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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.

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ACR-AIUM-SRU PRACTICE GUIDELINE FOR THE PERFORMANCE OF PERIPHERAL ARTERIAL ULTRASOUND USING COLOR AND SPECTRAL DOPPLER

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 evaluation of the peripheral arteries using color and spectral Doppler ultrasound. The sonographic examination of patients with peripheral vascular disease will, in general, complement the use of other physiologic tests, such as pressure measurements, pulse volume recordings, and continuous wave Doppler.

In selected cases a tailored examination is used to answer a specific diagnostic question. 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 extremity arteries.

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 ARTERIAL EXAMINATIONS

The indications for peripheral arterial ultrasound examination include, but are not limited to:

1. The detection of hemodynamically significant stenoses or occlusions in specified segment(s) of the peripheral arteries in symptomatic patients with suspected arterial occlusive disease. These patients could present with recognized clinical indicators, including claudication, rest pain, ischemic tissue loss, or suspected arterial embolizations [1-8].
2. The monitoring of sites of previous surgical interventions, including sites of previous bypass surgery with either synthetic or autologous vein grafts [9,10].
3. The monitoring of sites of various percutaneous interventions, including angioplasty, thrombolysis/thrombectomy, atherectomy, or stent placements [11].
4. The evaluation of suspected vascular and perivascular abnormalities, including such entities as masses, aneurysms, pseudoaneurysms [12], or arteriovenous fistulae.
5. Mapping of arteries prior to surgical interventions [1,13].
6. Clarifying or confirming the presence of significant arterial abnormalities identified by other imaging modalities.

Additional uses of Doppler ultrasound can include preoperative mapping for dialysis access and postoperative follow-up (see the [ACR–AIUM–SRU Practice Guideline for the Performance of Ultrasound](#)

[Vascular Mapping for Preoperative Planning of Dialysis Access](#) and the [ACR–AIUM Practice Guideline for the Performance of Vascular Ultrasound for Postoperative Assessment of Dialysis Access](#)) [14].

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 arterial 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 initial examination for determining the presence of arterial occlusive disease remains the determination of blood pressures in the extremities being studied. Blood pressure measurement at different levels should be reported as a ratio (e.g., ankle/brachial index) where appropriate. The sonographic examination consists of grayscale imaging and the evaluation of the spectral Doppler waveforms in the corresponding arterial segments. Color Doppler should be used to improve detection of arterial lesions and guide placement of the sample volume for spectral Doppler assessment [15].

A. Appropriate Techniques and Diagnostic Criteria

Specific sonographic techniques must be tailored to the different arterial segments studied and to the specific pathology being evaluated. Established imaging, Doppler, and pressure criteria may be used to identify arterial stenoses and occlusions, identify graft abnormalities, detect abnormal arteriovenous communications, and evaluate suspected soft tissue abnormalities in proximity to an artery.

B. Arterial Occlusive Disease

For arterial occlusive disease, the following general considerations apply. The full length of the arterial segment(s) of interest should be evaluated with color Doppler. Suspected abnormalities should also be imaged with grayscale ultrasound. Representative spectral Doppler waveforms with velocity measurements should be obtained and documented along the length of the arterial segment(s) and at any area of color or grayscale abnormality. A spectral Doppler waveform with velocity measurements in the arterial segment 2 to 4 cm proximal (upstream) to any stenosis should be documented. The location and the length of any diseased or nonvisualized segment(s) should also be documented. Every attempt should be made to acquire spectral Doppler waveforms with velocity measurements with the angle between the direction of moving blood and the direction of the ultrasound beam kept at less than or equal to 60 degrees. Velocity estimates made with larger angles are less reliable.

An evaluation of the following arterial segments should generally be performed as indicated below. However, a focused or limited examination may be appropriate in certain clinical situations. At a minimum an angle corrected spectral Doppler waveform with velocity measurements should be obtained from the following sites:

1. Lower extremity
 - a. Common femoral artery.
 - b. Proximal superficial femoral artery.
 - c. Mid superficial femoral artery.
 - d. Distal superficial femoral artery.
 - e. Popliteal artery.

If clinically appropriate, imaging of the iliac, deep femoral, tibio-peroneal, and dorsalis pedis arteries can be performed.

2. Upper extremity
 - a. Subclavian artery.
 - b. Axillary artery.
 - c. Brachial artery.

If clinically appropriate, imaging of the innominate, radial, and ulnar arteries and/or the palmar arch can be performed.

C. Evaluation of Surgical and Percutaneous Interventions

1. Bypass grafts

An attempt should be made to sample the full length of any bypass graft whenever possible

with color Doppler. Suspected abnormalities should also be imaged with grayscale ultrasound. Spectral Doppler waveforms and velocity measurements should be documented in the native artery proximal to the graft anastomosis, at the proximal anastomosis, at representative sites along the graft, at the distal anastomosis, and in the native artery distal to the anastomosis. Angle corrected spectral Doppler waveforms and velocity measurements should also be obtained in regions of suspected flow abnormalities noted on grayscale or color Doppler imaging.

2. Sites having undergone percutaneous interventions

An attempt should be made to sample the site of selective arterial interventions as well as the segment immediately proximal (upstream) and distal (downstream) to the site of intervention. Spectral Doppler waveforms and velocity measurements should be documented.

D. Other

1. Suspected soft tissue abnormalities in proximity to arteries

The entire area of a suspected soft tissue abnormality should be imaged. If appropriate, spectral and color Doppler may be performed to determine the presence and nature of blood flow in the region of the suspected abnormality.

2. Pseudoaneurysms

The size of the pseudoaneurysm, the residual lumen, and the length and width of the communicating channel should be documented. Spectral Doppler waveforms should be obtained in the communicating channel to demonstrate "to-and-fro" flow. In case of therapeutic intervention, color and/or spectral Doppler may be used as a guide to therapy and as a means of documenting therapeutic success [12,16-18].

3. Abnormal communication between artery and vein

Color and spectral color Doppler may be used to document the location of abnormal vascular communications. Angle corrected spectral Doppler waveforms should be documented from within vessels proximal to, in the area of, and distal to abnormal communications. Color Doppler is particularly useful for identifying the level of such communications and resultant

transmitted soft tissue vibrations secondary to the flow disturbances produced by abnormal vascular communications.

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

Peripheral arterial sonography should be performed with a real-time scanner with a linear array or curved array transducer equipped with pulsed Doppler and color Doppler capability. (Power or energy Doppler may be used if needed.) The transducer should operate at the highest clinically appropriate frequency, recognizing that there is a trade-off between resolution and penetration. This should usually be at a frequency of 3.5 MHz or greater, with the occasional need for a lower frequency transducer. Evaluation of the flow signals originating from within the lumen of the vessel should be conducted with a carrier frequency of 2.5 MHz or greater.

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](#).

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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)
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