

# AIUM Practice Parameter for the Performance of Duplex Sonography of Native Renal Vessels

## Introduction

The American Institute of Ultrasound in Medicine (AIUM) is a multidisciplinary association dedicated to advancing the safe and effective use of ultrasound in medicine through professional and public education, research, development of clinical practice parameters, and accreditation of practices performing ultrasound examinations.

The *AIUM Practice Parameter for the Performance of Duplex Sonography of Native Renal Vessels* was developed (or revised) by the AIUM in collaboration with other organizations whose members use ultrasound for performing this examination(s) (see “Acknowledgments”). Recommendations for personnel requirements, the request for the examination, documentation, quality assurance, and safety may vary among the organizations and may be addressed by each separately.

Sonography using grayscale imaging, color Doppler imaging, and spectral Doppler analysis is a proven and useful procedure for evaluating the renovascular system. Occasionally, an additional and/or specialized examination may be necessary. This Practice Parameter is intended to provide the medical ultrasound community with recommendations for the performance and recording of high-quality ultrasound examinations. The parameter reflects what the AIUM considers the appropriate criteria for this type of ultrasound examination but is not intended to establish a legal standard of care. Examinations performed in this specialty area are expected to follow the parameter with recognition that deviations may occur depending on the clinical situation.

## Indications

Indications for renal duplex sonography include but are not limited to:

1. Evaluation of patients with hypertension when there is a strong suspicion of renovascular hypertension (eg, uncontrolled hypertension despite optimal medical therapy, hypertension with a progressive decline in renal function, a progressive decline in renal function associated with angiotensin-converting enzyme inhibition therapy, and abrupt onset of hypertension).<sup>1,2</sup>

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2. Follow-up of patients with known renovascular disease who have undergone renal artery stent placement, angioplasty, or surgical bypass or who have a known unilateral stenosis with concern for a stenosis in the contralateral kidney.
3. Evaluation of an abdominal or flank bruit.
4. Evaluation of a suspected vascular abnormality, such as an aneurysm, pseudoaneurysm, arteriovenous malformation, or fistula, or following treatment of any of the above.
5. Evaluation of vascular causes of renal insufficiency.
6. Evaluation of renal perfusion in patients with known aortic dissection, trauma, or other abnormalities or conditions that may compromise renal blood flow.
7. Evaluation of discrepant renal size.
8. Concern for aortic or renal artery thrombosis in infants who have or have had an aortic catheter, such as an umbilical arterial catheter.
9. Evaluation for congenital or syndromic causes of renovascular hypertension.
10. Evaluation for renal vein thrombosis.
11. Evaluation of the renal vein for renal tumor extension and differentiation of a renal vein tumor thrombus from a bland thrombus.
12. Evaluation of the renal vein in patients suspected of having nutcracker syndrome.

There are no absolute contraindications to performing this examination.

## Qualifications and Responsibilities of Personnel

Physicians interpreting or performing this type of ultrasound examination should meet the specified AIUM Training Guidelines in accordance with AIUM accreditation policies.

Sonographers performing the ultrasound examination should be appropriately credentialed in the specialty area in accordance with AIUM accreditation policies.

Physicians not personally performing the examination must provide supervision, as defined by the

Centers for Medicare and Medicaid Services Code of Federal Regulations 42 CFR §410.32.

## Request for the Examination

The written or electronic request for an ultrasound examination must originate from a physician or other appropriately licensed health care provider or under the provider's direction. The clinical information provided should allow for the performance and interpretation of the appropriate ultrasound examination and should be consistent with relevant legal and local health care facility requirements.

## Specifications of the Examination

The study is generally performed for both kidneys. If not, the report should state the reason for a unilateral study (eg, evaluation of a renal stent or known solitary kidney).

Obtaining the following grayscale images and a Doppler evaluation is recommended when possible:

### A. Renal Arteries

The study consists of grayscale imaging of the kidneys and limited grayscale views of the aorta with color and spectral Doppler imaging of the intrarenal and extrarenal vessels and suprarenal aorta.

#### 1. Grayscale Imaging

The longest renal length should be measured and reported. In patients who have not had recent cross-sectional imaging of the kidneys, a complete renal ultrasound examination may be considered. See the AIUM Practice Parameter for the Performance of an Ultrasound Examination of the Abdomen and/or Retroperitoneum. Longitudinal and transverse views of the aorta should be obtained at the level of the kidneys and above.

#### 2. PColor and Spectral Doppler Evaluation

An analysis of main renal artery and intrarenal arterial waveforms should be performed to evaluate for renal artery stenosis.

Careful attention to technique is important to ensure accurate results, including selecting a transducer that is appropriate for the patient's

body habitus, optimizing color Doppler parameters, using an appropriate spectral Doppler sample volume, optimizing the velocity scale for the size of the waveform to avoid aliasing (this may require adjusting the scale [pulse repetition frequency], baseline, or frequency), selecting a lower-frequency transducer, and using the lowest feasible angle of insonation. Angle correction is essential for determining blood flow velocity. The angle between the direction of flowing blood and the ultrasound beam should not exceed 60°.

a. Main renal artery and aorta evaluation

The entire main renal artery should be scanned along its long axis using optimized color Doppler parameters. Occasionally, power Doppler or grayscale imaging may be necessary to localize a portion of the artery. Inability to visualize a specific part (eg, the origin) of the entire main renal artery should be reported.

Spectral Doppler waveforms should be obtained along the length of the main renal artery from the origin to the hilum at the lowest feasible angle of insonation.

At a minimum, the highest peak systolic velocities should be recorded at the origin/proximal, mid, and hilar segments of the main renal artery.<sup>3-20</sup> Peak systolic velocity should also be recorded at any site of color aliasing, narrowing, or suspected stenosis. If there is a significant stenosis, additional Doppler waveforms should be recorded within the stenosis and distal to the stenosis. In small children/infants, one measurement of peak systolic velocity in the main renal artery is acceptable.<sup>19</sup>

An effort should also be made to search for accessory/duplicated renal arteries.<sup>19,21,22</sup> When visualized, peak systolic velocities should be recorded as described above.

An appropriate angle-corrected spectral Doppler waveform from the abdominal aorta at or slightly cephalic to the level of the origins of the renal arteries should be recorded. The aortic peak systolic velocity is used to calculate the ratio of the peak systolic velocity in the renal artery to the aorta.

A renal artery stent evaluation should include recording of peak systolic velocities in the proximal renal artery (if possible), within the stent, and distal to the stent.<sup>23</sup>

In infants who have developed an aortic thrombus after catheterization, the relationship of the clot with the renal artery orifices and flow around the thrombus should be documented. If the thrombus is located near a renal artery orifice, waveforms should be obtained in the main and intraparenchymal renal arteries to assess renal perfusion.

b. Intrarenal evaluation

Spectral Doppler waveforms should be recorded from segmental or interlobar arteries in the upper and lower poles and in the interpolar region (midportion) of each kidney. It is important to use a fast sweep speed and optimize the velocity scale to ensure accurate and reproducible measurements. If acceleration index measurements are used in the assessment, angle correction is needed; the angle of insonation should be as low as possible, usually 30° or less.

An intrarenal analysis consists of a quantitative and/or qualitative evaluation of the Doppler waveforms. The quantitative evaluation may include acceleration times, acceleration indices,<sup>24,25</sup> or resistive indices.<sup>26-28</sup> For the qualitative analysis, the morphology of the waveform should be assessed for a normal sharp systolic upstroke or abnormal tardus parvus changes.<sup>20,22,24,25</sup> Particularly in children, because of motion, it may be important to document more than 1 spectral Doppler interrogation of a region to ensure optimal interpretation.

3. Contrast-Enhanced Ultrasound (CEUS)

The use of microbubble ultrasound contrast agents may be helpful in identification of the main renal artery(ies) and branches and in detection of duplicated or accessory renal arteries. Note: This would be an off-label use of CEUS based on the current Food and Drug Administration approval status.

B. Renal Veins

1. For a routine evaluation of the renal veins (ie, in an examination not performed specifically

for evaluation of suspected renal vein pathology), grayscale and color Doppler longitudinal views of the main renal vein with accompanying spectral Doppler waveform should be obtained.

2. If there is a specific concern for renal vein stenosis or thrombosis, or if abnormal findings are made on routine views, then a more detailed protocol may be performed and may include the following:
  - a. Grayscale imaging: An evaluation of the main renal vein should be performed in longitudinal and transverse views. Notes should be made of any area of stenosis and/or intraluminal thrombus.
  - b. Color and spectral Doppler evaluation: An analysis of main renal vein and intraparenchymal renal vein waveforms should be performed to evaluate for renal vein stenosis. The peak velocity should be recorded proximal to, within, and distal to the stenosis. In the presence of a thrombus, color and spectral Doppler imaging may be used to evaluate for vascularity of the thrombus, and the presence or absence of extension of the thrombus into the inferior vena cava should be documented.
  - c. CEUS: The use of microbubble ultrasound contrast agents may be helpful in identification of main renal vein stenosis or thrombosis as well as tumor neovascularity within the thrombus. Note: This would be an off-label use of CEUS based on the current Food and Drug Administration approval status.

## Documentation

Accurate and complete documentation is essential for high-quality patient care. Written reports and ultrasound images/video clips that contain diagnostic information should be obtained and archived, with recommendations for follow-up studies if clinically applicable, in accordance with the AIUM Practice Parameter for Documentation of an Ultrasound Examination.

## Equipment Specifications

Duplex and color Doppler ultrasound examinations of the renal arteries should be performed in real time using a scanner with color and spectral Doppler capabilities. Transducer selection should be based on the body habitus. In adults, typically used transducer frequencies range from 2 to 9 MHz. In neonates, transducer frequencies of 7 to 15 MHz are typically used.

## Quality and Safety

Policies and procedures related to quality assurance and improvement, safety, infection control, and equipment performance monitoring should be developed and implemented in accordance with the AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices.

### *ALARA (as Low as Reasonably Achievable) Principle*

The potential benefits and risks of each examination should be considered. The ALARA principle should be observed for factors that affect the acoustical output and by considering transducer dwell time and total scanning time. Further details on ALARA may be found in the current AIUM publication Medical Ultrasound Safety.

### *Infection Control*

Transducer preparation, cleaning, and disinfection should follow manufacturer recommendations and be consistent with the AIUM Guidelines for Cleaning and Preparing External- and Internal-Use Ultrasound Transducers Between Patients, Safe Handling, and Use of Ultrasound Coupling Gel.

### *Equipment Performance Monitoring*

Monitoring protocols for equipment performance should be developed and implemented in accordance with the AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices.

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