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# Stone Disease/Endourology

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## Imaging/Diagnosis of Ureteral Calculi

- Non-contrast CT preferred method for **initial** diagnosis
- Renal US plus KUB acceptable in **known opaque** stone formers
- **Low dose** CT (< 4mSv) preferred *if* BMI < 30
- If stone **not** seen on CT scout, KUB recommended to determine opacity of stone
- Visible, opaque stones: repeat KUBs can monitor stone progression
  – helps reduce overall radiation exposure

## Imaging/Diagnosis of Ureteral Calculi

- Pediatrics:
  - renal US initially
  - low-dose CT if needed
- Pregnancy:
  - 1st line: renal ultrasound
  - 2nd line: MRI **without** contrast
  - low dose CT an option in 2nd/3rd trimesters only
  - up to 5 rads not associated with fetal anomalies or fetal loss

Based on AUA Clinical Guidelines on Imaging for Ureteral Stones

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## Important Prognostic Factors on CT

- Hydronephrosis: not by itself a determinant of need to intervene
  - Lowers success rate of ESWL; less impact on URS
- Stone size and location: predictive of stone passage
- Peri-ureteral/renal stranding, ureteral edema (tissue rim sign) and peri-renal fluid: do **NOT** consistently influence likelihood passage
- Skin to stone distance: impacts success of ESWL of **renal** stones, not necessarily ureteral stones

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# Important Prognostic Factors on CT

- Hounsfield units: can be used to diagnose stone composition; impacts success of **ESWL**:
  - Uric acid: 200-500
  - Struvite: 500-700
  - Cystine: 900-1200
  - Calcium phosphate: 1250-1650
  - Calcium oxalate dihydrate: 1800-2200
  - Calcium oxalate monohydrate: >2000

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# Radiation Doses (mSv)

| Type of Exam | Effective dose (mSv) | Reference |
|---|---|---|
| **Ultrasound (US)** | | |
| Abdomen and pelvis US | 0 | |
| **Magnetic Resonance Imaging (MRI)** | | |
| Abdomen and pelvis MRI | 0 | |
| **Conventional Radiography (CR)** | | |
| KUB | 0.7 | A |
| KUB with tomograms | 3.9 | B |
| IVU | 3.0 | A, C |
| **Computed Tomography (CT)** | | |
| Non-contrast CT, abdomen and pelvis | 10.0 | D,E |
| Without and with contrast CT, abdomen and pelvis (2-phase) | 15.0 | F |
| Without and with contrast CT, abdomen and pelvis (3-phase) | 20.0 | A |
| Non-contrast CT, abdomen and pelvis (low-dose protocol) | 3.0 | G |

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# Ureteral Stones—AUA Guidelines 2016

- Uncomplicated ureteral stones <10 mm
  - should be offered observation
  - if distal, MET with α-blockers should be offered.
  - *Strong Recommendation; Evidence Level Grade B*
- SWL has least morbidity and lowest complication rate, but URS has greater stone-free rate in a single procedure
  - *Strong Recommendation; Evidence Level Grade B*
- Mid/distal stones requiring intervention should be offered URS as first-line therapy or SWL if URS is refused
  - *Strong Recommendation; Evidence Level Grade B*

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# Ureteral Stones—AUA Guidelines 2016

- Routine stenting should not be performed in pts undergoing SWL or prior to URS.
  - *Strong Recommendation; Evidence Level Grade B*
- Obstructing stones and suspected infection: must urgently drain collecting system with a stent or nephrostomy tube and delay stone treatment.
  - *Strong Recommendation; Evidence Level Grade C*

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# Follow up

- Spontaneous passage: no further imaging needed in most pts.
- ESWL: imaging **recommended** to rule out residual fragments and/or hydro
- URS: imaging **recommended** to rule out silent hydronephrosis

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# Renal Stones—2016 AUA Guidelines

- Symptomatic patients with total non-lower pole stone burden < 10 mm:
  - can offer SWL or URS
  - *Strong Recommendation; Evidence Level Grade B*
- Symptomatic patients with total stone burden > 20 mm:
  - should be offered **PCNL** as first-line therapy and ***not*** ESWL
  - *Strong Recommendation & Moderate Recommendation; Evidence Level Grade C*

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# Lower Pole Renal Stones—2016 AUA Guidelines

- Less than 10 mm:
  - URS *or* SWL should be offered to symptomatic patients
    - *Strong Recommendation; Evidence Level Grade B*
- Greater than 10 mm:
  - SWL should not be offered as first-line
    - *Strong Recommendation; Evidence Level Grade B*
  - Pts should be informed that PCNL has a higher stone-free rate but greater morbidity
    - *Strong Recommendation; Evidence Level Grade B*

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# Pregnancy and Stones

- **No** increased incidence
  - Hypercalciuria occurs due to placental vitamin D production
  - This is ameliorated by increased citrate excretion
- Observation is first line therapy (AUA guideline 2016)
- Avoid NSAIDs
  - Cause pulmonary HTN and premature closure of the fetal ductus arteriosus
- Alpha blockers: pregnancy category B
- 2nd trimester safest time to intervene—shield pelvis or use only US guidance
- 3rd trimester
  - elevate right flank to prevent IVC compression
  - Consider intraop fetal monitoring
- PCN or stents require frequent changing
  - consider URSLL with Holmium laser if unable to tolerate stent or fails observation
  - shown to be safe--***not*** EHL or US or ESWL (fetal hearing loss)

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# ARS Q1:

A 24-year-old man has acute severe left flank pain. Urinalysis is normal. He denies a history of urinary stone disease or recent trauma. The next step is:

a) Reassurance
b) Non-contrast helical CT scan
c) Abdominal ultrasonography
d) IVP
e) MRI scan

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# Answer: B

B. Non-contrast helical CT scan

A clinical history of acute renal colic should not be dismissed due to a normal urinalysis without evidence of microhematuria. Noncontrast CT is a study of choice to confirm the diagnosis of nephro or ureterolithiasis.

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# ARS Q2:

For patients with a 1-cm proximal ureteral stone, placement of an internal stent at the time of the SWL will result in:

a) A higher stone free rate
b) A lower complication rate
c) Less hematuria
d) Increased irritative voiding symptoms
e) Reduced analgesic requirements

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# Answer: D

D. Increased irritative voiding symptoms

A randomized study demonstrated that the stent placement at the time of SWL in patients with 1-2 cm solitary renal stones or proximal ureteral calculi less than 2 cm did not improve stone free or retreatment rates or lessen pain or hematuria. However, stent insertion was associated with an increase in irritative voiding symptoms.

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# ARS Q3:

A 38-year-old woman has severe right flank pain. She is afebrile, and urinalysis demonstrates pyuria and microhematuria. A helical CT scan demonstrates right perinephric fluid and right hydroureteronephrosis down to a 3 mm distal ureteral stone. The best treatment is:

a) Ureteral stent
b) Percutaneous nephrostomy drainage
c) Percutaneous drainage of the perinephric fluid
d) Ureteroscopic stone removal
e) Analgesic therapy

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# Answer: E

E. Analgesic therapy

No need for intervention for forniceal rupture

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# ARS Q4:

The increased risk for calculus disease during pregnancy is associated with:

a) Increased parathyroid hormone levels
b) Absorptive hypercalcuria
c) Placental suppression of 1, 25 dihydroxycholecalciferol
d) Decreased urinary glycosaminoglycans
e) Decreased urinary citrate levels

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# Answer: B

B. Absorptive hypercalcuria

Placental vitamin D increases absorption of calcium

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# ARS Q5:

The physiologic change during the third trimester pregnancy that offers protection against kidney stone formation is:

a) Increased ureteral peristalsis
b) Increased ureteral dilation
c) Increased urinary citrate
d) Decreased urinary calcium
e) Decreased urinary uric acid

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# Answer: C

C. Increased urinary citrate

This balances the hypercalciuria

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# Renal Calculi

- Stone size most important; location #2
- Large stones > 2cm: PCNL
- Lower pole stones:
  - Less than 1 cm: ESWL
  - Greater than 1 cm: ESWL success only 21%; esp. poor with hydronephrosis, abnormal anatomy (e.g. horseshoe kidney; ileal conduit)
  - 1-2 cm: PCNL or URSLL acceptable
- Calyceal tics: PCNL generally preferable; URS good for small stones in anterior upper pole calyces

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# Complications

- ESWL:
  - Hematoma: 1-2%; HTN, anticoagulants are risk factors
    - Transfusion, hydration, observation, bedrest; no long term damage
  - Steinstrasse: drainage; PCN may be better than stent
    - Spontaneous resolution common once PCN placed
  - HTN: esp. in elderly and with prior CRI; DM ?; interstitial fibrosis has been demonstrated
  - Slow rate and pre-treating with 100 shocks and doing 3-4 min pause can decrease injury
- URS :
  - Stricture (1-2%); silent hydronephrosis—follow up imaging can detect
  - Ureteral tear/perforation: majority heal with a stent; consider foley
  - Avulsion: immediate repair if possible; if not, percutaneous nephrostomy
- PCNL:
  - Bleeding: immediate-place large NT and clamp; delayed--AVF or pseudoaneurysm—embolize
  - Perforation of pelvis: if large, abort, place NT; return when nephrostogram shows resolution
  - Colon injury: pull back NT into colon, place ureteral stent (separate wind and water)
  - Duodenal injury: bowel rest/NG suction, TPN; pull NT back into renal pelvis
  - Hemo/hydro/pneumothorax: recognize intraop and place pigtail catheter into pleural space
  - Sepsis: do stone cultures in patients at risk; most predictive of causative organism

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# AUA Guidelines for Staghorn Calculi

- Standards:
  - Newly diagnosed pts should be actively treated; observation not acceptable in most cases (10 yr. mortality 28%)
  - Pt must be informed about relative benefits and risks associated with all active treatment modalities; must offer regardless of available equipment or expertise
- Recommendations:
  - PCNL should be first treatment utilized for most pts
  - With combination therapy (ESWL and PCNL), percutaneous nephroscopy should be the last procedure for most pts
  - ESWL monotherapy should not be used for most pts; if it is undertaken adequate drainage of the treated renal unit should be established *before* treatment
  - Open surgery should not be used for most pts
  - ESWL monotherapy should not be used for pts with staghorn or partial staghorn **cystine** stones

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# ARS Q6:

A 40-year-old woman has a large staghorn stone (surface area 3500 mm2) in her right kidney. The collecting system is grossly dilated with infundibular stenosis. Nuclear renography demonstrates that this kidney provides 30% of global renal function. Serum creatinine is 1.2 mg/dL. The best treatment is:

a) Serial SWL with ureteral stent
b) Percutaneous nephrolithotomy
c) Percutaneous nephrolithotomy combined with SWL
d) Ureteroscopy and holmium laser lithotripsy
e) Nephrectomy

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# Answer: B

B. Percutaneous nephrolithotomy

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# ARS Q7:

A decrease in renal injury w/ SWL can be accomplished by:

a) Starting at a low energy setting
b) Starting at a low energy setting and pausing for 3-4 min before increasing the energy setting
c) Starting at a slow shockwave firing rate and pausing for 3-4 minutes before increasing the shockwave firing rate
d) Decreasing the total number of shocks delivered
e) Starting at a slow rate and gradually increasing

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# Answer: B

B. Starting at a low energy setting and pausing for 3-4 min before increasing the energy setting

- The power level of the priming dose is not the factor responsible for the protection from injury from SWL
- The inclusion of a 3-4 minute pause following the priming dose is protective, while increasing the power setting without this delay did not result in reduced injury
- Increasing the shockwave firing rate would increase the renal injury incurred

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# ARS Q8:

During PCNL, a collecting system perforation is noted. The first sign of significant extravasation of irrigant into the peritoneal cavity is:

a) Abdominal distension
b) Narrowed pulse pressures
c) Increasing ventilatory pressures
d) Hypertension
e) Bradycardia

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# Answer: B

B. Narrowed pulse pressures

- Narrowed pulse pressures (rise in diastolic pressure) precede difficulty with ventilation, hypercarbia and a rise in central venous pressure.
- Extravasated irrigant increases abdominal pressure leading to decreased venous return and thus narrowing the pulse pressure.
- Distension is not appreciated in the prone position until later in the course

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# ARS Q9:

Three days s/p a right PCNL, green fluid begins to drain through the nephrostomy tube. The patient is afebrile and there is no abdominal tenderness. Contrast instilled into the tube immediately outlines the second part of the duodenum. The tube is repositioned into the renal pelvis. The next step is:

a) Upper GI Series
b) Surgical exploration
c) Nasogastric suction and parenteral nutrition
d) Duodenoscopy and attempted closure
e) Placement of a peri-duodenal drain

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# Answer: C

C. Nasogastric suction and parenteral nutrition

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# ARS Q10:

A 10 Fr nephrostomy tube was placed uneventfully to drain a pyonephrotic kidney. Follow-up nephrostogram reveals a 6 cm staghorn calculus. The percutaneous nephrostomy tube enters directly into the renal pelvis. At time of PCNL, optimal access is obtained via:

a) Dilating the established nephrostomy tract
b) A new percutaneous tract- inferior anterior calyx
c) A new percutaneous tract- inferior posterior calyx
d) Getting as much stone out as possible through established tract then getting a new access
e) Getting as much stone out through established tract then bringing the patient back for ESWL

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# Answer: C

C. A new percutaneous tract- inferior posterior calyx

- PCNL access into collecting system should be as peripheral as possible to help avoid serious hemorrhage.
- Direct puncture into an infundibulum or into the renal pelvis substantially increases the risk of hemorrhage.
- The temptation to utilize a previously placed nephrostomy tube in a suboptimal location should be abandoned.
- Staghorn calculi are best approached through polar access.
- Inferior or superior pole optimizes access to most of the collecting system.
- A posterior calyceal puncture decreases the need to torque instruments into the collecting system and helps reduce hemorrhage and eases stone extraction.

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# ARS Q11:

When performing percutaneous access to the upper collecting system:

a) It is best to secure a safety guidewire down the ureter
b) Dilation of the tract should be performed over the floppy portion of the working guidewire
c) The final diameter of the tract should be 10F greater than the largest instrument to be inserted
d) Dilation of the tract should include the calyx and infundibulum into the renal pelvis
e) Arterial bleeding is most likely with a superior pole puncture

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# Answer: A

A. It is best to secure a safety guidewire down the ureter

The direct posterolateral puncture is the safest percutaneous renal access and least likely to be associated with major bleeding. The guidewire is secured down the ureter if possible. Dilation of the tract is over the stiff portion of the working wire to 2-4Fr larger than the largest working instrument. To avoid rupture of the infundibulum and subsequent bleeding the tract dilation should be just to but not beyond the chosen calyx.

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# ARS Q12:

The following true statement regarding ureteral obstruction in pregnancy is:

a) This phenomenon is related to the progesterone-mediated relaxation of urinary tract smooth muscle
b) Dilation of the ureters occurs commonly in pregnancy at the fourth week of gestation
c) Dilation of the ureters progresses such that 90% of women will demonstrate ureteral dilation by the 10th week of gestation
d) This phenomenon is related to the estrogen-mediated relaxation of urinary tract smooth muscle
e) This phenomenon is not related to compression of the ureters by the gravida uterus

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# Answer: A

A. This phenomenon is related to the progesterone-mediated relaxation of urinary tract smooth muscle

Dilation of ureters occurs commonly during pregnancy starting in the sixth to tenth week of gestation and progressing to 90% of women by the 26th or 28th week of gestation. This phenomenon is related to the progesterone-mediated relaxation of urinary tract smooth muscle and the compression of the ureters by the grab of the uterus.

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# ARS Q13:

The following situation when arterial bleeding is most likely is:

a) Direct posterolateral puncture of the kidney.
b) Direct posteromedial puncture of the kidney.
c) Superior pole puncture of the kidney.
d) Mid zone puncture of the kidney.
e) Inferior pole puncture of the kidney.

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# Answer: B

B. Direct posteromedial puncture of the kidney.

In more than 50% of kidneys, the posterior segmental artery is located in the middle or upper half of the posterior renal surface, and it may be damaged with an excessive medial needle puncture of the upper calix. A direct posterior puncture that is too medial risks injury to the posterior segmental artery, which is the artery most commonly injured in endourologic procedures.

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# ARS Q14:

A 33-year-old woman develops gross hematuria requiring multiple transfusions four weeks after a percutaneous nephrolithotomy. The next step is:

a) Observation
b) Renal arteriogram
c) CT scan
d) Exploration and repair
e) Nephrectomy

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# Answer: B

B. Renal arteriogram

The most likely diagnosis is an AV fistula or a pseudoaneurysm. Renal arteriography should be performed and embolization procedure can be undertaken if one of the aforementioned lesions is identified.

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# ARS Q15:

30 hours after a successful left PCNL, a 35 year-old man has a fever of 100.2°F, ileus, urine mixed with feces from the nephrostomy tube, and bloody stools. His WBC is 18,000/cu mm. Nephrostogram demonstrates the tube is transcolonic. The best next steps are to administer parenteral antibiotics, prohibit food by mouth and:

a) Observe the patient.
b) Withdraw the nephrostomy tube into the colon.
c) Place a second nephrostomy tube.
d) Perform a colostomy.
e) Close the bowel perforation.

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# Answer: B

B. Withdraw the nephrostomy tube into the colon.

After withdrawing the nephrostomy tube into the colon, colonic fistulas usually seal in a few days if discovered promptly. In addition a double-J stent can be inserted; the point is to separate “wind” and “water”. Surgical closure or a colostomy should be reserved for those cases that have persistent fever and evidence of abscess formation.