

# AIUM Practice Parameter for the Performance of a Peripheral Venous Ultrasound Examination

## 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.

The *AIUM Practice Parameter for the Performance of a Peripheral Venous Ultrasound Examination* 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.

This practice parameter is intended to assist practitioners performing noninvasive ultrasound evaluations of peripheral veins and is intended to provide the medical ultrasound community with recommendations for the performance and recording of high-quality ultrasound examinations. The pediatric population may require targeted evaluations depending on the clinical situation. 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

The indications for peripheral venous ultrasound examinations include but are not limited to the following<sup>1-4</sup>:

1. Evaluation for suspected deep venous thrombosis (DVT) or venous obstruction based on clinical assessment, a risk score based on the clinical prediction rules (eg, the Wells score), and/or D-dimer levels. This includes patients with intermediate or high risk (likelihood) based on pretest probability, low-risk (likelihood) patients with a positive D-dimer test result,

- patients with positive D-dimer test results, and patients whose pretest probability for DVT has not been evaluated.
2. Serial evaluation for DVT in some high-risk individuals (eg, based on the history, pretest probability, or persistent or worsening symptoms) whose initial examination results are negative for DVT.<sup>5</sup>
  3. Evaluation of patients with an ilio caval thrombus or occlusion or with asymmetric iliofemoral Doppler waveforms.<sup>6</sup>
  4. Assessment of venous insufficiency, reflux, and varicosities.
  5. Postprocedural assessment of venous ablation or other interventions.
  6. Assessment of dialysis access.
  7. Venous mapping before surgical procedures (see also the *ACR–AIUM–SRU Practice Parameter for the Performance of Ultrasound Vascular Mapping for Preoperative Planning of Dialysis Access*<sup>7</sup>).
  8. Evaluation of veins before venous access.
  9. Evaluation of a suspected or known vascular anomaly.
  10. Repeated ultrasound at or near the end of anticoagulation is recommended to establish a new baseline and to determine whether scarring is present.<sup>1,8</sup>
  11. Follow-up of patients with known calf (distal) DVT who are not being treated but are being monitored for progression.<sup>5</sup> If calf DVT is being followed and not treated, the first follow-up examination is usually at 5 to 7 days.<sup>9</sup>
  12. Follow-up of patients with limited lower extremity evaluations when either the calf veins or portions of the thigh veins could not be imaged. In general, follow-up should be done within 5 to 7 days.<sup>10,11</sup>
  13. Follow-up of patients with suspected recurrent DVT and with equivocal findings. In general, follow-up should be done within 3 days and if still equivocal repeated at 7 to 10 days.<sup>12</sup>
  14. Follow-up of patients with known venous thrombosis on therapy and who undergo a clinical change and where a change in the thrombus burden will alter treatment.<sup>13</sup>
  15. To help determine the source of a known pulmonary embolism.
  16. High-risk asymptomatic patients may undergo screening if the benefit of screening is warranted.

A limited study to assess the patency of the upper extremity veins to be used for catheter placement may be performed, especially in the setting of documented upper extremity DVT. If a thrombus is discovered, then a full examination should be performed unless otherwise requested by the clinician.

## 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.

## Specification of the Examination

The requesting health care provider should be encouraged to provide the pretest probability of acute DVT and/or the results of a D-dimer assay, if known.<sup>3,14,15</sup>

Note: The words *proximal* and *distal* refer to the relative distance from the attached end of the limb per *Gray's Anatomy*. For example, the proximal femoral vein is closer to the hip, and the distal femoral vein is closer to the knee. The longitudinal or long axis is

parallel to or along the length of the vein. Transverse or short axis is perpendicular to the long axis of the vein. Compression can be documented by using cine clips or without and with compression images. "It is the consensus of the ACR's Economics Committee on Coding and Nomenclature and the ACR's Economics Committee of the Commission on Ultrasound that duplex codes should only be used when grayscale and both spectral and color Doppler are performed."<sup>16</sup>

A. Venous Thromboembolic Disease: Lower Extremity

1. Technique

- a. The evaluation is from the inguinal ligament to the ankle when feasible. This represents a change from prior guidelines.<sup>1</sup> The major reasons for the change are: (1) a single comprehensive protocol avoids errors identifying those who need scanning to the ankle and those who do not; (2) a single ultrasound examination of the ankle excludes DVT safely without the need for a serial examination in most patients; and (3) an examination of the calf may explain symptoms in patients in whom cases of calf DVT or other abnormalities are detected. The study of the ankle will detect more calf DVT, recognizing that treatment for calf DVT is not entirely established. There are benefits to detecting DVT regardless of whether calf DVT is followed with serial ultrasound or treated.<sup>17-21</sup>
- b. Compression ultrasound: Venous compression is applied every 2 cm or less in the transverse (short-axis) plane with adequate pressure on the skin to completely obliterate the normal vein lumen. The fullest visible extent of the common femoral, femoral (formerly known as the superficial femoral<sup>22</sup>), popliteal, and posterior tibial and peroneal veins must be scanned by an optimal grayscale compression technique. The deep femoral vein should also be examined at the confluence with the femoral vein. The great saphenous vein is examined at the saphenofemoral junction.
- c. Focal symptoms will generally require evaluations of those areas, such as gastrocnemius or soleal veins. A focal symptom evaluation

is especially important if the standard ultrasound examination did not confirm the presence of DVT. Patients with calf vein DVT, with DVT involving one of duplicated veins, or with superficial thrombophlebitis may present with tenderness or pain rather than swelling, and such cases of venous thrombus may be detected by these scans.

- d. All studies, unilateral or bilateral, should include right and left common femoral or right and left external iliac venous spectral Doppler waveforms. Recordings should evaluate for asymmetry and/or loss of respiratory phasicity.<sup>23</sup> Both sides should be assessed with a similar patient posture and similar respiration so symmetry can be assessed. Popliteal venous spectral Doppler waveforms of the symptomatic leg should also be obtained. All spectral Doppler waveforms should be obtained from the long axis. Routine spectral Doppler distal augmentation is not necessary to diagnose DVT.<sup>24</sup>
  - e. A color or spectral Doppler evaluation can be used to support the presence or absence of an abnormality.<sup>25</sup> Color Doppler imaging using distal augmentation can be helpful to identify vessels and to distinguish complete versus incomplete occlusion.
2. Recordings
- a. For normal examinations, images or cine loops are recorded at selected sites to represent a subset of the images seen during the more comprehensive scanning:
    - i. Grayscale images (or cine loops) should be recorded without and with compression at each of the following levels when feasible:
      - Common femoral vein.
      - Confluence of the common femoral vein with the great saphenous vein.
      - Deep femoral vein at the confluence with the femoral vein separately or along with the femoral vein.
      - Femoral vein at the upper thigh.
      - Femoral vein at the mid thigh.
      - Femoral vein at the distal thigh.
      - Popliteal vein.

- Representative images without and with compression (or cine loops) of posterior tibial and peroneal veins with both veins on the images or as separate images for each vein.
  - ii. Color and spectral Doppler waveforms from the long axis should be recorded at each of the following levels:
    - Right common femoral or external iliac vein.
    - Left common femoral or external iliac vein.
    - Popliteal vein on the symptomatic side or on both sides if the examination is bilateral.
  - b. Abnormal symptoms or findings generally require additional images to document the complete extent of the abnormalities.
    - i. The extent and location of sites where the veins fail to compress completely should be clearly recorded and generally require additional images. Long-axis views without compression and color/power Doppler imaging may be helpful to characterize abnormal findings.
    - ii. Symptomatic areas in the calf and thigh generally require additional evaluations and additional images if the cause of the symptoms is not readily clarified by the standard examination.
  - c. The patient presentation, clinical indication, or clinical management pathways may require protocol adjustments (eg, more detailed evaluation of the superficial venous system) or a bilateral study.<sup>26–28</sup>
  - d. Other vascular and nonvascular abnormalities, if found, should be recorded but may require additional imaging for diagnosis or further characterization. Anatomic variations, such as duplications, should be noted.
- B. Venous Insufficiency: Lower Extremity
1. Technique
    - a. Reflux is evaluated as documented by spectral Doppler waveforms showing the baseline and the response to accepted provocative maneuvers.<sup>29,30</sup> An abnormal reflux time should be reported.<sup>31</sup> Measurement units must be consistent and can be expressed in units of either milliseconds or seconds. For competent veins, the report can state “There is no abnormal reflux” without or with reporting the actual normal reflux time.
    - b. A duplex interrogation should be performed at as many levels as necessary to ensure a complete examination based on the clinical indications and a standard protocol.<sup>30,32–34</sup> Veins in the superficial and deep system should be evaluated for reflux.
    - c. The Valsalva maneuver may be used at the groin; however, augmentation of flow with calf compression should generally be used. A rapid cuff inflation system may also be used.
    - d. The patient should be standing for the detection or exclusion of reflux. A minimum of a 45° reverse Trendelenburg position can be used if the standing examination is not feasible. The examined leg should be in a non-weight-bearing position. A sitting position can be used for evaluating the superficial and perforating veins of the calf. The patient should not be studied for reflux in the less than 45° supine position.
    - e. All spectral Doppler waveforms and measurements should be obtained from the long axis.
  2. Recording
    - a. Recordings should document the presence, absence, and location of reflux. At a minimum, abnormal reflux times should be measured and reported.
    - b. Recording of the transverse diameter of the vein must be performed.
    - c. Visible varicosities should be documented, and their connection to larger veins should be reported.
    - d. Anatomic variations, such as hypoplastic or aplastic segments, significant accessory veins, or duplications, should be noted.
    - e. The patient presentation, clinical indication, or clinical management pathways may require protocol adjustments, such as a more detailed evaluation of perforating veins, the deep venous system, or a bilateral study.
    - f. Other vascular and nonvascular abnormalities, for example, chronic post-thrombotic changes or obstruction of the deep veins,

should be commented on if found and should be recorded but may require additional imaging for diagnosis or further characterization.

3. Interpretation

- a. A single negative ultrasound finding from the thigh to the ankle generally excludes acute DVT. A more limited study generally requires follow-up in 1 week or further evaluation.<sup>1</sup>
- b. Abnormal findings include acute DVT, chronic post-thrombotic changes, and indeterminate (equivocal) results. Indeterminate studies generally need other confirmatory tests or follow-up. Follow-up may be as short as 1 to 3 days and up to 1 week based on findings, symptoms, or risk factors.
- c. A negative study is usually accurate to exclude femoropopliteal DVT but less accurate to exclude calf DVT. The report may state this: "No DVT in the femoropopliteal veins. No DVT in visible portions of the calf veins."
- d. Technically compromised studies do occur, most commonly at the calf veins and femoral vein in the Hunter canal.<sup>25,35,36</sup>

A difficult body habitus is a major cause of technically compromised studies. In such circumstances, the study can at times be improved by placing the patient in a reversed Trendelenburg position (improving venous distention), using a lower-frequency transducer, and using color Doppler imaging, possibly with augmentation, to evaluate for filling defects.

Minor issues, such as an inability to visualize a less than 3-cm segment in an otherwise normal study, are unlikely to be significant. In such circumstances, normal color flow and a normal spectral waveform can help exclude DVT, whereas abnormal Doppler findings should raise clinical suspicion. More compromised studies may require an additional evaluation such as a D-dimer test or follow-up imaging.

- e. Follow-up after an initially negative study may be warranted.<sup>1</sup> Persistent or worsening symptoms, high-risk groups, and those with concern for ilioacaval DVT may require further evaluation.
- f. Follow-up after a positive study may be warranted. Calf vein DVT that is not treated

may be followed weekly, generally up to 2 weeks, to exclude extension. Acute DVT on treatment does not need short-term follow-up unless the change will affect management.

- g. Abnormalities in superficial veins and the findings of nonvascular abnormalities should be mentioned in the report. If a specific diagnosis cannot be made, additional evaluation/imaging may be recommended.

C. Venous Thromboembolic Disease: Upper Extremity<sup>37-39</sup>

1. Technique

An upper extremity duplex evaluation consists of grayscale, color, and spectral Doppler assessments of all of the accessible portions of the internal jugular, subclavian, axillary, and brachiocephalic (innominate) veins as well as compression grayscale ultrasound of the brachial, basilic, cephalic, internal jugular, and axillary veins in the upper arm to the elbow. All accessible veins should be scanned by optimal grayscale and Doppler techniques as well as appropriate positioning. Venous compression is applied to accessible veins in the transverse plane with adequate pressure on the skin to completely obliterate the normal vein lumen. The supine position, if possible, is preferred. Symmetric posture to prevent false asymmetry, if possible, is preferred.

Symptomatic areas, such as the forearm, may require an additional evaluation if the cause of the symptoms is not already clarified by the standard examination.

2. Recording

- a. For each normal examination, at a minimum:
  - i. Grayscale images or cine loops should be recorded without and with compression at each of the following levels:
    - Internal jugular vein
    - Axillary vein
    - Brachial vein in the upper arm
    - Cephalic vein in the upper arm
    - Basilic vein in the upper arm
    - Focal symptomatic areas, if present
  - ii. Color and spectral Doppler images should be recorded at each of the following levels:

- Internal jugular vein
  - Subclavian vein
  - Axillary vein
  - If seen, the brachiocephalic vein, brachial vein, cephalic vein, and basilic vein may be recorded with color Doppler imaging.
- iii. All studies, unilateral or bilateral, should include the right and left subclavian venous spectral Doppler waveforms. Recordings should evaluate for asymmetry or loss of pulsatility and respiratory phasicity.
- iv. All spectral Doppler images should be obtained from the long axis.
- b. Abnormal examinations generally require additional images. The extent and location of sites where the veins fail to compress or fill with color completely should be clearly recorded and generally require additional images. Long-axis views without compression may be helpful to characterize the abnormal vein.
- c. The patient presentation, clinical indication, or clinical management pathways may require protocol adjustments, such as imaging the forearm veins or performing a bilateral study.<sup>26–28</sup>
- d. Other vascular and nonvascular abnormalities, if found, should be recorded but may require additional imaging for diagnosis or further characterization.

#### D. Vein Mapping

Mapping of superficial leg or arm veins is performed to determine the patency, size, condition (such as calcification or thickening), and course of superficial veins. If found, duplications and anatomic anomalies should be noted. The location of the vein may be marked on the skin overlying the veins. Tourniquets or other methods to accentuate the veins may be used based on the clinical indication (eg, mapping before hemodialysis grafts or fistulas).

#### 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

Equipment must be capable of duplex imaging, both real-time imaging with compression of the veins and a Doppler evaluation of the blood flow signals originating from within the lumen of the veins. Imaging should be conducted at the highest clinically appropriate frequency, realizing that there is a trade-off between resolution and beam penetration. This should usually be at a frequency of 5 MHz or greater, with the occasional need for a lower-frequency transducer. In most cases, a linear or curved linear transducer is preferable, but sector scanners can be helpful for difficult patients or for the medial subclavian or brachiocephalic veins. The evaluation of the blood flow signals originating from within the lumen of the vein should be conducted with a carrier frequency of 2.5 MHz or greater. A display of the relative amplitude and direction of moving blood should be available.

Imaging and blood flow analyses are currently performed with duplex ultrasound using range gating. Color Doppler imaging can be used to facilitate the examination.

#### 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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