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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 PRACTICE GUIDELINE FOR THE PERFORMANCE OF AN ULTRASOUND EXAMINATION OF THE EXTRACRANIAL CEREBROVASCULAR SYSTEM**

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### **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 on 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. It should be recognized; therefore, 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.

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Revised as stated below by a collaborative panel of the American Institute of Ultrasound in Medicine (AIUM) and the American College of Radiology (ACR).

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### **I. INTRODUCTION**

The clinical aspects of this guideline (Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the ACR and AIUM.

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 guidelines 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 [ACR Practice Guideline for Performing and Interpreting Diagnostic Ultrasound Examinations](#).

## 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  $\theta$ , 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 [ACR Practice Guideline for Communication: Diagnostic Radiology](#).

## 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 ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

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 guideline was revised according to the process described in the ACR Practice Guidelines and Technical Standards book by the Guidelines and Standards Committee of the Ultrasound Commission in collaboration with the AIUM.

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