Ultrasound – Contrast Enhanced Voiding Urosonography (ceVUS)

PURPOSE:
To evaluate the pediatric urinary system for vesicoureteral reflux (VUR), posterior urethral valves (PUV), and other urinary system abnormalities

SCOPE:
Applies to all ultrasound ceVUS studies performed in:

- UT Southwestern William P. Clements Jr. University Hospital and Clinics, Imaging Services (UTSW Radiology)
- Parkland Health (Hospital and Clinics), Department of Radiology (PHHS Radiology)

ORDERABLE:

- US Urinary Tract with Contrast

INDICATIONS:

- Abnormal lab values, urinalysis indicating UTI e.g. hematuria, fevers,
- Prior history of UTI
- New, persistent, or otherwise unexplained hydronephrosis

CONTRAINDICATIONS:
No absolute contraindications

EQUIPMENT:

- Ultrasound system with high-resolution curved probe e.g. 9-2MHz. Additional probes may include 5-1MHz, and micro-convex (eg. mC12-3MHz)
- Sulphur hexafluoride contrast (Lumason) kit.
- Add 0.7mL Lumason diluted to 250mL normal saline bag (as recommended by Children's Health)
- Bladder catheterization

PATIENT PREPARATION:

- Patient does not need to be NPO
- Bladder catheterization prior to performing ceVUS (to be performed by NICU/Nursery Staff)

EXAMINATION:

GENERAL GUIDELINES:

A complete examination includes pre contrast greyscale evaluation of bilateral kidneys and bladder. Post contrast imaging of bilateral kidneys ureters, bladder and urethra.

EXAM INITIATION:

- Introduce yourself to the patient/family
- Verify patient identity using patient name and DOB
- Explain test
- Obtain patient history including symptoms. Enter and store data page
- Place patient in supine position.
- Allow NICU/Nursery staff to place catheter

TECHNICAL CONSIDERATIONS:

- Review prior imaging.
- Short cines obtained throughout examination. Representative static images can be taken during the exam, or afterwards, from acquired cines at end of examination, due to rapid imaging.
- Obtain minimum 3 cycles of bladder and kidney imaging e.g. at filling, reflux, voiding.
- Assess bladder for filling defects and obtain volumes as indicated.
- Obtain maximum reflux images, prior to removing catheter.
- Obtain urethra at base of bladder to assess for structural or functional abnormalities.
    - Assess female urethra for structural and functional urethral abnormalities; spinning top urethra, urethrovaginal reflux, urethral diverticula, and periurethral cysts.
    - Assess male urethra for obstructing urethral pathology including posterior urethral valves (PUV) and congenital strictures.

DOCUMENTATION:

- **Pre-Contrast:**
    - Long greyscale cine of Right Kidney (document dilation, if present)
    - Long greyscale cine of Left Kidney (document dilation, if present)
    - Trans greyscale cine of Bladder demonstrating catheter and contracted status
    - Long cine of Right Kidney in dual screen contrast mode
    - Long cine of Left Kidney in dual screen contrast mode
- **During contrast filling:**
    - Long cine Bladder during contrast filling
    - Long cine Right Kidney during filling
    - Long cine Left Kidney during filling
    - Long cine of Bladder at maximum volume
        - Document "Full" on image, with volume
    - Trans cine of Bladder at maximum volume
    - Long cine of Right Kidney at max volume
    - Long cine of Left Kidney at max volume
- **During voiding:**

  Trans cine of Bladder, assess for opacified ureter
    - Long cine of Bladder, assess for opacified ureter
    - Long of distal ureters, if reflux detected
    - Long cine of Right Kidney (grade of reflux)
    - Long Cine of Left Kidney (grade of reflux)
    - Repeat Bladder and bilateral Kidney cines to ensure maximum reflux of each kidney is detected.
    - Long cine "voiding" dorsal urethra with catheter
    - Long cine "voiding" dorsal and ventral urethra with catheter out
- **Post contrast:**
    - Long and Trans dual screen static post void bladder for volume calculation
- Data page(s)

PROCESSING:

- 3 bladder volumes calculated at; maximum distention, during reflux, and post void.
- Review all images and edit as needed

- Export all images to PACS
- APS will present to Childrens' Radiologist

REFERENCES:

Contrast-enhanced voiding urosonography, part 1: vesicoureteral reflux evaluation, Aikaterini Ntoulia, Elisa Aguirre Pascual, Susan J. Back, et al.

- Contrast-enhanced voiding urosonography part 2: urethral imaging, Carol E. Barnewolt & Patricia T. Acharya & Elisa Aguirre Pascual, et al.

CHANGE HISTORY:

STATUS	NAME & TITLE	DATE	BRIEF SUMMARY
Submission	Surekha Patel APS	**08/18/2025**	Submitted
Approval(s)	David T. Fetzer, MD	**08/23/2025**	Approved
	Kate Mangona, MD		Approved
Reviews			Reviewed
Revisions			

DIAGNOSTIC CRITERIA:

Grading reflux using grading system:

- Vesicoureteral reflux grading Reflux with ceVUS is classified into five grades in a similar manner as the international reflux grading system for VCUG (according to the degree of filling and dilation of the ureter and upper urinary tract:
    - Grade I: refluxing microbubbles in the ureter, which is not dilated.
    - Grade II: refluxing microbubbles in the pelvicalyceal system, which is not dilated.
    - Grade III: refluxing microbubbles fill the pelvicalyceal system with mild dilation and without change of the calyceal contour.
    - Grade IV: refluxing microbubbles fill the pelvicalyceal system, with moderate dilation and blunting of the renal fornices, but with papillary impressions still visible.
    - Grade V: refluxing microbubbles fill the pelvicalyceal system with marked dilation and loss of papillary impressions and tortuous course of the dilated ureter
    -

Assessing Bladder and Urethra:

- Bladder assessed for filling defects and obtain volumes as indicated.
- Female urethra assessed for structural and functional urethral abnormalities; spinning top urethra, urethrovaginal reflux, urethral diverticula, and periurethral cysts.
- Male urethra for obstructing urethral pathology including posterior urethral valves (PUV) and congenital strictures.

APPENDIX:

Grading of Vesicoureteral Reflux

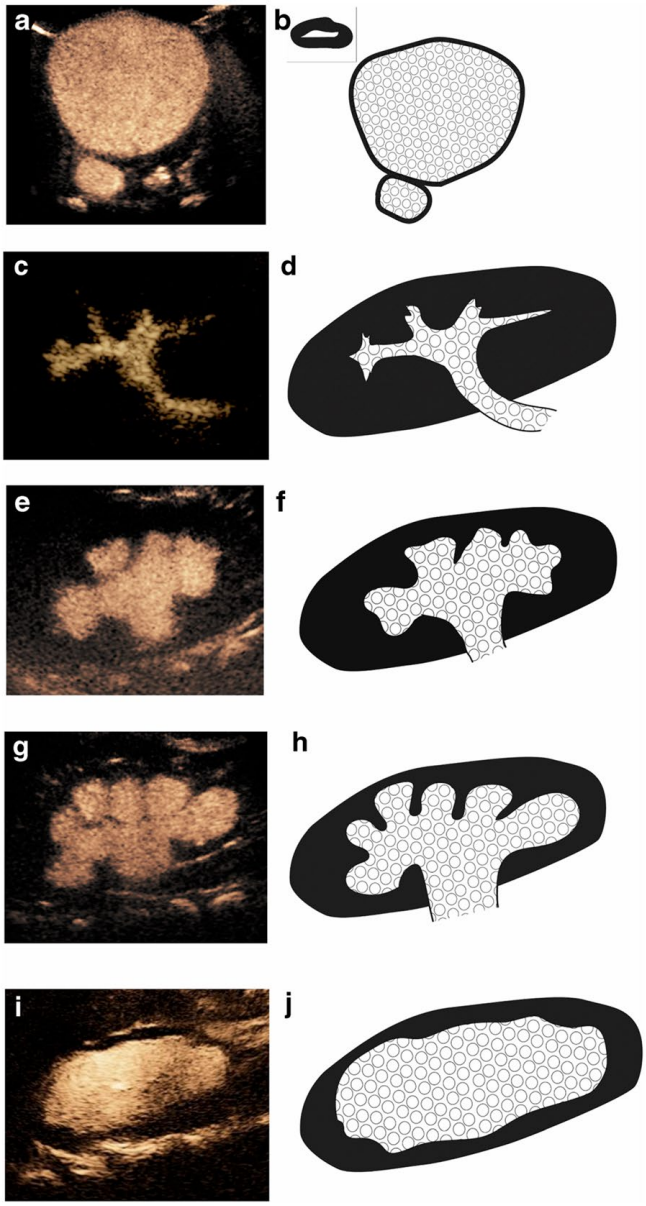

Fig. 12 Grading vesicoureteral reflux (VUR) on contrast-enhanced voiding urosonography. Contrast-only mode, sagittal images of the kidney in different children with different grades of VUR (**a, c, e, g, i**) and corresponding graphic illustrations (**b, d, f, h, j**), where black color represents the renal parenchyma and open circles represent US contrast agent filling the pelvicalyceal system. **a, b** A 2-week-old boy with grade I VUR: refluxing microbubbles in the ureter. **c, d** A 5-month-old boy with grade II VUR: refluxing microbubbles in the pelvicalyceal system, which is not dilated. **e, f** A 2-week-old boy with grade III VUR: refluxing microbubbles fill the pelvicalyceal system with mild dilation and without change of the calyceal contour. **g, h** A 2-month-old girl with grade IV VUR: refluxing microbubbles fill the pelvicalyceal system, with moderate dilation and blunting of the renal fornices but with papillary impressions still visible. **i, j** A 2-year-old boy with grade V VUR: refluxing microbubbles fill the pelvicalyceal system with marked dilation and loss of papillary impressions

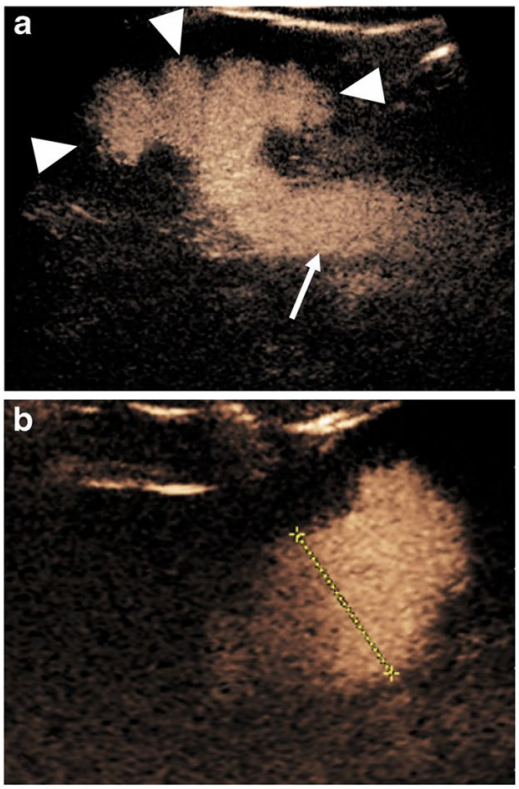

Fig. 7 Renal imaging on contrast-enhanced voiding urosonography in a 2-week-old boy. Contrast-only mode of the left kidney. **a, b** Sagittal (**a**) and axial (**b**) images of the left kidney show contrast agent reflux into the proximal ureter (*arrow*) and pelvicalyceal system (*arrowheads*), which is mildly dilated, with preservation of the calyceal contour in keeping with reflux grade III. Measurements of the maximum anterior–posterior diameter of the renal pelvis are obtained in axial view (**b**)

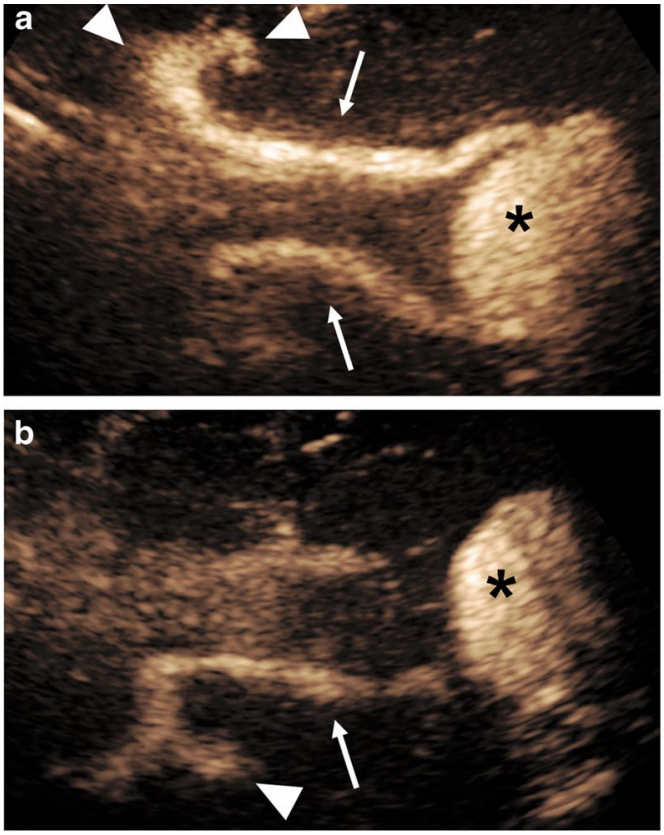

Fig. 9 Panoramic view on contrast-enhanced voiding urosonography in a 2-month-old boy. **a, b** Contrast-only mode of the bladder, bilateral ureters and pelvicalyces in coronal view from the flank. Images show echogenic microbubbles in the bladder (*asterisks*) and refluxing into both ureters (*arrows*) and pelvicalyceal systems (*arrowheads*), which are not dilated, in keeping with bilateral grade II reflux (**a, b**). The right pelvicalcyeal system is better visualized in (**b**)

Assessing Bladder Volumes and Ureterovesicle Junction (UVJ)

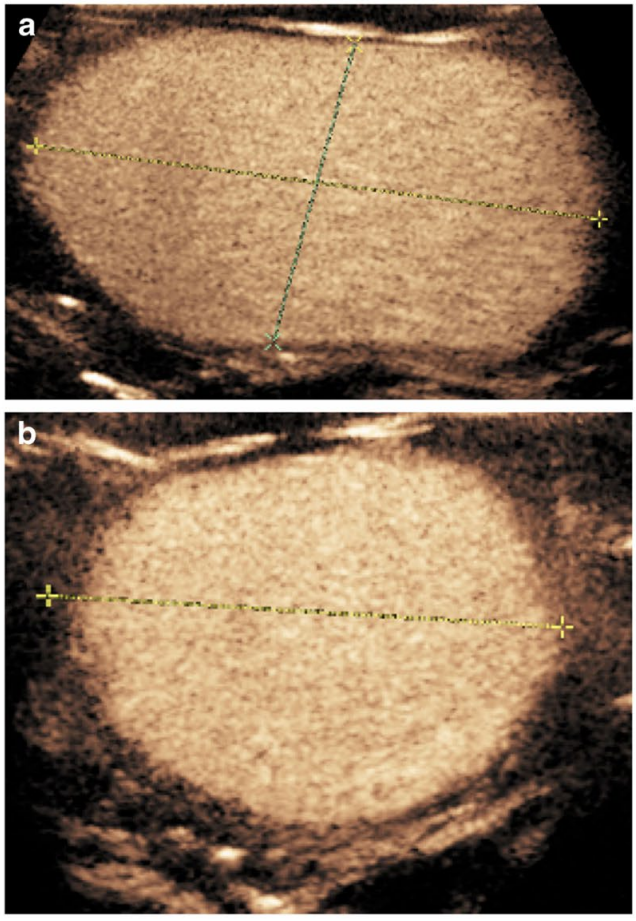

Fig. 4 Measuring bladder capacity during contrast-enhanced voiding urosonography (ceVUS) in a 2-month-old boy. Contrast-only mode. **a, b** Sagittal (**a**) and axial (**b**) images of the bladder show measurements (*calipers*) to sonographically calculate the bladder capacity during ceVUS

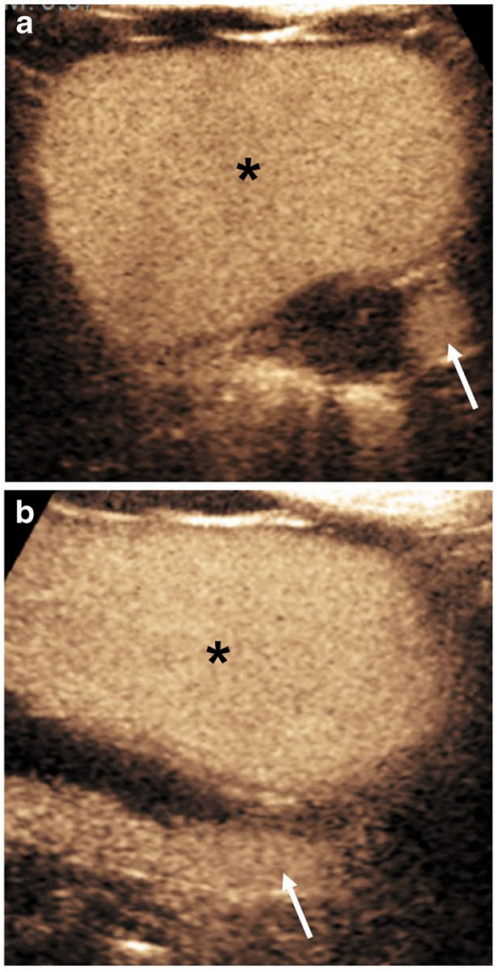

Fig. 5 Ureter insertion on contrast-enhanced voiding urosonography in a 2-month-old girl. Contrast-only mode. **a, b** Axial (**a**) and sagittal (**b**) images of the bladder show optimal concentration and homogeneous distribution of ultrasound contrast agent in the bladder (*asterisks*). The dilated left ureter (*arrows*) is seen behind the bladder filled with refluxing microbubbles

Assessing Female Urethra During Voiding

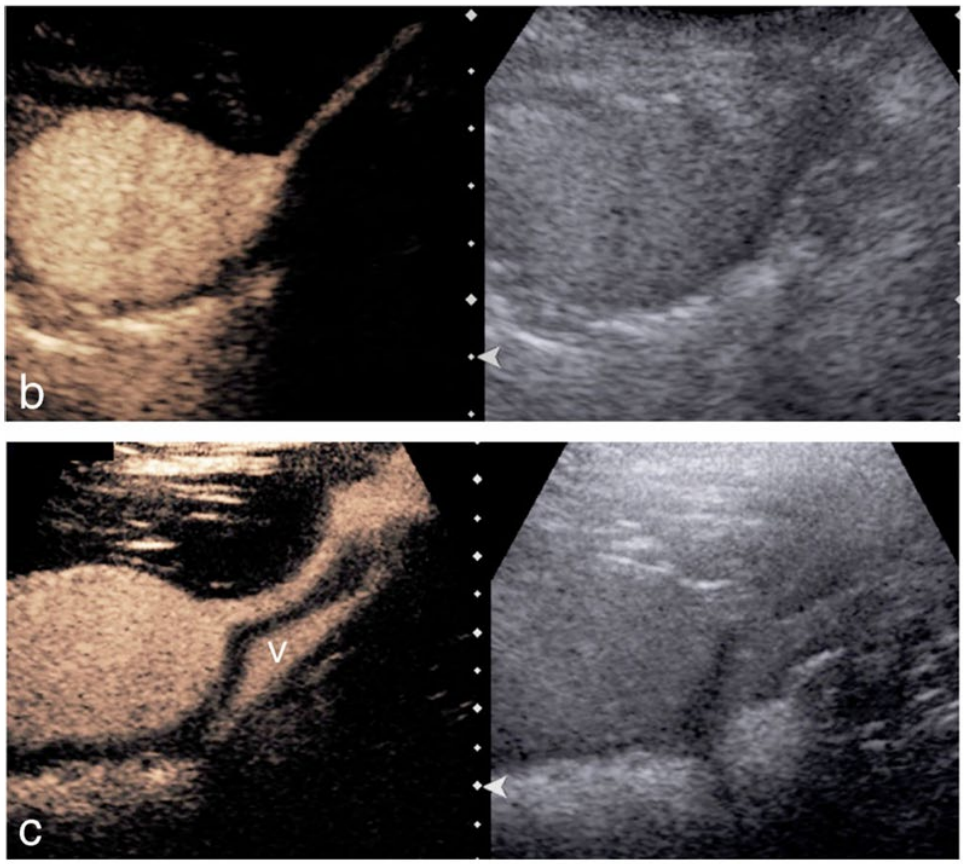

Fig. 6 Contrast-enhanced voiding urosonography (ceVUS) in a normal female urethra. **a** A 15-month-old girl examined with a 4-MHz curved probe positioned in a sagittal orientation on the anterior pelvic wall (suprapubic view). **b** Sagittal ceVUS with dual display of contrast (*left*) and gray-scale (*right*) images during contrast agent instillation via the catheter in the same girl as in (**a**). **c** A 3-month-old girl examined with a 9-MHz linear probe. Sagittal ceVUS with dual display of contrast (*left*) and gray-scale (*right*) images during voiding, where the urethra is distended with US contrast agent. Vaginal reflux (*V*) is depicted

Assessing Male Urethra

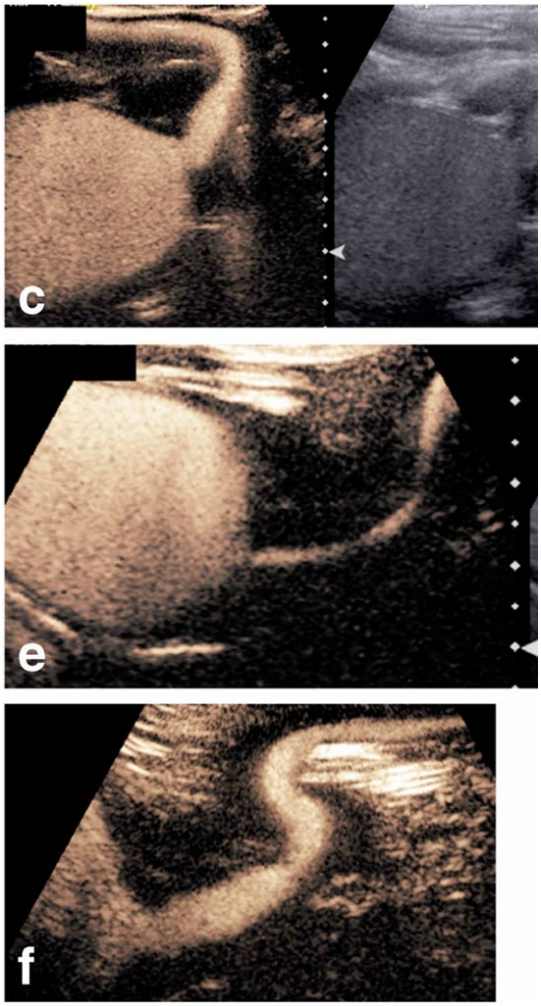

Fig. 8 Contrast-enhanced voiding urosonography in a normal male urethra examined with a 9-MHz linear probe. **a** A 3-month-old boy with the transducer positioned in a sagittal plane on the scrotum (transscrotal view). **b** Same boy as in (**a**) with the transurethral catheter in place and contrast instillation into the bladder on sagittal dual display of contrast (*left*) and gray-scale (*right*) images. **c** A 7-month-old boy with the transducer positioned in a sagittal plane on the scrotum (transscrotal view)