Pitfalls in Renal Ultrasound

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May 15, 2019

Outline
- Technique
- Size
- Hydronephrosis
- Cysts
- Masses
- Calculi
- Collections
- Acute vascular issues

Technique
- Appropriate frequency transducer
  - High and lower as needed
  - Liberal use of color and spectral Doppler
- Scan from more than one orientation if possible
  - However, be careful about believing the labels and use CT or MR for orientation
- Always include cine clips if you have the capability

Non contrast CT with possible hyperdense cysts

Transverse coronal US imaging makes cysts appear anterior rather than lateral

Lateral cyst appears anterior on US

Only scanning window is from lateral approach due to atrophic right lobe of liver with intervening bowel

Is a portion of this kidney abnormally echogenic?

Scanning through large pocket of ascites artificially increases echogenicity of underlying kidney
Echogenic lower pole secondary to gas

Re-imaging from different approach

Is this region of increased echogenicity technical?

Acute Pyelonephritis

Sometimes scanning from a different angle is helpful!

Issues of Size

Accuracy of measurements

How to interpret

History of Diabetes Mellitus

Nephromegaly and steatosis

Diabetes and Nephromegaly

- Most common cause in our practice for large, otherwise normal appearing kidneys
- Probably due to combination of factors related to poor glycemic control
  - Glycosuria
  - Glomerular hyperfiltration
  - Protein leakage
  - Nephron hypertropy
- As diabetic nephropathy progresses, kidneys may shrink into “normal” range
Large kidneys with thin cortex and sinus lipomatosis

Elevated creatinine: Are these just large echogenic kidneys?

Multifocal lymphoma

Other Causes of Nephromegaly with smooth kidneys
- Glomerulonephritis: SLE, Wegener's, Goodpasture's, TTP, Henoch-Schönlein syndrome, HIV Nephropathy
- Amyloidosis
- Acute Tubular Necrosis
- Acute Cortical Necrosis
- Acute interstitial Nephritis
- Acute Urate Nephropathy
- Glycogen Storage Disease (von Gierke's)
- Sickle Cell Disease
- Paroxysmal Nocturnal Hemoglobinuria
- Hemophilia
- Cirrhosis

Issues of Size
- Accuracy of renal measurements: In direct comparison with CT, 95% confidence interval of 7.5 – 9mm for ultrasound measurements
- Measurements more accurate for dedicated renal US studies
- Renal length correlates with height, age, hydration
  - Normal range in adults 10 – 12 cm
  - Small, echogenic kidneys correlate best with poor GFR
- Cortical thickness may correlate better with GFR than overall length (measure perpendicularly from renal capsule to cortico-medullary junction, normal 7-10 mm)
Hydronephrosis

Overcalls and undercalls
Is it really obstruction?

Prominent renal veins simulate hydronephrosis

Is there hydronephrosis?

Endstage renal disease:
Hypoechoic sinus fat simulates hydronephrosis, especially with decreased gain

Homogeneously echogenic fat changes as renal failure worsens, simulating hydronephrosis

Is this hydronephrosis?

Parapelvic cysts simulate hydronephrosis on US and early phase CT

Cine clips helpful to confirm parapelvic cysts
Parapelvic cysts simulate severe hydronephrosis

Megacalycyes

- Congenital underdevelopment of papillae leading to increased number and size of calyces
- Calyces have a faceted or polygonal shape with no fornices or papillary impressions and with hypoplastic medullary pyramids
- Hypothesis for pathogenesis is anomalous ureteral bud division leading to extra calyces at the expense of the medullary portion of the kidney
- Diagnosis should be made only in patients without prior or concurrent obstruction or reflux.
- Renal function is normal, kidney is large

Pyonephrosis

- Increased overall gain allows visualization of internal debris
- Requires urgent drainage

Gallbladder US for acute RUQ pain (Gallbladder was normal)

- Calculi
- Perinephric fluid
- Slight Hydronephrosis (not appreciated)

Acutely obstructing right ureteral calculus: ruptured fornix decompresses collecting system
Issues Related to Hydronephrosis

- **Mimics**
  - Dilated veins
  - Parapelvic cysts
  - Megacalycyces
  - Unusual hypoechoic sinus fat
- **Misses**
  - Complex urine: blood, pus, gas
  - Slight dilatation (compare with other kidney)
- **Dilatation without obstruction**
  - Dilatation related to over distended bladder, patulous collecting system, pregnancy
  - Use ureteral jets

Burge et al. Radiology 1991;180:437-442
Hertzberg et al. Radiology 1993;186:689-692

Cysts and cyst look-a likes

Duplicated collecting system
upper pole moiety obstructed by distal ureteral calculus

History of biopsy: Is this a cyst?

Pseudoaneurysm

Is this an upper pole cyst?

Are these cysts?

Varices and cysts are similar in gray scale imaging
Left flank pain
What is your diagnosis?
Interpreted as a hemorrhagic cyst

Renal Abscess
Give differential!

Papillary type renal cell carcinoma
Hx ESRD: pre-tx evaluation
Is this a cyst with reverberation artifact in near field?

Masses
What are we likely to miss?
When do we overcall?

Is there a renal mass?
Prominent un-resorbed junctional zone from fusion of fetal renal moieties
Accentuated on US because tissue planes are perpendicular to US beam, reflecting more sound than normal cortex with tissue planes parallel to beam
Normal color Doppler may help distinguish from true mass

Hypertrophied Column of Bertin

ESRD, pre-transplant evaluation;
Is this a mass?
Column of Bertin enhances the same as renal parenchyma

Without flow in color Doppler more concerning for solid mass

Though non contrast image looks like column, mass enhances but less than normal renal parenchyma

Oncocytoma

Hematuria: Is this a column of Bertin?

odd appearance central sinus fat hydronephrosis, echoes in renal sinus

Infiltrative transitional cell carcinoma of renal pelvis

Is there a renal mass?

Note slightly odd orientation of left kidney
Large left angiomyolipoma missed on US

- Arise from subcapsular cortex with predominant exophytic growth
- Difficult to distinguish from perinephric fat
- Look for parenchymal notch to indicate origin of lesion
- Liposarcomas are often at periphery of kidney and are exophytic, but typically have no identifiable fat
- Liposarcomas (very rare) can arise from renal capsule or within perinephric space

Focal hypoechoic sinus fat/lipoma

Screening US native kidneys in dialysis patient during pre-transplant evaluation interpreted as no significant abnormality

Missed renal cell carcinoma

Small renal mass difficult to appreciate on US and non-contrast CT

Screening US for hematuria interpreted as simple cyst

Initial ultrasound misses small renal cell carcinoma adjacent to cyst

Rapidly growing RCC in renal transplant patient with endstage kidneys: interpreted as a cyst on US
Mass noted only on cine clip

Portable US with normal Static images

Small renal mass confirmed on CT

Left Kidney Try

Subtle mass in gray scale does not deform renal contour

History of thyroid cancer

Metastases and lymphoma often do not deform renal contour

Is there a renal mass?

Metastatic thyroid cancer to lung and kidneys

Leiomyoma of renal capsule
Renal pseudotumor due to inflamed tail of pancreas

Multiple splenules

Combination of deep cortical scars and hypertrophy of remaining kidney causes pseudotumor

Other examples of deep scars with adjacent hypertrophy simulating masses

Prominent scar filled with fat simulates echogenic mass

US for renal mass

- Low sensitivity compared to CT
  - CT compared to US for lesions 1.0 – 1.5 cm: 75% to 28%
  - Lesions < 1 cm neither modality sensitive
  - Lesions > 1.5 cm similar sensitivities
- Some masses are more difficult
  - Metastases are less well marginated, lymphomatous masses similar in echogenicity to normal kidney, small urothelial tumors difficult to appreciate in sinus fat
- Pseudomasses: focal scars, splenules, pancreatitis, focal pyelonephritis
- Cystic lesions may appear more complex on US than CT and thus difficult to apply Bosniak criteria

References:
Is this a scar?

Right renal scar simulates junctional defect

Junctional line

Calculi

How to improve accuracy
Look-a-likes

Hematuria: Is this a calculus?

Renal calculus confirmed with greater confidence by using color Doppler to produce twinkle artifact

How to optimize twinkle artifact?

Lower focal zone

Increase PRF

Accuracy of US for Renal Calculi

- Compared to IVU and radiographs, sensitivities reported as high as 96%
- Compared to modern helical CT, sensitivities between 24 and 61%
- Most missed calculi are < 3mm
- Improve detection with sensitive technique
  - Remove smoothing algorithms, narrow focal zone
- Improve detection with color twinkle artifact
  - Improves sensitivity to 78% compared to CT

Lee, et al. AJR 2001;176:1441-1445
Is this a staghorn calculus?
Gas in collecting system simulates staghorn calculus

Is this a calculus in the renal pelvis?

Is this a calculus in the renal pelvis?

Is this a calculus in the renal pelvis?

Renal artery aneurysms

Are these calculi or gas?
Vascular calcifications simulate calculi and gas

Collections
Misses and Look-a-likes

Are these perinephric collections?
Hypoechoic perinephric fat simulates a collection

Elevated creatinine and pain over renal transplant: Is this acute rejection?
Large subcapsular hematoma compresses kidney
Function improved with evacuation
Recent cardiac catheterization and drop in hematocrit US interpreted as perinephric hematoma and "confirmed" on non contrast CT

Biopsy reveals lymphoma

Vascular Issues

Focal infarct, hx cocaine use

Acute R flank pain
No calculi or hydronphrosis

Acute global right renal infarct

Conclusions and Advice

• Insist upon scrupulous technique
• Be honest about limitations of study
• Include cine clips and always review them
• Use color and spectral Doppler liberally
• If survey images of kidneys are obtained as part of complete abdominal scan, be wary of interpreting kidneys as "normal"
• Be cautious about patients with ESRD
• Use CEUS, particularly in patients with CRF