AIUM Practice Parameter for the Performance of an
Ultrasound Examination
of the Extracranial
Cerebrovascular System

Parameter developed in collaboration with the American College of Radiology
and the Society of Radiologists in Ultrasound.

© 2011 by the American Institute of Ultrasound in Medicine
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 an Ultrasound Examination of the Extracranial Cerebrovascular System. We are indebted to the many volunteers who contributed their time, knowledge, and energy to bringing this document to completion.

The AIUM represents the entire range of clinical and basic science interests in medical diagnostic ultrasound, and, with hundreds of volunteers, the AIUM 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.
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 between the 3 organizations and are addressed by each separately.

Ultrasound imaging, using gray scale imaging, Doppler spectral analysis, and color Doppler imaging, is a proven and useful procedure for evaluating the extracranial cerebrovascular system. While it is not possible to detect every abnormality, adherence to the following parameters will maximize the probability of detecting most extracranial cerebrovascular abnormalities. Occasionally, an additional and/or specialized examination may be necessary.

II. Indications

Indications for an ultrasound examination of the extracranial carotid and vertebral arteries include but are not limited to:

1. Evaluation of patients with hemispheric neurologic symptoms, including stroke, transient ischemic attack, and amaurosis fugax;  
2. Evaluation of patients with a cervical bruit;  
3. Evaluation of pulsatile neck masses;  
4. Preoperative evaluation of patients scheduled for major cardiovascular surgical procedures;  
5. Evaluation of nonhemispheric or unexplained neurologic symptoms;  
6. Follow-up of patients with proven carotid disease;  
7. Evaluation of postoperative patients after cerebrovascular revascularization, including carotid endarterectomy, stenting, or carotid-to-subclavian bypass;  
8. Intraoperative monitoring of vascular surgery;  
9. Evaluation of suspected subclavian steal syndrome;  
10. Evaluation for suspected carotid artery dissection, arteriovenous fistula, or pseudoaneurysm; and  
11. Patients with carotid reconstruction after extracorporeal membrane oxygenation bypass.

III. Qualifications and Responsibilities of the Physician

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

A. Technique

Extracranial cerebrovascular ultrasound evaluation consists of assessment of the accessible portions of the common and internal carotid arteries and basic assessment of the external carotid and vertebral arteries. All arteries should be scanned using appropriate gray scale and Doppler techniques and proper patient positioning. Gray scale imaging of the common carotid artery, its bifurcation, and both the internal and external carotid arteries should be performed in longitudinal and transverse planes. The internal carotid and common carotid arteries should be imaged as completely as possible with caudad angulation of the transducer in the supraclavicular area and cephalad angulation at the level of the mandible.

Color Doppler imaging should be used to detect areas of narrowing and abnormal flow to select areas for Doppler spectral analysis. Color Doppler imaging should also be used to clarify the cause of image/pulsed Doppler mismatches and to detect narrow flow channels seen in high-grade (near-occlusive) stenoses. Power Doppler evaluation may be helpful to search for a narrow channel of residual flow in suspected occlusion or near occlusion.

Spectral Doppler imaging with angle-corrected blood-flow velocity measurements should be obtained at representative sites in the vessels. Additionally, scanning in areas of stenosis or suspected stenosis must be adequate to determine the maximal peak systolic velocity associated with the stenosis and to document disturbances in the waveform distal to the stenosis. Consistent angle correction is essential for determining blood flow velocity. All angle-corrected spectral Doppler waveforms must be obtained from longitudinal images.

Angle correction should be applied in a consistent manner for all measurements (typically either parallel to the vessel wall or in line with the color lumen but not both). The angle between the direction of flowing blood and the applied Doppler ultrasound signal (angle \( \theta \) [theta], the Doppler angle) should not exceed 60°. The reliability of velocity measurements decreases significantly at angles greater than 60°, and the use of velocity measurements obtained at angles greater than 60° is discouraged. Deviations from the protocol may be unavoidable (eg, with a very tortuous vessel) but should be minimized. Gain should be appropriate for the vessel scanned (undergaining or overgaining may affect velocity measurements).
B. Recording

1. Gray Scale Images—At a minimum, for each normal side evaluated, gray scale images must be obtained at each of the following levels:
   a. Long axis, common carotid artery;
   b. Long axis, at the carotid artery bifurcation;
   c. Long axis, internal carotid artery; and
   d. Short axis, proximal internal carotid artery.

   If abnormalities are found, additional images must be recorded:
   a. If atherosclerotic plaques are present, their extent, location, and characteristics should be documented with gray scale imaging in both the longitudinal and transverse planes.
   b. Other vascular or significant perivascular abnormalities should be documented.

1. Color Doppler Images—Color images may be recorded using appropriate color technique to show filling of the normal lumen and/or flow disturbances associated with stenoses. In cases of occlusion, a color and/or power Doppler image of the abnormal vessel should be obtained to confirm that it is occluded.

2. Spectral Doppler Images—For each normal side evaluated, spectral Doppler waveforms and maximal peak systolic velocities must be recorded at each of the following levels:
   a. Proximal common carotid artery;
   b. Mid or distal common carotid artery (generally 2–3 cm below the bifurcation);
   c. Proximal internal carotid artery;
   d. Distal internal carotid artery;
   e. Proximal external carotid artery; and
   f. Vertebral artery (in neck or near origin).

   If significant stenosis is found or suspected, additional images must be recorded and the location of the stenosis determined:
   a. At the site of maximum velocity due to the stenosis; and
   b. Distal to the site of maximal velocity to document the presence or absence of disturbed flow.

   Diastolic velocities and velocity ratios may also be calculated as warranted depending on the laboratory interpretation criteria.

   The peak systolic velocity and flow direction in each of the vertebral arteries should be recorded.

   Stents require additional images. Indwelling stents should be sampled within, proximal, and distal to each stent, and the site of highest velocity should be determined and recorded.
C. Interpretation

The interpretation of cerebrovascular ultrasound images requires careful attention to protocol and interpretation criteria.

1. Each laboratory must have interpretation criteria that are used by all members of the technical and physician staff.

2. Diagnostic criteria must be derived from the literature from internal validation based on correlation with other imaging modalities or from surgical and/or pathologic correlation.\(^2,3,6,9–11\)

3. The report must indicate internal carotid artery stenosis categories that are clinically useful and nationally accepted.\(^1–3\) Stenosis of greater than 50% should be graded as a range (eg, 50%–69% or 70% to near occlusion) or a numeric grade (eg, 60% ± 10%) to provide adequate information for clinical decision making. Numerous factors affect interpretation criteria (eg, contralateral severe disease or occlusion and ipsilateral near occlusion).\(^7,12–14\)

4. The report must indicate the vertebral artery flow direction and should indicate an abnormal waveform shape.\(^5,15\)

5. The report may indicate plaque characterization depending on the laboratory interpretation criteria.\(^16–20\)

6. The report should indicate other significant nonvascular abnormalities.

7. The criteria for common and external carotid artery stenosis differ from internal carotid artery criteria.\(^21,22\)

8. Stents require different criteria than native vessels.\(^23–26\)

When available, modalities, parameters, and tests other than duplex ultrasound imaging may add valuable information to the cerebrovascular Doppler ultrasound examination.

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

The examination should be conducted with a real-time scanner with Doppler capability, preferably using a linear transducer. The examination should use the highest clinically appropriate frequency, realizing that there is a trade-off between resolution and beam penetration. Imaging frequencies should be 5.0 MHz or greater. Doppler flow analysis should be conducted with a carrier frequency of 3.0 MHz or greater. Lower frequencies are occasionally appropriate in patients with a large body habitus or densely calcified vessels. Examination using lower-frequency transducers can also be useful when the vessels are not adequately imaged at higher frequencies. Color Doppler imaging can be used to localize blood flow abnormalities for range gate placement for the Doppler spectral analysis, thus facilitating the examination.

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, Second Edition.

Acknowledgments

This parameter was revised by the American Institute of Ultrasound in Medicine (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 and final revisions of this parameter.
References


