AIUM Standard for the Performance of Ultrasound Examination of the Extracranial Cerebrovascular System

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The American Institute of Ultrasound in Medicine (AIUM) is an educational, scientific, and professional society concerned with the advancement of the art and science of ultrasound in medicine and research. To promote this mission, the AIUM is pleased to publish, in conjunction with the American College of Radiology (ACR), this Standard for 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.

Clinical Standards of the AIUM are intended to provide the medical ultrasound community with guidelines for the performance and recording of high quality ultrasound examinations. The standards 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 standards with the recognition that deviations from the standards will be needed in some cases depending on patient needs and available equipment. Practices are encouraged to go beyond the standards to provide additional service and information as needed by their referring physicians and patients.

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I. Introduction

The clinical aspects of this standard (Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American Institute of Ultrasound in Medicine (AIUM) and the American College of Radiology (ACR).

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

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. Evaluation of blunt neck trauma.
5. Preoperative evaluation of patients scheduled for major cardiovascular surgical procedures.
6. Evaluation of nonhemispheric or unexplained neurologic symptoms.
7. Follow-up of patients with proven carotid disease who are receiving medical therapy.
8. Evaluation of postoperative patients following carotid revascularization.
9. Intraoperative monitoring of vascular surgery.
10. Evaluation of suspected subclavian steal syndrome.
11. Evaluation of suspected dissection.

III. Qualifications and Responsibilities of the Physician

See the AIUM Official Statement: *Training Guidelines for Physicians Who Evaluate and Interpret Diagnostic Ultrasound Examinations* and the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

IV. Specifications of the Examination

Real-time imaging of the common carotid, internal carotid, and external carotid arteries should be performed in longitudinal and transverse planes with representative images, including documentation of all pathology recorded. The extent, location, and characteristics of atherosclerotic plaque should be documented with gray scale imaging. Other vascular or perivascular abnormalities should be documented as well. The vessels 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. The vertebral artery should be imaged in the longitudinal plane, and the velocity spectrum and flow direction in each of the vertebral arteries should be recorded.

CDI should be used to screen for areas of abnormal blood flow and to select areas for Doppler spectral analysis. CDI may also be used to clarify the cause of apparent image/pulsed Doppler mismatches and to detect narrow flow channels seen in high-grade (near occlusive) stenoses.

Blood-flow velocity measurements should be made at selected intervals of accessible portions of the internal and common carotid arteries. Angle correction is essential for determining blood-flow velocity. The angle between the direction of flowing blood and the applied Doppler ultrasound signal (angle ø, the Doppler angle) should not exceed 60 degrees, whenever possible. The reliability of velocity measurements decreases significantly at angles above 60 degrees, and the use of angles above 60 degrees is discouraged. Maximal peak systolic velocity and end diastolic velocity measurements should be recorded for the common and internal carotid arteries bilaterally. Evaluation of velocity waveforms of the external carotid artery is necessary. Calculations such as velocity ratios may be helpful. If there are significant stenoses, the Doppler spectrum should be recorded proximal to, at, and distal to each stenosis. The location of each stenosis should be documented.

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

1. Power Doppler evaluation may be helpful in searching for a narrow channel of residual flow in suspected occlusions.

2. Separate indirect tests such as periorbital directional Doppler and oculoplethysmography may provide valuable information to study for the hemodynamic effects distal to a stenosis and to discover lesions, which may not be within the reach of transducers from a cervical approach.

V. Documentation

Adequate documentation is essential for high quality in 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 in a suitable archival format. Variations from normal should be accompanied by measurements. Images are to be labeled with the examination date, patient identification, and image orientation. A report of the ultrasound findings should be included in the patient's medical record regardless of where the study is performed. Retention of the ultrasound examination should be consistent both with clinical need and with relevant legal and local health care facility requirements.

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

VI. Equipment

The examination should be conducted with a real-time scanner with Doppler capability, preferably using a linear transducer. The examination should utilize the highest clinically appropriate frequency, realizing 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. CDI can be used to localize blood-flow abnormalities for range gate placement for the Doppler spectral analysis, thus facilitating the examination.

VII. Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns

Policies and procedures related to quality, 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*.

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This standard was developed by the American Institute of Ultrasound in Medicine (AIUM) in collaboration with the American College of Radiology (ACR) according to the process described in the ACR Book of Standards.

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