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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

Revised 2010 (Resolution 31)*

ACR–AIUM–SRU PRACTICE GUIDELINE FOR THE PERFORMANCE OF PERIPHERAL VENOUS ULTRASOUND EXAMINATION

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

The clinical aspects contained in specific sections of this guideline (Introduction, Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American College of Radiology (ACR), the American Institute of Ultrasound in Medicine (AIUM), and the Society of Radiologists in Ultrasound (SRU). Recommendations for physician requirements, written request for the examination, procedure documentation, and quality control vary among the three organizations and are addressed by each separately.

These guidelines are intended to assist practitioners performing noninvasive ultrasound evaluation of peripheral venous structures. Occasionally, an additional and/or specialized examination may be necessary. For the pediatric patient, the examination may be tailored according to the size of the patient and the specific clinical question asked. While it is not possible to detect every abnormality, adherence to the following guidelines will maximize the probability of detecting most of the abnormalities that occur in the veins of the extremities.

II. QUALIFICATIONS AND RESPONSIBILITIES OF THE PHYSICIAN

Each organization addresses this requirement individually. ACR language is as follows:

See the [ACR–SPR–SRU Practice Guideline for Performing and Interpreting Diagnostic Ultrasound Examinations](#).

III. INDICATIONS FOR PERIPHERAL VENOUS EXAMINATIONS

The indications for peripheral venous ultrasound examinations include, but are not limited to [1-5]:

1. Evaluation of possible venous thromboembolic disease or venous obstruction in symptomatic or high-risk asymptomatic individuals.
2. Assessment of venous insufficiency, reflux, and varicosities.
3. Assessment of dialysis access.
4. Venous mapping prior to surgical procedures (see also the [ACR–AIUM–SRU Practice Guideline for the Performance of Ultrasound Vascular Mapping for Preoperative Planning of Dialysis Access](#)).
5. Evaluation of veins prior to venous access.
6. Follow-up for patients with known venous thrombosis near the anticipated end of anticoagulation to determine if residual venous thrombosis is present [6].

IV. WRITTEN REQUEST FOR THE EXAMINATION

Each organization addresses this requirement individually. ACR language is as follows:

The written or electronic request for a peripheral venous ultrasound examination should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical

problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

V. SPECIFICATIONS OF THE EXAMINATION

The requesting health care provider should be encouraged to provide the pretest probability of acute deep venous thrombosis and/or the results of D-dimer assay if known [4,7,8].

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.

A. Venous Thromboembolic Disease: Lower Extremity

1. Technique

- a. Compression ultrasound: The fullest visualized extent of the common femoral, femoral (formerly known as the superficial femoral [9]) and popliteal veins must be imaged using optimal grayscale compression technique. The popliteal vein is examined distally to the tibioperoneal trunk. The proximal deep femoral and proximal great saphenous veins should also be examined. Venous compression is applied in the transverse plane with adequate pressure on the skin to completely obliterate the normal vein lumen.

Focal symptoms will generally require evaluation of those areas.

- b. At a minimum (even if the examination is otherwise unilateral), right and left common femoral or right and left external iliac venous spectral Doppler waveforms should be recorded to evaluate for asymmetry or loss of respiratory phasicity [10]. A popliteal venous spectral Doppler waveform of the symptomatic leg should also be obtained. All spectral Doppler should be obtained from the long axis.
- c. Color or spectral Doppler evaluation can be used to support the presence or absence of an abnormality.

2. Recording

- a. For normal examinations, at a minimum:
 - i. grayscale images should be recorded without and with compression at each of the following levels:
 - a. Common femoral vein.
 - b. Junction of the common femoral vein with the great saphenous vein.

- c. Proximal deep femoral vein.
- d. Proximal femoral vein.
- e. Distal femoral vein.
- f. Popliteal vein.
- ii. Spectral Doppler waveforms from the long axis should be recorded at each of the following levels:
 - a. Right common femoral or external iliac vein.
 - b. Left common femoral or external iliac vein.
 - c. Popliteal vein on symptomatic side, or on both sides if there are bilateral symptoms.
- b. Abnormal findings generally require additional images to document the complete extent of the abnormalities.
 - i. Symptomatic areas such as the calf generally require additional evaluation and additional images if the cause of the symptoms is not readily elucidated by the standard examination.
 - ii. 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 may be helpful to characterize the abnormal vein.
- c. The patient presentation, clinical indication, or clinical management pathways may require protocol adjustments such as more detailed evaluation of the superficial venous system, evaluation of the deep calf veins, or a bilateral study [11-13].
- d. Other vascular and nonvascular abnormalities, if found, should be recorded, but may require additional imaging for diagnosis or further characterization. Anatomical variations such as duplications should be noted.

B. Venous Insufficiency

1. Technique

- a. When evaluating for venous insufficiency, the location and duration of reversed blood flow should be determined during the performance of accepted maneuvers [14,15].
- b. Duplex interrogation should be performed at as many levels as necessary to ensure a complete examination based on the clinical indications [15-18]. Generally veins in the superficial and deep system should be evaluated.
- c. Augmentation with squeezing of the calf musculature should generally be used. Valsalva may be used at the groin. -

- d. The patient should be positioned in the erect position for the detection or exclusion of reflux. The reverse Trendelenburg position can be used if erect scanning is not possible. The examined leg should be in a non-weight-bearing position. The patient should not be studied for reflux in the supine position.
- e. All spectral Doppler should be obtained from the long axis.

2. Recording

- a. Recordings should document the extent and location of reflux. Varicosities and abnormal perforating veins should generally also be documented.
- b. Recording the size of dilated vessels may be helpful for clinical management.
- c. Anatomical variations such as hypoplastic or aplastic segments, significant accessory veins, or duplications should be noted.
- d. The patient presentation, clinical indication, or clinical management pathways may require protocol adjustments such as more detailed evaluation of the deep venous system or a bilateral study.
- e. Other vascular and nonvascular abnormalities, if found, should be recorded, but may require additional imaging for diagnosis or further characterization.

C. Venous Thromboembolic Disease: Upper Extremity [19-21]

1. Technique

Upper extremity duplex evaluation consists of grayscale and Doppler assessment of all the accessible portions of the subclavian, innominate, internal jugular, and axillary veins, as well as compression grayscale ultrasound of the brachial, basilic, and cephalic veins in the upper arm to the elbow. All accessible veins should be scanned using 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.

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

2. Recording

- a. For each normal examinations, at a minimum:

- i. Grayscale images should be recorded without and with compression at each of the following levels:
 - a. Internal jugular vein.
 - b. Peripheral subclavian vein.
 - c. Axillary vein.
 - d. Brachial vein in the arm.
 - e. Cephalic vein in the arm.
 - f. Basilic vein in the arm.
 - g. Focal symptomatic areas, if present.
- ii. Color images are recorded at each of the following levels using appropriate color technique to demonstrate filling of the normal venous lumen:
 - a. Internal jugular vein.
 - b. Subclavian vein.
 - c. Axillary vein.
 - d. If seen, the innominate vein should be recorded with color Doppler.
- iii. At a minimum (even if the examination is otherwise unilateral), the right and left subclavian venous spectral Doppler waveforms should be recorded to evaluate for asymmetry or loss of cardiovascular pulsatility and respiratory phasicity. All spectral Doppler should be obtained from the long axis.
 - a. Right subclavian vein.
 - b. Left subclavian vein (from same location in the vein and in same patient position as the right one).
- 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 [11-13].
- 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 the course of superficial veins to be used for vein grafts. 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 (for instance, mapping prior to hemodialysis grafts or fistulas).

VI. DOCUMENTATION

Each organization addresses this requirement individually. ACR language is as follows:

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the ultrasound examination and its interpretation. Comparison with prior relevant imaging studies may prove helpful. Images of all appropriate areas, both normal and abnormal, should be recorded. Variations from normal size should generally be accompanied by measurements. Images should be labeled with the patient identification, facility identification, examination date, and image orientation. An official interpretation (final report) of the ultrasound examination should be included in the patient's medical record. Retention of the ultrasound examination images should be consistent both with clinical need and with relevant legal and local health care facility requirements.

Reporting should be in accordance with the [ACR Practice Guideline for Communication of Diagnostic Imaging Findings](#).

VII. EQUIPMENT SPECIFICATIONS

Equipment must be capable of duplex imaging: both real-time imaging with compression of the veins and Doppler evaluation of the 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 innominate veins. Evaluation of the flow signals originating from within the lumen of the vein should be conducted with a carrier frequency of 2.5 MHz or above. A display of the relative amplitude and direction of moving blood should be available.

Imaging and flow analysis are currently performed with duplex sonography, using range gating. Color Doppler can be used to facilitate the examination.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Each organization addresses this requirement individually. ACR language is as follows:

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web page (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Real Time Ultrasound Equipment](#).

ACKNOWLEDGEMENTS

This guideline was revised according to the process described under the heading *The Process for Developing ACR Practice Guidelines and Technical Standards* on the ACR web page (<http://www.acr.org/guidelines>) by the Guidelines and Standards Committee of the Commission on Ultrasound in collaboration with the AIUM and the SRU.

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- Suggested Reading** (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

*Guidelines and standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Guideline
 1993 (Resolution 6)
 Revised 1997 (Resolution 28)

Revised 2001 (Resolution 37)
Revised 2006 (Resolution 40, 35)
Revised 2010 (Resolution 31)