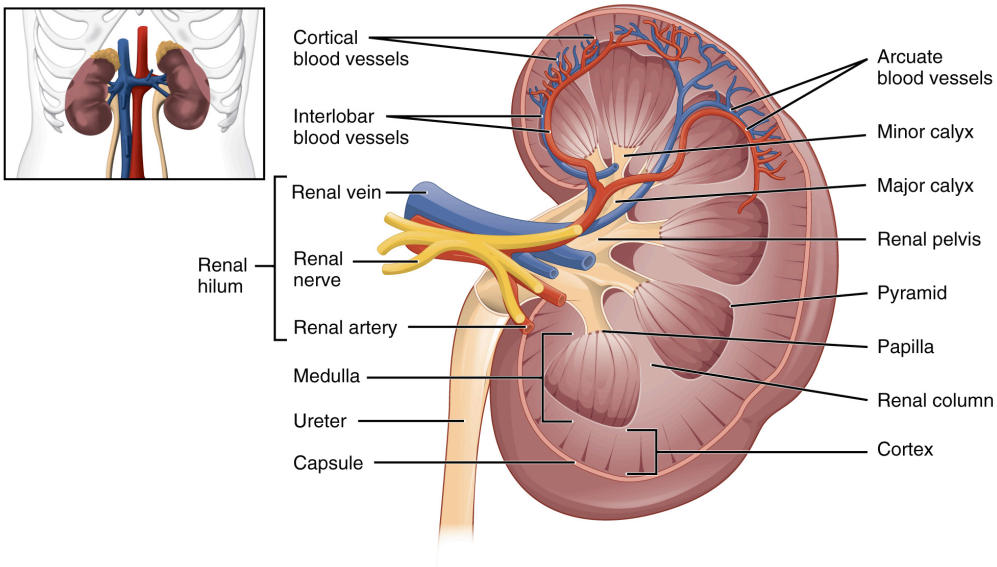
UCSF ED Renal/Bladder/UVJ Ultrasound Protocol

Indications: 1) Concern for renal stone or urinary obstruction; 2) evaluation of new onset renal failure to rule out a post-renal cause.

Renal Anatomy:



Transducer: Low frequency 5-2 MHz curvilinear probe, Mode set to "Abdomen".

Patient Positioning: Supine or slightly rolled into lateral decubitus with ipsilateral arm resting above head.

Technique Guidelines:

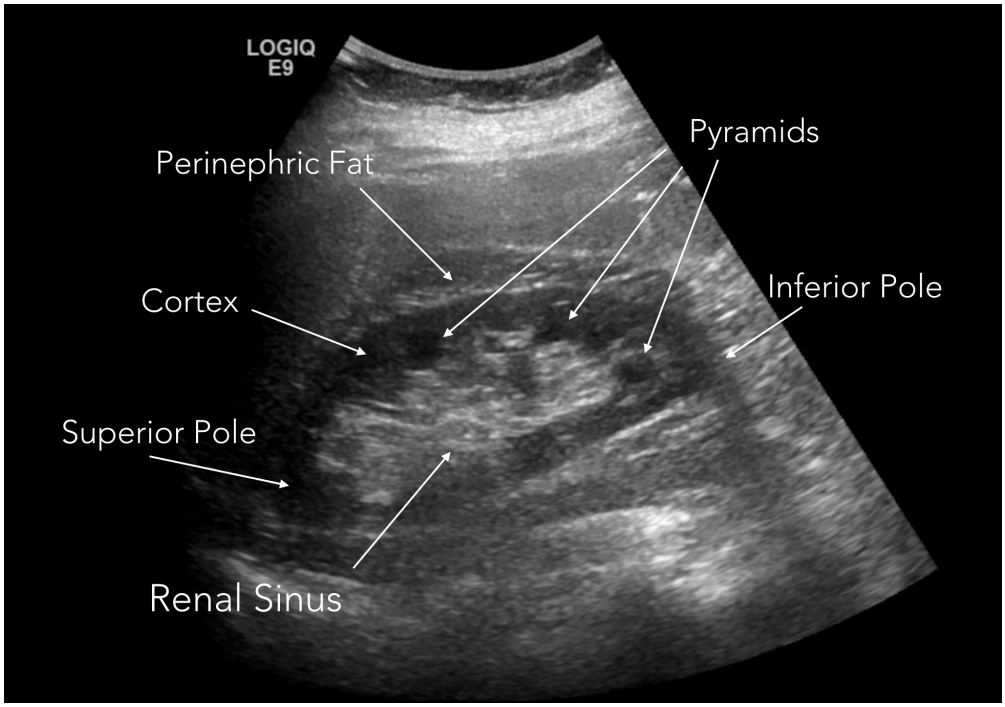
- A full bladder is needed to visualize the UVJ, so ideally patient should not void until after the study.
- Rib shadow is often an issue. In general, adjusting your transducer orientation so that the probe is between and parallel to the ribs will help. Also, try asking the patient to inhale and hold breath. This will flatten the diaphragm and may pull the kidney down into a better view.
- Renal views should be completed for **bilateral** kidneys, as you will need to compare the affected side to the normal side. **Please make sure to label "right" and "left" since liver and spleen may not be seen in your images!**

Scanning protocol:

1) Views #1-3 should be still images of the right kidney in a sagittal/long axis orientation as shown below. Place the probe in a slightly oblique orientation parallel to the ribs in the mid-axillary line, usually just above the costal margin. In some patients you will need to move down to below the ribs. The probe marker should be pointing toward the axilla. In some patients, the best images are obtained by using the liver as your acoustic window, so try

moving the probe more anteriorly if you are not getting good images from the mid-axillary position. Save at least 3 still images.

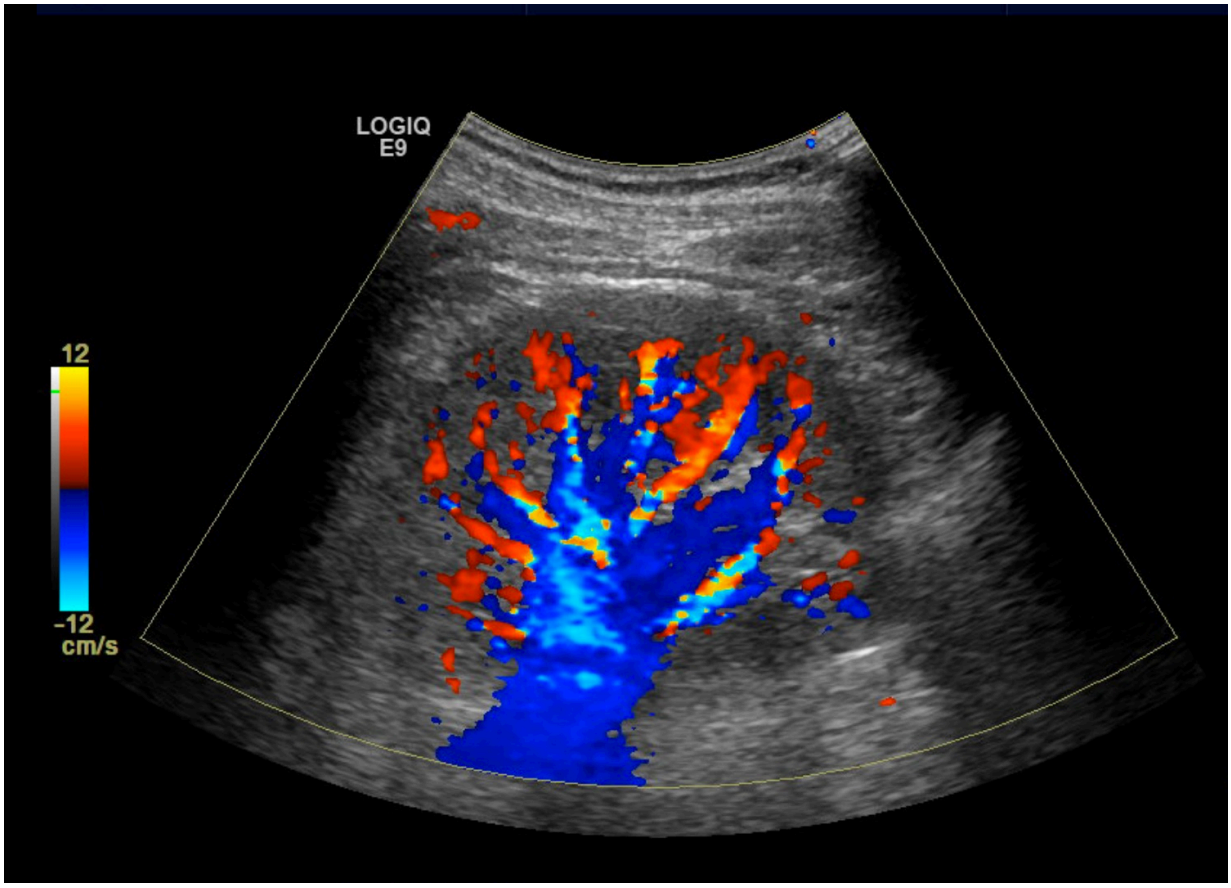
Left: Sagittal/Long Axis View of Normal R Kidney. Views #1-3 should be still images, views #4 & 5 should be cine clips.



Above: Normal R kidney with structures labeled. Note that the medullary pyramids are hypoechoic relative to the surrounding cortex. The renal sinus is the central cavity containing the renal vasculature and the collecting system. It appears echogenic relative to the rest of the kidney. **Novice sonographers frequently misidentify normal pyramids and/or vessels as dilated calyces, leading to misdiagnoses of hydronephrosis.** Become familiar with normal sonographic anatomy and avoid this mistake.

2) Views #4-5 should be clips of the kidney in a longitudinal axis. One should be a slow fan through the entire kidney.

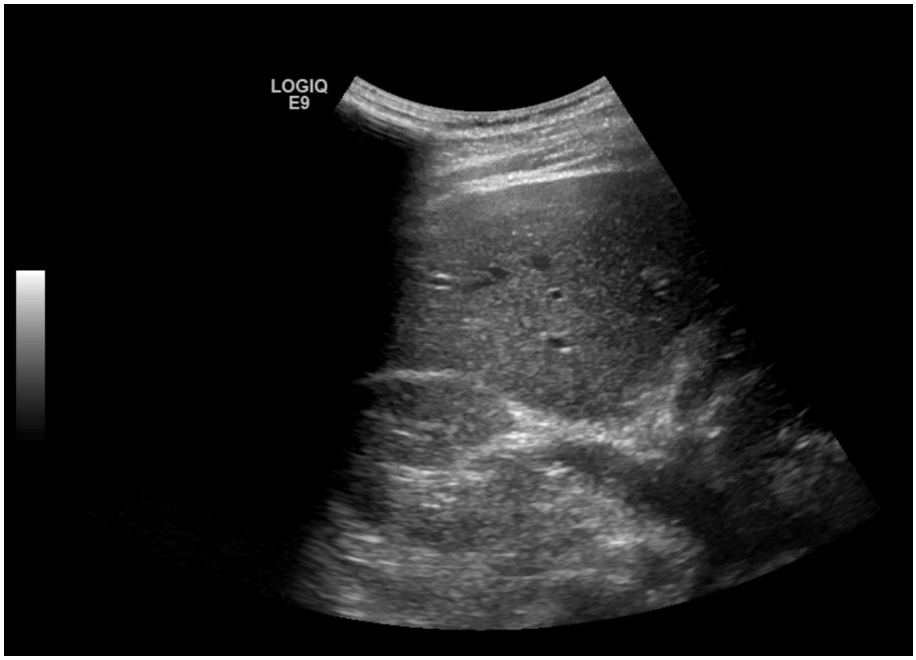
3) Views #6 & 7 should be still images of the kidney in long axis with a color Doppler box over the majority of the entire structure, including the renal pelvis. Using color Doppler will help you differentiate the renal vasculature (has flow) from the collecting system (no flow). Make sure that the color Doppler scale is set to an appropriate level (usually 10-20 cm/sec).



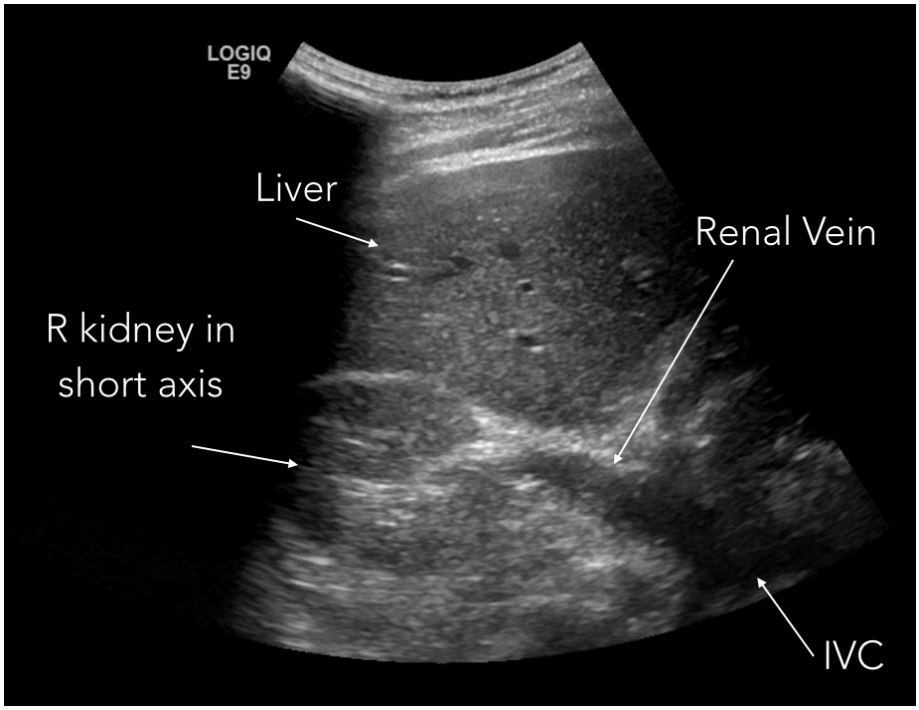
Above: Long Axis view of R kidney with color Doppler. The main renal artery and vein in the renal sinus and the interlobar vessels adjacent to the pyramids generate color Doppler flow. The color signal outside the kidney is artifact. Note the appropriate color scale setting on the left of the image. Views #6 & 7 should be still images, view #8 is a cine clip.

4) View #8 should be a cine clip of the kidney in long axis with color Doppler. Avoid fanning as this will cause lots of artifact within your color Doppler box.

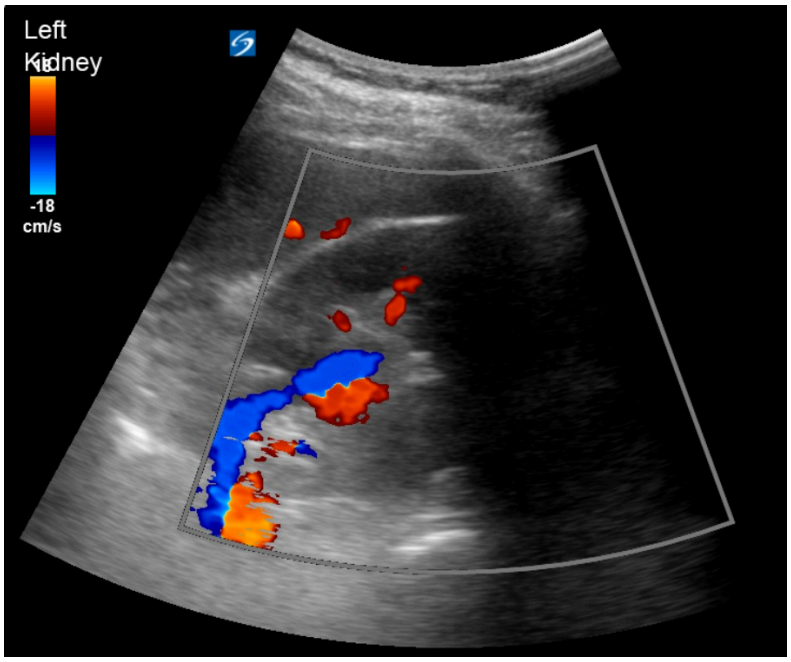
5) Now rotate the transducer 90 degrees to switch to transverse/short axis orientation. Views #9 & 10 should be a still image and clip of the right kidney in short axis through the middle of the structure. You should see the renal vein emerging from the kidney and heading toward the IVC.



Left: R kidney in transverse/short axis orientation. Note the prominent renal vein heading medially toward the IVC.



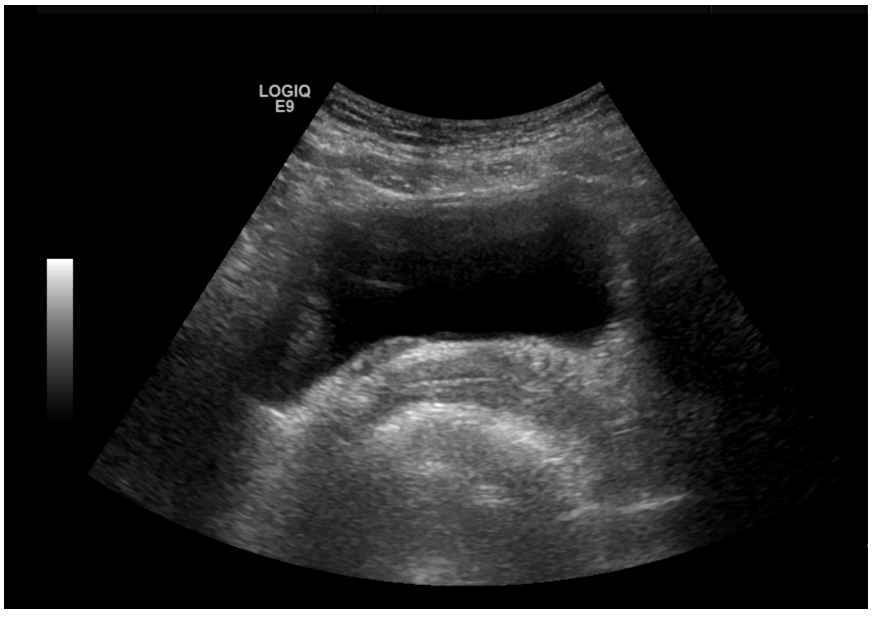
Left: Above image with labels. Clip #9 should be a still image, #10 should be a cine clip.



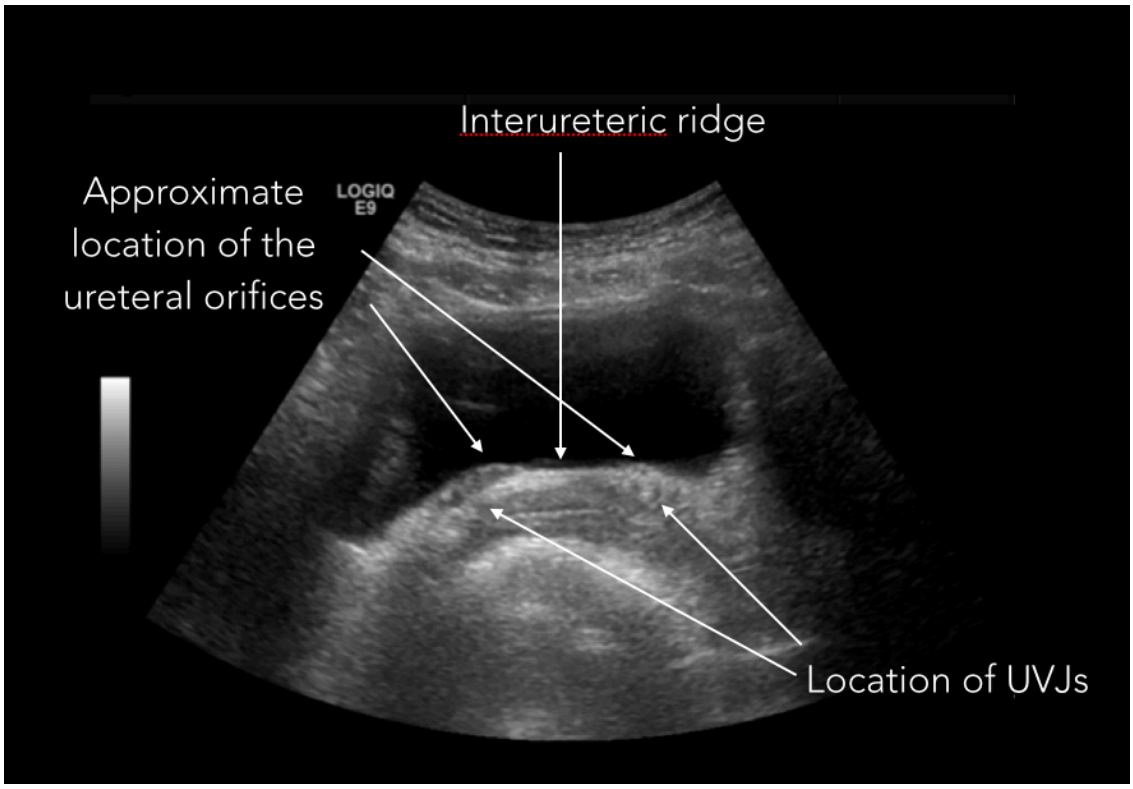
Left: Left Kidney with color Doppler demonstrating position of renal artery and vein. Color Doppler is optional for these views.

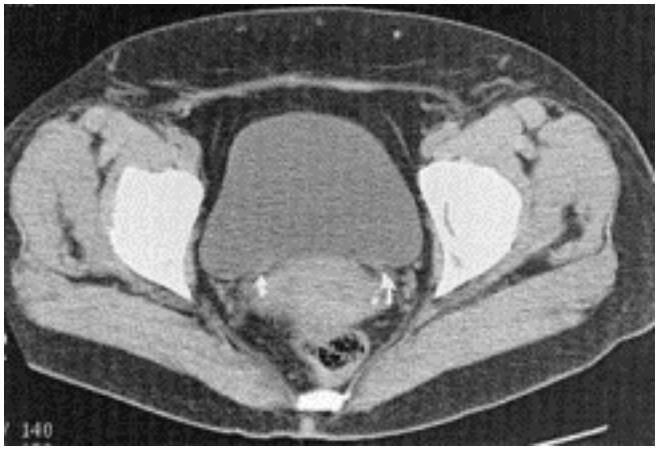
6) Views #11-20 should be the above views on the opposite side. **Don't forget to change your label to the other side!** Remember that the left kidney is more posterior and cranial than the right side, so don't be shy about getting your knuckles all the way down on the bed, and/or asking the patient to roll toward you slightly.

7) Now switch to the bladder. Views #21 & 22 should be still images of the bladder in transverse. If you are looking for a kidney stone, focus your attention on the UVJ's. They are difficult to directly visualize, but their position can be estimated by finding the ureteral orifices on either side of the interureteric ridge. This is the most common place to visualize a ureteral stone, if present.



Left: Transverse View of urinary bladder. The ureteral orifices are located roughly where the two subtle, knobby projections on either side of the interureteric ridge project upward from the posterior wall of the bladder. The UVJ's are just below the ureteral orifices.





Above: Transverse sonogram of urinary bladder with labels. In normal patients, the UVJ/distal ureters are collapsed and cannot be seen directly.

Left: CT image demonstrating position of UJVs (arrows). Look here for stones.

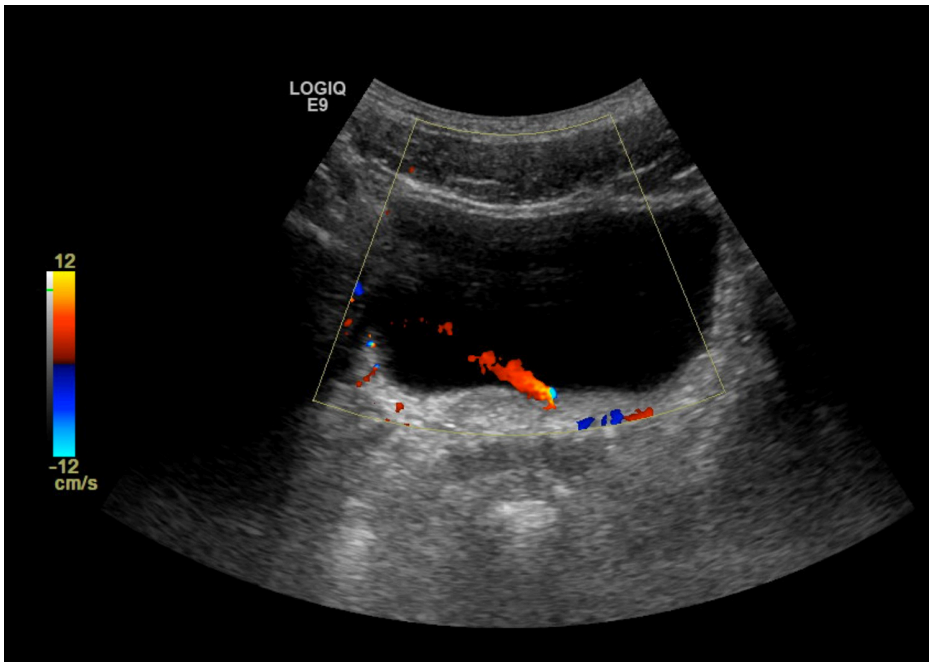
8) View #23 should be a cine clip slowly fanning through the bladder across the UVJ's.

9) Views #24 & 25 should be cine clips interrogating each UVJ individually. To do this, turn the transducer into an oblique or sagittal orientation and scan from the opposite side of the abdominal wall, using the bladder as an acoustic window. This technique will improve your ability to locate a stone at the UVJ (see below).

10) If you see a UVJ stone, put a color Doppler box on it and you should see the "twinkle artifact" that is a classic finding for these. You should also measure the stone diameter if identified.

11) Optional: Put a color Doppler box over bilateral UVJ's and observe the ureteric jets that arise like little geysers from the ureteral orifices as shown

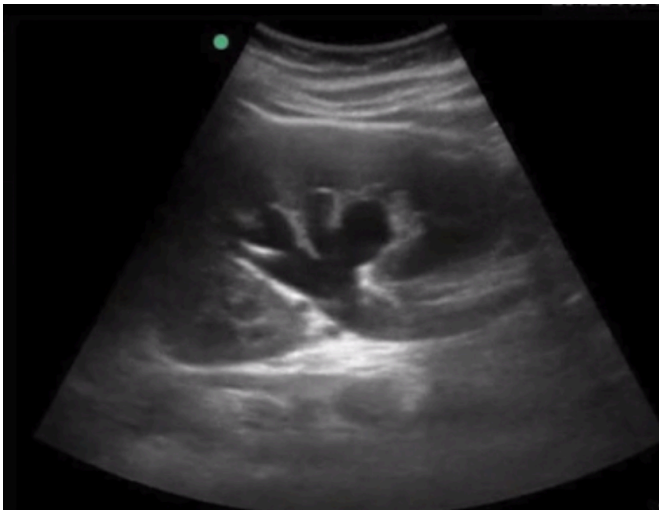
below. The absence of a jet suggests that ipsilateral ureteral obstruction is present, though you must wait at least 5 minutes before calling this. The presence of a jet suggests either that a stone is absent, or if a stone is present on that side, it is not completely obstructive. But since many patients with proven stones will still have jets (the urine can pass around the stone), this is not a particularly useful finding to rule out this dx.

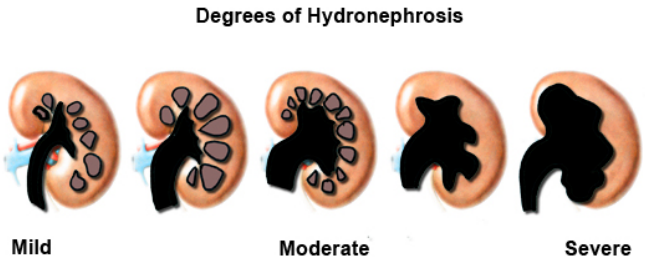


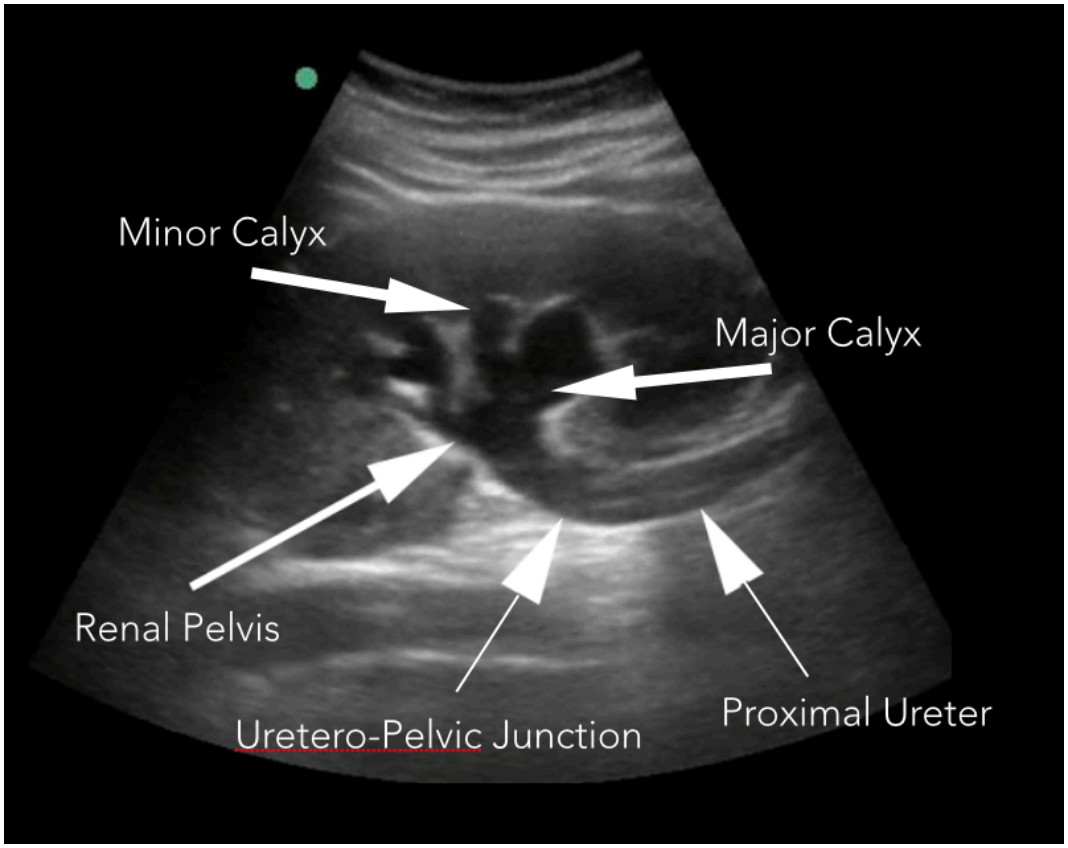
Left: A ureteric jet from the left ureteral orifice lets loose. Note the characteristic upward and medially oriented trajectory.

How to identify hydronephrosis:

Hydronephrosis refers to dilation of the renal collecting system. This includes dilation of the renal pelvis (pelviectasis) and major & minor calyces (caliectasis). You may also see a dilated proximal ureter (hydroureter). Generally speaking, the collecting system should <u>not</u> really be visible unless an obstruction is present, though the renal pelvis may be somewhat prominent in certain normal patients. In general though, the ability to clearly visualize the collecting system suggests that hydro is present.



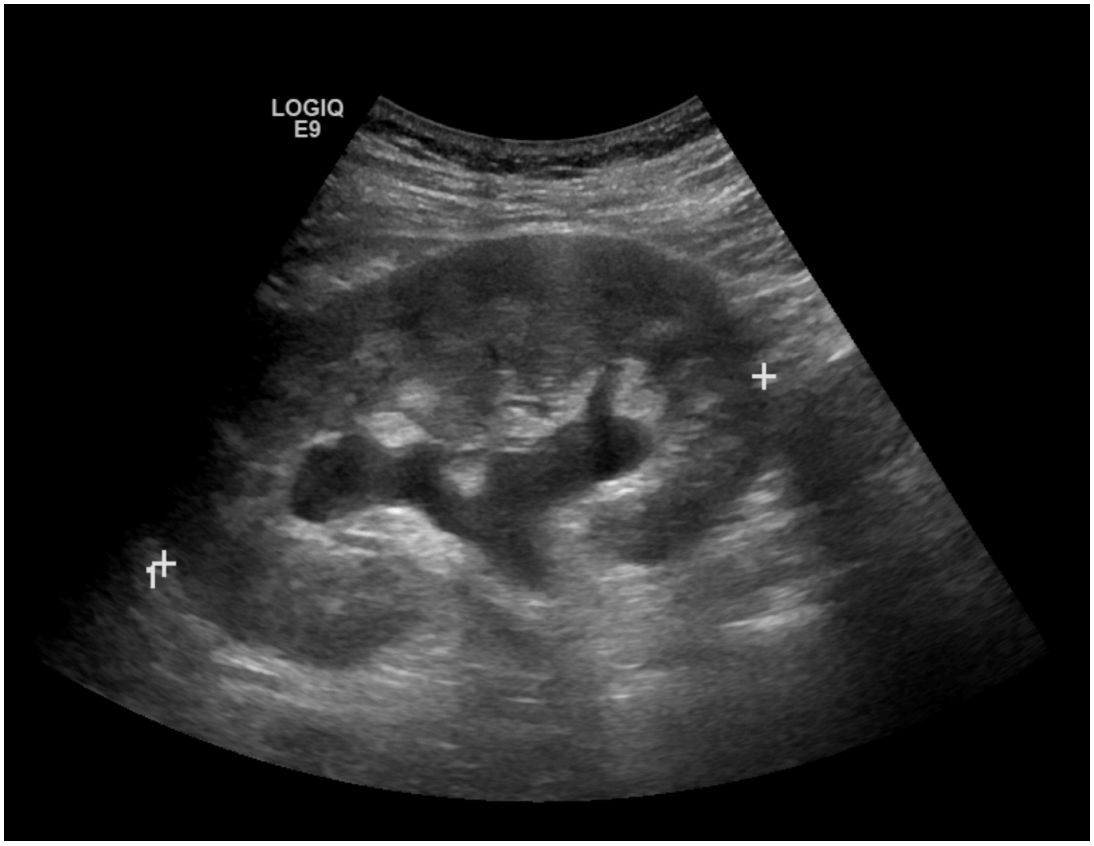




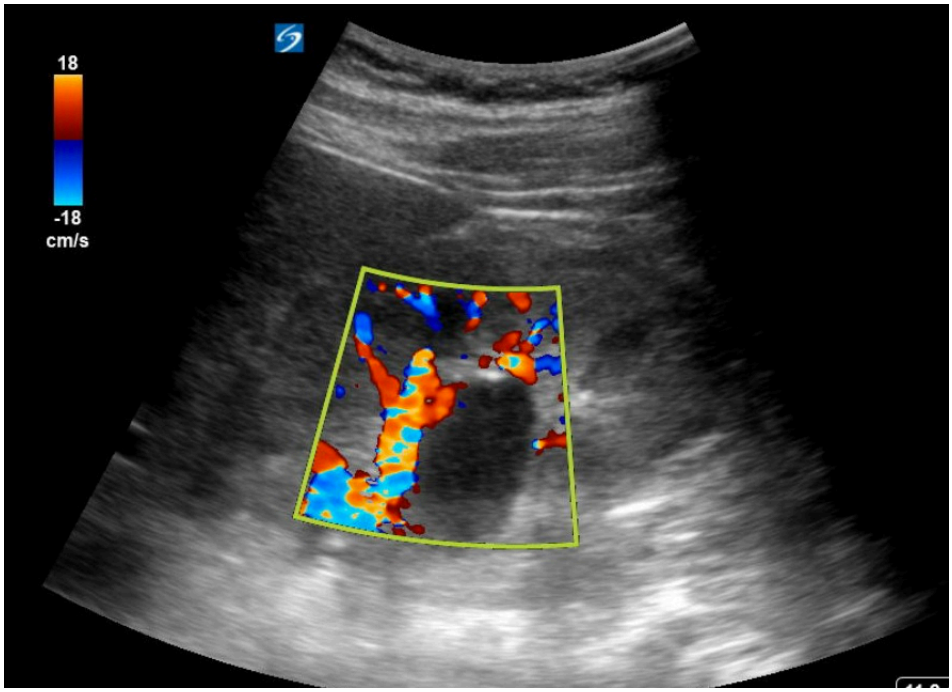
Above: A kidney with mild hydronephrosis. The major and minor calyces, renal pelvis, and proximal ureter are dilated.

The 6 sonographic finding consistent with a diagnosis of acute ureteral stone:

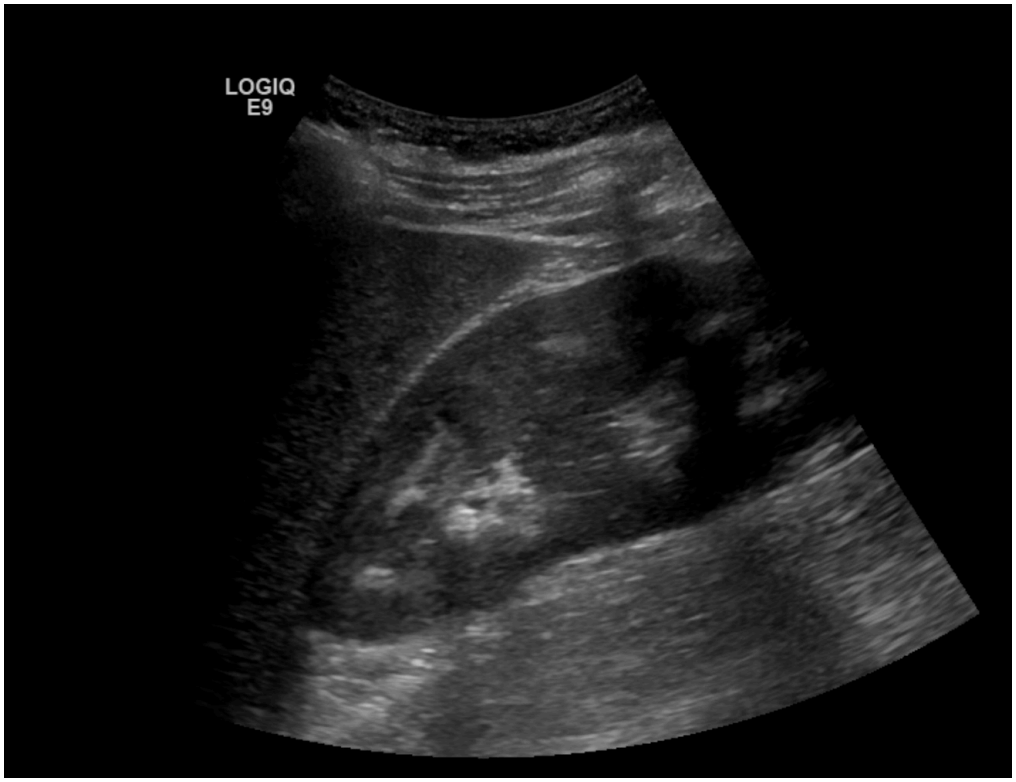
1) The presence of hydronephrosis/hydroureter as above. Usually mild.
2) The presence of an intrarenal renal stone. This stone is not the one causing the acute symptoms, but rather suggests guilt by association.
3) The presence of a perinephric fluid collection. This results from a sudden increase in the pressure in the collecting system causing forniceal rupture with a jet of urine getting expelling into the potential space between the surface of cortex and the surrounding fascia. This finding is fairly specific for an acute stone. Since the urine just gets reabsorbed, no specific treatment is needed.
4) The presence of a stone at the UPJ or proximal ureter.
5) The presence of a stone at the UVJ or within the bladder.
6) The absence of a ureteric jet. This is more theoretical than practical as you can have a stone and still have a jet, as long as the stone is not completely obstructing. Thus, looking for jets is considered optional for our purposes.



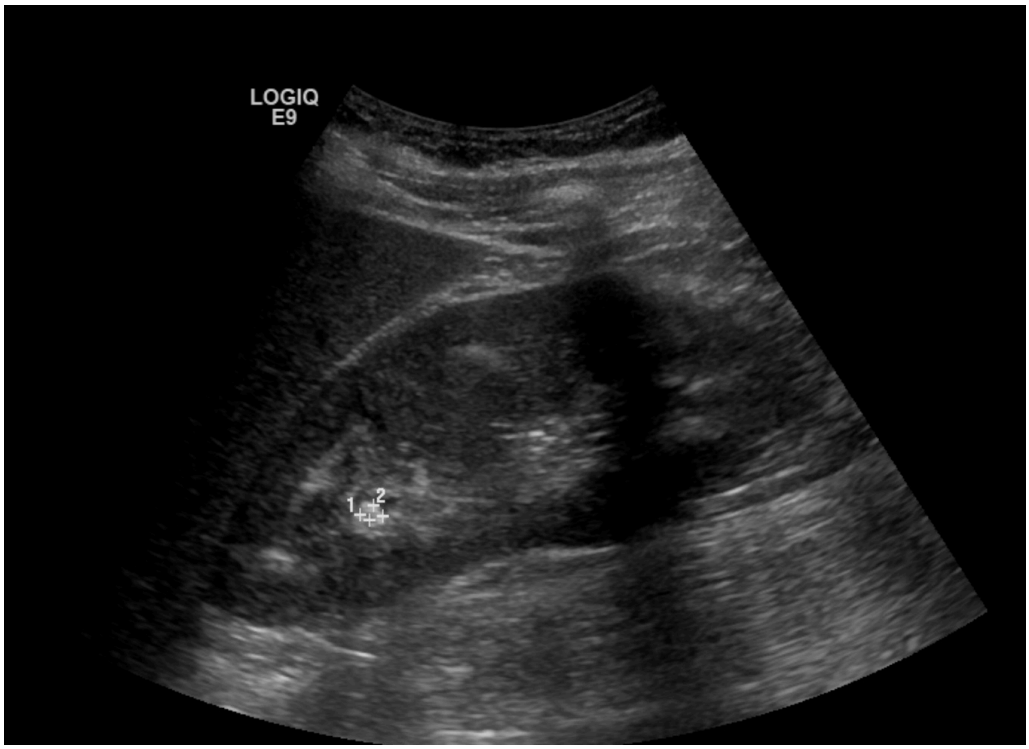
Above: Hydronephrosis in a patient with an acute ureteral stone. Note the characteristic "saguaro cactus" appearance of the dilated collecting system.



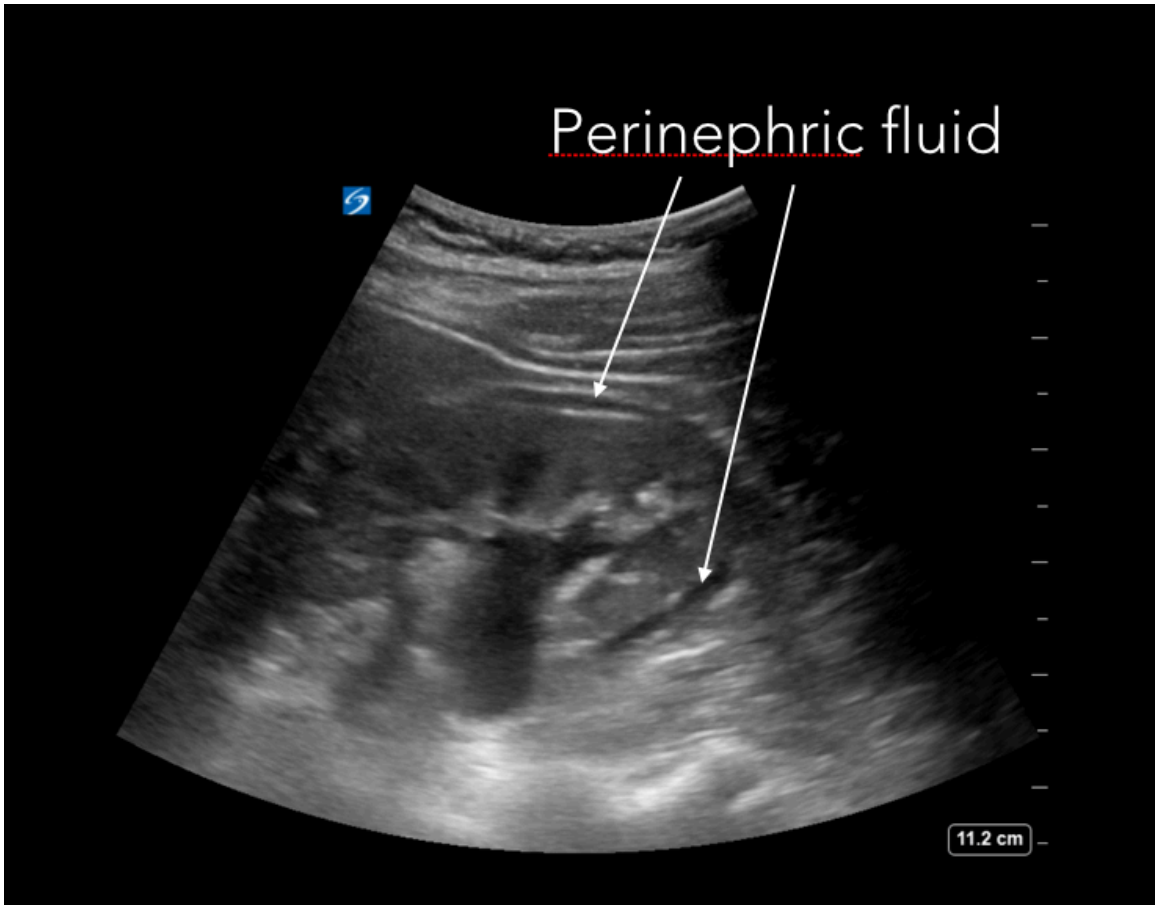
Left: A dilated renal pelvis in a patient with an acute stone. Note the use of color Doppler to confirm no flow in the collecting system and positive flow in the adjacent vasculature.



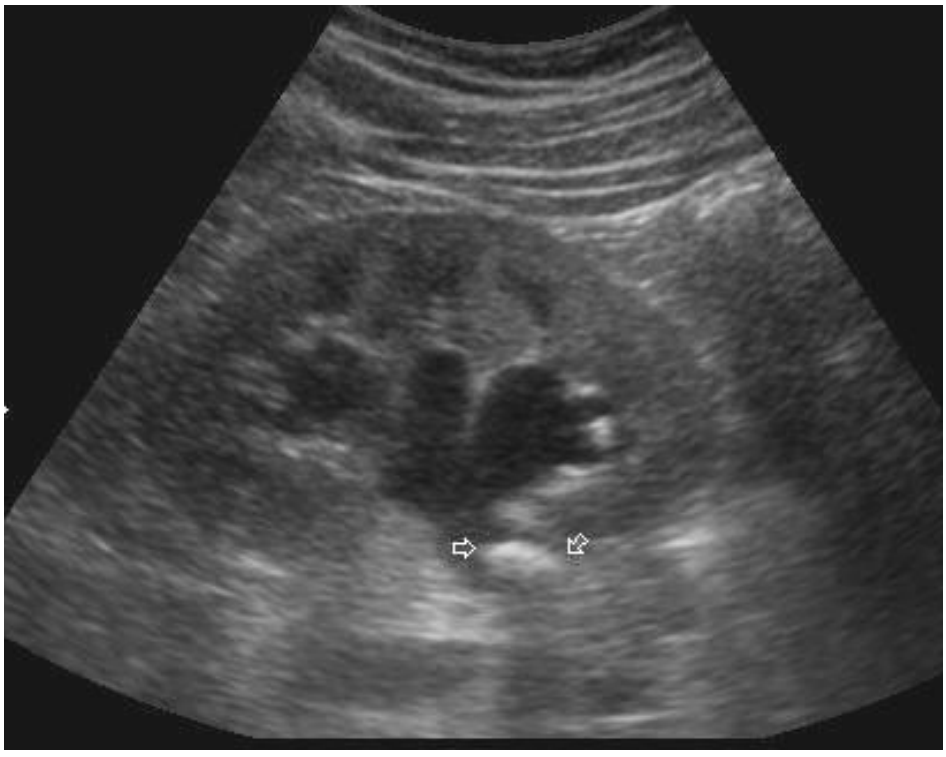
Left: An intrarenal kidney stone in the upper pole. This can be a subtle finding. Note the acoustic shadow. No hydro is present.



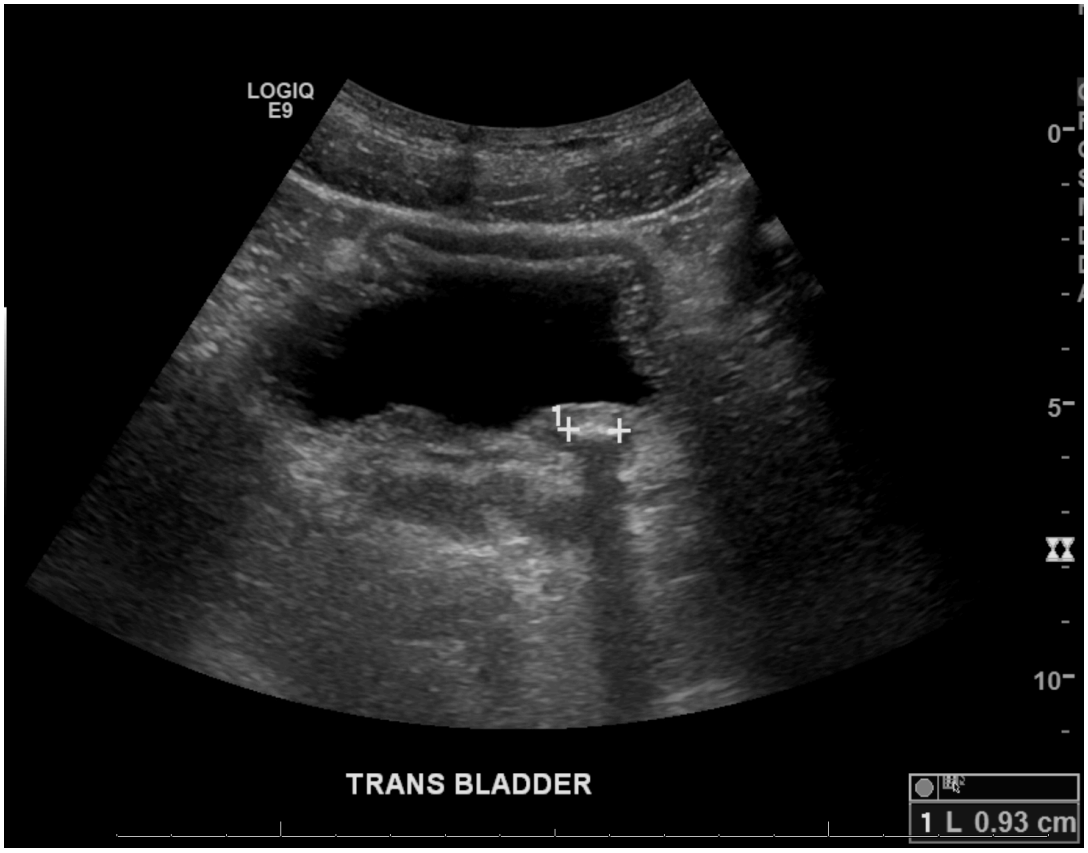
Left: Stone with measurements.



Above: Perinephric fluid collection in a patient with an acute ureteral stone. Note the thin, anechoic strip of fluid tracking around to the lower pole of the kidney. Note also the dilated renal pelvis.

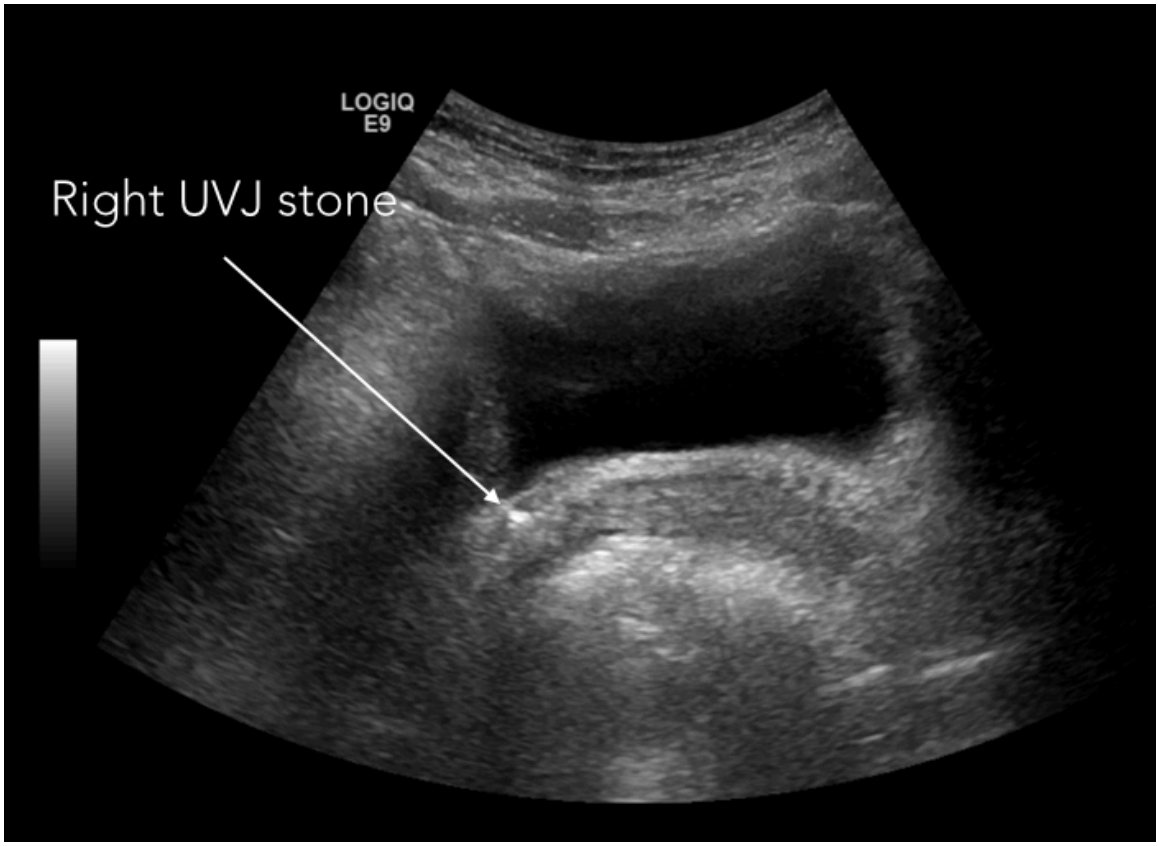


Left: Large stone at the UPJ. Hydronephrosis is also present.



Above: Transverse sonogram through the bladder demonstrating a renal stone at the Left UVJ. Note the acoustic shadow. Stone diameter measures 9mm. A full bladder will make visualizing stones at this location much easier.


LOGIQ
E9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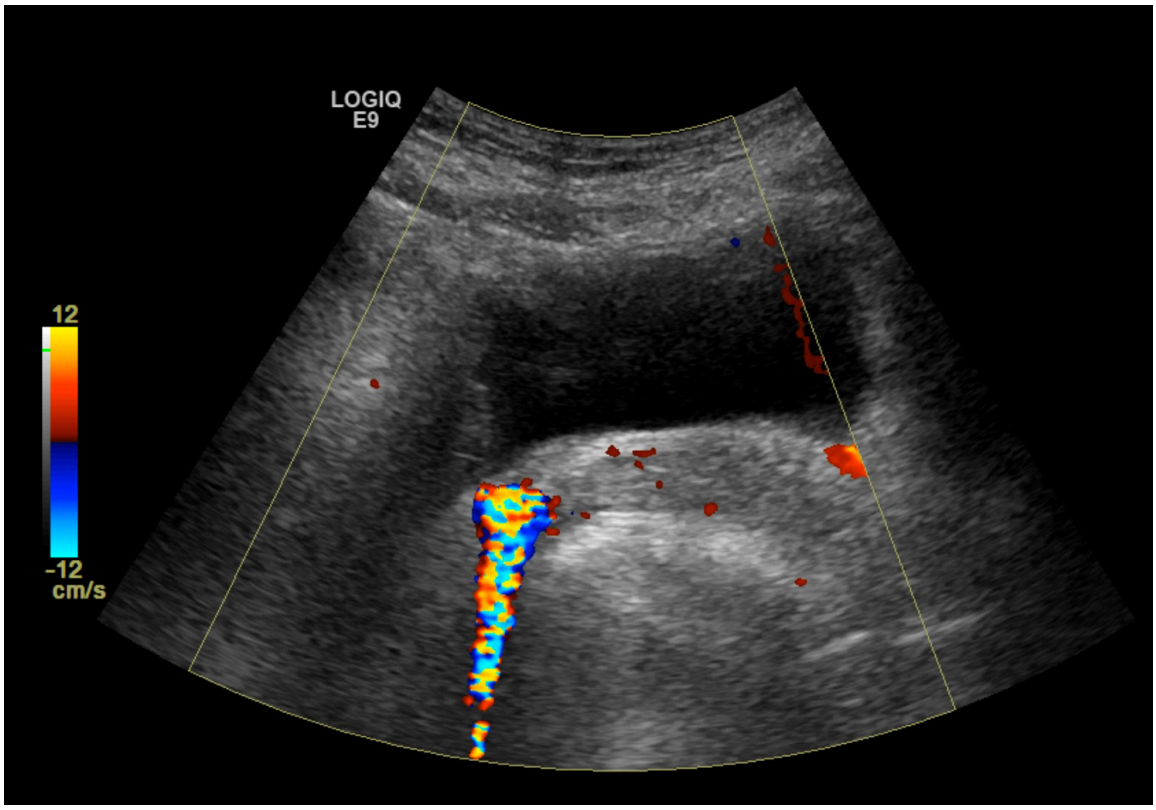
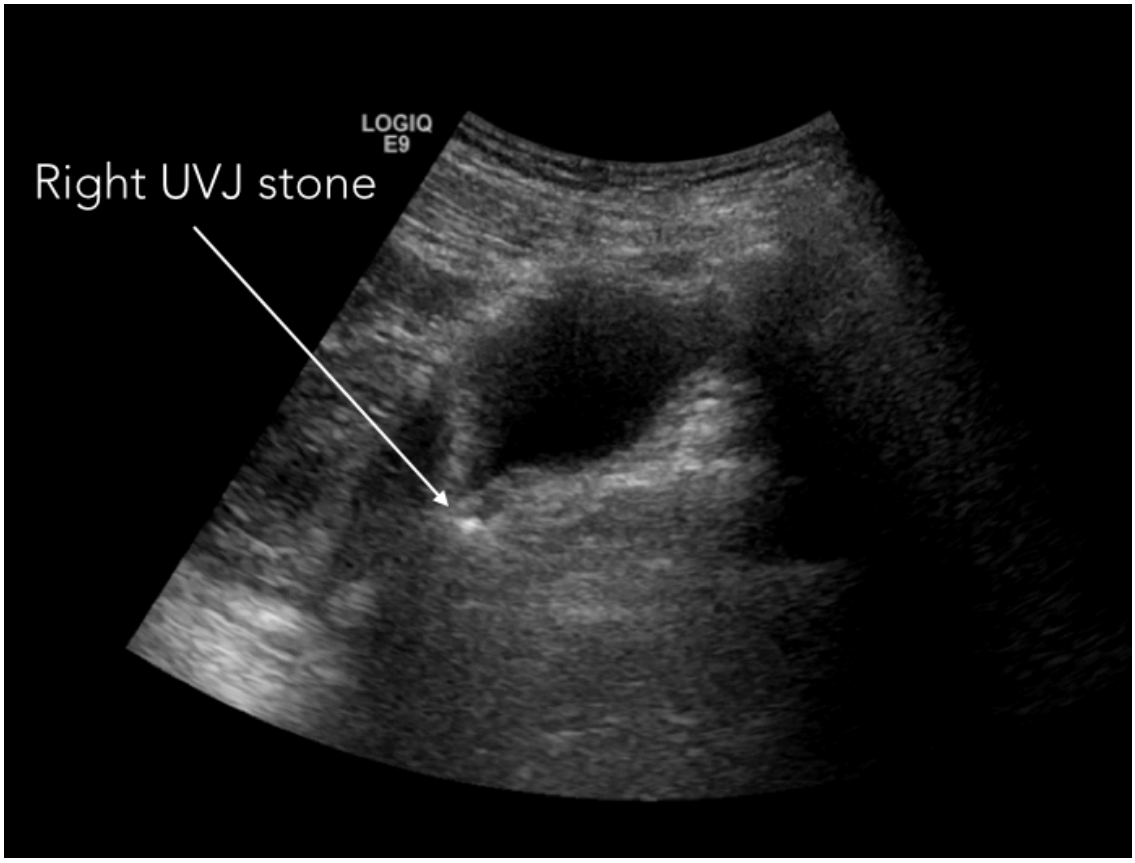
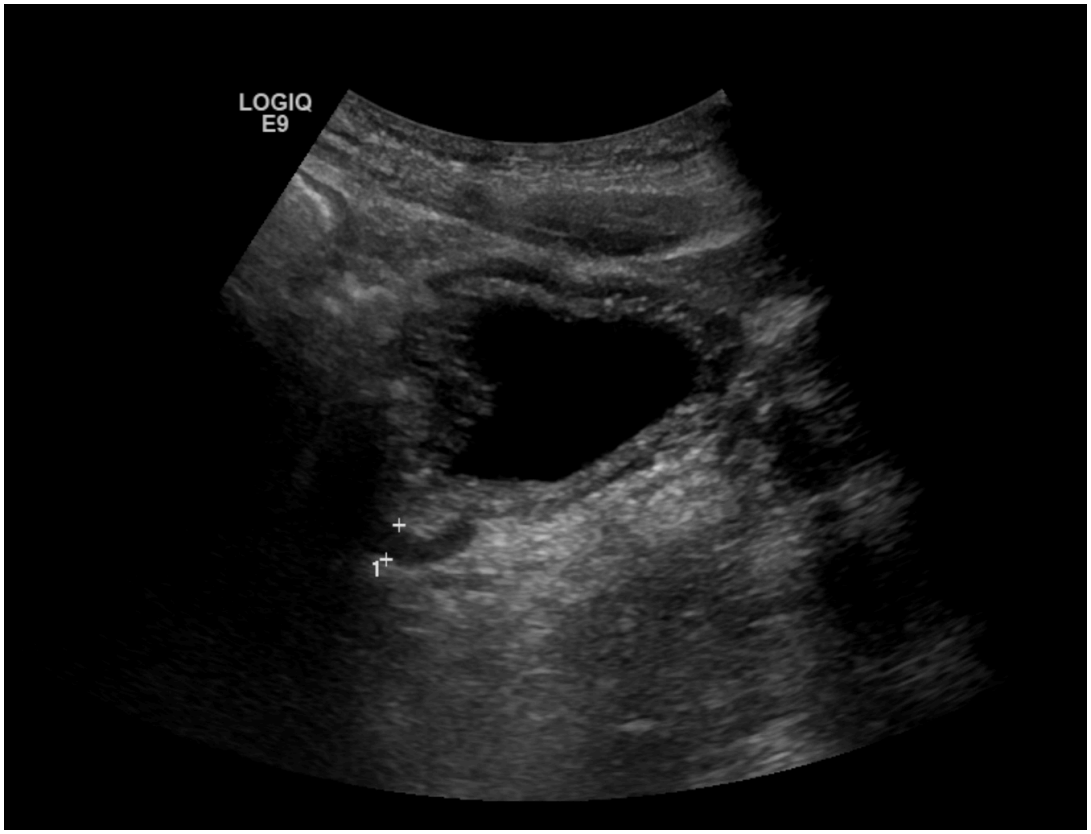
Right UVJ stone



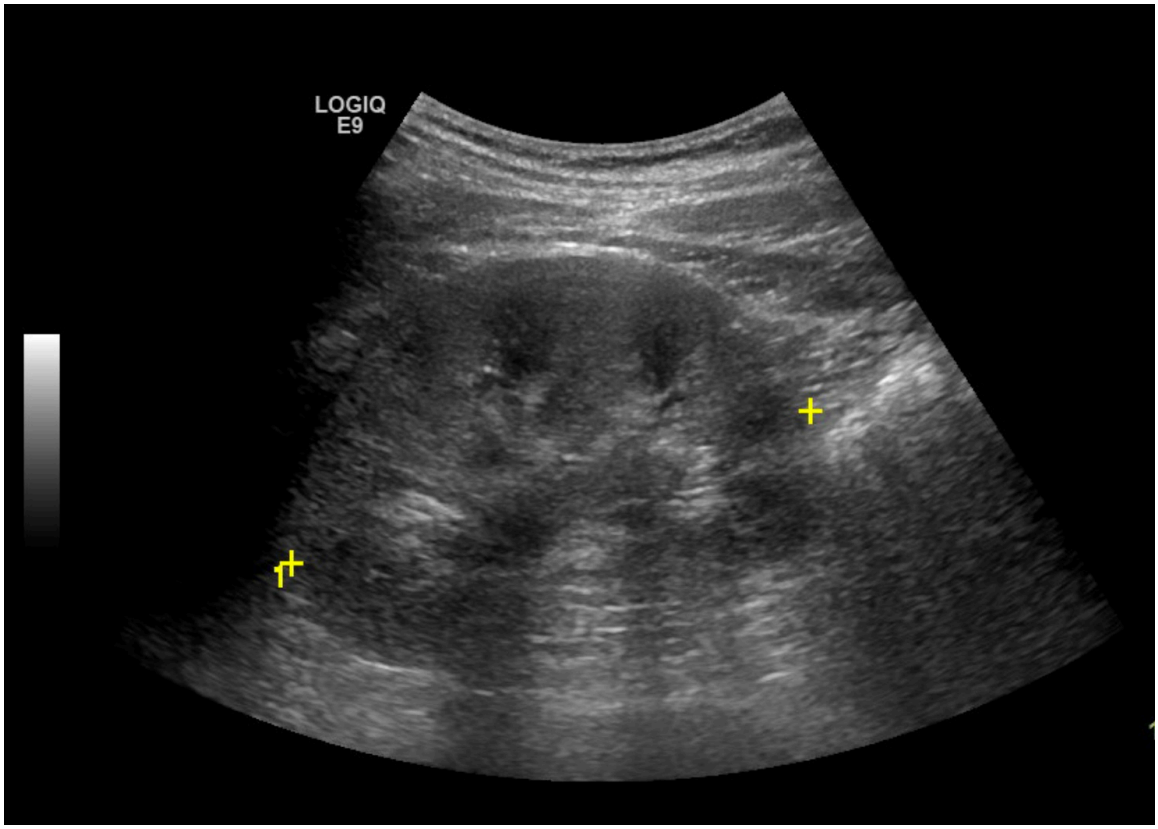
Above: 3 transverse sonograms through the bladder demonstrating a small renal stone at the Right UVJ. The stone is small enough that only a very subtle shadow is visible. In the bottom image, a color Doppler box is used to reveal the twinkle artifact that is commonly seen with renal stones. Note that only the Zonare machine will reliably give you a twinkle.

Left: Oblique view of the same patient as above. The stone is visible at the R UJV. Rotate the transducer about 45 deg to obtain this view. It may assist in visualizing the stone as the plane of the ultrasound beam is more in line with the course of the distal ureter.

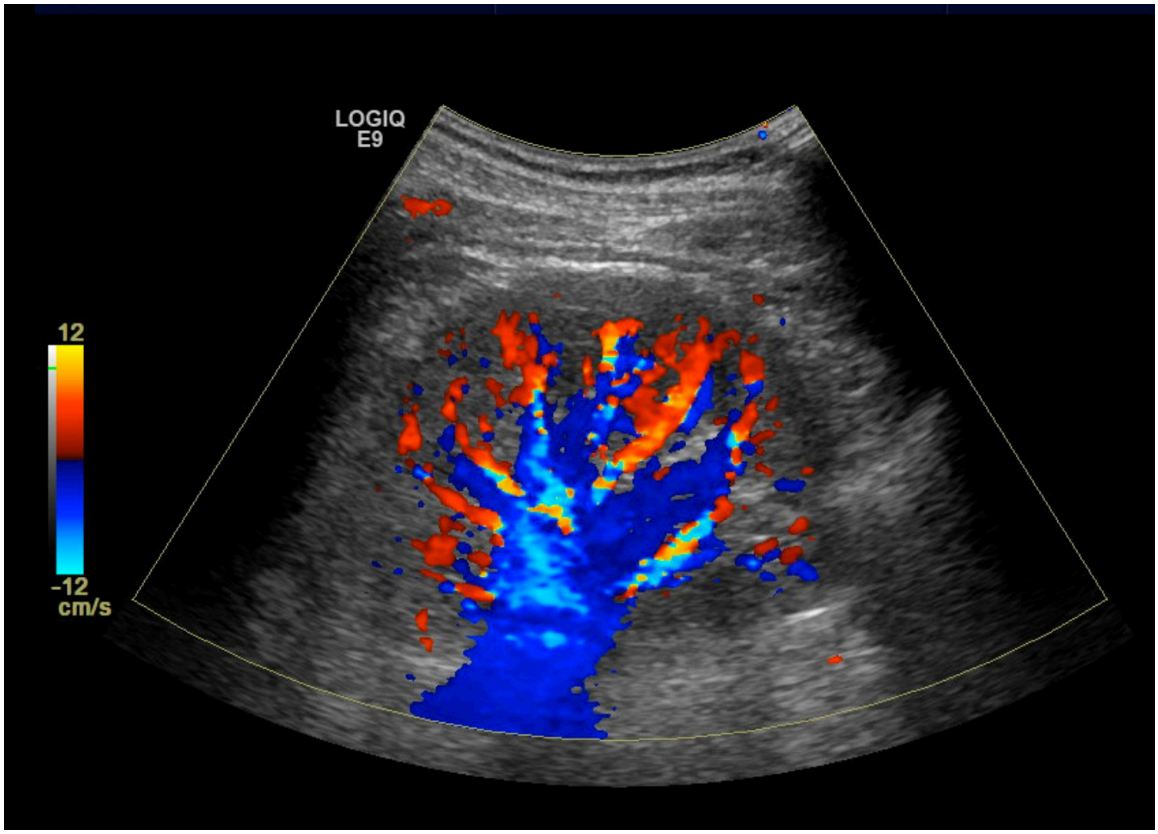




Above: Sagittal views of the same patient as above. The UVJ stone is not visible in the lower image, however the dilated distal ureter (measured) just proximal to it is.



Above: Does this patient have hydro?



Answer: No! This is a completely normal kidney. The anechoic areas within the sinus are normal renal vessels as demonstrated by color Doppler.

Assessement of Renal Arterial Waveform

This is an advanced topic and is not considered part of a standard point-of-care study. The appearance of the intrarenal arterial waveform can assist in the diagnosis of renal artery stenosis, rejection (in renal transplant grafts), and may be helpful in the diagnosis of renal stones.

Technique:

Obtain a clear long-axis view of the kidney. Position a color Doppler ROI box over the majority of the organ, and then position your pulsed Doppler gate over the main renal artery or an interlobar artery. Adjust both the color Doppler and pulsed Doppler scale to appropriate levels. Measure the peak systolic and end-diastolic velocities. The resistive index (RI) is defined as the difference between the peak systolic velocity and the end-diastolic velocity divided by the peak systolic: (PSV-EDV)/PSV. Normal is between 0.6 – 0.7. Elevated resistive indicies may suggest a stone or other pathology as above.