

**Ultrasound – Renal Doppler Complete (Renal Artery Stenosis)**

**PURPOSE:**

To evaluate the vasculature associated with the native kidneys for arterial stenosis.

**SCOPE:**

Applies to all ultrasound abdominal studies performed in Imaging Services / Radiology

**EPIC ORDERABLE:**

- US Doppler Renal (perform this protocol only)

**CHARGEABLES:**

- US Doppler Renal (US DOPPLER COMPLETE CPT 93975)
- Add to US Renal if ordered together (US RENAL COMPLETE, CPT 76770)
  - See specific *US Renal* protocol for details regarding a complete renal examination.

**INDICATIONS:**

- Suspected renal artery stenosis (examples: hypertension resistive to treatment, hypertension in young patients etc.);
- Suspected vasculitis or fibromuscular dysplasia (FMD);
- Abnormal findings on other imaging studies;
- If renal vessel patency is the clinical concern, refer to protocol “US Renal Doppler Patency”;
- If nutcracker Syndrome (renal vein entrapment) is the clinical concern, refer to protocol “US Renal Doppler Nutcracker”.

**CONTRAINDICATIONS:**

- No absolute contraindications
- For unstable, hospitalized, and ventilated patients, ordering providers should consider alternative modalities for ruling out RAS. Doppler is frequently nondiagnostic in these situations. A diagnostic Doppler exam for RAS should be reserved for stable outpatients who are able to comply with breathing instructions.

**EQUIPMENT:**

- Curvilinear transducer with a frequency range of 1-9 MHz that allows for appropriate penetration and resolution depending on patient’s body habitus

**PATIENT PREPARATION:**

- Patient must be NPO for 4-6 hours prior to study
- Patients should be medically stable, able to following breathing instructions, and be transported to the Radiology Department Ultrasound Lab

**EXAMINATION:**

**GENERAL GUIDELINES:**

A complete examination includes evaluation of:

- Both main renal arteries from origin to hilum and intrarenal branches, including interlobar arteries
- Both main renal veins

- Abdominal aorta proximal to the origins of the main renal arteries.
- Additional image acquisition protocols based on orderable (above)
- **NOTE: This examination is reserved for NPO patients able to be transported to Radiology for scanning. For renal vessel patency (e.g. for ICU patients), refer to “US Renal Doppler Limited” protocol**

**EXAM INITIATION:**

- Introduce yourself to the patient and explain test
- Verify patient identity using patient name and DOB
- Obtain patient history including symptoms. Enter and store data page
- Place patient in supine position. Right or left lateral decubitus (RLD, LLD) positioning may be required

**TECHNICAL CONSIDERATIONS:**

- Review any prior imaging, making note of abnormalities or other findings requiring further evaluation-follow up.
- Optimize gain and display setting with respect to depth, dynamic range, and focal zone on greyscale imaging first.
- Obtain renal length measurement.
  - For the right kidney include adjacent liver for echogenicity comparison.
- Optimize color Doppler setting to show optimal flow
  - Adjust scale and gain to maximally fill the vessel of interest without artifact
    - Light color in the middle of the vessel lumen
  - Use Power Doppler if flow is not seen with color Doppler
  - Look for color aliasing and/or post-stenotic turbulence to identify stenosis
  - In severe stenosis, a color soft tissue “bruit” may be present
- Optimizing spectral Doppler:
  - Place time-gate centrally within the vessel of interest
  - Adjust scale to extend spectral waveform (amplitude adequate for interpretation)
  - Eliminate aliasing for high flow evaluation by increasing the velocity scale and/or lowering the base line.
- As much as possible, utilize angle correction of  $< 60^\circ$  to measure velocities
  - Angle correction should always be parallel to the vessel wall, in line with flow direction
  - For certain anatomy, may need to try from different approaches to optimize angle
- Aortic velocity (peak systole only) measurements should be obtained proximal to the main renal arteries origins.
- Renal Arteries:
  - Using color Doppler, survey the aorta for the multiple renal arteries. The arteries are often best seen in the coronal view, with the patient in the decubitus position. This view also gives the best Doppler angle for accurate velocity measurements.
  - If able, obtain the “banana peel” view with both ostia of both main renal arteries, including velocity measurements
  - The majority of renal artery stenosis in adults occurs at the ostium.
    - If identified, measure the peak systolic velocity of the suspected stenotic area (don’t forget to **angle correct**)

- Obtain the Acceleration Time (AT) and Acceleration Index (AI) of the interlobar arteries in the upper pole, interpolar region, and lower pole. Several waveforms may be needed to obtain an optimal waveform for accurate AT and AI measurements. **Be patient!**
  - Choose the waveform that clearly shows an early systolic peak (ESP)
  - Beware of different variants of the ESP. If not clearly seen, look for the “break point”. See Appendix).

**IMAGE DOCUMENTATION:**

 Perform the blow measurements for **LEFT** and **RIGHT** kidneys.

**If multiple arteries are present, obtain color and spectral images as above for each artery.**

Anatomy	Grey Scale	Color Doppler	Waveform	PSV	RI	eSAT	eSAI
*Longitudinal kidney: mid, without and with measurements	x						
Renal artery ostium	x	x	X	x			
Renal artery: proximal	x	x	X	x			
Renal artery: middle	x	x	X	x			
Renal artery: distal	x	x	X	x			
Interlobar artery: upper pole	x	x	X		x	x	x
Interlobar artery: mid segment	x	x	X		x	x	x
Interlobar artery: lower pole	x	x	X		x	x	x
Main renal vein	x	x	X				
Aorta: proximal to the renal arteries	x	x	X	x			
Data page with measurements							
*Include one grayscale image with length measurement and one without							
PSV = peak systolic velocity EDV =end diastolic velocity RI = resistive index eSAT = early systolic peak acceleration time eSAI = early systolic peak acceleration index							

**PROCESSING:**

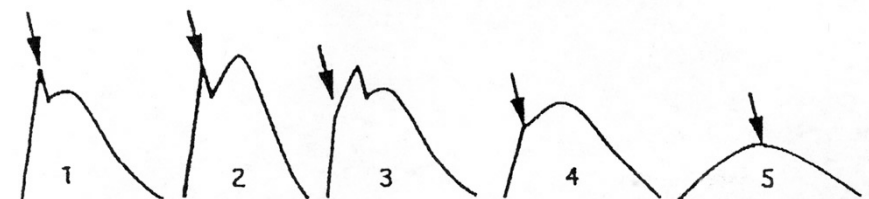
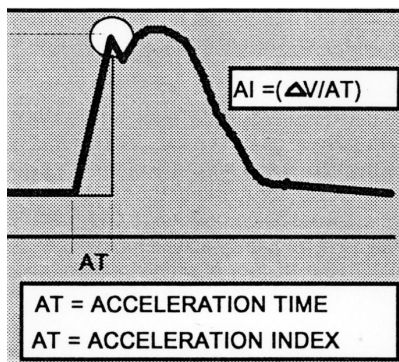
- Review examination data
- Export all images to PACS
- Confirm data Imorgon (UTSW only)
- Note any study limitations (in Epic Study Note or paper communication, per Radiologist preference)

**REFERENCES:**

- ACR-AIUM Practice Guideline (Revised 2007)
- ICAVL Guidelines (Updated 8/2012)

**APPENDIX:**

- Criteria for >60% stenosis of the renal artery:
  - Indirect (interlobar artery) SAT > 0.1 sec SAT and AI < 300 cm/sec<sup>2</sup>
  - Direct (main artery) PSV > 200cm/sec  
RAR >3.5 (trumps a normal or abnormal PSV)
- Acceleration Time (AT) and Acceleration Index (AI) of the interlobar arteries are calculated by identifying the point of systolic upstroke and the FIRST (early) systolic peak (ESP).
- Beware of different variants of the ESP. If not clearly seen, look for the “break point”.



Measure acceleration in early systole; if break in systolic upstroke, measure at break (#3 and 4); if no break; measure at highest first peak (#1,2,5)

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**Criteria s/p Renal Artery Stenting**

- Change over time
- Intraluminal echoes on gray scale
- Narrowing and aliasing on color Doppler
- Tardus Parvus waveforms in the intraparenchymal vessels
- Renal artery velocity higher than 296 cm/sec (sensitive) to 395 cm/sec (specific)
- RAR ranging from 4.4 (sensitive) to 5.1 (specific)

**References:**

- Thornton SN, et al. Circulation 2007;116:II-745, New Doppler Ultrasound Criteria for Renal Artery In-Stent Re-Stenosis
- Ultrasound velocity criteria for renal in-stent restenosis Yung-Wei Chi, DO, Christopher J. White, MD, Stanley Thornton, MD, and Richard V. Milani, MD, New Orleans, La. Journal of Vascular Surgery, July 2009.

**CHANGE HISTORY:**

<b>STATUS</b>	<b>NAME &amp; TITLE</b>	<b>DATE</b>	<b>BRIEF SUMMARY</b>
<b>Submission</b>	David Fetzer, MD, Director	<b>1/31/2016</b>	Submitted
<b>Approval</b>	David Fetzer, MD, Director	<b>1/31/2016</b>	Approved
<b>Review</b>	Anthony Setiawan, MD	<b>11/14/2018</b>	Reviewed
<b>Revisions</b>	David Fetzer, MD	<b>07/25/2016</b>	Segmental renal artery waveform descriptions
	David Fetzer, MD	<b>06-19-2017</b>	Changes to list of relevant orders to reflect consolidation of EPIC orderables.
	David Fetzer, MD	<b>01-14-2020</b>	Renamed protocol to specific RAS
	David Fetzer, MD; Kanu Vijay MD	<b>04-12-2021</b>	Added criteria for RAS in presence of stents
	Skye Smola RDMS, RVT	<b>8/12/2022</b>	Removed all language requiring Aorta images and PSV "at and inf to renal arteries". <u>Only prox</u> to renal artery Aorta images and PSV need be obtained.