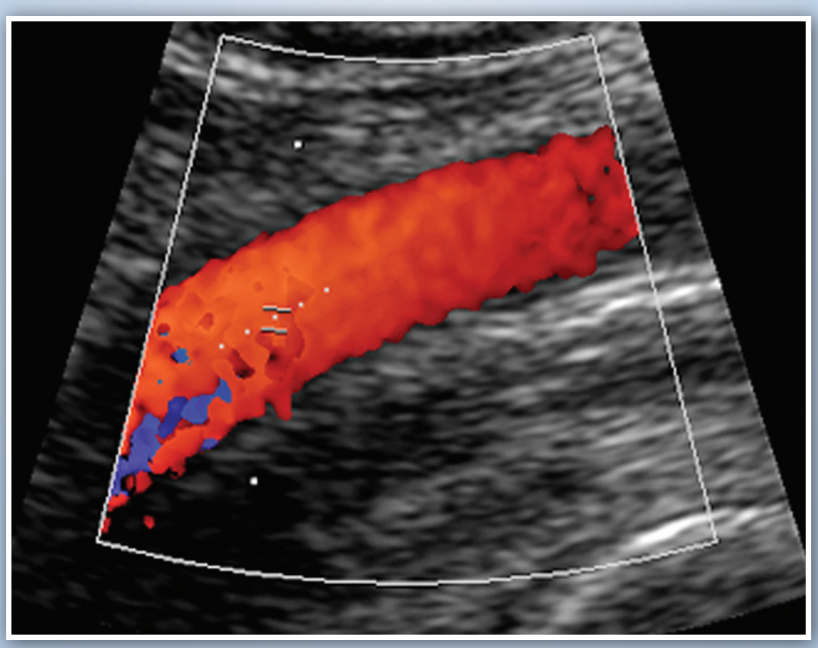
AIUM Practice Parameter for the Performance of

Peripheral Arterial Ultrasound Examinations Using Color and Spectral Doppler Imaging

Parameter developed in collaboration with the American College of Radiology (ACR) and the Society of Radiologists in Ultrasound (SRU).



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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 parameters, and accreditation. To promote this mission, the AIUM is pleased to publish in conjunction with the American College of Radiology (ACR) and the Society of Radiologists in Ultrasound (SRU) this *AIUM Practice Parameter for the Performance of Peripheral Arterial Ultrasound Examinations Using Color and Spectral Doppler Imaging*.

The AIUM represents the entire range of clinical and basic science interests in medical diagnostic ultrasound, and, with hundreds of volunteers, this multidisciplinary organization has promoted the safe and effective use of ultrasound in clinical medicine for more than 50 years. This document and others like it will continue to advance this mission.

Practice parameters of the AIUM are intended to provide the medical ultrasound community with parameters for the performance and recording of high-quality ultrasound examinations. The parameters reflect what the AIUM considers the minimum criteria for a complete examination in each area but are not intended to establish a legal standard of care. AIUM-accredited practices are expected to generally follow the parameters with recognition that deviations from these parameters will be needed in some cases, depending on patient needs and available equipment. Practices are encouraged to go beyond the parameters to provide additional service and information as needed.

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I. Introduction

The clinical aspects contained in specific sections of this parameter (Introduction, Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American Institute of Ultrasound in Medicine (AIUM), the American College of Radiology (ACR), 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 organizations and are addressed by each separately.

These 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 ultrasound. 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 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. Detection of stenoses or occlusions in segments 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, an aneurysm, and arterial embolization.[1–10]
2. Monitoring of sites of previous surgical interventions, including sites of previous bypass surgery with either synthetic or autologous vein grafts.[11–14]
3. Monitoring of sites of various percutaneous interventions, including angioplasty, thrombolysis/thrombectomy, atherectomy, and stent placements.[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. Evaluation of suspected vascular and perivascular abnormalities, including such entities as masses, aneurysms, pseudoaneurysms, arterial dissections, vascular injuries, arteriovenous fistulas, thromboses, emboli, and vascular malformations.[20–22]
6. Mapping of arteries before 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. The Allen test to establish patency of the 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 *AIUM Practice Parameter for the Performance of Ultrasound Vascular Mapping for Preoperative Planning of Dialysis Access* and the *AIUM Practice Parameter for the Performance of Vascular Ultrasound for Postoperative Assessment of Dialysis Access.*)[28]

III. Qualifications and Responsibilities of the Physician

See www.aium.org for AIUM Official Statements including *Standards and Guidelines for the Accreditation of Ultrasound Practices* and relevant Physician Training Guidelines.

IV. Written Request for the Examination

The written or electronic request for an ultrasound examination should provide sufficient information to allow for the appropriate performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider or under the provider's direction. The accompanying clinical information should be provided by a physician or other appropriate health care provider familiar with the patient's clinical situation and should be consistent with relevant legal and local health care facility requirements.

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 imaging 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 60° or less. Velocity estimates made from images using larger angles are less reliable.

B. Arterial Occlusive Disease (Peripheral Arterial Disease)

Physiologic tests of the arterial system such as the 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; and
   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; and
   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 with color Doppler imaging whenever possible. 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.

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.

   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 imaging may be performed to determine the presence and nature of blood flow in the region of the suspected abnormality.

2. 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 the 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 cases of therapeutic interventions, color and/or spectral Doppler imaging may be used as a guide to therapy and as a means of documenting therapeutic success.[22,31–35]

3. Abnormal communication between an artery and a vein:

   Color and spectral color Doppler imaging 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 imaging 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 locations 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 an intraluminal thrombus should be documented with color Doppler imaging.

VI. Documentation

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the ultrasound examination and its interpretation. Images of all appropriate areas, both normal and abnormal, should be recorded. Variations from normal size should be accompanied by measurements. Images should be labeled with the patient identification, facility identification, examination date, and side (right or left) of the anatomic site imaged. An official interpretation (final report) of the ultrasound findings should be included in the patient's medical record. Retention of the ultrasound examination should be consistent both with clinical needs and with relevant legal and local health care facility requirements.

Reporting should be in accordance with the *AIUM Practice Parameter for Documentation of an Ultrasound Examination*.

VII. Equipment Specifications

Peripheral arterial sonography should be performed with a real-time scanner and a linear 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 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

Policies and procedures related to quality control, patient education, infection control, and safety should be developed and implemented in accordance with the AIUM *Standards and Guidelines for the Accreditation of Ultrasound Practices*.

Equipment performance monitoring should be in accordance with the AIUM *Standards and Guidelines for the Accreditation of Ultrasound Practices*.

IX. ALARA Principle

The potential benefits and risks of each examination should be considered. The ALARA (as low as reasonably achievable) principle should be observed when adjusting controls that affect the acoustic output and by considering transducer dwell times. Further details on ALARA may be found in the AIUM publication *Medical Ultrasound Safety, Third Edition*.

Acknowledgments

This parameter was revised by the AIUM in collaboration with the American College of Radiology (ACR) and the Society of Radiologists in Ultrasound (SRU) according to the process described in the AIUM *Clinical Standards Committee Manual*.

Collaborative Committee

Members represent their societies in the initial version and final revision of this parameter.

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