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:

- 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:
- UTSW: US Doppler Kidneys Only
- PHHS: US Doppler Renal

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 Complete (Patency Check)" protocol
- If nutcracker Syndrome (renal vein entrapment) is a 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.

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

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: For renal vessel patency, refer to "US Renal Doppler Complete (Patency Check)" protocol**

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. Right or left lateral decubitus (RLD, LLD) positioning may be required

TECHNICAL CONSIDERATIONS:

General

- 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 or Microvascular Flow Imaging techniques 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 sample gate centrally within the vessel of interest
  - Adjust scale to extend spectral waveform to at least 2/3 height of the amplitude plot for adequate interpretation
  - Eliminate aliasing for high flow evaluation by increasing the velocity scale and/or lowering the baseline
  - Obtain at least 3 consecutive representative waveforms to ensure that representative measurements are being obtained
- As much as possible, utilize angle correction of <60° to measure velocities.
  - Angle correction should always be parallel to the vessel wall, in line with flow direction
  - Try alternate windows if anatomy limits angle optimization
- Aortic velocity (peak systole only) measurements should be obtained proximal to the main renal arteries origins.

Renal Arteries

- Up to one-third of patients have accessory renal arteries – survey the aorta for multiple renal artery origins. Each artery should be interrogated independently.

- 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.

DOCUMENTATION:

- Perform the measurements below for RIGHT and LEFT kidneys.
- **If multiple arteries are present, obtain color and spectral images as below for each artery.**

Required Images for All Renal Doppler Evaluations for RAS

Anatomy	Grey Scale	Color Doppler	Waveform	PSV	RI	eSAT
Longitudinal kidney: lateral, mid without and with measurements, and medial	x					
Transverse kidney: sup, mid, inf	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
Interlobar artery: mid segment	x	x	x		x	x
Interlobar artery: lower pole	x	x	x		x	x
Main renal vein	x	x	x			
Aorta: proximal to the renal arteries	x	x	x	x		

PSV = Peak Systolic Velocity
RI = Resistive Index
eSAT = Early Systolic Acceleration Time

Additional Image Documentation for Stents:

Anatomy	Grey Scale	Color Doppler	Waveform	PSV	RI	eSAT
Native artery at prox end of stent	x	x	x	x		x

Prox stent	x	x	x	x		x
Mid stent	x	x	x	x		x
Dist stent	x	x	x	x		x
Native artery at distal end of stent	x	x	x	x		x

- Data page(s)

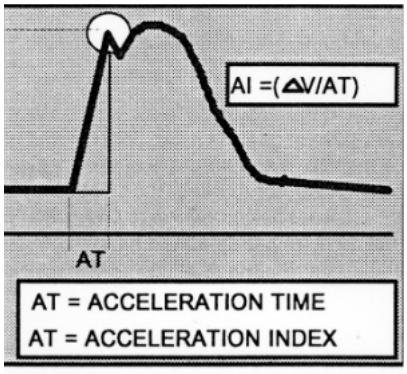
PROCESSING:

- Review examination data
- Export all images to PACS
- Confirm data in iMorgon (UTSW only)
- Document relevant history and any study limitations

APPENDIX:

DIAGNOSTIC CRITERIA:

- Criteria for >60% stenosis of the renal artery:
  - Indirect (interlobar artery) SAT > 0.1 sec SAT and AI < 300 cm/sec^2
  - 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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DIAGNOSTIC 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.
- ACR-AIUM Practice Guideline (Revised 2007)
- ICAVL Guidelines (Updated 8/2012)
- IAC Standards and Guidelines for Vascular Testing Accreditation (2024)
- ACR Requirements: Vascular Ultrasound (Revised 8/23/2024)

CHANGE HISTORY:

DATE:	SUBMITTED BY: (NAME, TITLE)	APPROVED BY: (NAME, TITLE)	SUMMARY:
1/31/2016		David Fetzer, MD, Medical Director	Submitted
1/31/2016		David Fetzer, MD, Medical Director	Approved
11/14/2018		Anthony Setiawan, MD	Reviewed
7/25/2016		David Fetzer, MD, Medical Director	Segmental renal artery waveform descriptions
06/19/2017		David Fetzer, MD, Medical Director	Changes to list of relevant orders to reflect consolidation of EPIC orderables
01/14/2020		David Fetzer, MD, Medical Director	Renamed protocol to specific RAS
04/12/2021		David Fetzer, MD, Medical Director; Kanu Vijay, MD	Added criteria for RAS in presence of stents
08/12/2022		Skye Smola RDMS, RVT	Removed all language requiring Aorta images and PSV "at and inf to renal arteries". Only prox to renal artery Aorta images and PSV need be obtained.
03/23/2026	Christine Ernst RDMS, RVT	David Fetzer, MD, Medical Director	Added required grayscale imaging and stent documentation. Removed acceleration index documentation. Added technical considerations.
09/22/2026	Angela Storto RDMS, RVT		Updated to A11y Format. Removed comments for exam only being for stable patients that can travel to department.