MARY WASHINGTON HEALTHCARE IMAGING SERVICES

RENAL ARTERY DUPLEX PROTOCOL

I. **Patient preparation:** NPO after midnight to minimize bowel gas and studies should be performed early in the day. The patient should take morning medications with sips of water only. Consideration should be given to patients who need to eat in order to take medications, i.e., those with diabetes.

II. **Equipment:** Performed with a real-time duplex scanner with imaging frequencies of 5.0 MHz curved transducer. Equipment capabilities include pulsed Doppler with directional flow, visual and audio output signals and Color Doppler Imaging.

III. **General comments:**

A. Clinical Indications

- New onset of hypertension (less than 4 mos) taking more than 2 medicines for high blood pressure.
- Epigastric bruit
- Monitoring or known renal artery stenosis
- Acute or chronic renal failure
- Presence of elevated creatinine or BUN
- Suspected renal vein occlusion
- Suspected renal artery aneurysm
- F/U renal artery bypass graft
- Patients who can't tolerate CTA of the abdomen due to creatinine greater than 2.0, who have a severe contrast allergy, or an MRA of the abdomen because of metal or pacemaker**.**
  When possible obtain and review prior MR and CT reports from abdomen. Have results available for radiologist to review.

B. Patient position

1. Patient is placed on a stretcher in supine position. The bed should be elevated about 10 degrees and the patient may use a pillow for head support.
2. The patient may also be rolled to either side to optimize the aorta, renal arteries and kidneys.

C. Equipment Set-up

1. Transducer Selection and Placement:
   a. Curved array transducer to visualize deep vessels and kidneys.
2. Choice of imaging frequency is made depending on the multiple factors including patient body habitus and vessel depth.
3. Image optimization
   a. Optimize gray scale images using TGC controls, I-scan, AGC, harmonics, depth, and transmit/focal zones controls to allow for vessel wall and plaque identification.
   b. Use lowest possible filter and minimum PRF before aliasing by adjusting the color scale/gain to ensure the color does not "bleed" out of the vessel walls. Use small color box and decrease depth to optimize frame rate. Adjust DRS to pen setting and use the low flow opt if appropriate. Try power Doppler for better edge definition especially with fibromuscular dysplasia.

IV. Anatomy of kidney – see additional images

Renal – Vascular Anatomy

- Renal arteries arise from aorta immediately distal to SMA.
- Right renal artery (RRA) passes underneath the inferior vena cava (IVC).
- RRA courses posterior to right renal vein (RRV).
- Left renal artery (LRA) courses posterior to the splenic vein and left renal vein (LRV).
- LRV courses between the SMA and aorta.
- Renal circulation includes:

Intrarenal arteries:

Segmental, interlobar, arcuate & interlobular

Renal – Vascular Anomalies

- Supernumerary renal arteries occur in approximately 30% of population and may be unilateral or bilateral. Usually arise from abdominal aorta, but may arise from common iliac artery (CIA), IMA, adrenal, or right hepatic artery (RHA).

V. Examination Protocol

A. Annotation

Hard copy images are labeled according to the following:

1. right or left when applicable
2. scan plane orientation – long or trans
3. vessel and organ identification

B. Measurement protocol

1. A Doppler angle of 60 degrees or less is maintained throughout the exam, aligning the Doppler angle with the direction of flow.
2. The sample volume size is kept small, approximately 1.5 – 2 mm, depending on the size of the vessel.
3. The sample volume is generally placed in the center of the vessel lumen to obtain the highest peak systolic and end diastolic velocities.
4. Optimize spectral Doppler display, paying close attention to obtaining "clean" spectral window, if appropriate, to appropriate, to avoid measuring artifact.
5. The scale and baseline controls are used to prevent aliasing of the spectral display when possible. Use lowest possible filter setting and minimum PRF before aliasing occurs.
6. The invert control is used to ensure all arterial velocity waveforms are displayed above the baseline.

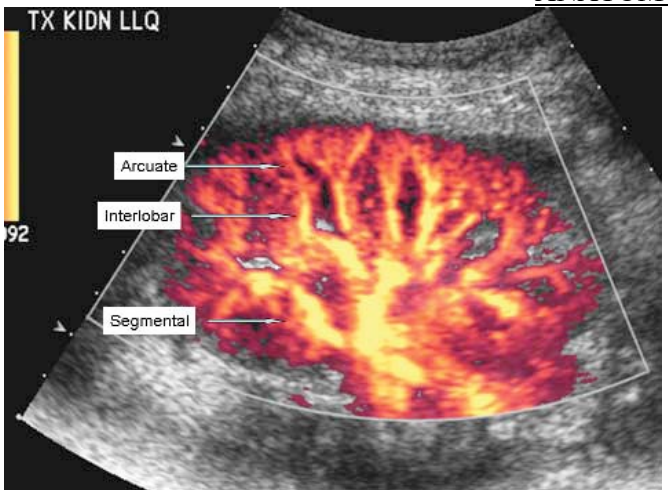
C. Gray scale imaging

1. Obtain transverse images of the proximal, mid and distal aorta obtaining maximal diameter measurements.
2. Obtain longitudinal images of the proximal, mid and distal aorta obtaining AP diameter measurements. Note the presence of atherosclerotic disease or thrombus. Measure peak systolic velocity of the suprarenal abdominal aorta. This velocity will be used to calculate the renal aortic ratio (RAR)
3. Return to transverse approach and document the patency of the renal veins bilaterally. Using the renal vein as a landmark, scan caudal until the origin of the renal arteries is visualized. Note, the right renal artery originates from the antero-lateral wall of the aorta while the left renal artery originates from the postero-lateral wall.
4. Doppler throughout the origin, and mid renal arteries and obtain the peak systolic velocities maintaining a 60 degree angle or less. Document post-stenotic turbulence, tardus parvus signal, aneurysm and Doppler accessory renal arteries.

5. Image the kidney in long & measure length & height. Image the mid pole in transverse & obtain width measurement. The presence of hydronephrosis, renal calculi, masses, cysts or other prominent abnormalities should be documented.
6. In transverse view obtain the distal renal artery velocity.
7. To obtain acceleration time, obtain Doppler in the distal renal artery as it enters the hilum of the transplanted kidney and increase sweep speed. Freeze image & select caliper on the touch screen. Then select time/slope on the touch screen. Place the first caliper at onset of systole and the second caliper at the early systolic peak. See example at end of protocol. The acceleration time should be <70ms
8. Within the kidney evaluate the arcuate and/or interlobar arteries within each pole, listen for any elevated velocities within and obtain resistive index (R.I.) from each pole of the kidney. RI=PSV-EDV/PSV
9. Take a color picture showing perfusion.
10. Repeat steps 4 through 9 for the contralateral kidney.

Note: significantly increased or decreased aortic velocities will result in inaccurate RAR and should not be calculated or used for disease classification; i.e. if the aortic velocity is less than 40 cm/sec or greater than 100cm/s.

ANATOMY OF THE KIDNEY



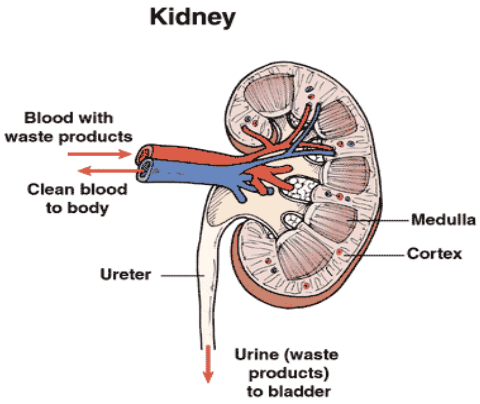
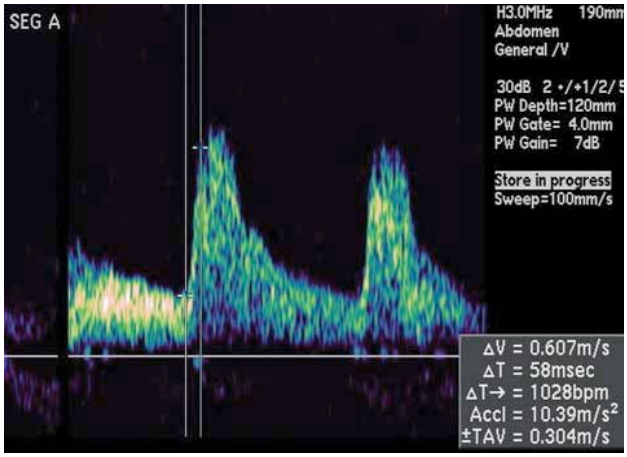


Image Reference: Krebs, Giyanani and Eisenberg. Ultrasound Atlas of Vascular Diseases: Abdomen and Renal Doppler pp 174 – 193.



Normal acceleration time 58ms

Image Summary

Image:	Measurement
1. Patient information screen	
2. Long proximal aorta grayscale	AP
3. Long mid aorta grayscale	AP
4. Long distal aorta grayscale	AP
5. Long suprarenal aorta color with spectral Doppler	PSV
6. Transverse proximal aorta grayscale	maximal diameter
7. Transverse mid aorta grayscale	maximal diameter
8. Transverse distal aorta grayscale	maximal diameter
9. Long right origin renal artery grayscale	
10. Long right origin renal artery color	
11. Long right origin renal artery spectral Doppler	PSV
12. Long right mid renal artery grayscale	
13. Long right mid renal artery color	
14. Long right mid renal artery spectral Doppler	PSV
15. Long left origin renal artery grayscale	
16. Long left origin renal artery color	
17. Long left origin renal artery spectral Doppler	PSV
18. Long left mid renal artery grayscale	
19. Long left mid renal artery color	
20. Long left mid renal artery spectral Doppler	PSV
21. Long right kidney grayscale	Length & Height
22. Long right kidney color	
23. Right superior, mid, inferior arcuate or interlobar arteries Doppler	R.I.
24. Transverse right mid kidney	Width
25. Right distal renal artery grayscale	
26. Right distal renal artery color	
27. Right distal renal artery spectral Doppler	PSV
28. Right distal renal artery spectral Doppler	AT
29. Right renal vein color with spectral Doppler	
30. Long left kidney grayscale	Length & Height
31. Long left kidney color	
32. Left superior, mid, inferior arcuate or interlobar arteries Doppler	R.I.
33. Transverse left mid kidney	Width
34. Left distal renal artery grayscale	
35. Left distal renal artery color	
36. Left distal renal artery spectral Doppler	PSV
37. Left distal renal artery spectral Doppler	AT
38. Left distal renal artery	
39. Left renal vein color with spectral Doppler	

Documentation of areas of suspected stenosis must include representative waveforms recorded **before, at and distal** to the stenosis.

**COMMENT-document any aortic dilatation measuring width diameter in transverse and AP diameter in sagittal; careful gain setting used to assess for thrombus, calcium, plaque and intimal flap/dissection; assess periaortic region or any evidence of fluid, inflammation or adenopathy; PW and/or Color Doppler may be used to document blood flow in aorta or when clinically indicated.

Reference:

1. Ultrasound of the Renal Arteries – Normal. Ultrasoundpaedia
2. Wolfson et al. Abdominal Aortic Aneurysm Screening in the elderly, syllabus PG 363, presented at 6th San Diego Symposium on vascular diagnosis, 1992
3. Neumyer, Marsha M. B.S. RVT Duplex Scanning /color flow Imaging for the evaluation of renal artery stenosis and renal parenchymal disease, syllabus pp 611-617, presented at 6th San Diego Symposium on vascular Diagnosis, 1992
4. Hoffman, U. et al. Role of duplex Scanning for the detection of atherosclerotic renal artery disease, Kidney Int. 1991; 39: 1232.
5. Rumwell, Claudia RN, RVT Vascular Technology, 2001 ESP Seminar Series, pp 68-70