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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF TRANSCRANIAL DOPPLER ULTRASOUND FOR ADULTS AND CHILDREN

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 mak 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 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.

I. INTRODUCTION

The clinical aspects contained in specific sections of this guideline (Introduction, Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American College of Radiology (ACR) and the American Institute of Ultrasound in Medicine (AIUM). Recommendations for physician requirements, written request for the examination, procedure documentation, and quality control vary between the two organizations and are addressed by each separately.

Transcranial Doppler is a noninvasive technique that assesses blood flow within the circle of Willis and the vertebrobasilar system in children who have a closed anterior fontanelle and in adults.

II. INDICATIONS

Indications for a transcranial Doppler ultrasound examination include, but are not limited to:

A. Adults

1. Detection of stenosis or occlusion in a major intracranial artery in the circle of Willis and vertebrobasilar system**,** including monitoring thrombolytic therapy for acute stroke patients.
2. Follow-up of patients with known stenosis or occlusion of a major intracranial artery in the circle of Willis and vertebrobasilar system.
3. Detection and monitoring of vasospasm in patients with subarachnoid hemorrhage.
4. Detection of circulating emboli in a major intracranial artery in the circle of Willis and vertebrobasilar system.
5. Detection of right-to-left shunts using agitated saline injection.
6. Assessment of vasomotor reactivity.
7. Confirmation of the clinical diagnosis of brain death by detection of complete cerebral circulatory arrest.
8. Intraoperative and periprocedural monitoring to detect embolization, thrombosis, hypoperfusion, and hyperperfusion.

B. Children

1. Evaluation of stenosis or occlusion in the circle of Willis and vertebrobasilar system in patients with sickle cell anemia to determine the need for and continuation of blood transfusions.
2. Follow-up of patients with known stenosis or occlusion of an artery in the circle of Willis and vertebrobasilar system in patients with sickle cell anemia.
3. Detection of vasculopathy, such as moyamoya.
4. Assessment of arteriovenous malformations.
5. Confirmation of the clinical diagnosis of brain death by detection of complete cerebral circulatory arrest in infants more than 6 months of age.

III. QUALIFICATIONS AND RESPONSIBILITIES OF THE PHYSICIAN

See the ACR Practice Guideline for Performing and Interpreting Diagnostic Ultrasound Examinations.

IV. WRITTEN REQUEST FOR THE EXAMINATION

The written or electronic request for transcranial Doppler ultrasound 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 scope of practice requirements. (ACR Resolution 35, adopted in 2006)

V. SPECIFICATIONS OF THE EXAMINATION

Either spectral Doppler or grayscale, color, and spectral Doppler ultrasound (transcranial duplex) should be performed with the patient in the supine position. Representative views of each anterior, middle, and posterior cerebral artery in the circle of Willis and vertebrobasilar system should be obtained, including documentation of pathology. Two windows can be used after closure of the anterior fontanelle to examine the intracranial vessels: the temporal bone and the foramen magnum.

The transtemporal window is the area on the temporal bone cephalad to the zygomatic arch and anterior to the ear. On grayscale images, the hypoechoic heart-shaped cerebral peduncles and echogenic star-shaped basilar cistern are the reference landmarks. Anterior to the cistern is the middle cerebral artery, which should be insonated with Doppler ultrasound, including color and spectral Doppler analysis. With a 2 MHz transducer or multifrequency transducer with 2 MHz spectral Doppler, the middle cerebral artery should be interrogated at 2-5 mm intervals from its most superficial point below the calvarium to the bifurcation of the A1 segment, and the anterior cerebral artery should be studied as far medially as possible.

The posterior cerebral artery is found immediately anterior to the heart-shaped cerebral peduncles and has forward flow toward the transducer in the P1 segment while flow in the more distal P2 segment is directed away from the probe. After completing insonation of the right sided vessels, repeat the imaging planes on the left side.

The foramen magnum can be used to study the vertebral and basilar arteries. The patient should be turned to one side and the neck should be flexed so that the chin touches the chest. A 2 MHz transducer is placed over the upper neck at the base of the skull and angled through the foramen of magnum towards the nose. The reference landmark is the hypoechoic medulla or bridge of the nose for nonimaging transducers. The vertebral arteries should

be interrogated at 2-5 mm intervals. On color Doppler ultrasound, the vertebral arteries have a V-shaped configuration as they extend superiorly to form the basilar artery. Flow in the vertebral and basilar arteries is directed away from the transducer and should be interrogated up to the distal end of the basilar artery.

In patients with suspected carotid stenoses or occlusions, a transorbital examination of the ophthalmic arteries and carotid siphons can be performed at reduced omitting power levels (10% or 17 mW). In patients with subarachnoid hemorrhage and signs of vasospasm, a submandibular approach can be used to sample the distal internal carotid artery in the neck to calculate mean flow velocity ratios between the middle cerebral and internal carotid arteries, also known as the hemispheric index. Both approaches are performed with 2 MHz spectral Doppler without angle correction.

Waveform analysis of the cerebral arteries should be performed, including the time average mean maximum velocity in children with sickle cell disease according to the STOP trial criteria. In adults, either mean flow velocity or peak systolic velocity with pulsatility indexes should be recorded. The velocity is obtained at 2-5 mm intervals along the entire course of the vessel. Velocity can be measured either by the automatic tracing method or by performing a manual tracing. Angle correction should not be used.

VI. DOCUMENTATION

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, image orientation and vessel labeling. 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 healthcare facility requirements.

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

VII. EQUIPMENT SPECIFICATIONS

Transcranial Doppler should be performed with a real-time scanner with Doppler capability, using a 2 to 4 MHz transducer that can penetrate the temporal bone and foramen magnum, or a nonimaging Doppler instrument with 2 MHz pulsed Doppler capability. Doppler images and/or data are obtained at 2 mm intervals with a 4 to 6 mm gate (larger steps such as 5 mm are allowed for 10-15 mm gates). Color or spectral Doppler should be used to locate the intracranial vessels in all cases. The color gain settings should be maximized so that a well defined flow jet is displayed. The Doppler setting should be adjusted to obtain the highest velocity in all cases. Doppler power output should be as low as reasonably achievable.

VIII. 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.

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