IMAGING OF RENAL CALCULI

• Obstructing renal or ureteric calculus most frequent cause of flank pain, but flank pain is a non specific symptom
• Seen in 35-55% of patients who undergo imaging for pain
• Lifetime risk of urinary calculus 12% for men and 6% for women
• Incidence increases with age until age 60
• Spontaneous passage is size dependent and inversely proportional to size. Calculus <5mm has 68% probability of spontaneous passage.
IMAGING MODALITIES

- Xray
- Ultrasound
- IVP
- Xray and Ultrasound
- CT
- MRI
Sensitivity 58-62% renal or ureteric
Accuracy 61%
Surgical planning, stent placement, follow-up calculus
Gives no information about hydronephrosis
Digital radiography 72% sensitive for >5mm calculi proximal ureter but only 29% overall for stone detection stones of any size
Dose 0.8mSv compared with 10-12 mSv conventional NCCT and 3-4 mSv low dose CT KUB
IVP

- Provides physiologic information
- Degree of delayed nephrogram is related to the severity of obstruction
- Sensitivity 85% Accuracy 92%
- Similar dose to low-dose NCCT (3.6mSv) and requires IV contrast
- Can take several hours to complete if obstruction and misses 31-48% of stones
ULTRASOUND

- Can assess for dilatation of collecting system without use of radiation
- Sensitivity 24-57% (renal/ureteral calculus) 73-86% (if secondary signs of obstruction such as hydronephrosis or lack of ureteric jet in bladder)
- Hydronephrosis can take hours to develop and varies with degree of hydration
- Accuracy 69%
- Calculus is echogenic focus with posterior acoustic shadowing. Best visualised when calculus >5mm
• Twinkle artifact is an intense multicoloured signal posterior to a stone with colour doppler. Distinguish between stones <5mm and vascular calcifications. High false-positive rate
• Absence of a unilateral ureteral jet within the bladder can support the presence of obstruction however the patient needs to be well hydrated
• Jet can still be present with partial obstruction
XRAY AND ULTRASOUND

- Prospective study 66 pts comparing CT with KUB/US revealed all stones not detected by KUB/US passed spontaneously
- US in initial ED flank pain evaluation does not increase the rate of adverse events or return ED visits
- However 27-41% of pts who initially had US required a subsequent CT
- Sensitivity 79% (v 93% for NCCT)
- Accuracy 71%

- Advantages: US is lack of ionising radiation
- Disadvantages: needs skilled personnel, inability to accurately measure stone size, need to observe ureteral jet phenomenon at the VUJ (takes time) and inability to distinguish dilatation without obstruction from true obstruction
CT

- Non contrast CT (NCCT) initial study for evaluating flank pain since 1995
- Sensitivity 95%  Accuracy 98%
- Virtually all stones radio-opaque on CT and size can be measured
- Fast readily available, provides over view of abdomen, stone burden and precise location
- Concerns over radiation exposure have led to reduced –dose CT regimens
- Lower kVp, lower tube current, automated tube current modulation and iterative reconstruction
• On CT calculi are hyper-dense foci within the renal collecting system, ureter or bladder
• Differential diagnosis for a calculus is a phlebolith within gonadal or pelvic vein
• Comet tail sign: tapering soft tissue=non calcified portion of the vein
• Tissue rim sign: oedematous ureteric wall surrounding ureteral stone
• Calculi often lodge at the 3 narrowest segments of the ureter 1. PUJ 2. crossing the iliac vessels 3. VUJ
PUJ CALCULUS
ILIAC VESSELS
DO YOU NEED IV CONTRAST?

- Miller and colleagues study to evaluate utility of IV contrast in flank pain assessment
- 708 pts received contrast 43 (6%) had findings that required IV contrast, 32 of those had pyelonephritis
- 8 patients had renal cell carcinoma, 6 of whom had masses large enough to see without IV contrast
- Specific indications for IV contrast in patients who present with flank pain include unilateral renal stranding/enlargement with risk factors for renal infarct or vein thrombosis, perirenal collection, renal mass/complicated cyst or unexplained haematuria
PARAPELVIC CYSTS
URETERIC CALCULUS V PHLEBOLITH?
DUAL ENERGY CT RENAL STONE CHARACTERIZATION

- Two different CT data sets at two different energy levels.
- DECT takes advantage of the unique absorption characteristics of urinary stone subtypes at high and low energy x-rays allowing composition characterization.
- Benefits the patient by directing treatment at the time of initial stone detection. 50% of patients will experience recurrent stone disease after treatment.
- Treatment ranges from medical management to a variety of non-invasive and invasive urologic techniques.
- Differentiation between uric acid (UA) and non-UA (commonly calcium containing) renal stones.
- UA calculi comprise 10% of stone disease and typically treated medically using urinary alkalization with stone dissolution.
- Characterization of additional stone types other than UA is important to patient management as stones known to be resistant to extracorporeal shock wave lithotripsy (cysteine, brushite or calcium oxalate) can be directed to management with percutaneous or endoscopic stone removal.
• Tailored approach: Initial low dose NCCT followed by limited unenhanced dual-energy CT through identified calculi.

• Calcium based 75%
• Struvite 15%
• Uric acid 8%
• Cysteine 3%

• Only 1/3 of calculi are pure stones, 44% contain 2 components, 25% contain 3 or more components. Characterization of mixed stone types more challenging than pure stone types.
INDICATION CREEP: 16-45%
PYELONEPHRITIS
DIVERTICULITIS

HAEMORRHAGIC RENAL CELL CARCINOMA
MRI

- Examination of choice for hydronephrosis in pregnancy
- Alternative to low-dose NCCT in certain patient populations such as pregnant women (non contrast MRI), young individuals and individuals who have undergone multiple prior CTs
- Sensitivity 50-60% (renal/ureteral calculi) 100% (if there are 2nd signs of obstruction)
- MRI highly accurate for diagnosis of hydronephrosis and perinephric oedema but less accurate in directly visualizing stones compared to NCCT
- MRI visible stones measured on average 11mm and stones not visible measured an average of 4.6mm
ACUTE FLANK PAIN-SUSPICION OF STONE DISEASE

- Suspicion of stone disease
- Recurrent symptoms of stone disease
- Suspicion of stone disease pregnant patient
- ACR appropriateness criteria
ACUTE FLANK PAIN-SUSPICION OF STONE DISEASE

- Suspicion of stone disease
- Recurrent symptoms of stone disease
- Suspicion of stone disease pregnant patient

- Non contrast CT: most rapid and accurate
- Ultrasound recommended initial modality for flank pain in young women (<45 years)
- Young women lower rate of stone detection than men (24% v 62%) due to gynaecologic causes for pain
- Organ dose for ovaries is higher due to position
- 83% of women with stones larger than 4mm have hydronephrosis therefore KUB/US initial modality for young women
ACUTE FLANK PAIN-SUSPICION OF STONE DISEASE

- Suspicion of stone disease
- Recurrent symptoms of stone disease
- Suspicion of stone disease pregnant patient

- KUB/US
  - Likelihood of urolithiasis as cause of flank pain is higher but repeated NCCT raise concern about excessive radiation
  - If previously documented stones seen on KUB, a repeat KUB provides useful information at lower dose
  - KUB can follow stones visible on scout radiograph of a CT. Stones not visible on scout may not be visible on KUB
  - KUB can assess stone burden and position of stones
ACUTE FLANK PAIN-SUSPICION OF STONE DISEASE

- Suspicion of stone disease
- Recurrent symptoms of stone disease
- Suspicion of stone disease pregnant patient

- MRI or US: First trimester
- CT: Second or third trimester
- Pregnant women physiologic right hydronephrosis is a confounding phenomenon in 2nd trimester. Occurs secondary to obstruction of right distal ureter by gravid uterus
SUMMARY

• Low-dose NCCT most accurate modality for evaluating flank pain
• If uncertainty whether calcific density represents a ureteral stone or phlebolith IV contrast can be administered and excretory phase images obtained
• Pregnant patients with flank pain US best modality
• KUB/US may be able to diagnose most clinically significant stones consider in young patients and those with known stone disease
• MRI can evaluate for hydronephrosis though is less accurate for direct visualization of renal and ureteral stones
• Abdominal xray $111
• Renal ultrasound $247
• CT KUB $715
• Renal CT with IV contrast $1167