Contrast-enhanced Voiding Urosonography: Comparison with VCUG

SPR Pediatric Ultrasound Course 2016

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Disclosures

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Background

Importance of vesicoureteral reflux

- Prevalence of 1%
  - may be higher
- Identified in 30-50% of all children presenting with a first UTI
- 27.4% of siblings of patients with documented VUR

Sargent MA. *Pediatr Radiol* 2000;30:587-593
Skoog SJ, Peters CA, Arant BS Jr et al. *J Urol* 2010; 184:1145-1151
Background

Investigations for vesicoureteral reflux

- Fluoroscopic voiding cystourethrography (VCUG)
- Radionuclide cystography (RNC)
  - Conventional techniques

- Contrast-enhanced voiding urosonography (ceVUS)
  - Radiation-free alternative to the traditional VCUG
  - ceVUS widely accepted in Europe/South America
    - not yet widely adopted in USA
Many recent studies have shown increased sensitivity of ceVUS for the diagnosis of VUR compared to fluoroscopic VCUG.

Wong et al demonstrated a sensitivity and specificity of 100% and 85%, respectively, of ceVUS for reflux detection compared to fluoroscopic VCUG.

Large review by Darge et al which concluded that ceVUS is more sensitive than fluoroscopic VCUG for the detection of VUR.

Darge K. *Pediatr Radiol* 2008; 38:54-63
Background

Development of ceVUS

• Traditionally VUR investigated with fluoroscopic VCUG
  – Limited/imperfect sensitivity due to intermittent fluoroscopy
  – Concerns about childhood radiation exposure
  – Search for a reliable, radiation-free alternative

• Development of US contrast agents/Availability in the U.S.A.

• Improvements in US technology
Summary

- Describe our initial experience with ceVUS using the second generation US contrast agent Optison™
- Optimization of examination technique
- Depiction of a variety of pathological entities
- Correlation with observation of reflux on VCUG
- Discussion of potential pitfalls
Materials and Methods

- Retrospective review
- 100 ceVUS studies
- Performed as a paired exam with VCUG
  - ceVUS
  - Single catheterization
  - Before VCUG (with the exception of one study)
- 54 girls, 46 boys
- Age range 2 days to 10 years (mean 10.2 months)
Technique

- All US studies performed on a GE Logiq E9 machine (GE Healthcare, Milwaukee, WI)
- Gray scale images of the kidneys and bladder obtained using C2-9, 9L, and/or ML6-15 probes
- Optison™ (GE Healthcare, Inc., Princeton, NJ)
- Contrast-enhanced imaging carried out with C2-9 probe
  - Contrast mode
  - Amplitude modulation
  - Mechanical index range 0.13 to 0.16
  - Frame rate 10/sec
Technique

• Focal point located posterior to the kidneys, ureters and bladder
• Overall tissue gain setting adjusted during bladder filling, not altered during subsequent imaging
• Instillation of 0.15 cc optimized dose of Optison™ into a 250 cc bag of saline
  – infused into the bladder by gravity
• Begin by observing bladder filling
• Advance to alternating between the bladder and kidneys during filling and voiding phases
• Transperineal images of the urethra during voiding
Technique

Dose too high
1.25 cc in 250 cc saline

Optimized dose
0.15 cc in 250 cc saline
Technique

- Excluding bladder catheterization, ceVUS takes 5-6 minutes on average (recall age range in our cohort)
- Optimized sonographic views of the kidneys and bladder prior to instillation of contrast are helpful (“Practice Views”)
Normal ceVUS in a 4 week old boy (fetal hydronephrosis)
Normal ceVUS in a 4 week old boy (fetal hydrenephrosis)
Transperineal Views of the Normal Urethra

Male

Female
Grading of Vescicoureteral Reflux: Prognostic Significance

- **VCUG**
  - International grading system (grades I-V; Lebowitz et al)
- **ceVUS**
  - Into the ureter (grade 1)
  - Into renal collecting system (grade 2)
  - Upper tract dilation (grade 3)
- **ceVUS grading system comparable to system used for grading radionuclide cystography (Treves et al)**

5 month old girl with a febrile UTI
5 month old girl with a febrile UTI
Bowel Gas/Stool

Right Flank
Vesicoureteral Reflux

ceVUS grade 3

VCUG grade II
Reflux into the Lower Pole of a Duplex Collecting System

Preoperative (Outside) sonogram:

Practice views after ureterocele incision:
Reflux with UPJ Obstruction
15-month-old male with prenatal diagnosis of hydronephrosis.

**a** Bilateral distal hydroureter without VUR on transverse bladder images (arrowheads).

**b** Normal transperineal view of the male urethra (arrow).
Reflux AND UVJ Obstruction

Transverse view of empty bladder
Intra-Renal Reflux

• Intrarenal reflux (IRR) is a rare but important phenomenon observed mainly in newborns and infants, frequently in the setting of high-grade VUR

• Cases of VUR accompanied by IRR generally considered to be at the more severe end of the clinical spectrum

• IRR manifested as linear, punctate, and halo-like echogenic foci extending into the renal parenchyma from the base of the calyces

• Extensive IRR may result in diffuse renal cortical enhancement
Intra-Renal Reflux

Intra-Renal Reflux

Posterior Urethral Valves

- Posterior urethral valves on VCU:
  - Filling defect
- ceVUS:
  - Caliber change
  - Urethral dilation proximal to valves
Posterior Urethral Valves

Thick-walled bladder on early filling views

Pre-OP

Post-OP
Spinning Top Urethra

- Can be normal variant
- Important to rule out functional voiding disorder

4y girl with a history of febrile UTI
Air in Bladder: An Avoidable Pitfall

- Gas bubbles cause dirty shadowing on initial images
- Cyclic study performed. Air passed with initial voiding and subsequent good visualization of bladder
- Ensure that tubing is flushed to avoid dirty shadowing from gas that limits assessment of bladder

5 month boy, Prenatal HN
Adjacent colonic stool may mimic a bladder mass on early filling views

22 month girl with recurrent UTIs

- “Filling defects” observed during initial instillation of contrast may represent adjacent stool (can be seen on VCUG too)
Complex anatomy can be seen on transperineal views

Contrast in incised cecoureterocele

Vaginal Reflux
An example of a false negative ceVUS

• Usual technique: ceVUS first, followed by VCUG
  — Same catheterization

• This was our only example where the VCUG was performed first:
  — left grade II vesicoureteral reflux

• Subsequent ceVUS: NO reflux

• Hypothesis
  — Residual heavier, dependent iodinated contrast in the bladder interfered with reflux of less dense US-contrast
  — Ureteral orifices are posterior

💡 Ensure there is no dense iodinated contrast in the bladder


False negative ceVUS

Colleran GC, Paltiel HJ, Barnewolt CE, Chow JS. Pediatric Radiology (in press).
Preliminary Results: n=100 pts (197 kidneys)

- Both studies negative: 75%
- Both studies positive: 12%
- $ceVUS$ pos and VCUG neg: 10%
- $ceVUS$ neg and VCUG pos: 3%
Preliminary Results: n=100 pts (197 kidneys)

- Both studies negative: 75%
- Both studies positive: 12%
- ceVUS pos and VCUG neg: 10%
- ceVUS neg and VCUG pos: 3%
5 kidneys negative for VUR on ceVUS (but positive on VCUG)

- 1 pt: Dense VCUG contrast may have interfered (grade II)
- 2 pts: Grade I on VCUG
- 2 Pts: Grade II on VCUG (2/197 kidneys)
2 kidneys where saw grade II on VCUG
(NO VUR on ceVUS)
• ceVUS: You CAN see the urethra and other details
• “Practice” sonographic views of the kidneys and bladder prior to instillation of contrast (helps you to establish your best window/patient position)
• A little contrast goes a long way (too much casts shadows that obscure deeper structures)
• Ensure that tubing is flushed to avoid introducing air into the bladder, resulting in intravesicle “dirty shadows”
• Adjacent bowel contents may distort the bladder shape during early filling and will appear “bright” on contrast-optimized views
• Beware: iodinated contrast is heavier than US-contrast so should be fully evacuated from the bladder prior to ceVUS
OUR next task

-The high-sensitivity, safety, and ease of performance of ceVUS has the potential to largely replace conventional fluoroscopic VCUG for diagnosis of VUR which requires exposure to ionizing radiation.

-What group(s) of patients would be best evaluated with ceVUS?
References


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