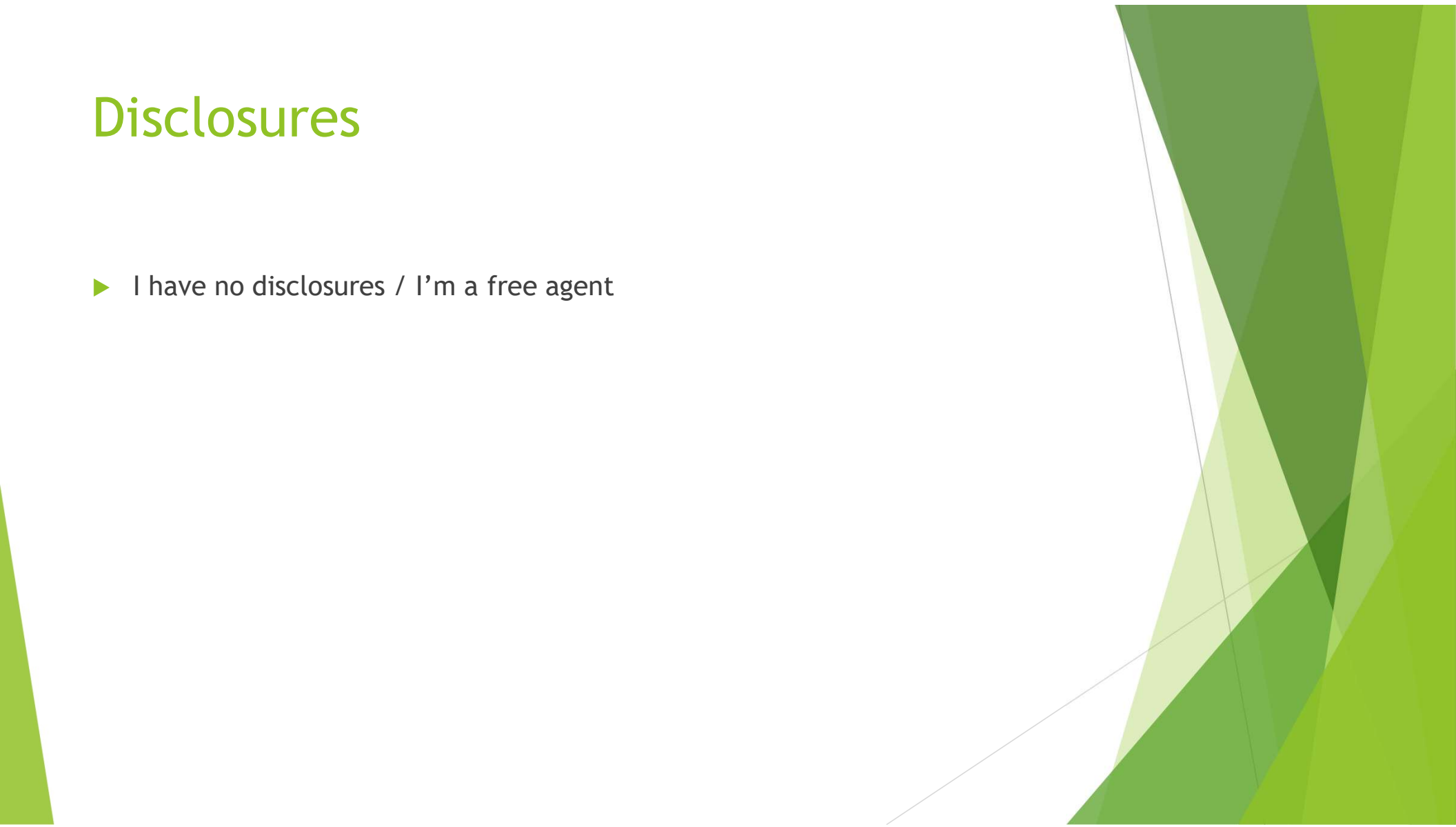
Painful Pebbles

Christy Wilson PA-C, MPAS, DFAAPA

Disclosures

- I have no disclosures / I’m a free agent



Objectives

- • 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
- • Review and interpret common radiographic images and be able to recognize an obstructing kidney stone
- • 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 prevent future kidney stones including metabolic evaluation

Question 1

- All of the following are risk factors for developing nephrolithiasis EXCEPT:

- 1. Obesity
- 2. HTN
- 3. Hyperparathyroidism
- 4. Hyperlipidemia
- 5. DM

Question 2

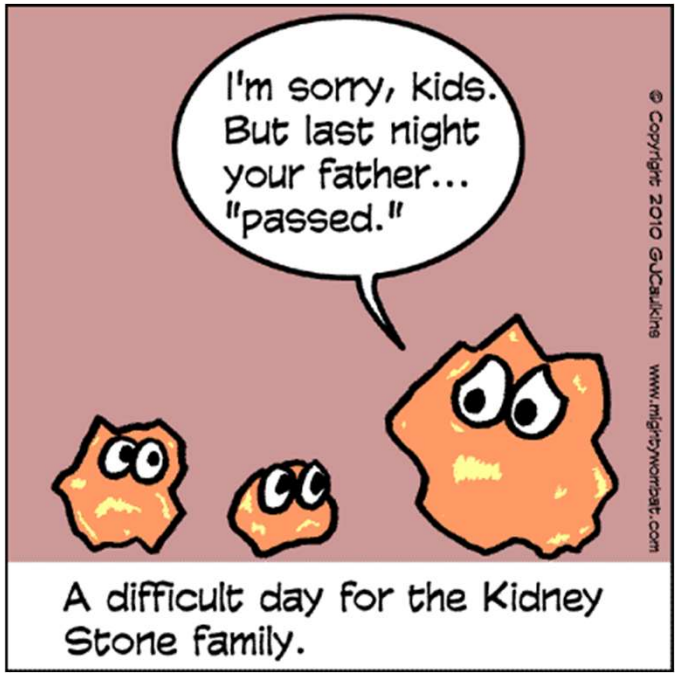
- A patient presents to the Emergency Room with RIGHT flank pain / nausea / vomiting and fevers. UA shows sig WBCs / Many bacteria and CT scan shows 5 mm right distal ureteral stone with moderate hydronephrosis. Which of the following is the best treatment plan for this patient?

- 1. Give IVF and anti-emetics and send home with a strainer, tamsolusin and Bactrim antibiotic.
- 2. Refer the patient to outpatient urology and Rx tamsolusin
- 3. Allow them to eat but admit them for observation with IVF, antibiotics and anti-emetics, having them strain their urine
- 4. Give IVF and antibiotics, make NPO and consult urology

Question 3

- Which of the following is FALSE when it comes to urolithiasis:

- 1. Calcium oxalate are the most common kidney stones
- 2. The size of the stone is more important than the location
- 3. Most stones are radiopaque
- 4. Diet and dehydration are the main causes of kidney stones

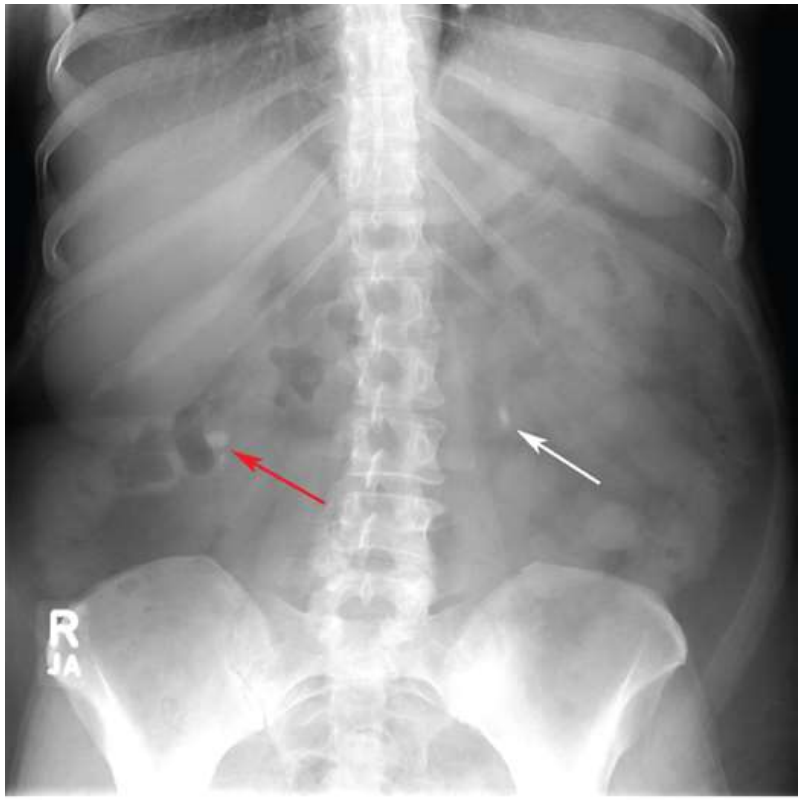


Urolithiasis / Nephrolithiasis

- Types of Stones
  - 80% - Calcium stones
    - Calcium oxalate > calcium phosphate
  - Uric acid
  - Struvite (magnesium ammonium phosphate)
  - Cystine
- Pathophysiology
  - Stones form when soluble material such as calcium / oxalate supersaturates the urine and crystals form

Facts about Nephrolithiasis

- Most common cause – DEHYDRATION
- Hypercalcemia can increase risk
- Most common stone – Calcium oxalate
- 90% of stones are RADIOPAGUE
- 50% chance of developing another stone within 10 years of first event



Source: Usatine RP, Smith MA, Mayeaux EJ, Chumley HS: *The Color Atlas of Family Medicine, Second Edition*: www.accessmedicine.com
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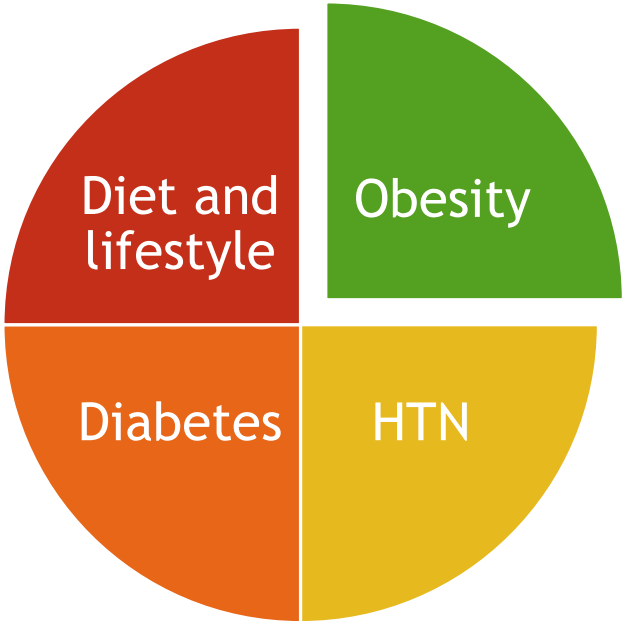
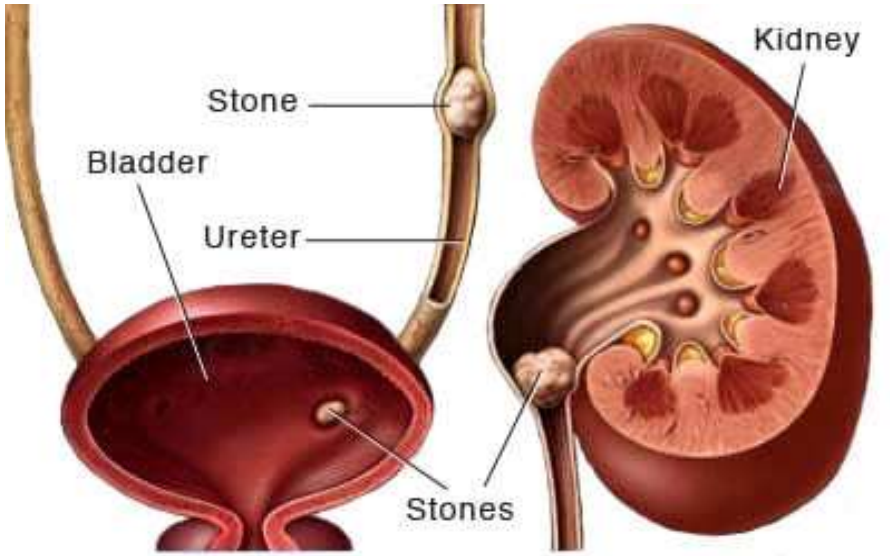
Medical Management of Kidney Stones: AUA Guidelines Pearle, et al American Urological Association 2014 Vol 192, 316-324 Aug 2014

Risk Factors For Kidneys Stones



Signs and Symptoms

- Asymptomatic stones
  - Incidental finding on imaging
- Symptomatic stones
  - Pain when the stone moves from the renal pelvis to the ureter
  - Waxes and wains
  - Site of obstruction determines location of pain
  - Hematuria – common
  - Burning with urination
  - Nausea / vomiting



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Differential Diagnosis

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

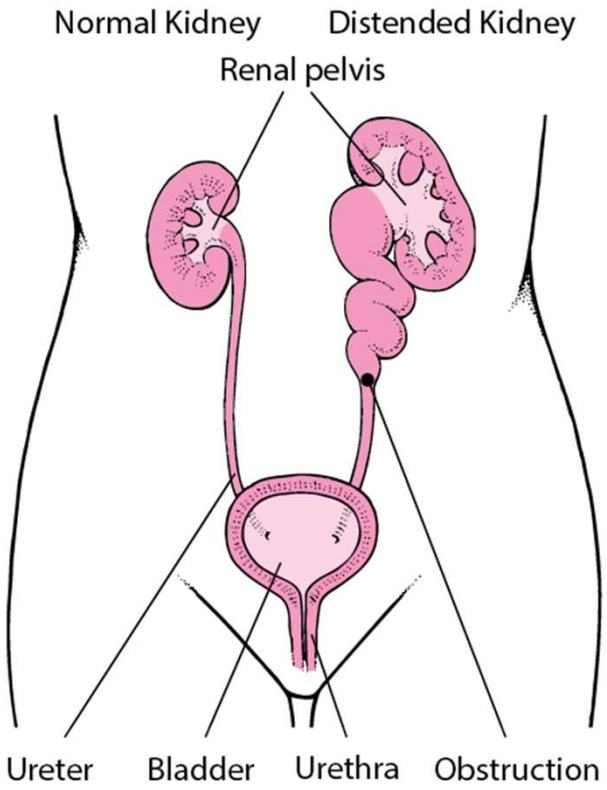
Evaluation of Suspected Urolithiasis

Labs:

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

Diagnostic Imaging

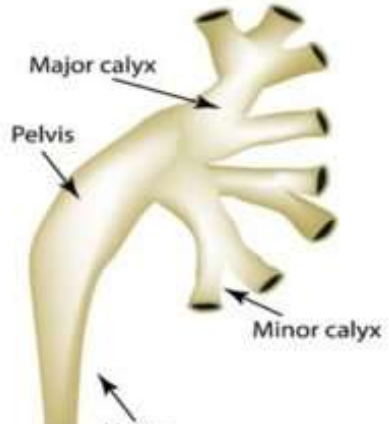
- CT abdomen / pelvis **without** contrast. (CT Stone protocol)
  - Hydronephrosis c/w obstructing kidney stones
  - Size and location of stone will determine likelihood of spontaneous passage
  - IV contrast will decrease the sensitivity for small stones
- Ultrasound of kidneys and bladder (second line 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%

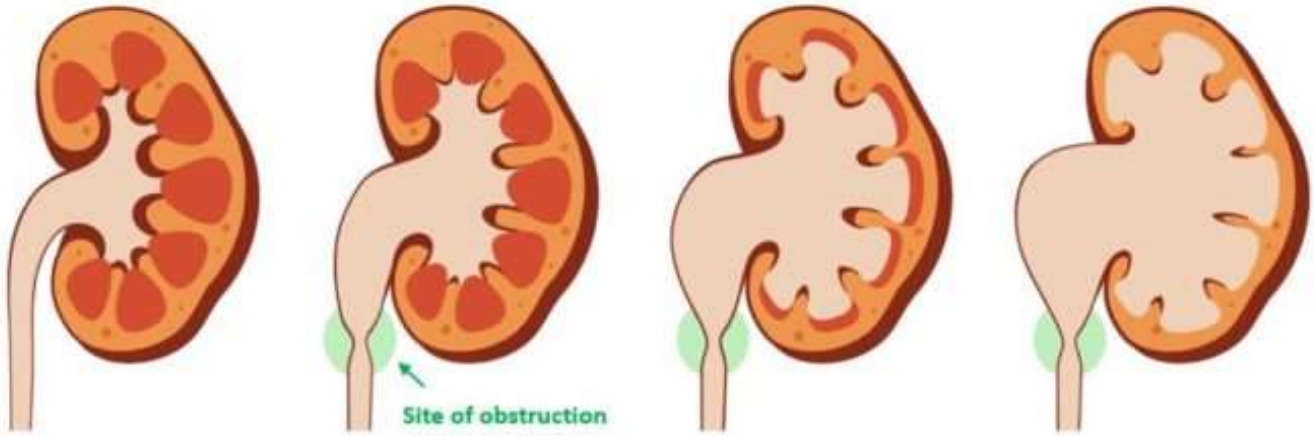


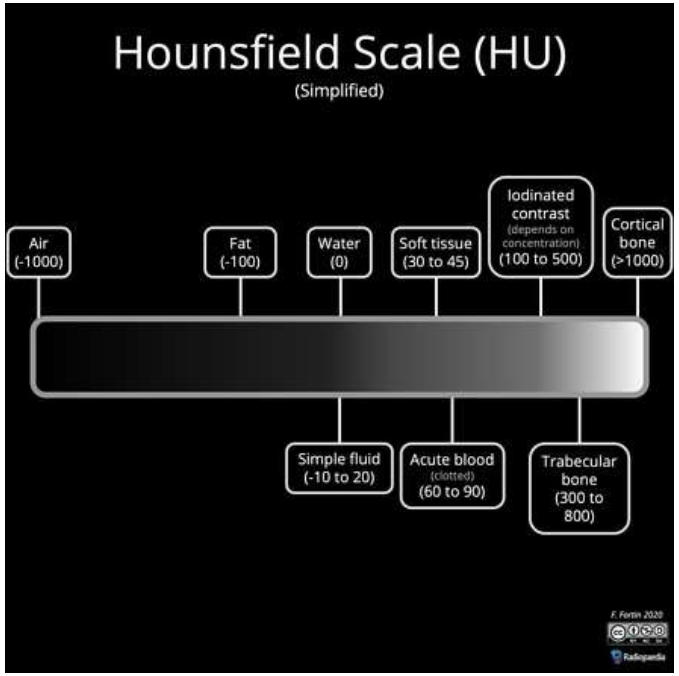
Importance of Hydronephrosis

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

Illustration of the renal collecting system





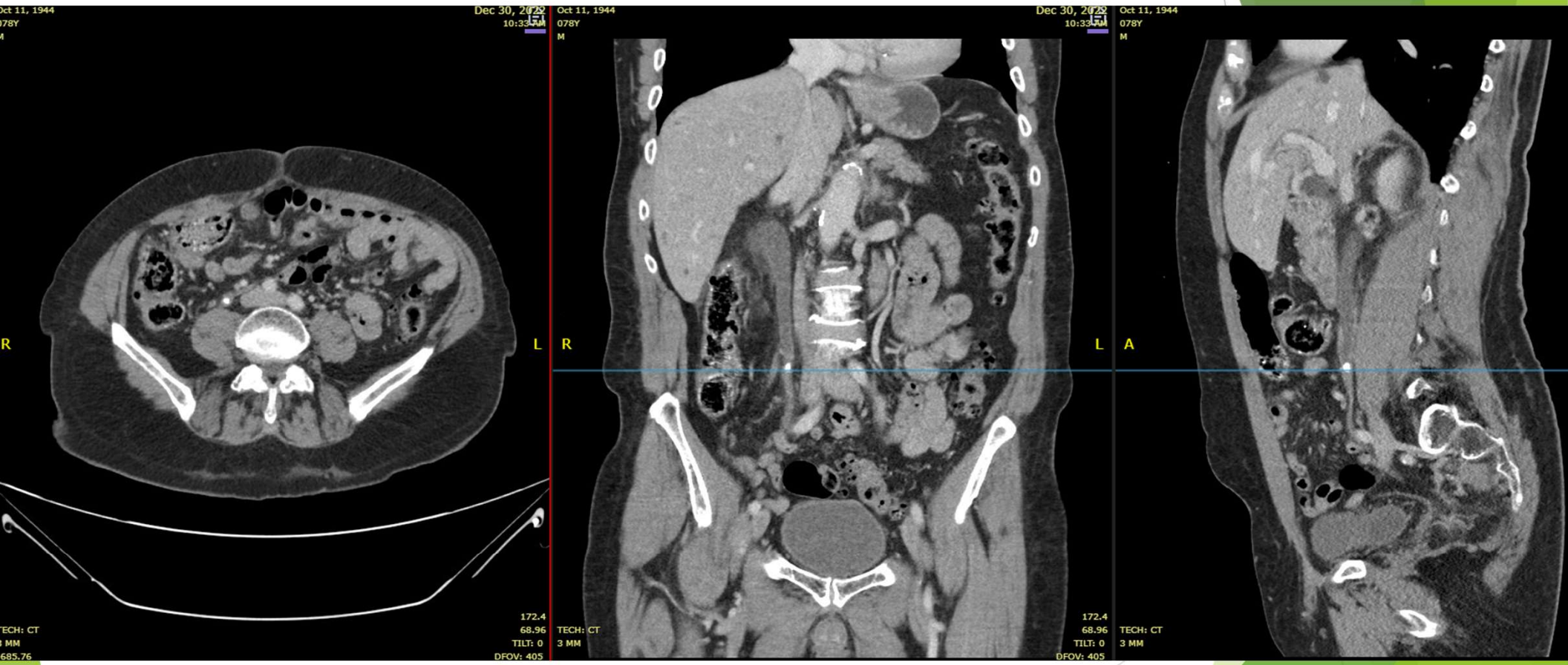


Using CT to determine the type of stone

- 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

- TM 78 yo male presented to ED with RIGHT flank pain radiating to RLQ
  - VSS afebrile
  - Creatinine 1.12 / CBC normal
  - UA – large blood, small LE, rare bacteria
  - Ucx obtained (pending in ED but was negative)
  - CT Stone Protocol obtained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TECH: CT
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3 MM
L
A
TECH: CT
3 MM

CT stone protocol . .. Results

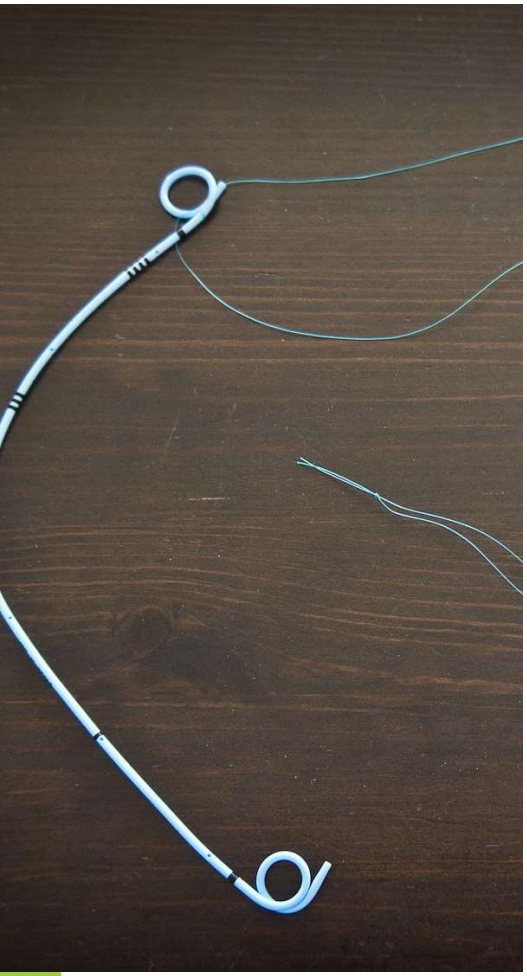
- Moderate RIGHT hydronephrosis
- 5-6 mm RIGHT mid ureteral stone (HFU 740)
- Bladder unremarkable
- Enlarged Prostate with mass effect on Bladder

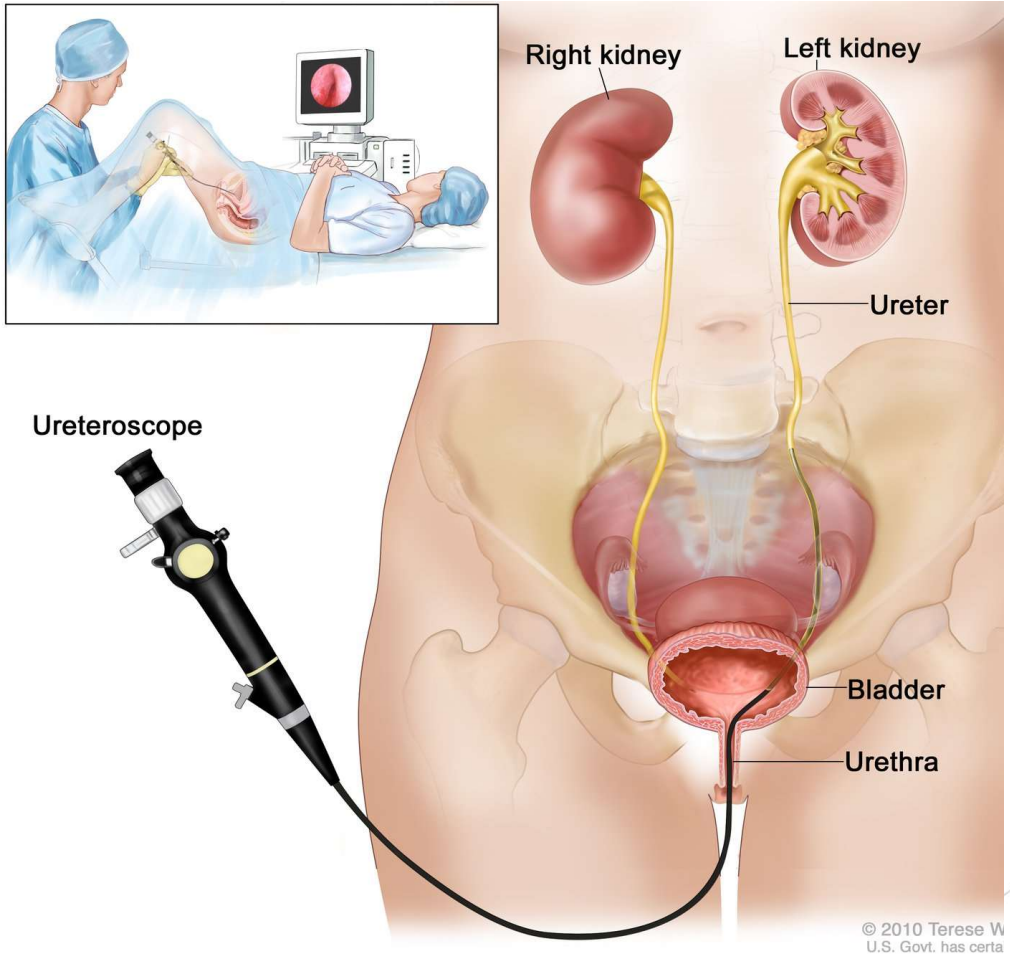
- It isn't just the **SIZE** of the stone but also the **LOCATION**

- What is the next step . . . .

RIGHT obstructing Ureteral Stone

- SHARED DECISION MAKING
- MET (Medical Expulsive Therapy) / Strain urine
- Referral to Urology
- Unable to pass stone
  - Cystoscopy with RIGHT ureteroscopy / Laser Lithotripsy with ureteral stent placement
    - Noted to have trilobar prostate with some bleeding required fulguration and foley placement
    - Stent removal in 2-3 weeks with cystoscopy
    - Stone analysis calcium oxalate




Right kidney
Left kidney
Ureter
Ureteroscope
Bladder
Urethra
© 2010 Terese W
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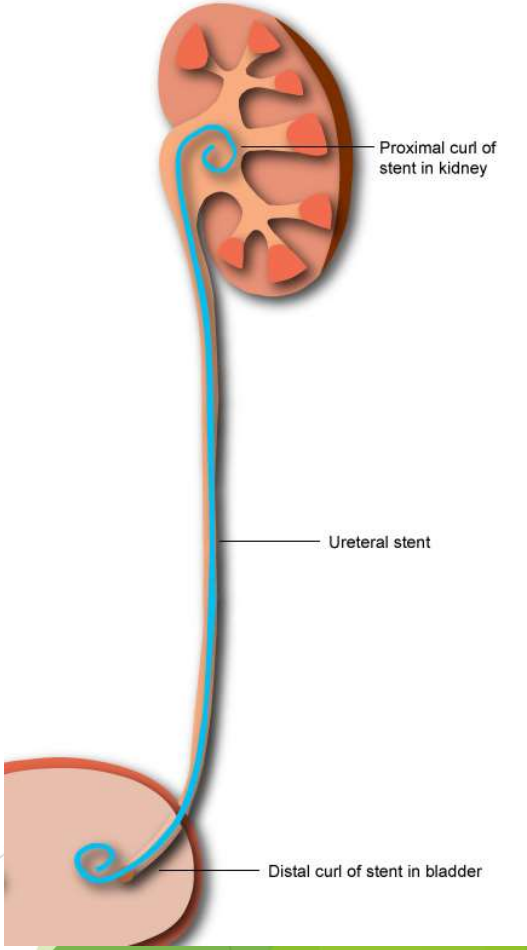
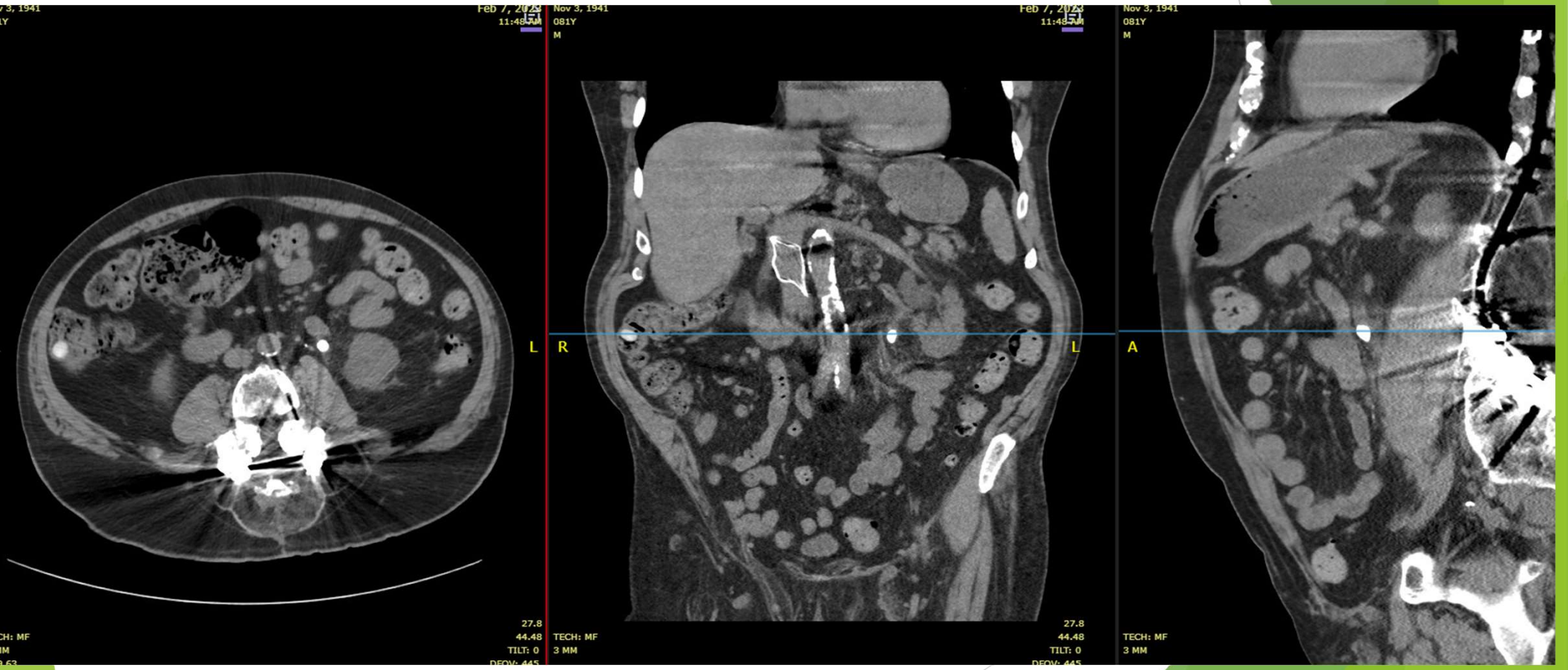

Proximal curl of stent in kidney
Ureteral stent
Distal curl of stent in bladder

Non obstructing nephrolithiasis

Three years late Develops LEFT flank pain . . .



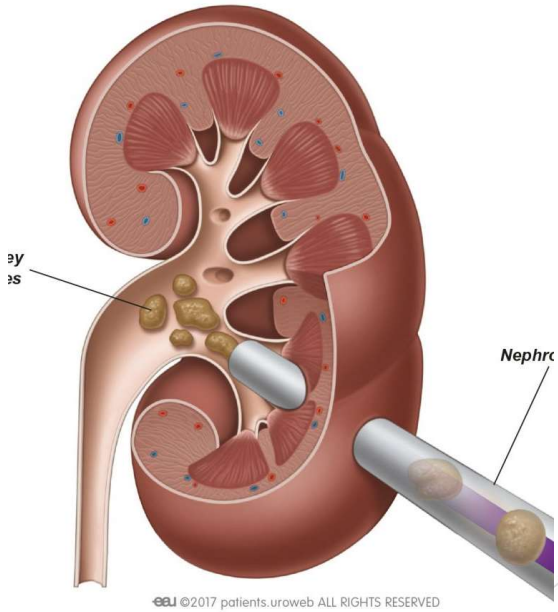
Management

- Acute Renal Colic
  - 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
    - If no success after 4-6 weeks -> need definitive surgical eval (imaging prior)
- Smaller, more distal stones have best change of passage on own
  - </= 5 mm
  - FU to confirm passage of stone (RUS)

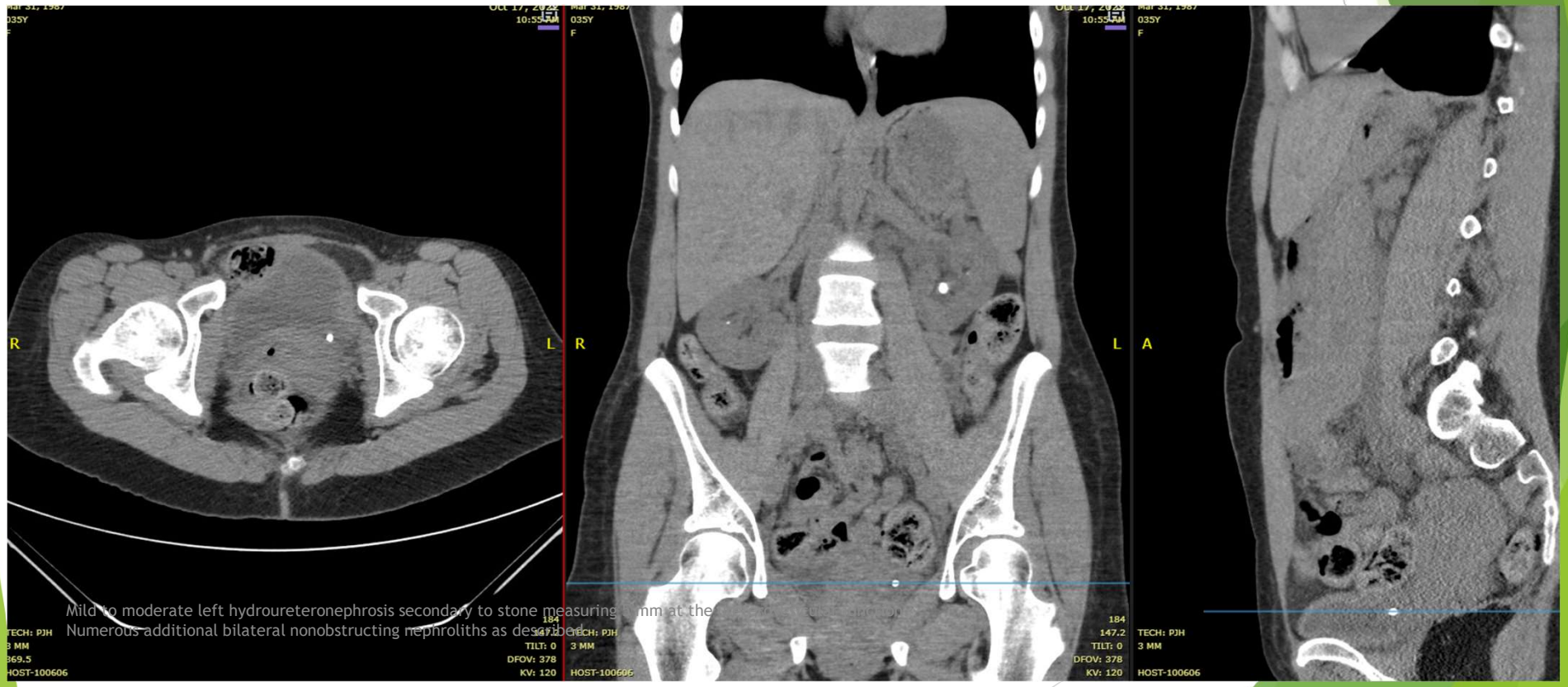
Surgical management of stones: AUA / Endourological Society Guidelines; Assimos et al. 2016

Surgical Options

- Ureteral stent placement – indications
- ESWL
  - Sound waves create vibrations to crush stones into smaller pieces
  - Stones must be radiopaque
  - Ca oxalate and cystine stones are VERY HARD and resistant to ESWL
  - Lowest complication rate
- Ureteroscopy (URS) with laser lithotripsy
  - Higher stone free rates
  - First line therapy for mid/ distal ureteral stones
  - TOC for cystine or uric acid stones who fail MET
- PCNL – Percutaneous nephrolithotomy
  - Large stones > 1.5 cm / harder composition
- Active Surveillance – asx / non obstructing stones



Case Study: 35 yo female with LEFT 5 mm UVJ stone

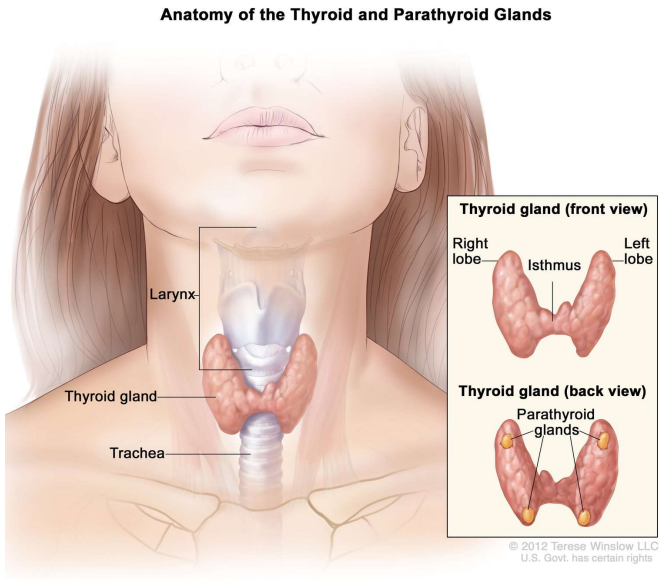


Mild to moderate left hydroureteronephrosis secondary to stone measuring [illegible] mm at the
Numerous additional bilateral nonobstructing nephroliths as described

Case Study: 35 yo female with LEFT 5 mm UVJ stone

- CT 10/17/22: LEFT hydro d/t 5 mm UVJ stone
- bilat non obstructing kidney stones largest 9 mm on right / 11x6 mm on LEFT
- - passed stone 10/24/2022
- Stone analysis - ca oxalate / hydroxyapatite
- **Serum ca levels from 10/2019 12.0**
- 1/16/2023 Litholink: Ur Vol3.62 / SS CaOx 5.49 **/ Ur Ca 461 (sig elevated**), Ur Ox 37 / Ur cit 578 / SS CaP 1.03 / ph 6.097 / SS Ur Acid 0.49 / Urine Uric Acid 1.016 (sig elevated)
- **Serum Ca 11.3 / P 2.2**
- Interpretation -
  - Severe hypercalciuria and Severe hyperurocalsuria
  - discussed diet modifications low Na+ / protein / monitor ca
  - low oxalate diet on AVS, add lemon to water
  - cannot exclude hypercalcemia as cause of hypercalciuria, labs ordered to rule out PTH dz

Parathyroid Disease



- Role with nephrolithiasis
- Most commonly seen with Calcium phosphate stones
- Elevated PTH can lead to increase serum Ca+

Litholink

The Kidney Stone Prevention Resource™

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 / 1000-1200 mg per day of Calcium
  - Limit animal protein
  - Consider adding thiazide diuretic (ex: HCTZ 25 mg BID)
- If HIGH urinary oxalate
  - Eat LOW oxalate diet
- If LOW urine citrate
  - Eat more fruits / vegetable
  - Consider adding potassium citrate (it will increase pH)
- Repeat 24 hour urine in 6 months after initiating therapy

Diet Adjustment depends on type of stones

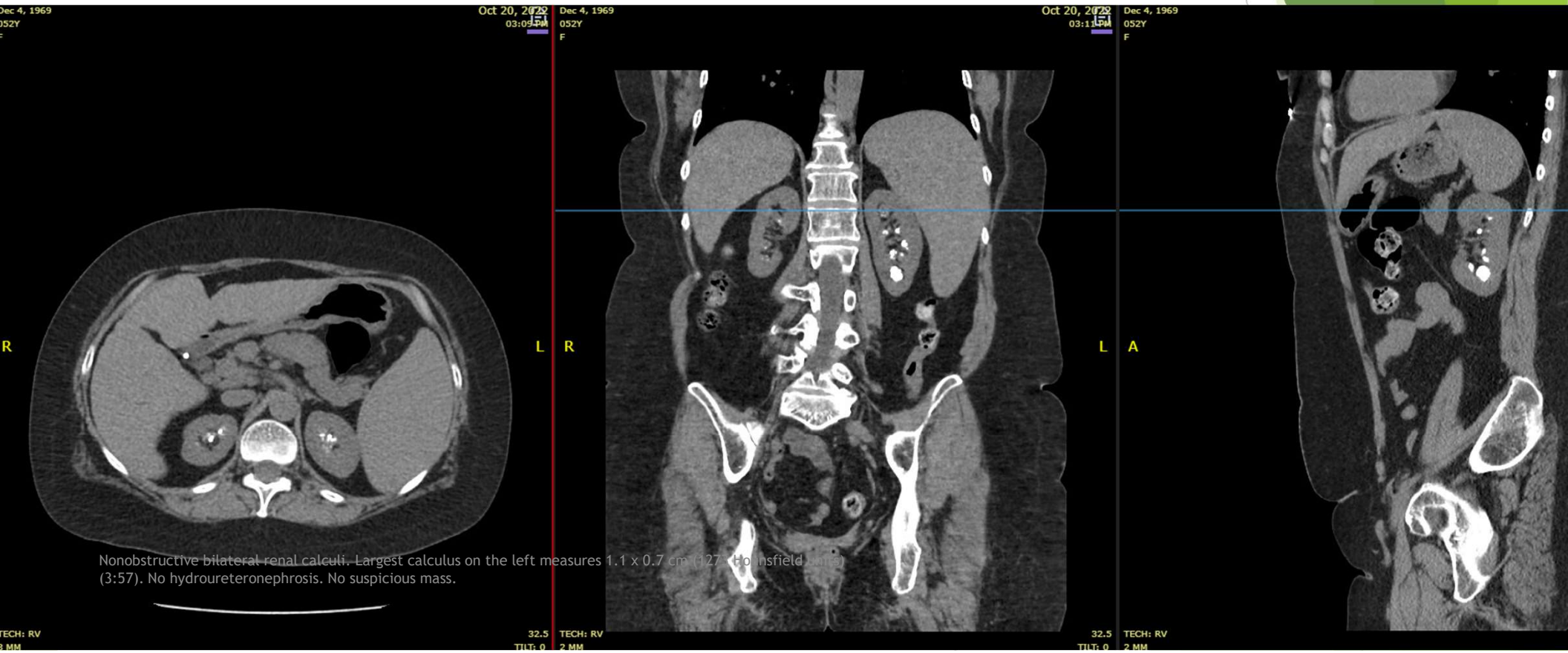
- Uric acid / Cystine stones
  - Can add potassium citrate to increase urinary pH
  - Allopurinol is NOT first line choice for uric acid stones – K citrate is TOC

DIETARY TREATMENTS

- CITRATE -> DECREASES CA STONE FORMATION
- UREA -> DECREASES URIC ACID STONE FORMATION
- Magnesium -> INCREASES SOLUBILITY OF CA / PHOS / OXALATE
- POTASSIUM CITRATE -> DECREASES ACID OF URINE

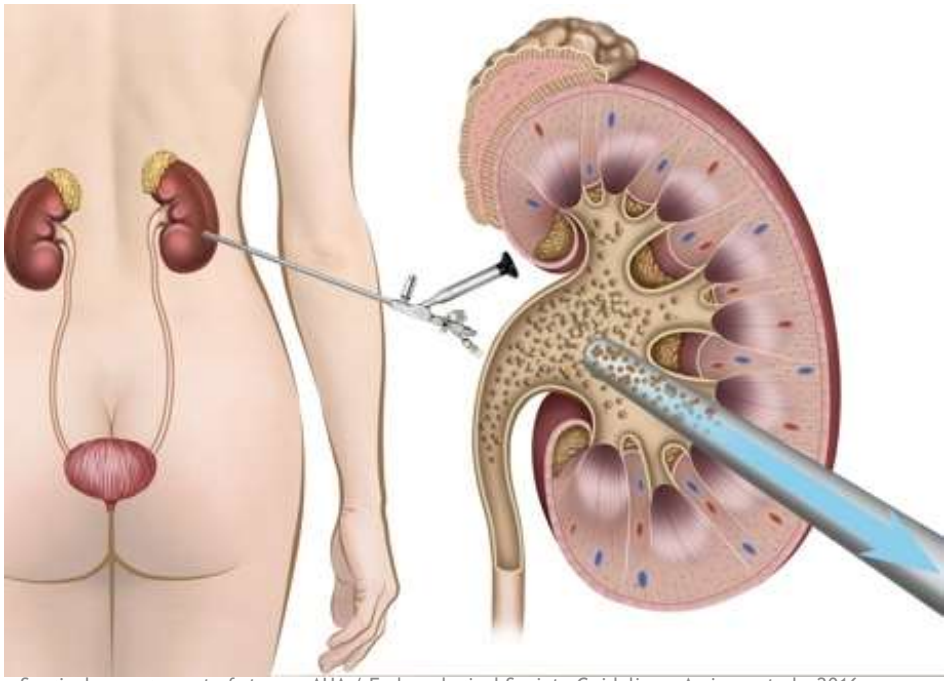
- MEDICATIONS / VITAMINES
  - VIT C – METABOLIZES TO OXALATE
  - VIT D – INCREASES CA+ ABSORPTION
  - TRIAMTERENE / PROTEASE INHIBITORIS / FUROSEMIDE INCREASE RISK OF STONES

52 yo female with extensive history of nephrolithiasis



Nonobstructive bilateral renal calculi. Largest calculus on the left measures 1.1 x 0.7 cm (127 Hounsfield units) (3:57). No hydroureteronephrosis. No suspicious mass.

When to consider PCNL



Surgical management of stones: AUA / Endourological Society Guidelines; Assimos et al. 2016

- Symptomatic patients with stone burden > 20 mm
  - First line therapy
- More invasive, will need to spend one night in hospital

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

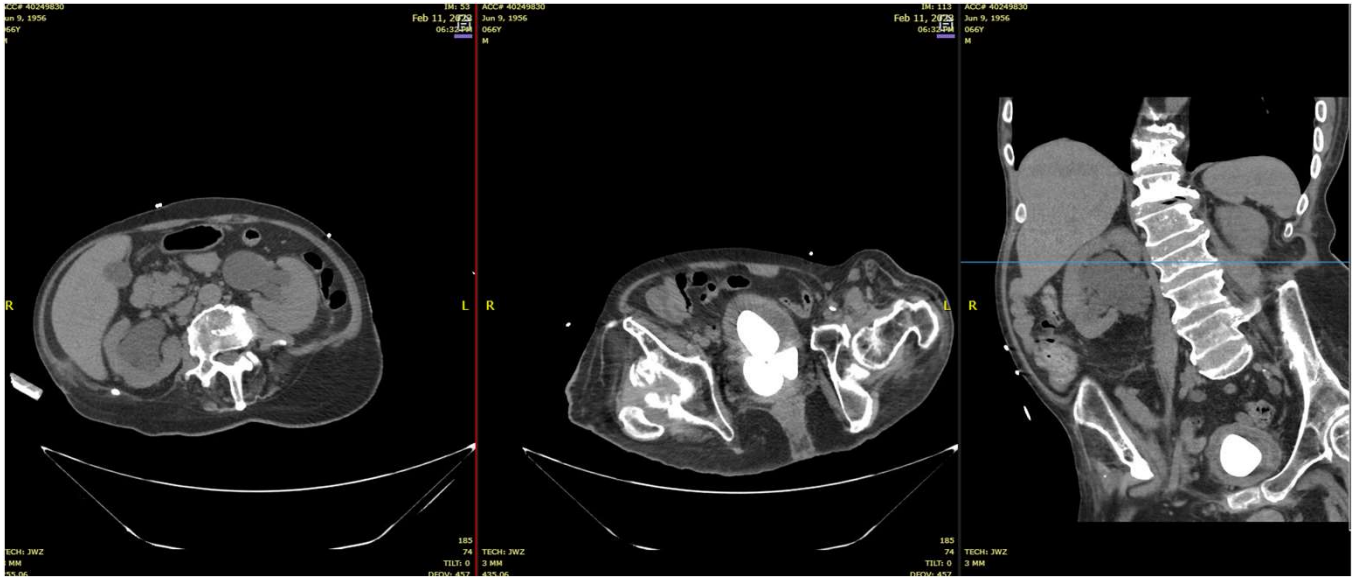
- Lower abdominal pain
- Pain during urination
- Frequent urination
- Difficulty urinating or interrupted urine flow
- Blood in the urine
- Cloudy or unusually dark-colored urine

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

URINE COLOR	YELLOW	YELLOW	
	URINE APPEARANCE	TURBID (A)	CLEAR
	Urine pH	7.0	5.0 - 8.0
	Urine Protein	2+ (A)	NEGATIVE
	URINE GLUCOSE,Iris	NEGATIVE	NEGATIVE
	URINE KETONES	NEGATIVE	NEGATIVE
	URINE BILIRUBIN	NEGATIVE	NEGATIVE
	URINE BLOOD	3+ (A)	NEGATIVE
	URINE NITRITES	NEGATIVE	NEGATIVE
	URINE LEUK ESTERASE	3+ (A)	NEGATIVE
	URINE PRESERVATIVE	NO	
	Urine Refrigerated	NO	
	URINE RBC	84 (H)	0 - 1 /HPF
	URINE WBC	>182 (H)	0 - 5 /HPF
	URINE BACTERIA	FEW (A)	NONE SEEN
	URINE SQUAMOUS EPI CELLS	8 (H)	0 - 3 /HPF
	URINE WBC CLUMPS	MANY (A)	REFERENCE RANGE NOT ESTABLISHED

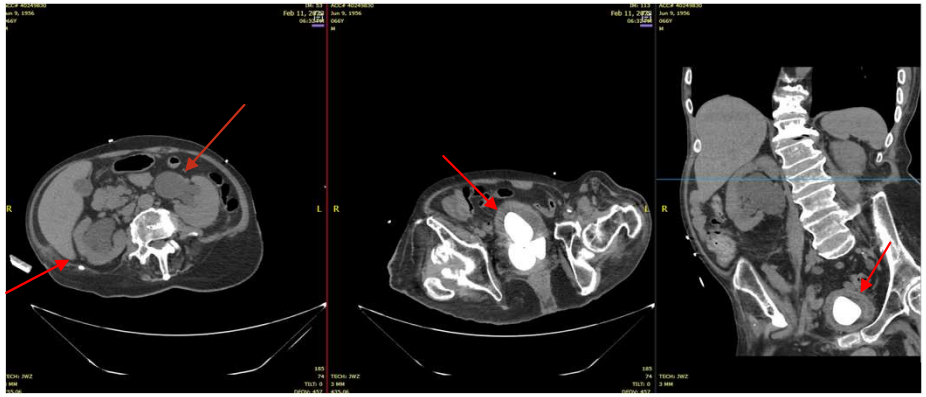
Case Study: 66 yo male

- 66 yo male with C7 paraplegia since 1985 / neurogenic bladder presents to ED with c/o UTI
- Does clean intermittent catheterization 3-4 x a day
- Noticed urine was cloudy 2 days PTA and now he is dehydrated and unable to do intermittent cath. C/o fever/ diarrhea / malaise
- UA micro - + bacteria / sig WBCs / sent for Ucx and BC
- Labs sig for:
  - WBC 29 / Na+ 126 / Create 5.04
- EKG – A fib with RVR
- CT A/P obtained



CT A/P – What do you see?

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

Case Study:

- Next steps . . .
  - Treat infection
  - Cardiology consult for A fib
  - Ucx and blood cultures = E coli
  - Take to OR for:
    - `Cystoscopy, bladder biopsy, left ureteral stent insertion, open cystolithotomy.`
    - `Bladder Bx pending`

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
- Struvite stones – monitor for rUTIs and re-image
  - Consider adding acetohydroxamic acid (urease inhibitor)

Other Interesting facts about stones . . .

- PPI use increases the incidence of stone formation due low urine magnesium
- 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

Question 1

- All of the following are risk factors for developing nephrolithiasis EXCEPT:

- 1. Obesity
- 2. HTN
- 3. Hyperparathyroidism
- 4. Hyperlipidemia
- 5. DM

Question 2

- A patient presents to the Emergency Room with RIGHT flank pain / nausea / vomiting and fevers. UA shows sig WBCs / Many bacteria and CT scan shows 5 mm right distal ureteral stone with moderate hydronephrosis. Which of the following is the best treatment plan for this patient?

- 1. Give IVF and anti-emetics and send home with a strainer, tamsolusin and Bactrim antibiotic.
- 2. Refer the patient to outpatient urology and Rx tamsolusin
- 3. Allow them to eat but admit them for observation with IVF, antibiotics and anti-emetics, having them strain their urine
- 4. Give IVF and antibiotics, make NPO and consult urology

Question 3

- Which of the following is FALSE when it comes to urolithiasis:

- 1. Calcium oxalate are the most common kidney stones
- 2. The size of the stone is more important than the location
- 3. Most stones are radiopaque
- 4. Diet and dehydration are the main causes of kidney stones

Summary

- Stones are very common but can be preventable
- Follow up after kidney stone event is important for prevention

Thank you

updated 3/9/23