite stones
- Serum calcium, PTH and uric acid
- If patient retrieves stone send for analysis
- Advanced work-up:
  - 24h urine collections

Stone Prevention: General Advice

- Increase Hydration to 2-3L per day
- Diet:
  - Maintain normal calcium intake
    - Used to advice low calcium diets - false
  - Minimize foods high in oxalate
  - Avoid excess salt, fat and animal protein
- Consider urinary alkalinization:
  - Mainly with uric acid and cystine stones
  - Potassium citrate - preferred
  - Sodium citrate - alternative

Stone Prevention: Calcium Stones (80%)

- Most are calcium oxalate
- Some are calcium phosphate or mixed
- Etiology
  - Hypercalciuria
    - Increased intestinal absorption
    - Bone resorption
      - PTH, malignancy
  - 25% also have hyperuricosuria
  - Hyperoxaluria
    - Usually increased intestinal absorption - SB resection/IBD
    - High ingested oxalate
  - Hypocitraturia

Stone Prevention:
Prevention of Calcium Stones:

- Hydration - 2-3L of urine per day
- Normal dietary calcium intake
- Dietary limitations:
  - Salt - potentiates hypercalciuria
  - Oxalates - coffee/tea/cola/chocolate/leafy vegetables
  - Animal protein
- Consider potassium citrate in recurrent cases

Stone Prevention: Struvite Stones (5-10%):

- Triple phosphate
  - Magnesium, ammonium phosphate
- Alkaline urine pH due to urea splitting organisms
  - Proteus, Pseudomonas, Klebsiella, Mycoplasma, Serratia, Staph Aureus
  - NOT E COLI
- Must clear all stone material and infection
  - SWL not often useful
- May form staghorn stones quickly

Stone Prevention:
Uric Acid Stones (10%):

- Radiolucent - not visible on KUB
- Occur in patients with low urine volume and acidic urine
  - Purine rich diets
  - High cell turnover - cancer treatment
- Prevention:
  - Hydration
  - Alkalinize urine

Stone Prevention:
Cystine Stones:

- Usually first detected in children
  - Often positive family history
- AR defect in absorption of dibasic amino acids
  - COLA
  - Only cystine is insoluble
- Rapid formation of staghorn stones
- Must remove all stone material aggressively
  - SWL has limited application
- Prevention:
  - Hydration
  - Early aggressive treatment
  - Alkalinize, penicillamine, captopril, thiola

Take Home Points: Urinary Calculi

- KUB is a useful initial investigation
- Non-contrast CT is the diagnostic gold standard (if available)
- Fever with an obstructing ureteral stone requires emergent intervention (decompression – stent/nephrostomy)
- Obstructing stones in a solitary kidney require emergent attention