Painful Pebbles

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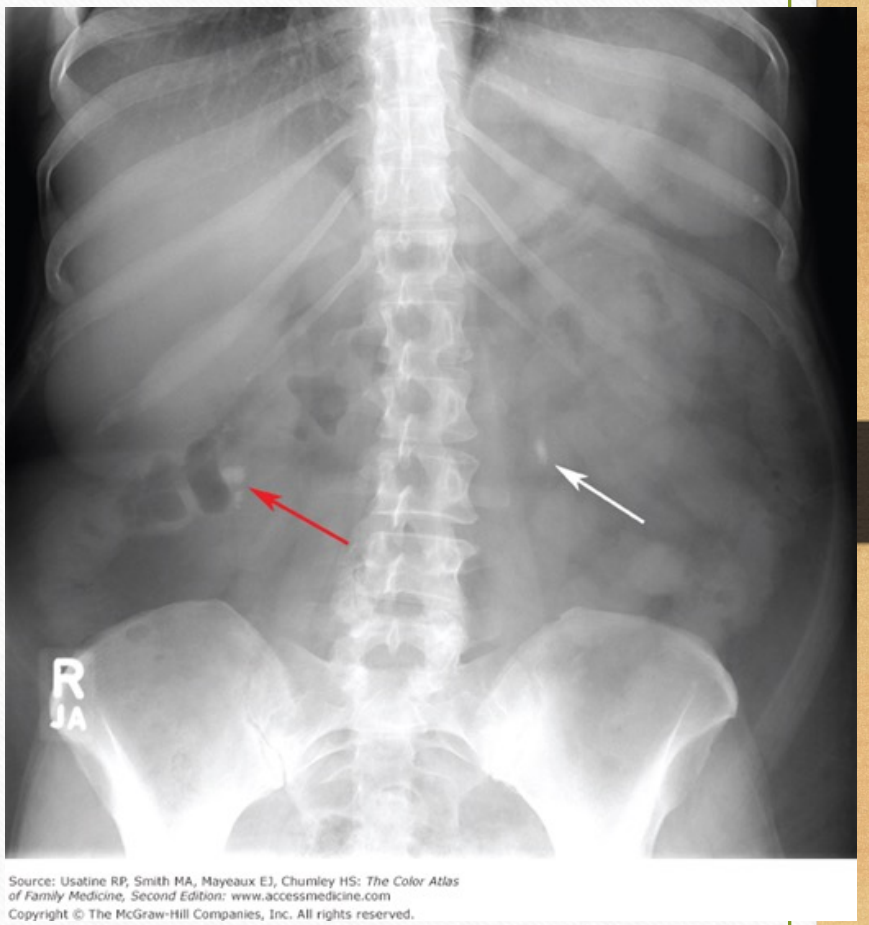
Objectives

At the conclusion of this session, participants should be able to:

- • Recognize the risk factors of urolithiasis and classify the different types of kidney stones
- • Identify signs and symptoms of urolithiasis and renal colic in an acute care setting
- • Discuss the role of imaging in diagnosing an obstructing kidney stone
- • Review and interpret common radiographic images and be able to recognize when surgical intervention is needed
- • Develop an individualized treatment plan (including different types of surgical interventions) for urolithiasis based on presentation, radiographic images, and diagnostic tests
- • Develop a personalized plan to decrease the risk of developing future kidney stones including metabolic evaluation

Facts about Nephrolithiasis

- Most common cause – DEHYDRATION
  - Hot Climates
- Men in North Carolina (14%)vs North Dakota (5%)
- Hypercalcemia can increase risk
- Most common stone – Calcium oxalate
- 90% of stones are RADIOOPAGUE
- 10% of the population



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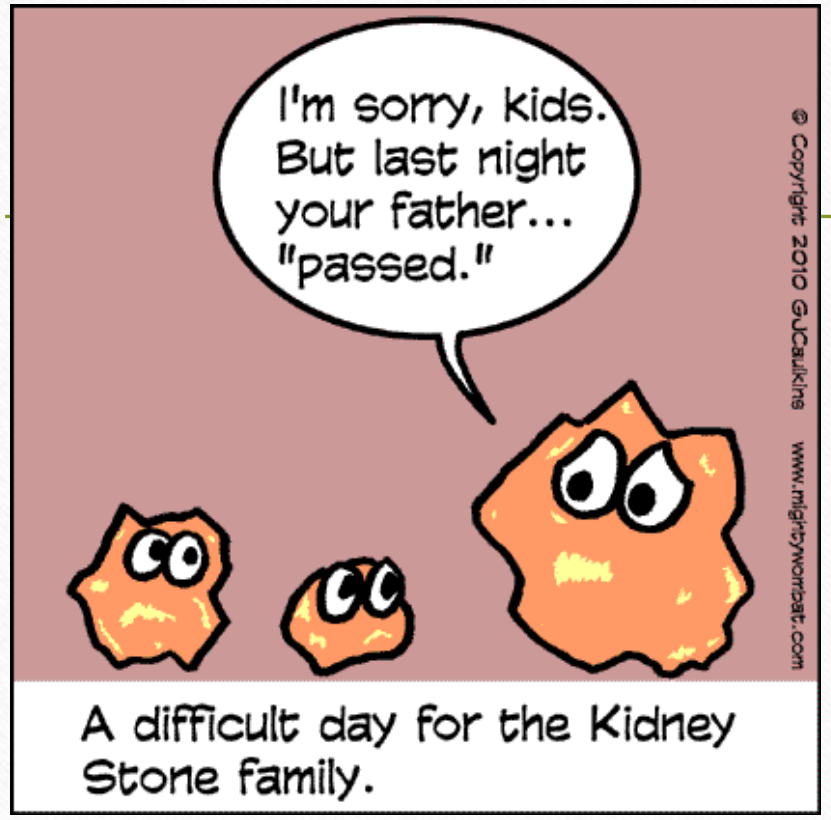
Medical Management of Kidney Stones: AUA Guidelines Pearle, et al American Urological Association 2014 Vol 192, 316-324 Aug 2014

Urolithiasis / Nephrolithiasis



- Types of Stones
  - 80% - Calcium stones
    - Calcium oxalate > calcium phosphate
  - Uric acid – not seen on XR
    - High diet animal protein
  - Struvite (magnesium ammonium phosphate)
    - Associated with bacterial infection
    - Can develop staghorn calculus
  - Cystine
- Pathophysiology
  - Stones form when soluble material such as calcium / oxalate supersaturates the urine and crystals form

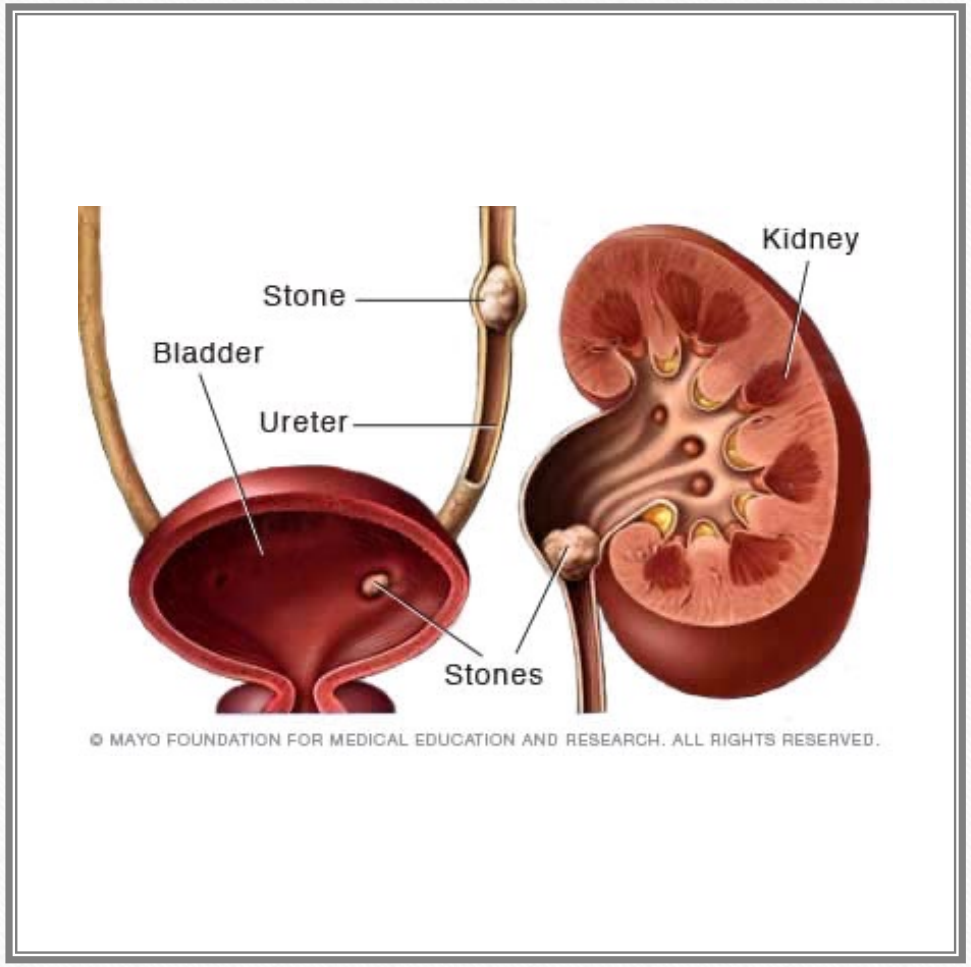
Risk Factors For Kidneys Stones

OBESITY

HTN

DIABETES

DIET AND LIFESTYLE



Signs and Symptoms

- Asymptomatic stones
  - Incidental finding on imaging
- Symptomatic stones
  - Pain when the stone moves from the renal pelvis to the ureter
  - Intermittent / colicky
  - Site of obstruction determines location of pain
    - Back / flank / lower abdomen
  - Hematuria – common
  - Burning with urination
  - Nausea / vomiting
  - Can present as a UTI

Differential Diagnosis

- Things that can mimic renal coli / nephrolithiasis
  - Bleeding in the kidney / clots in ureter
  - Pyelonephritis / UTI
    - Fever uncommon with uncomplicated obstructing stones
    - Can develop pyelonephritis with obstructing stone
  - Ectopic Pregnancy /Ruptured ovarian cyst
  - Dysmenorrhea
  - Incarcerated Hernia
  - AAA / diverticulitis / cholecystitis / herpes zoster

Evaluation of Suspected Urolithiasis

Labs:

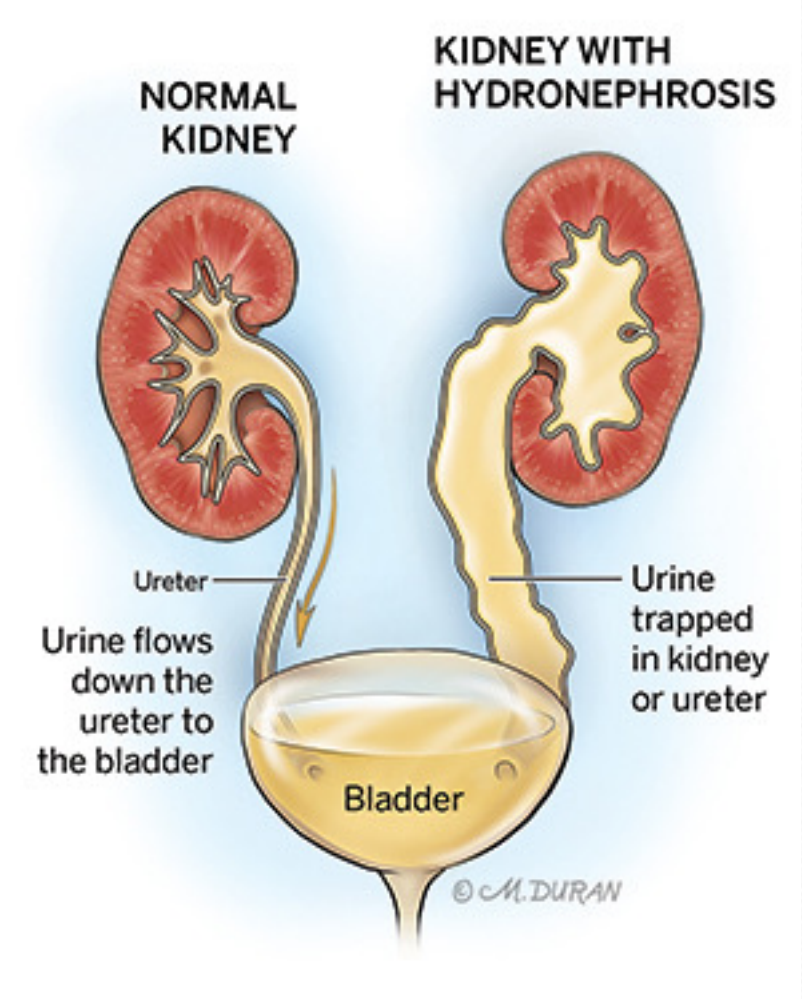
- BMP – monitor kidney function
- Urinalysis – hematuria / rule out infection
  - Pyruia + nitrites -> concerning for UTI
  - Urine Culture

Diagnostic Imaging

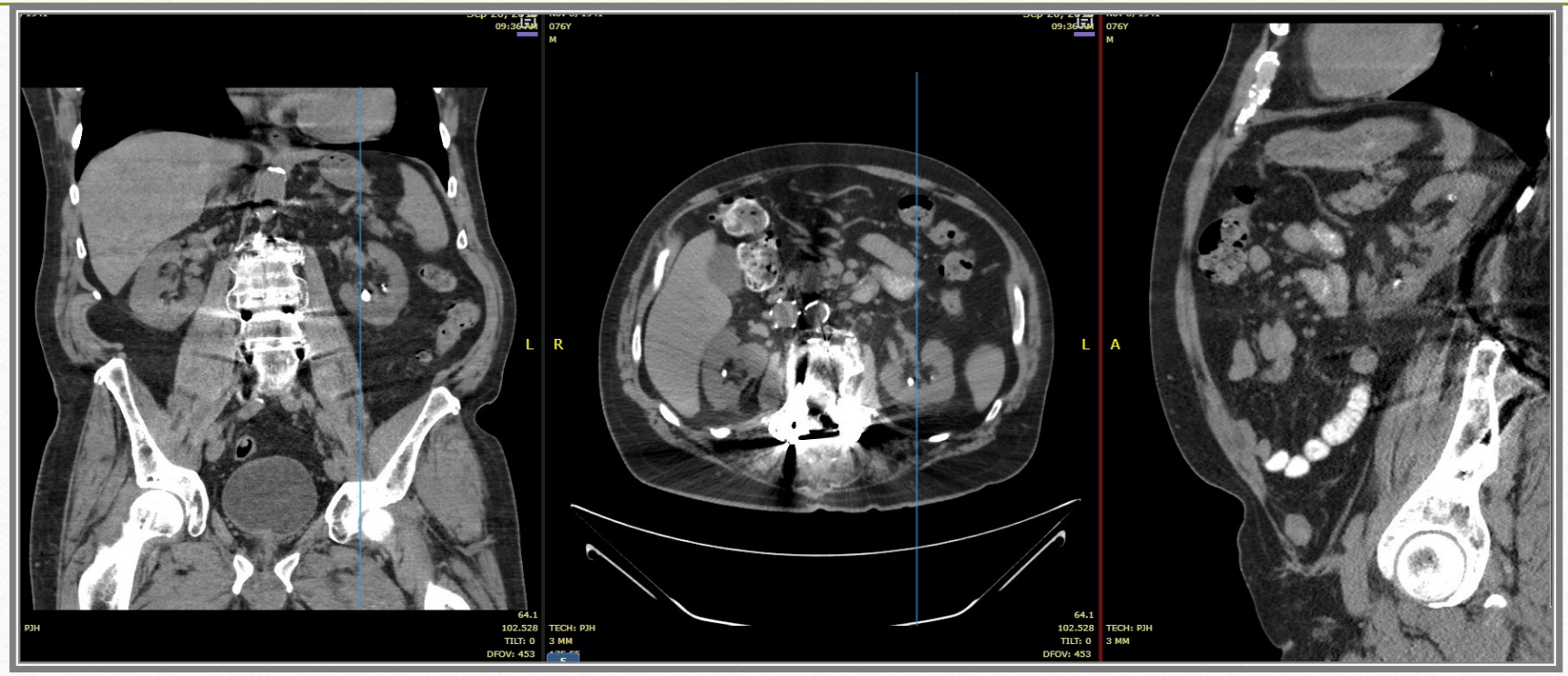
- CT abdomen / pelvis **without** contrast. (CT Stone protocol)
  - Hydronephrosis c/w obstructing kidney stones
  - Size and location of stone will determine likelihood of spontaneous passage
  - IV contrast will decrease the sensitivity for small stones
- Ultrasound of kidneys and bladder (second line choice)
  - Preferred in pregnancy
  - Can do point of care kidney US at bedside but usually it is followed by CT
  - Sensitivity at 54% compared to CT at 88%

Importance of Hydronephrosis

- Shows a blockage from kidney to bladder
- Helps to determine OBSTRUCTIVE vs NON-Obstructive uropathy
- Check and trend creatinine
- Repeat imaging – Renal Ultrasound



Non obstructing nephrolithiasis



patient LT

Obstructing Stone

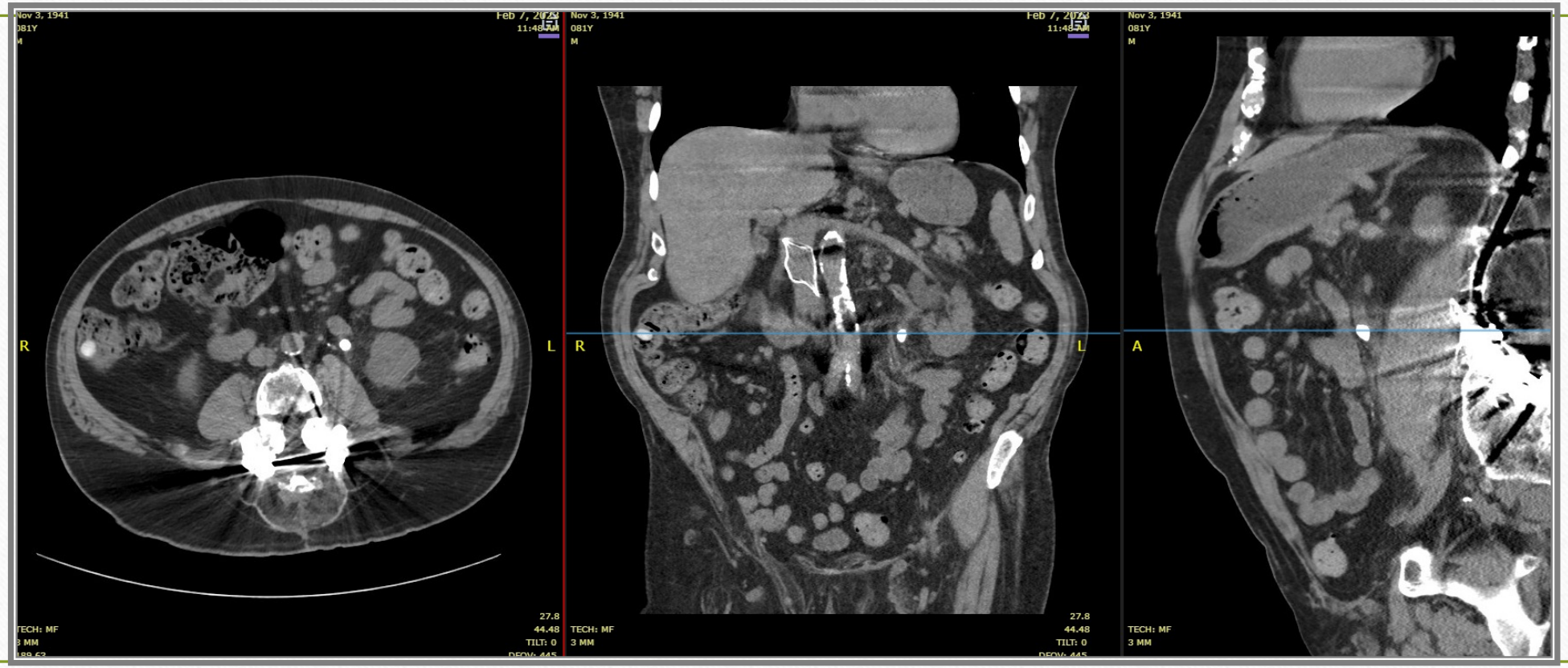
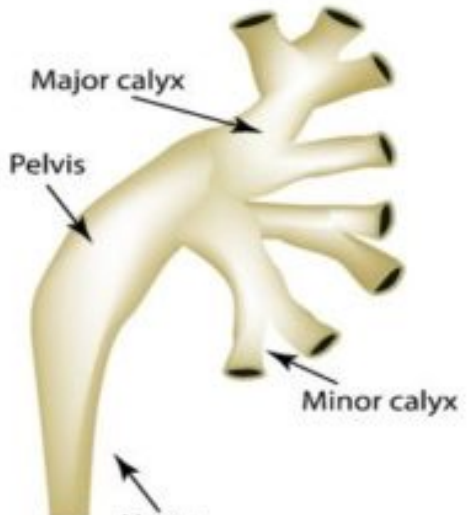
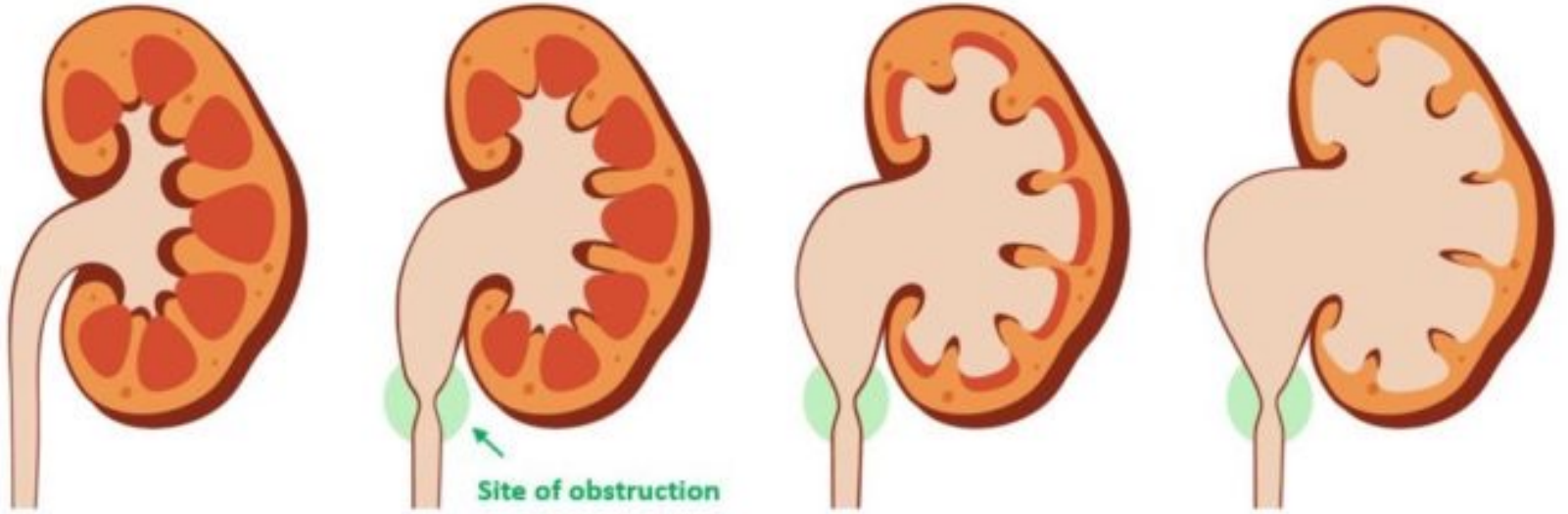
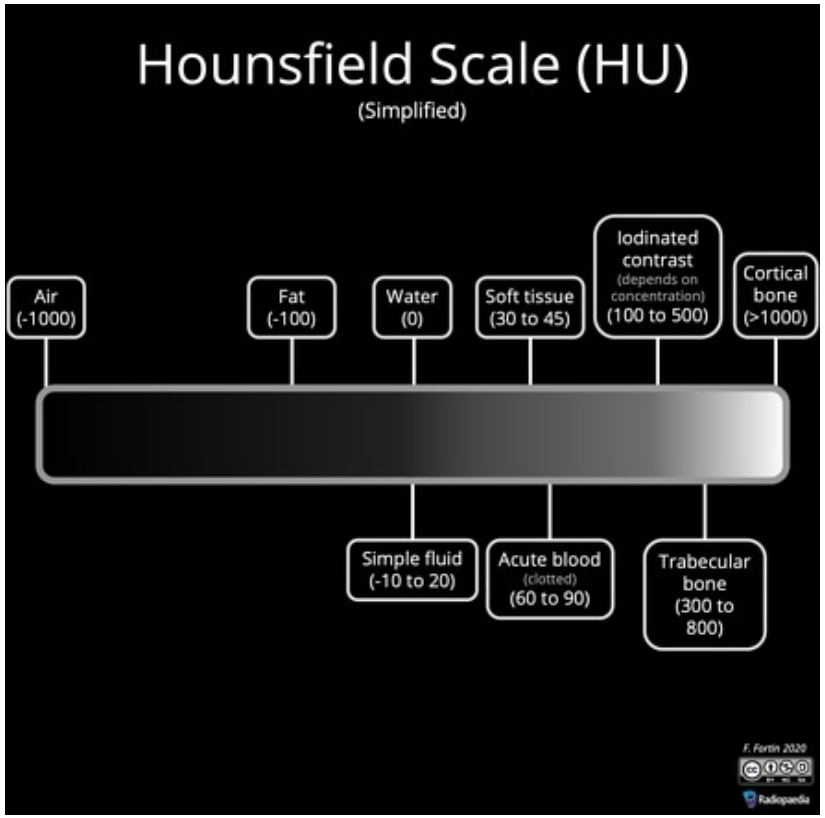


Illustration of the renal collecting system





Right Hydronephrosis



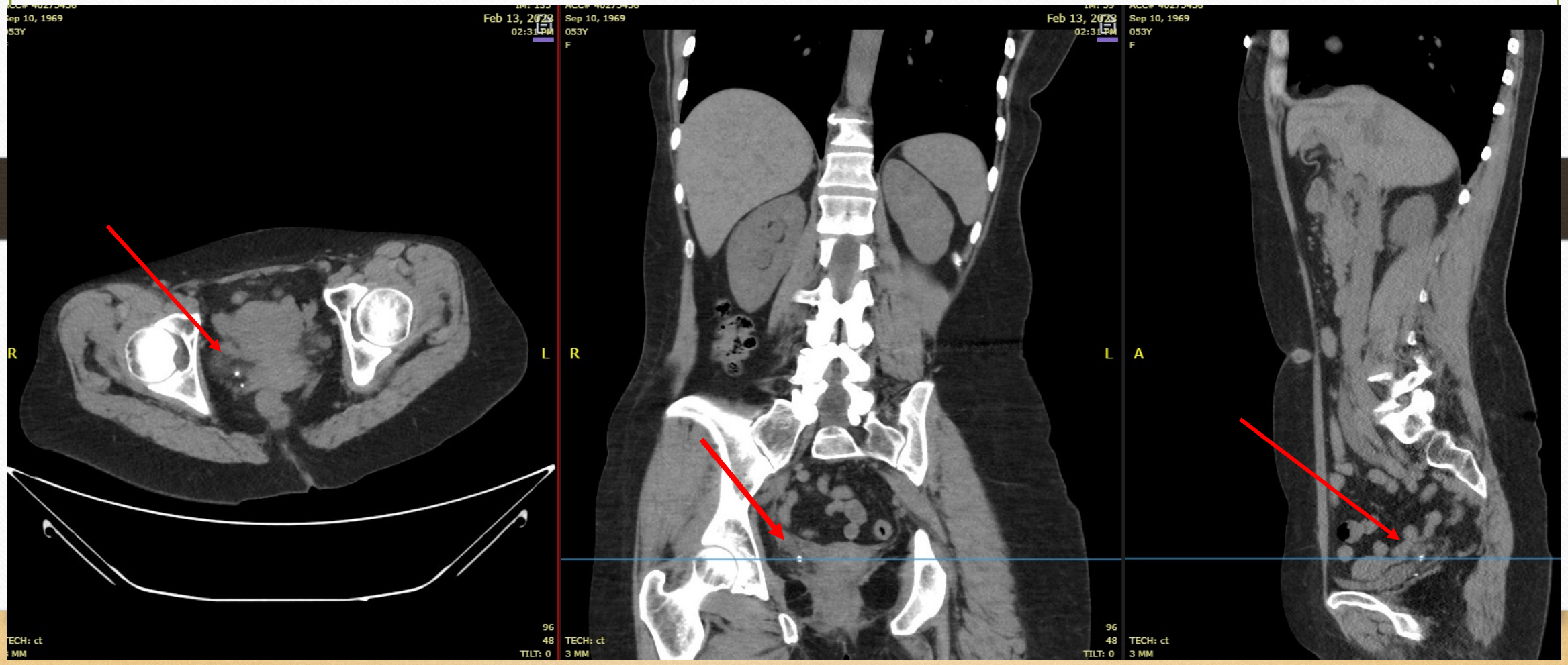
Using CT to determine the type of stone

- Uric acid / cystine / struvite stones
  - Less dense compared to calcium oxalate / calcium phosphate
  - Magnesium ammonium and cystine stones – radiopaque on CT
  - Large calculi in the renal pelvis are more likely to be STRUVITE stones
    - Struvite stones have carbonate apatite mixed in making them radiodense
  - Medullary sponge kidney with bilat calcifications – typically ca oxalate / ca phosphate stones.
- HFU (Hounsfield Unit)
  - How dense is the STONE

Case Study #1

- 53 yo KP presented to ED with c/o severe right flank pain, nausea and vomiting
- She also complained of urgency and frequency of urination
- UA + bacteria / RBC / WBC
- BMP to rule out AKI
- CT stone protocol and Ucx obtained
- VSS

Case Study #1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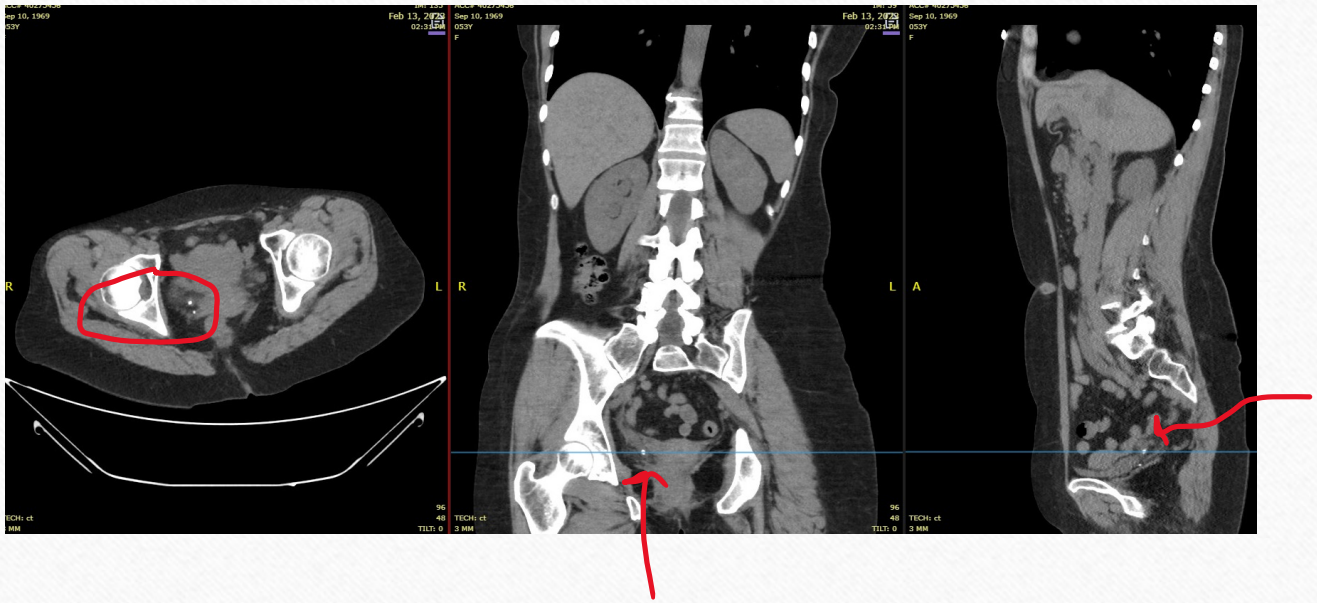
Case Study #1

CT A/P

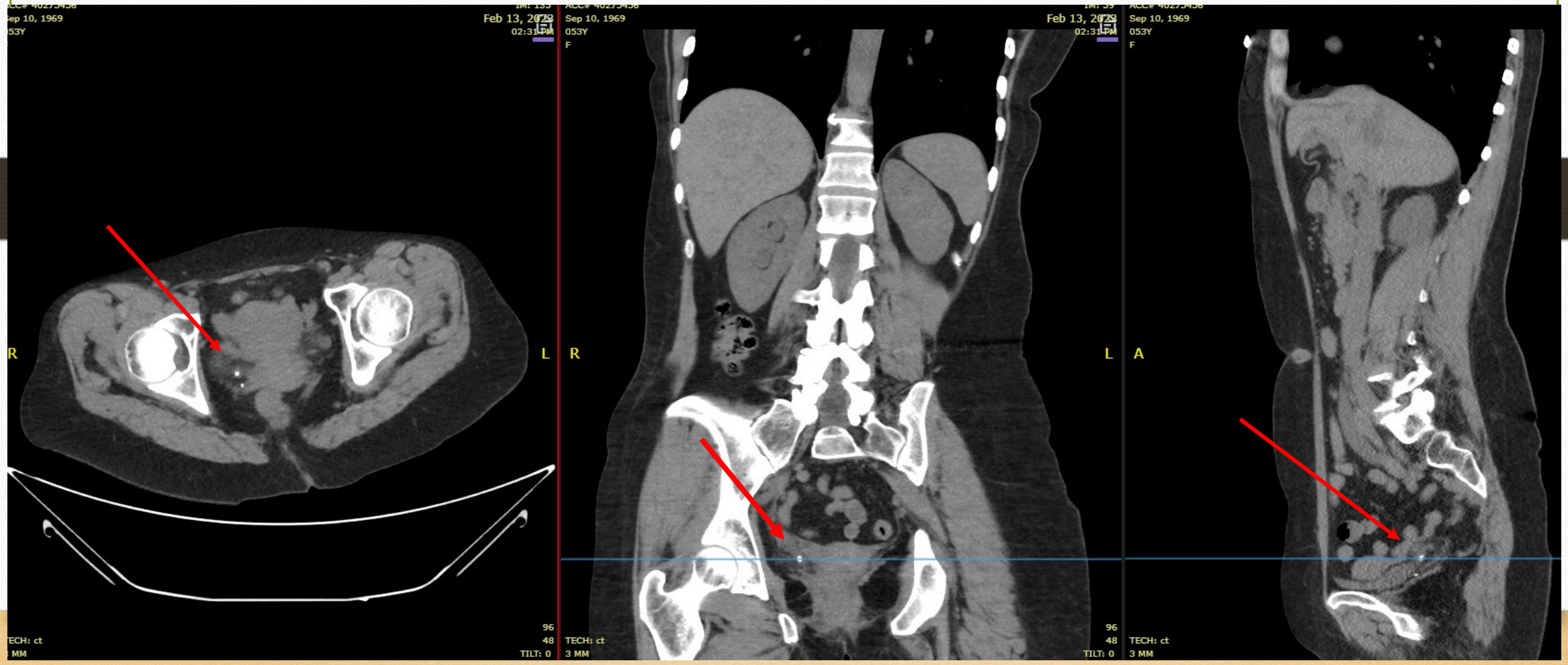
- 4 mm RIGHT distal ureteral stone
- Mild / moderate hydronephrosis



Case Study #1

- Questions to ask:
  - Is there obstruction? . . . hydronephrosis / Acute Kidney Injury
  - Stone Location
    - Proximal or distal
  - Stone Size
    - Able to pass or not
  - Is there infection present?
  - Is the patient stable?

Case Study #1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F
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TECH: ct
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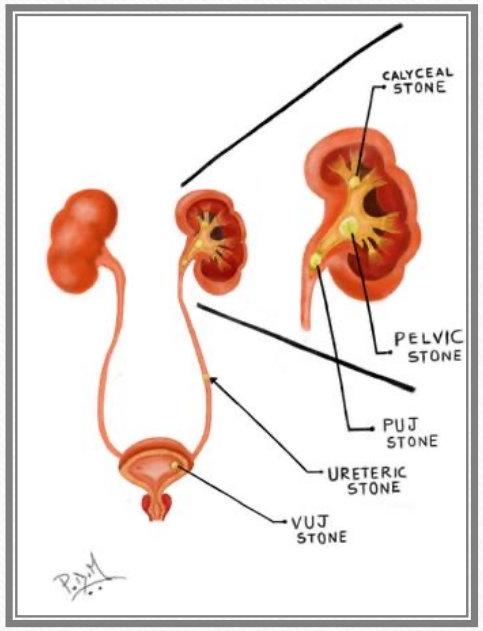
Case Study #1

- Questions to ask:
  - Is there obstruction? AKA hydronephrosis / acute kidney injury (BMP)
    - YES – mild/ moderate RIGHT hydronephrosis
  - Stone Location
    - Proximal or distal -> DISTAL
  - Stone Size
    - Able to pass or not
      - 4 mm – ABLE TO PASS
  - Is infection present?
    - YES – according to UA – RBC / WBC and bacteria
  - Is the patient stable?
    - YES – VSS but with nausea and vomiting

Treatment Options for Obstructing Stones

. . . And then think about which one is the best for this patient

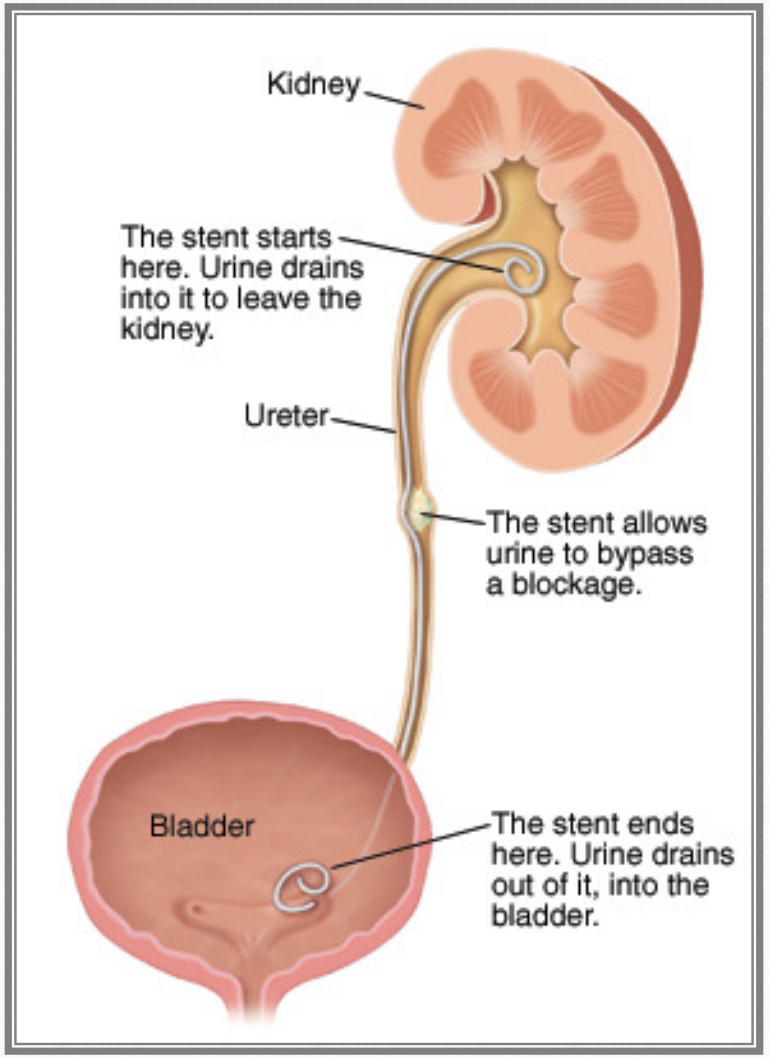
Conservative Management



- **Pain medications** – NSAIDS and opiates – ketorolac / diclofenac, indomethacin, tenoxicam
  - Check renal fx / GFR
  - 2018 meta-analysis NSAIDS were comparable to opiates in controlling pain
- **Hydration / Push LOTS of fluids**
- Tamsulosin 0.4 mg (alpha-blockers) / calcium channel blockers – less effective
- Strain urine
- MET – medical expulsive therapy
- Rule out UTI and treat accordingly
- **AUA guidelines – UNCOMPLICATED URETERAL STONE </= 10 mm – Conservative treatment**
  - **DISTAL stones have a better chance of passing on their own**
  - **If no success after 4-6 weeks -> need definitive surgical eval (imaging prior)**
- **Active Surveillance** – asx / non obstructing stones
- Smaller, more distal stones have best change of passage on own
  - </= 5 mm
  - FU to confirm passage of stone (RUS)

Surgical Management with Infection

- Obstructing Ureteral stone WITH Infection
  - Urine looks "dirty"
  - Treat infection- Ucx
- Placement of ureteral stent is needed until infection is resolved prior to treatment of stone
  - Ureteroscopy with stent placement
    - Allows the kidney to drain, preventing worsening infection, AKI, pyelonephritis

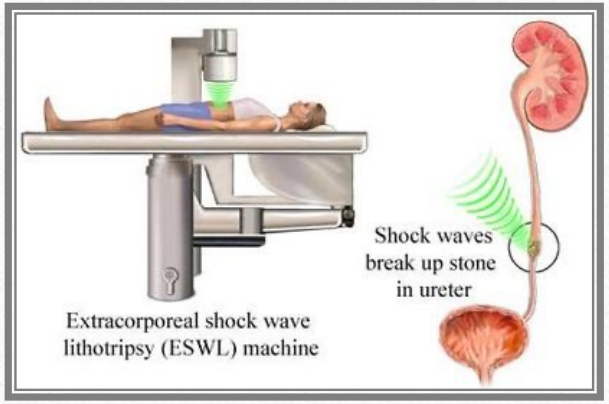


Failed Conservative Management

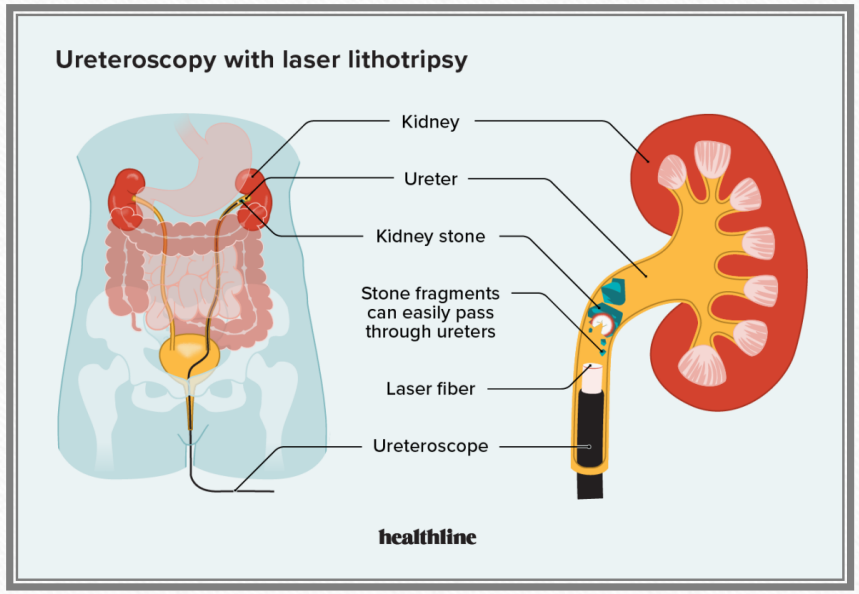
- Proceed with surgical intervention – options
  - Review CT scan
  - Based on location / size / body habitus / stone density
- ESWL
- Ureteroscopy (URS) with laser lithotripsy
- PCNL – Percutaneous nephrolithotomy

ESWL – extracorporeal shock wave lithotripsy

- Only NON-INVASIVE procedure to treat kidney stones
- Sound waves create vibrations to crush stones into smaller pieces
- Stones must be radiopaque
- Outpatient procedure /Lowest complication rate
- Disadvantage – stone fragments are NOT removed, and patients must pass them on their own after the procedure
- Ca oxalate and cystine stones are VERY HARD and resistant to ESWL
- HFU > 900 – high density, likely not to be broken up by ESWL
- High skin to stone ration results in lower chance of stone being broken up
- NOT recommended for renal pelvic stones > 20 mm or lower pole stones > 10 mm

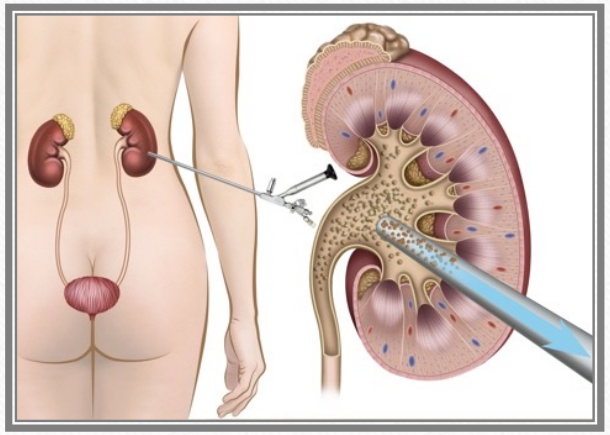


Ureteroscopy (URS) with laser lithotripsy



- Most common procedure for stone treatment
- First line therapy for mid/ distal ureteral stones
- Higher stone free rates
- Invasive procedure requiring anesthesia
- Risk of ureteral perforation
- Ureteral stent is placed after laser lithotripsy, will require removal
- TOC for cystine or uric acid stones who fail MET

PCNL – Percutaneous nephrolithotomy



- GOLD STANDARD for treatment of LARGE stones
  - Kidney stones > 20 mm, lower pole stones 10-20 mm, staghorn calculi
  - Higher stone free rate compared to URS with LL / ESWL
  - Higher mortality / INVASIVE / staged procedure
  - 15% complication rate (bleeding / ptx / renal pelvis perforation)

Nephrectomy for Staghorn Calculi

- Indications:
  - Significantly decreased kidney function
    - Mag3 Lasix Renal Scan
  - Recurrent infections / UTIs

Back to Case Study #1

- Questions to ask:
  - Is there obstruction? AKA hydronephrosis / acute kidney injury (BMP)
    - YES – mild/ moderate RIGHT hydronephrosis
  - Stone Location
    - Proximal or distal -> DISTAL
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      - 4 mm – ABLE TO PASS
  - Is infection present?
    - YES – according to UA – RBC / WBC and bacteria
  - Is the patient stable?
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Case Study #1

- Question
  - What is the best treatment for this case?
    A. Send home with Rx Zofran, Flomax, NSAIDs and tell them to strain the urine
    B. Radical nephrectomy
    C. Ureteroscopy with laser lithotripsy
    D. ESWL
    E. Ureteroscopy with stent placement

Case Study #1

- Question
  - What is the best treatment for this case?
    A. Send home with Rx Zofran, Flomax, NSAIDs and tell them to strain the urine

    - pt is not able to be sent home with nausea and vomiting infection present

    B. Radical nephrectomy

    - a little too extreme

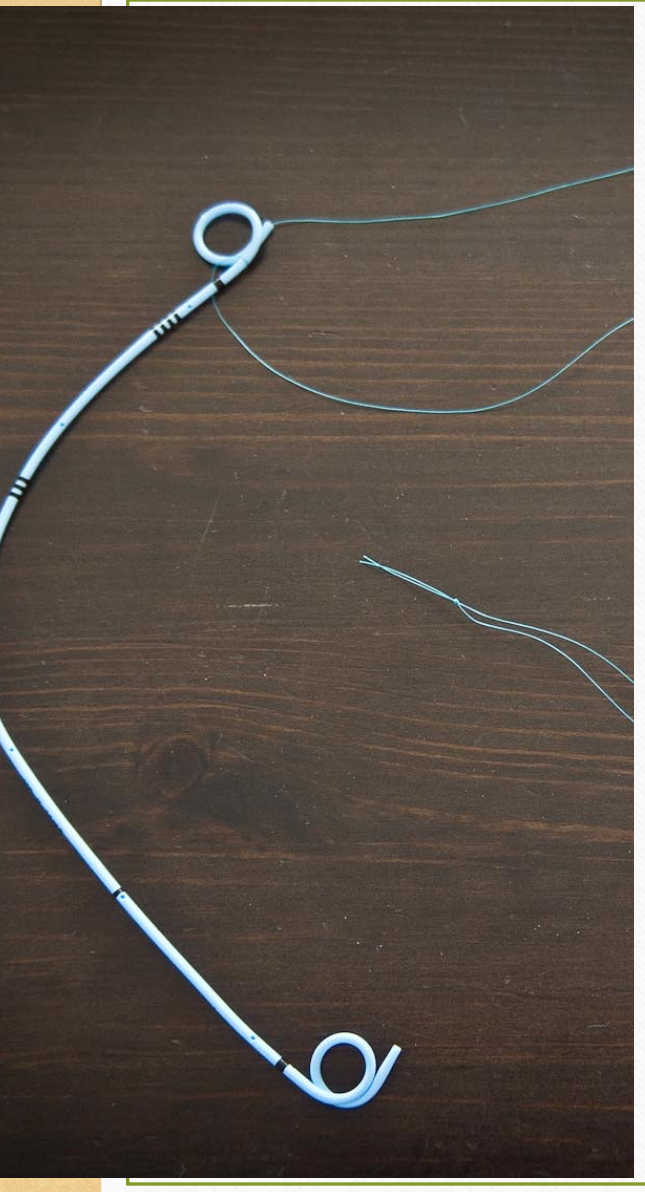
    C. Ureteroscopy with laser lithotripsy

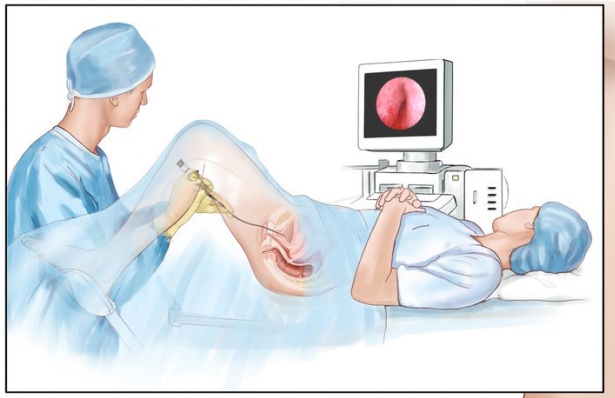
    - patient has infection, treating the stone is NOT indicated until infection is treated

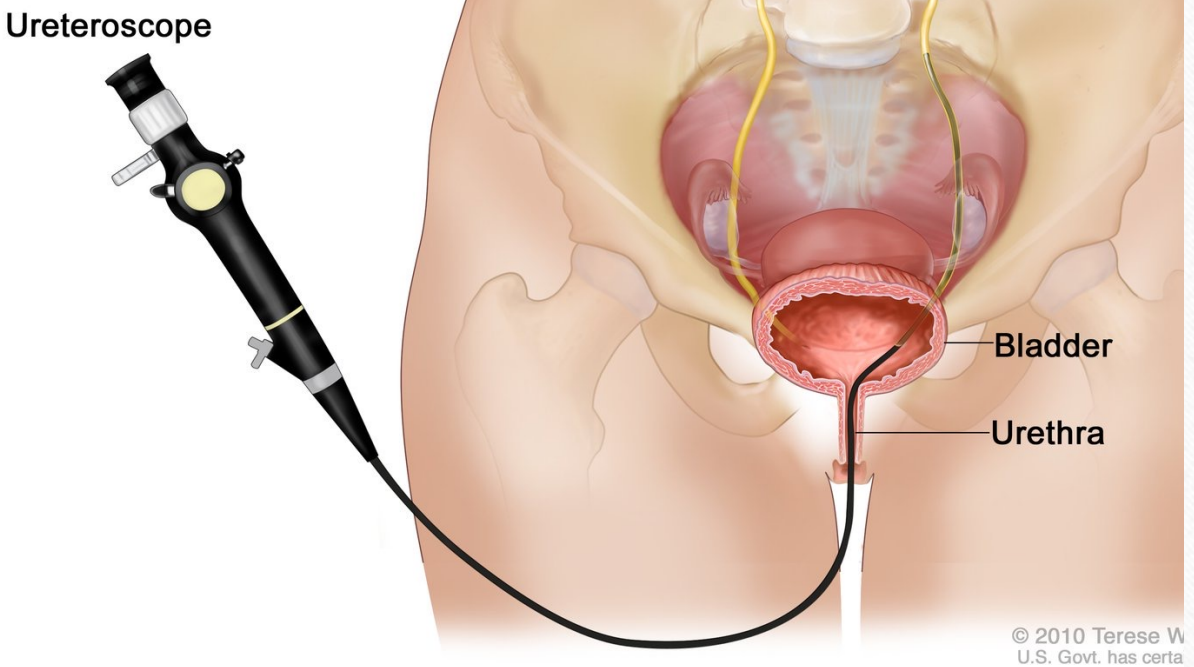
    D. ESWL

    - outpatient procedure, pt has infection

    E. Ureteroscopy with stent placement – need to place a stent to resolve the obstruction, treat the infection and then will need definitive stone treatment






Right kidney
Left kidney
Ureter
Ureteroscope
Bladder
Urethra
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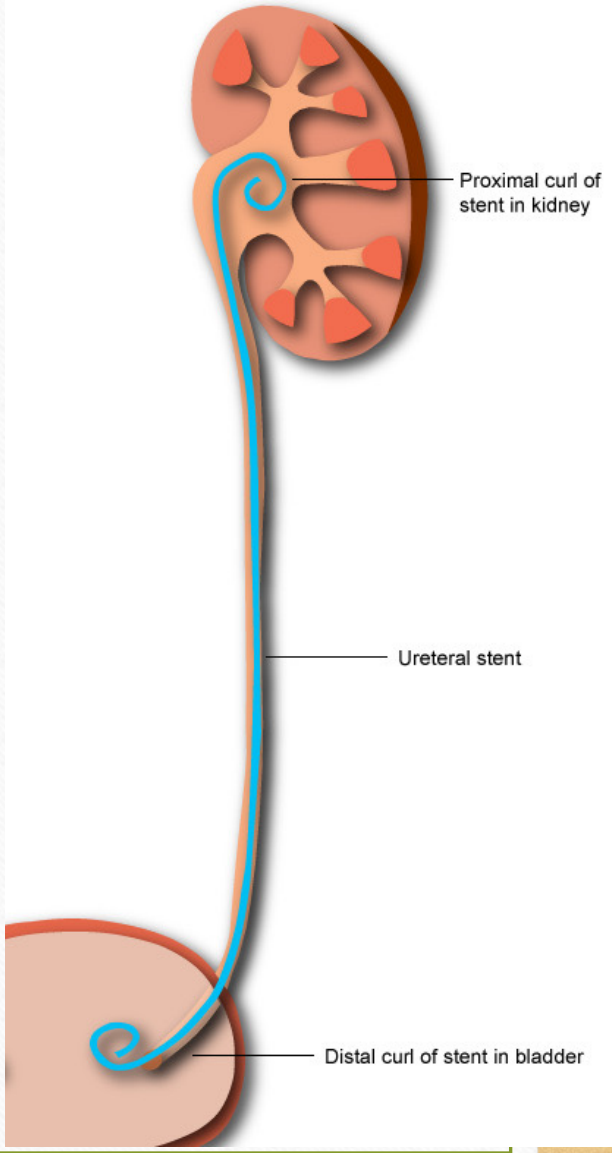
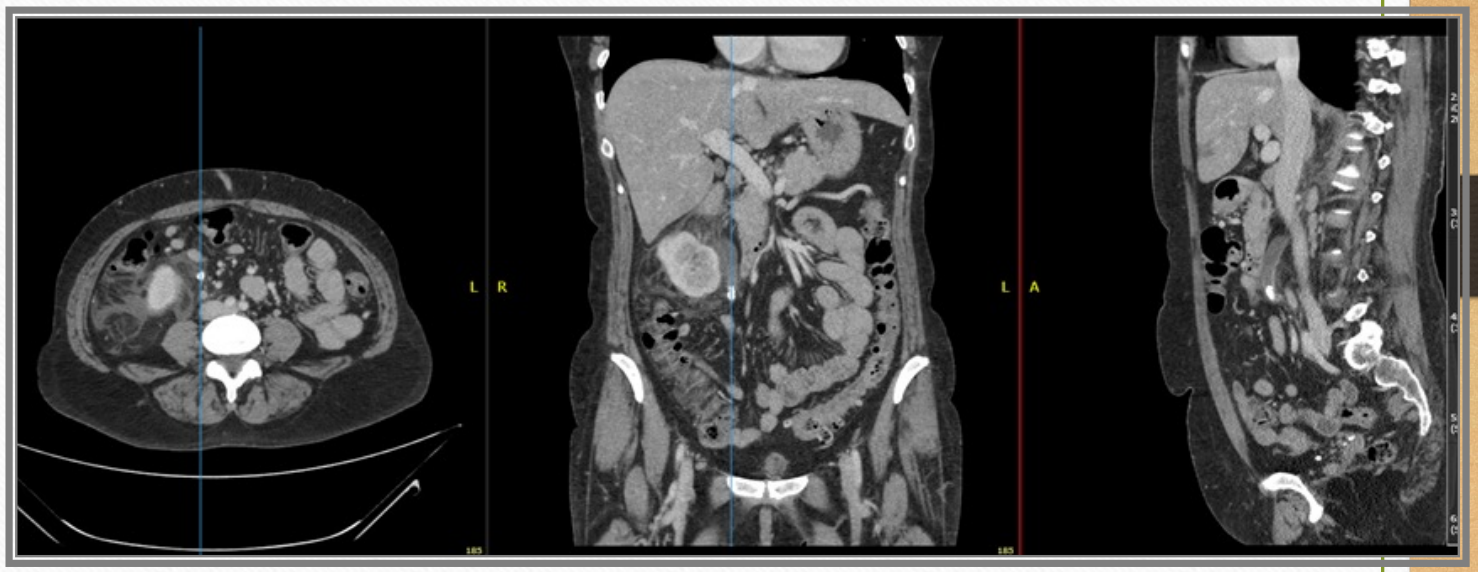
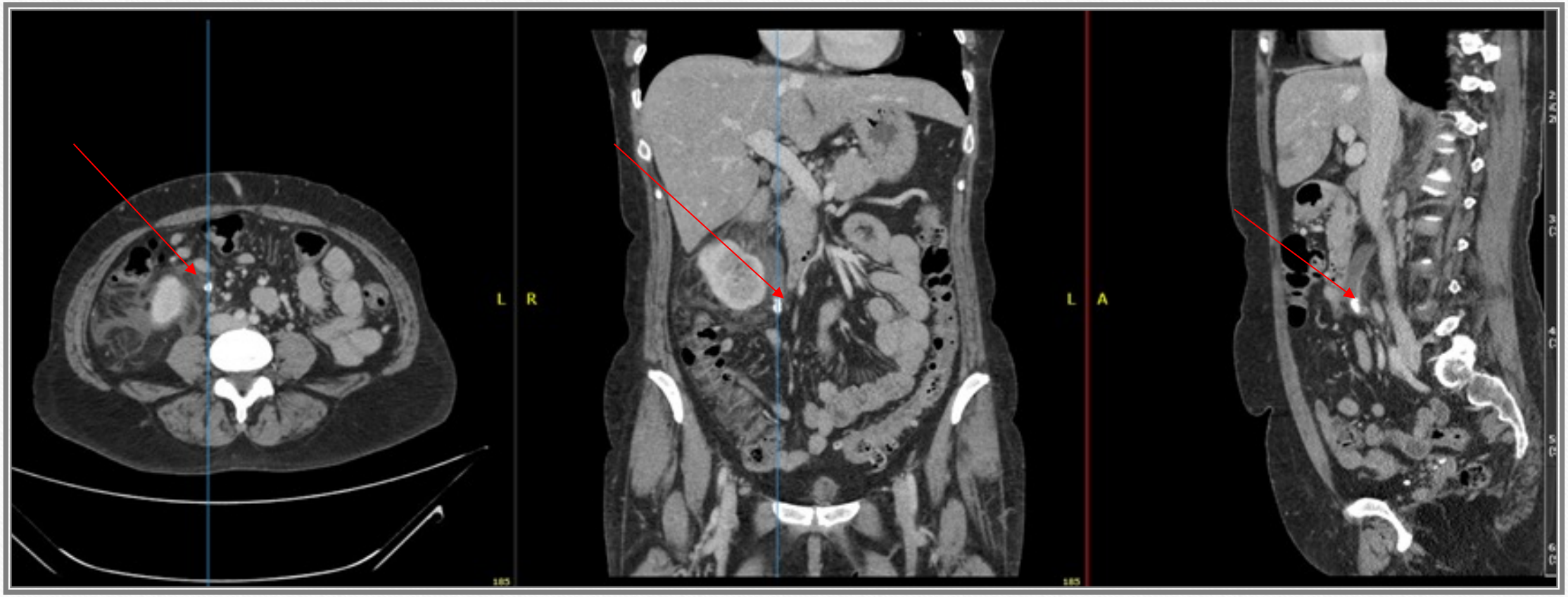

Proximal curl of stent in kidney
Ureteral stent
Distal curl of stent in bladder

Case Study #2

- JW 44 yo female presented to urgent care with right abdominal pain and mild nausea
- CT showed the following:
  - Right hydronephrosis
  - 1-2 stones tandem in proximal right ureter
- SENT HOME
- Rx – Flomax / cipro / MET / norco/ NSAIDS
- Instructed to FU with Urology in 1-2 days
- Ucx showed ecoli

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Case Study #2

- Pain worsened and pt presented to ED 5 days later with severe abdominal pain / severe nausea and vomiting "not consistent with kidney stone pain"
- Repeat CT in ED showed:
  - Small amount of free fluid and moderate amount of free gas within the abdomen. Likely gastric perforation. Surgical consultation recommended
  - Redemonstration of right hydronephrosis secondary to a proximal ureteral 7 mm stone.
- Pt taken to OR for gastric perforation s/p repair / Pt admits to taking LOTS of naproxen for pain since Urgent care visit
- Urology consulted for persistent obstructing RIGHT ureteral stone with hydronephrosis
- s/p ureteroscopy with ureteral stent placement (not able to treat the kidney stone d/t persistent UTI / infection)

Stone Prevention

- Metabolic workup for recurrent events or interested 1st time stoners
- Metabolic Workup
  - Two 24 hour urine collections at random
  - Measures for pH / Cal ox / uric acid / Citrate / Na / K / creatinine
  - Rule out primary hyperparathyroidism
- Drink LOTS of water > 2.5 Liters daily

Metabolic Work up

- **If HIGH urinary calcium**
  - Limit sodium <2300 mg/day / 1000-1200 mg per day of Calcium
  - Limit animal protein
- **If HIGH urinary oxalate**
  - Eat LOW oxalate diet <100 mg/ day
  - Limit Vitamin C
- **If LOW urine citrate**
  - Eat more fruits / vegetable / lemon juice
  - Limit non diary animal protein
  - Consider adding potassium citrate (it will increase pH)
- **Cystine stones**
  - Low sodium <2300 mg/day
  - Limit non diary animal protein
- Repeat 24 hour urine in 6 months after initiating therapy

LOW Oxalate Diet

- To decrease risk of ca oxalate stones

BLADDER STONES

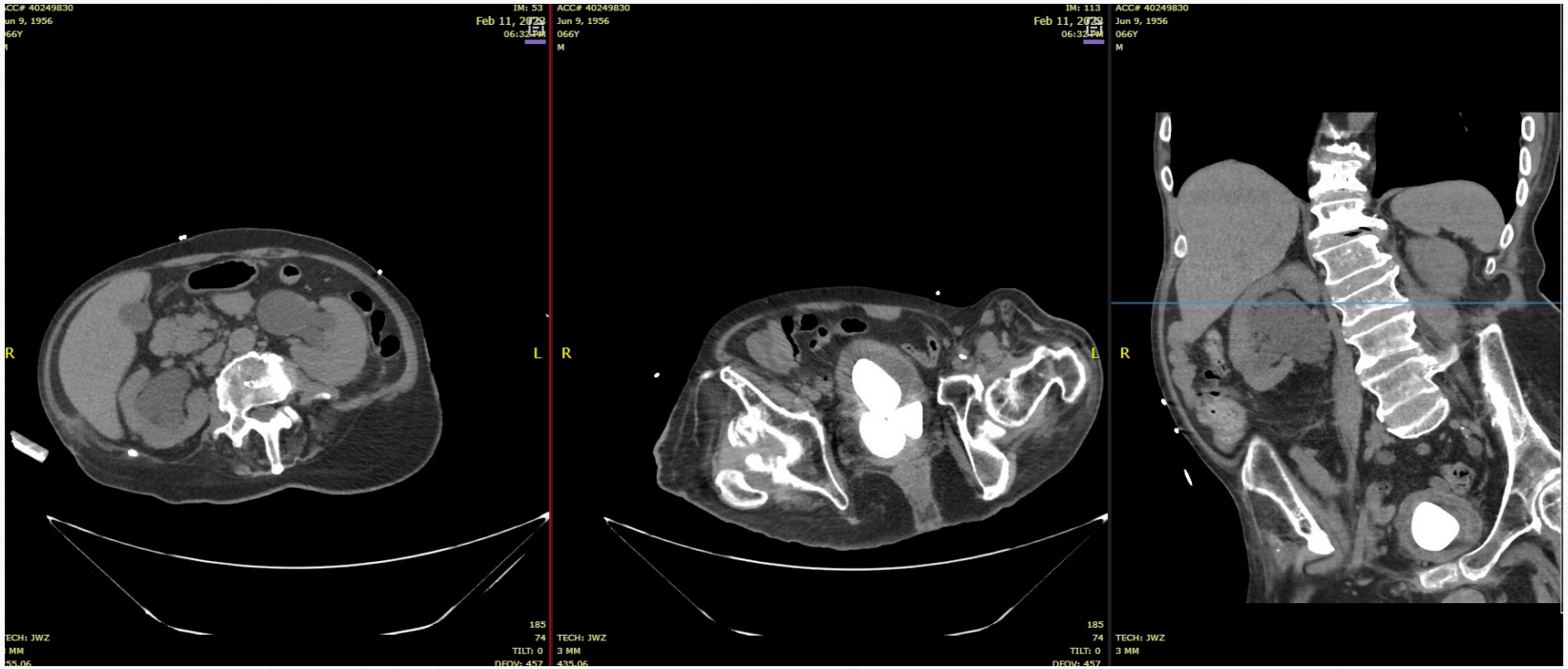
Risk Factors

- Bladder diverticulum.
- Blockage at the base of the bladder.
- Enlarged prostate (BPH)
- Neurogenic bladder.
- Urinary tract infection (UTI)
- Incomplete emptying of the bladder.
- Foreign objects in the bladder.

Signs and Symptoms

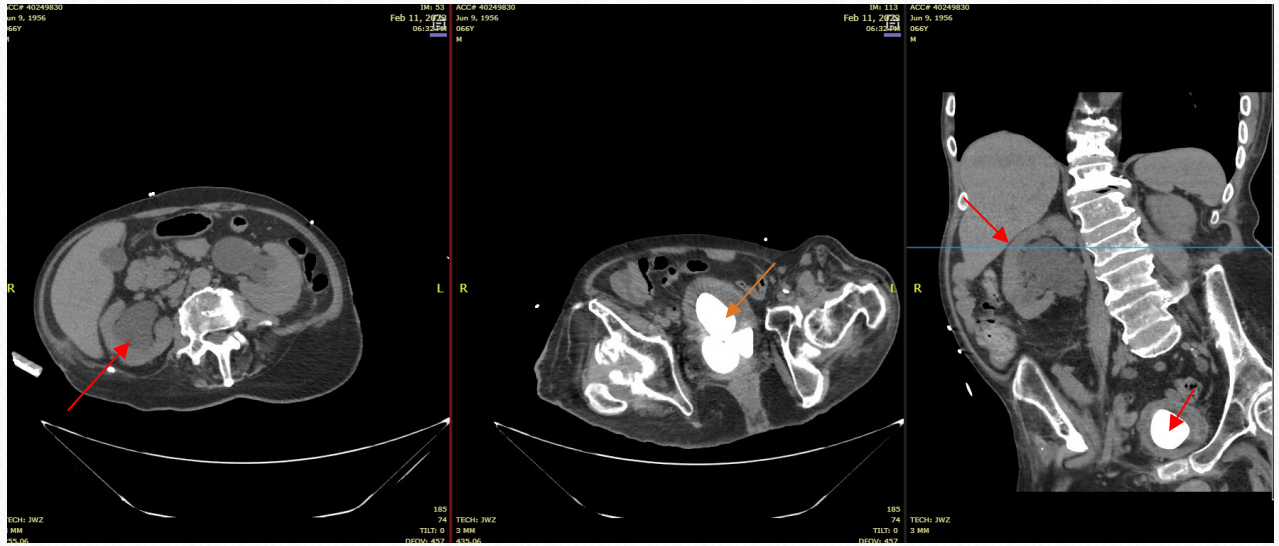
- Lower abdominal pain
- Pain during urination
- Frequent urination
- Difficulty urinating or interrupted urine flow
- Blood in the urine
- Cloudy or unusually dark-colored urine

https://www.mayoclinic.org/diseases-conditions/bladder-stones/symptoms-causes/syc-20354339



Bladder Stones

CT shows . . . .



Bilateral hydronephrosis with ureters dilated down to the urinary bladder

urinary bladder there are three large stones. The density measurements are between 1300 and 1400 Hounsfield units each.

Foley Catheter to be placed

Follow up for patients with Neurogenic Bladder

- Neurogenic Lower Urinary Tract Dysfunction: AUA/SUFU Guideline (2021)
- In NLUTD patients with indwelling catheters who are at risk for upper and lower urinary tract calculi (e.g., patients with spinal cord injury, recurrent urinary tract infection, immobilization, hypercalcuria) clinicians should perform urinary tract imaging every 1-2 years.

Ginsberg DA, Boone TB, Cameron AP et al. The AUA/SUFU Guideline on Adult Neurogenic Lower Urinary Tract Dysfunction: Diagnosis and Evaluation. J Urol 2021; 206: 1097.

Tips and Tricks – when to send to Urology

- When to take to surgery
  - Stones 10 mm or bigger
  - Failure to pass a stone after 4-6 weeks of MET
  - Poorly controlled pain on MET
- Always send stone for analysis (at least once)
- Personally look at imaging for "stone burden"
- Routinely check BMP on patients who are on pharmacotherapy for stones
- Alpha blockers and antimuscarinic therapy can decrease stent discomfort / prepare patients they may have stent discomfort
- Ureteral stents can cause gross hematuria
- Struvite stones – monitor for rUTIs and re-image
  - Consider adding acetohydroxamic acid (urease inhibitor)

Other Interesting facts about stones . . .

- Bacteria associated with kidney stones:
  - Proteus species, Klebsiella, Pseudomonas, Corynebacterium species, urease-negative organisms such as E. coli
- Patients who have passed one kidney stone have a very high rate of recurrence; lifetime recurrence rate is estimated at 60%–80%
- First time stone formers during pregnancy have increased risk of developing more stones within 4 years
- Delay in stone treatment in pregnancy can increase risk of maternal-fetal complications
  - AUA 2021: Take Home Message: Stones; Bhojani et al 01/ Dec 2021
  - Ureteral stones with well controlled symptoms – can offer observation as TOC

Summary

- Stones are very common but can be preventable
- Encourage drinking 2.5-3 L of WATER daily
- Lemon juice / Lemonade – citrate decreases stone formation
- Follow up after kidney stone event is important for prevention
  - Resolution of hydronephrosis

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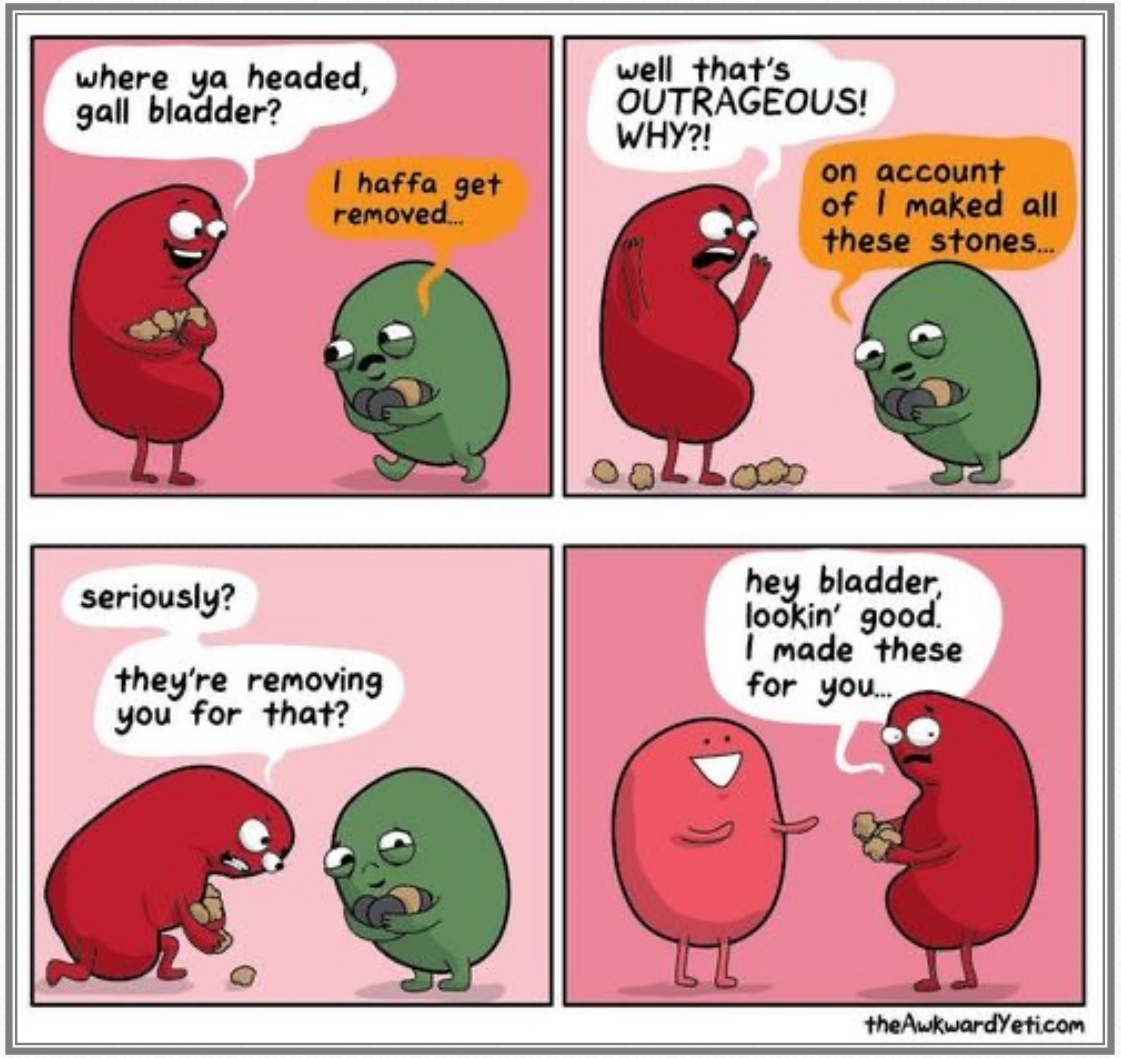
Thank you


where ya headed, gall bladder?
I haffa get removed...
well that's OUTRAGEOUS! WHY?!
on account of I maked all these stones...
seriously?
they're removing you for that?
hey bladder, lookin' good. I made these for you...
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