Contrast Enhanced Ultrasound (CEUS) Applications in Genitourinary Imaging

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Disclosure

- **Lumason®** [Bracco, Italy]
  - *FDA approved*
  - IV CEUS Liver
    Pediatrics 4/2016
  - ceVUS
    Pediatric 12/2016
  - Only agent with pediatric approval
Why use CEUS for GU imaging?

• No nephrotoxicity  
  • Multiple injections in one examination  
  • Complete contrast elimination in 20 minutes
• No radiation
• Reduce need for sedation
• Problem solving tool
What is ultrasound contrast? **MICROBUBBLES**

• Gas filled microbubbles
• Bubbles resonate during US
  • Enhance sound reflection
• US software background subtraction
• Bubbles remain intravascular
  • Depicts blood flow
Administration

• Intravenous
• Intravesicular
• Intracavitary
Safety: IV administration

- 11 studies with 2nd generation US contrast agent
  ~1300 children
- 1 anaphylactic reaction (~ 0.077%)
- Minor 0.1-0.5%
  - Mild tinnitus, light headedness, taste alteration
  - irritability/hyperactivity, rash, hyperventilation

Darge et al 2013 Pediatr Radiol 43:1063-1073
Piskunowicz et al 2015 Ultrasound Med Biol 41:1095-1099
Safety: Intravesicular administration

- 15 studies, 2951 children
- Survey 4131 children

• Minor 0.8% - similar to transurethral catheter
  Dysuria, transient hematuria, pain, anxiety, urinary retention, UTI, vomiting, blood/mucous discharge, frequency, urethral pain

Darge et al 2013 Pediatr Radiol 43:1063-1073
Piskunowicz et al 2015 Ultrasound Med Biol 41:1095-1099
GU Applications

- Kidney
- Testes
- ceVUS and Urethrography
- Genitography
- Tumor
- Interventions
Kidney

- Arterial phase
  20 to 40 seconds
  Corticomedullary differentiation

- Homogeneous
  45 to 120 seconds
Infection

• Pyelonephritis: Hypoechoic
• Abscess: Anechoic
• Infection: Bulge
• Infarction: No bulge

Fontanilla et al 2012 Abdom Imaging 37:639-646
Infection

• Adult reference standard CT

• 100 patients
  • APN: CT 84, US 82
  • Missed 2 in young obese women
  • No false positive

• Sens 98%, Spec 100%, PPV 100%, NPV 89%

NO pediatric studies

Mitterberger et al 2008 BJU Int 101:341-344
11 yo boy, pyelonephritis
2 week follow up

Left Kidney
2 week follow up

6 months later

Left Kidney
Indeterminate renal lesions

• CEUS more sensitive than CT
  - Show blood flow in hypovascular lesions
  - Show blood flow in septations and solid components

Quaia et al 2008 AJR 191:1239-1249
Ascenti et al 2007 Radiology 243:158-165
16 yo boy, back pain and urinary incontinence

Right Kidney
Right Kidney Surgery → cystic nephroma
Trauma

Stable blunt abdominal trauma
American Association for the Surgery of Trauma score
• Limitation collecting system injury

Pediatric studies  CT vs CEUS
• 3 studies
• 25 renal injuries all detected by CEUS

Menichini et al 2015 Radiol med 120:989-1001
Valentino et al 2008 Radiology 246:903-909
Armstrong et al 2017 J Ped Surgery
16 yo boy, kneed in abdomen during baseball game

Shattered kidney
2 days later Hb 11 g/dL → 8 g/dL

perinephric collection

Right Kidney
active bleeding
1 month follow up

Right Kidney
GU Applications

- Kidney
- **Testes**
- ceVUS and Urethrography
- Genitography
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- Interventions
Scrotal

• CEUS as a problem solving tool
• Malignant pattern - early enhancement with washout
• Small tumors color Doppler may not show flow
• Improved diagnostic accuracy incidental testicular lesions

Huang et al 2012 Br J Radiol 85:S41-53
Lock et al 2011 Urology 77:1049-1053
Isidori et al 2014 Radiology 273:606-61
Scrotal

• Fracture lines depicted, contour abnormalities, rupture
• Torsion- Doppler artifact or arterial pulsation from the contralateral testis

Huang et al 2012 Br J Radiol 85:S41-53
Testicular masses- observations on CEUS

Rapid wash in neoplasm (benign or malignant)
Rapid washout distinctive of malignant

Leydig tumors slower washout
Haphazard vascular pattern
- Germ cell tumors
- Lymphoma 1/7 large B cell lymphoma

Isidori et al 2014 Radiology 273:606-61
Huang 2012 Br J Radiol 85:S41-S53
16 yo boy, scrotal swelling 2 weeks after straddle injury

Right Testis
GU Applications

• Kidney
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• Interventions
Contrast enhanced voiding urosonography (ceVUS)

Compared with VCUG
- ceVUS detects more reflux
- ceVUS detects higher grades of reflux
ceVUS Examination

Bladder

Left Kidney
ceVUS Urethral Imaging

Transperineal

ceVUS Urethral Imaging

Suprapubic

1 mo boy
17 yo boy, difficult voiding.
17 yo boy, difficult voiding. Intraoperative exam
17 yo boy, difficult voiding. Intraoperative exam

Bulbar urethral stricture
GU Applications

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5 mo girl, salt wasting CAH and ambiguous genitalia
GU Applications

• Kidney
• Testes
• ceVUS and Urethrography
• Genitography
• Tumor
• Interventions
15 yo girl, uterine rhabdomyosarcoma

Coronal T2 FS

Axial T1 FS + C
Post chemotherapy
GU Applications

• Kidney
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• Genitography
• Tumor
• Interventions
Interventions

• Biopsy
  • Improve conspicuity of lesion
  • Target viable part of tumor and not necrosis
• Guide nephrostomy tube
• Replace fluoroscopy

Huang et al 2017 RadioGraphics 37
13 yo girl, left upper pole renal cyst

Left Kidney
13 yo girl, left upper pole renal cyst

Left Kidney
6 yo boy, mid aortic syndrome right RAS
1 day post angioplasty

Right Kidney
1 day post angioplasty

12 days post angioplasty

Right Kidney
Summary CEUS in GU imaging

• Safe
• Effective
• Numerous applications
• Expanding indications and experience in pediatrics