

**VASCULAR TECHNOLOGY
PROFESSIONAL PERFORMANCE GUIDELINES**

Transcranial Doppler in Pediatric Patients with Sickle Cell Anemia: (Non-Imaging)

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Transcranial Doppler in Pediatric Patients with Sickle Cell Anemia: (Non-Imaging)

PURPOSE

- Transcranial Doppler (TCD) studies use pulsed Doppler ultrasound to non-invasively evaluate intracranial arterial hemodynamics.
- Ischemic stroke will occur in over 10% of children with homozygous Sickle Cell Anemia (HbSS) by the age of 20
- STOP Trial :
 - The Stroke Prevention Trial in Sickle Cell Anemia (STOP Trial) used TCD to screen and identify children at greatest risk of ischemic stroke.
 - Patients with increased velocity flow in the distal Internal Carotid Artery (dICA) and the proximal Middle Cerebral Artery (MCA) are at highest risk for stroke.
 - The STOP trial reported a 10% incidence of stroke/year.
 - Once identified, confirmed and treated with transfusion therapy, children with intracranial stenosis showed >90% reduction in stroke risk if hemoglobin S was less than 30%.
- Changes in intracranial flow must be documented on two consecutive abnormal TCD studies, with Time Averaged Mean of the Maximum (TAMM) velocities of > 200 cm/sec in the dICA or proximal MCA. (Elevated velocities in other intracranial vessels are included in the evaluation of these children, but the focus of the exam is careful evaluation of the distal internal carotid and proximal middle cerebral arteries)

APPROPRIATE INDICATIONS

Indications for performance of a Transcranial Doppler Evaluation for sickle cell anemia include:

- Presence of Sickle Cell anemia with no prior stroke in a child between the ages of 2–16 years
- Abnormal findings on a previous TCD screening examination (dICA or MCA TAMM with velocities of >170 cm/sec (Conditional) or >200cm/sec (Abnormal))

CONTRAINDICATIONS AND LIMITATIONS

- Children should be evaluated when healthy: hypoxia, hypercarbia, fever, sickle chest syndrome, pneumonia, hypoglycemia, and other processes can result in an increase in cerebral blood flow and velocity
- Hypocarbica and recent transfusions can decrease cerebral blood flow and flow velocity. It is crucial to document if/when a transfusion has occurred
- Children must remain awake and alert during the TCD examination: sleeping results in increased CO₂ and can cause increased velocities and misdiagnosis; crying may also result in hyperventilation, which can abruptly impact velocities
- Restless or agitated children may be unable to maintain the appropriate position for a complete exam. Note variations in exam performance in technical report

PATIENT COMMUNICATION:

The technologist/sonographer/examiner should:

- Explain the purpose of the Transcranial Doppler evaluation in terms that are understood by the child (if age appropriate) and the parents and indicate the usual exam length.
- Provide a brief summary of the exam procedure
- Respond to questions and address concerns expressed by the patient or parent/guardian about the exam
- Refer specific diagnostic, treatment or outcome questions to the patient's physician
- Remove the patient's eyeglasses and hair ornaments
- Explain the importance of remaining awake and breathing normally throughout the exam

PATIENT ASSESSMENT

The initial screening exam is performed to document presence or absence of elevated velocities, and will be followed by a confirmatory exam if elevated velocities are documented. Prior to initiating the TCD exam, the technologist/sonographer/examiner should:

- Measure and document the bi-temporal head diameter with calipers positioned just anterior to the ear, above the zygomatic arch.
- Dividing this measurement in half to give a good estimate of the midline (to assist in vessel identification)
- Record age, gender and current lab values
- Assess current medical status; patient should be without fever, cough or any symptoms of illness that could impact physiology
- If child has had recent transfusion, document date
- A child with a previous stroke is usually not a candidate for TCD screening

PATIENT POSITIONING

Review patient positioning requirements for the examination and determine patient's ability to maintain proper positioning for all portions of the exam, which include:

- Supine position with head supported or stabilized for transtemporal window
- Turned to side with neck flexed/chin toward chest for transforaminal/suboccipital window
- Exam positions may be adapted to keep patient from moving, crying or becoming restless
- the TCD examiner should be sitting at the patient's head with arms supported if possible

INSTRUMENTATION

- Equipment specifically designed for TCD applications should be utilized, with appropriate frequencies (1.5-2.5 MHz) focus and resolution to adequately penetrate the temporal bone
- Spectral waveform analysis, with appropriate technology to resolve and display variable amplitude and frequency data.
- Instrumentation with the ability to display all data in real time including:
 - depth of sample volume
 - size of sample volume
 - time averaged mean of the maximum velocity
 - peak and end diastolic velocities
 - pulsatility index
 - power output
 - frequency of transducer
- Data storage capability in hard copy and audio/video clips

EXAM PROTOCOL

A complete examination includes documentation from the following vessels:

Transtemporal window:

- Middle Cerebral Artery (MCA)
- Anterior Cerebral Artery (ACA)
- Bifurcation of the internal carotid artery (ICA) into the MCA and ACA
- Terminal ICA
- Anterior Communicating Artery (when identified as a collateral pathway)
- **Posterior Communicating Artery (when identified as a collateral pathway)**

Transforaminal (suboccipital) window:

- Vertebral Arteries (VA)
- Basilar Artery (BA)

Orbital window (if utilized when a transtemporal window is not available):

- Ophthalmic Artery (OA)
- Siphonous portion of the ICA
- Record mean velocity (TAMM or time averaged mean of the maximum velocity) and waveform characteristics in the preceding vessels to include:
 - pulsatility
 - systolic/diastolic velocities and ratios
 - evidence of turbulent flow
 - systolic upstroke delays
 - side to side asymmetry in mean velocity
 - focal increase in velocity (particularly distal ICA or proximal MCA indicative of stenosis)
 - increase in flow velocity in other basal cerebral arteries indicative of collateral effects
- Document presence of collateral flow in basal cerebral arteries and branch vessels, as they may be support findings of intracranial stenosis.

Technical Considerations:

- In younger children, the temporal bone is easy to penetrate. It is important to make a technical note of the temporal window (anterior, middle or posterior) used for the exam, should a follow-up examination be performed
- Older children may be more difficult to insonate through the temporal. It may be necessary to complete the entire exam from one side. Documentation should be made to prevent confusion and misdiagnosis of flow direction or velocity
- The STOP Trial did not include the orbital exam; however, if a temporal window cannot be identified, the orbital exam may be useful, as it provides access to the carotid siphon. **The power must be decreased for this approach**
- Waveform acquisitions are required at every 2mm to ensure accurate vessel identification
- The velocity measurement used for Sickle Cell studies is the Time Averaged Mean of the Maximum (TAMM) velocity
- An abnormal finding must be verified with a second exam, preferably within a one to two week period
- Conditional exams, those with elevated velocities between 170-199cm/sec should be monitored, and repeated within 3-6 months to document potential progression to abnormal status (mean flow velocity in all vessels may exceed 140 cm/sec due to anemia; only vessels with a focal increase of >170 cm/sec are classified as conditional or abnormal)
- Exam should include evaluation of the basal cerebral arteries with spectral waveform data acquired at 2-4 mm increments from all vessels.

To achieve complete and accurate result the Transcranial Doppler Evaluation should:

- Verify the presence or absence of flow in all vessels
- Mean flow velocity in all vessels may exceed 140cm/sec due to anemia; only vessels with a focal increase of >170cm/sec are classified as conditional or abnormal
- Identify vessels based on depth of the pulsed Doppler sample volume and flow direction

REVIEW OF THE DIAGNOSTIC EXAM FINDINGS

- Review data acquired during the Transcranial Doppler Examination to ensure that a complete and comprehensive evaluation has been performed and documented when indicated.
- Document any exceptions to the routine TCD protocol to ensure that study limitations, omissions or revisions are adequately reflected in the patient's medical record
- Record all technical findings required to complete the final diagnosis on a worksheet so that the measurements can be classified according to the laboratory diagnostic criteria (STOP Trial).
- Document exam date, clinical indication(s), technologist performing the evaluation and exam summary in patient's medical record
- Alert the medical director of technical results when findings indicate a need for immediate medical care or intervention.

PRESENTATION OF EXAM FINDINGS

Presents recording of diagnostic spectral waveforms and the technical worksheet with pertinent and technical observations about the TCD examination to the interpreting physician for use in rendering a diagnosis and for archival purposes

EXAM TIME RECOMMENDATIONS

High quality, accurate results are fundamental elements of the Transcranial Doppler examination. A combination of indirect and direct exam components is the foundation for maximizing exam quality and accuracy.

- Indirect exam components include pre-exam activities: review all prior diagnostic data pertinent to the TCD examination; complete pre-examination paperwork and prepare the exam room and instrumentation. Prepare the patient for the exam by explaining the procedure, completing the history and physical and positioning the patient for the study. Post-exam procedures: cleanup; compiling, processing, reviewing exam data for preliminary /or formal interpretation activities; and, patient communication; exam charge and billing activities. Recommended time allotment is 25 minutes.
- Direct exam components include equipment optimization and the actual hands-on, examination process. Recommended time allotment is 30-60 minutes.

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