The American College of Radiology, with more than 30,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice parameters 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 parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

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Revised 2014 (Resolution 26)*

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

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards 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 and our collaborating medical specialty societies caution against the use of these documents 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 practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, 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 this document 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 this document. However, a practitioner who employs an approach substantially different from the guidance in this document 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 the guidance in this document 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 this document is to assist practitioners in achieving this objective.

1 Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard’s stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that “published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation” even though ACR standards themselves do not establish the standard of care.
I. INTRODUCTION

The clinical aspects contained in specific sections of this practice parameter (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 3 organizations and are addressed by each separately.

These practice parameters 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. Although it is not possible to detect every abnormality, adherence to the following practice parameters will maximize the probability of detecting most of the abnormalities that occur in the extremity arteries.

II. INDICATIONS FOR PERIPHERAL ARTERIAL EXAMINATIONS

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

1. The detection of stenoses or occlusions in segment(s) of the peripheral arteries in symptomatic patients with suspected arterial occlusive disease. These patients could present with recognized clinical indicators, such as claudication, rest pain, ischemic tissue loss, aneurysm, or arterial embolization [1-10].

2. The monitoring of sites of previous surgical interventions, including sites of previous bypass surgery with either synthetic or autologous vein grafts [11-14]

3. The monitoring of sites of various percutaneous interventions, including angioplasty, thrombolysis/thrombectomy, atherectomy, or stent placement [14-19]

4. Follow-up for progression of previously identified disease, such as documented stenosis in an artery that has not undergone intervention, aneurysms, atherosclerosis, or other occlusive diseases

5. The evaluation of suspected vascular and perivascular abnormalities, including such entities as masses, aneurysms, pseudoaneurysms, arterial dissections, vascular injuries, arteriovenous fistulae, thromboses, emboli, or vascular malformations [20-22]

6. Mapping of arteries prior to surgical interventions [23-27]

7. Clarifying or confirming the presence of significant arterial abnormalities identified by other imaging modalities

8. Evaluation of arterial integrity in the setting of trauma

9. Evaluation of patients suspected of thoracic outlet syndrome, such as those with positional numbness, pain, tingling, or a cold hand

10. Allen’s test to establish patency of palmar arch

11. Temporal artery evaluation to rule out temporal arteritis and/or localize temporal arterial biopsy
Additional uses of Doppler ultrasound can include preoperative mapping for dialysis access and postoperative follow-up (see the ACR–AIUM–SRU Practice Parameter for the Performance of Ultrasound Vascular Mapping for Preoperative Planning of Dialysis Access and the ACR–AIUM–SRU Practice Parameter for the Performance of Vascular Ultrasound for Postoperative Assessment of Dialysis Access) [28].

III. QUALIFICATIONS AND RESPONSIBILITIES OF THE PHYSICIAN

Each organization will address this section in its document. ACR language is as follows:

See the ACR–SPR–SRU Practice Parameter for Performing and Interpreting Diagnostic Ultrasound Examinations.

IV. WRITTEN REQUEST FOR THE EXAMINATION

Each organization will address this section in its document. 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 sonographic examination consists of grayscale/color Doppler imaging and spectral Doppler waveforms in the appropriate arterial segments. Color Doppler should be used to improve detection of arterial lesions by identifying visual narrowing and changes in color and to guide placement of the sample volume for spectral Doppler assessment [8].

A. Appropriate Techniques and Diagnostic Criteria

Specific sonographic techniques must be tailored to the clinical indication, the different arterial segments studied, and the specific pathology being evaluated. Diagnostic criteria for stenosis differ between native and postoperative and postprocedural arteries.

Velocity measurements are obtained from angle-corrected longitudinal spectral Doppler images. Every attempt should be made to acquire images where the angle created by the direction of blood flow and the direction of the ultrasound beam is kept at \( \leq 60 \) degrees. Velocity estimates made from images using larger angles are less reliable.

B. Arterial Occlusive Disease (Peripheral Arterial Disease)

Physiological tests of the arterial system such as ankle brachial index (ABI), segmental pressure, and waveform analysis are frequently the initial examinations performed to determine the presence of arterial disease and to identify patients appropriate for imaging [22,29,30]. These studies are complementary and not equivalent to the sonographic examination.
The ABI may help evaluate the hemodynamic consequences of lower extremity arterial disease. A contemporaneous ABI, along with imaging, is complementary and supports the imaging findings or, if discrepant, helps avoid pitfalls.

An evaluation of the following arterial segments should generally be performed as indicated below. The accessible portion of the entire vessel or the arterial segment(s) of interest should be evaluated.

1. Lower extremity
   a. Common femoral artery
   b. Proximal superficial femoral artery
   c. Mid superficial femoral artery
   d. Distal superficial femoral artery/popliteal artery above the knee
   e. Popliteal artery below the knee
   If clinically appropriate, imaging of the iliac, deep femoral, tibioperoneal trunk, anterior tibial, posterior tibial, peroneal, and dorsalis pedis arteries should be performed.

   However, a focused or limited examination may be appropriate in certain clinical situations.

2. Upper extremity
   a. Subclavian artery
   b. Axillary artery
   c. Brachial artery
   If clinically appropriate, imaging of the innominate, radial, and ulnar arteries and the palmar arch should be performed.

   However, a focused or limited examination may be appropriate in certain clinical situations.

Representative longitudinal color Doppler and/or grayscale images along with angle-corrected spectral Doppler waveforms with velocity measurements should be documented for each normal arterial segment(s).

Suspected abnormalities should be documented with longitudinal grayscale and color Doppler images. Transverse images may be helpful.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images proximal to, at, and distal to sites of suspected stenosis. The sonographer/technologist should evaluate the vessel thoroughly throughout the stenosis to determine the highest peak systolic velocity.

The highest peak systolic velocity in a stenosis should be recorded from an angle-corrected longitudinal spectral Doppler image. A spectral Doppler waveform with velocity measurements should be recorded in the normal arterial segment 1 to 4 cm proximal (upstream) to a suspected stenosis. A waveform distal to a stenosis should be recorded since it is helpful to document a drop in velocity beyond the stenosis and poststenotic disturbed flow/turbulence. Distal abnormalities, as well as a poststenotic tardus parvus waveform, are signs of hemodynamic significance.

The location of any diseased or occluded segment(s) should also be documented. Estimated lengths of diseased or occluded segments may be helpful.
C. Evaluation of Surgical and Percutaneous Interventions

1. Bypass grafts

An attempt should be made to sample the full length of any arterial bypass graft whenever possible with color Doppler.

Representative longitudinal color Doppler and/or grayscale images should be documented for normal segments.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images.

Angle-corrected spectral Doppler waveforms and peak systolic 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.

Suspected abnormalities should also be imaged with longitudinal grayscale ultrasound. Representative longitudinal color and/or grayscale images of stenoses should be documented. Transverse images may be helpful.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images proximal to, at, and distal to sites of suspected stenosis. The sonographer/technologist should evaluate the vessel thoroughly throughout the stenosis to determine the highest peak systolic velocity.

The highest peak systolic velocity in a stenosis should be recorded from an angle-corrected longitudinal spectral Doppler image. A spectral Doppler waveform with velocity measurements should be recorded in the normal arterial segment 1 to 4 cm proximal (upstream) to a suspected stenosis. A waveform distal to a stenosis should be recorded since it is helpful to document a drop in velocity beyond the stenosis and poststenotic disturbed flow/turbulence and/or tardus parvus waveform.

2. Endovascular interventions

An attempt should be made to sample the site of arterial interventions as well as the segment immediately proximal (upstream) and distal (downstream) to the site of intervention. Stents should generally be scanned along their entire length, and representative images within the stent should be obtained.

Representative longitudinal color Doppler and/or grayscale images should be documented.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images.

Angle corrected spectral Doppler waveforms and peak systolic velocity measurements should be documented in the native artery proximal to the intervention, at the interventional site, and in the native artery distal to the intervention.

Suspected abnormalities should also be imaged with longitudinal grayscale ultrasound. Representative longitudinal color and/or grayscale images of stenoses should be documented. Transverse images may be helpful.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images proximal to, at, and distal to sites of suspected stenosis. The sonographer/technologist should evaluate the vessel thoroughly throughout the stenosis to determine the highest peak systolic velocity.
The highest peak systolic velocity in a stenosis should be recorded from an angle-corrected longitudinal spectral Doppler image. A spectral Doppler waveform with peak systolic velocity measurements should be recorded in the normal arterial segment 1 to 4 cm proximal (upstream) to a suspected stenosis. A waveform distal to a stenosis should be recorded since it is helpful to document a drop in velocity beyond the stenosis and poststenotic disturbed flow/turbulence and/or tardus parvus waveform.

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.

   Pseudoaneurysms

   In evaluating patients with suspected pseudoaneurysms, the sonographer/technologist should generally scan at and on either side of the site of trauma/puncture since the vessel may have been punctured at or several centimeters from the skin wound.

   Hematomas should be differentiated from pseudoaneurysms with appropriate technique to detect flow, thereby avoiding false-positive results. Hematomas, if present, should be documented.

   When a pseudoaneurysm is identified, the size of the pseudoaneurysm, the size of the residual lumen, and the length and width of the communicating channel should be documented with appropriate grayscale and color Doppler techniques. 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 [22,31-35].

3. Abnormal communication between artery and vein

   Color and spectral color Doppler may be used to document the location of abnormal vascular communications. Spectral Doppler waveforms should be documented from the artery proximal to, in the area of, and distal to abnormal communications. Flow within the fistula should be recorded, if found. A spectral Doppler waveform from the draining vein should be documented.

   Color Doppler is particularly useful for identifying the level of such communications because the flow disturbances in a fistula often create color in the adjacent soft tissue from transmitted vibrations and pressure changes (color bruit).

4. Peripheral aneurysms

   The location of aneurysms should be documented. The widest diameter of the artery or aneurysm should be measured (outer wall to outer wall) on grayscale images in a plane perpendicular to the long axis of the lumen. If present, patency and the presence of intraluminal thrombus should be documented with color Doppler.
VI. DOCUMENTATION

Each organization will address this section in its document. 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 Parameter 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.) A linear array transducer is preferred if it allows for adequate penetration. 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 will address this section in its document. 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 website (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 practice parameter was revised according to the process described under the heading The Process for Developing ACR Practice Parameters and Technical Standards on the ACR website (http://www.acr.org/guidelines) by the Committee on Practice Parameters – Ultrasound of the ACR Commission on Ultrasound in collaboration with the AIUM and the SRU.

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REFERENCES


*Practice parameters and technical 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 practice parameters and technical standards published
before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

**Development Chronology for this Practice Parameter**

1993 (Resolution 7)
Amended 1995 (Resolution 53)
Revised 1997 (Resolution 29)
Revised 2001 (Resolution 35)
Revised 2006 (Resolution 41, 35)
Revised 2010 (Resolution 30)
Revised 2014 (Resolution 26)