VASCULAR TECHNOLOGY
PROFESSIONAL PERFORMANCE GUIDELINES

Intracranial Cerebrovascular Evaluation Transcranial Doppler (Non-Imaging) and Transcranial Duplex Imaging (TCD-I)

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Society for Vascular Ultrasound
4601 Presidents Drive, Suite 260
Lanham, MD 20706-4831
Tel.: 301-459-7550
Fax: 301-459-5651
• mail: svuinfo@svunet.org
Internet: www.svunet.org

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Intracranial Cerebrovascular Evaluation
Transcranial Doppler (Non-Imaging) and Transcranial Duplex Imaging (TCDI)

Purpose
Transcranial Doppler (TCD) studies use pulsed Doppler ultrasound to noninvasively evaluate intracranial arterial hemodynamics. By insonating the Circle of Willis and verteobasilar circulation through the natural cranial windows (orbit, temporal bone and foramen magnum), focal intracranial lesions, flow disturbances and other findings within the arterial system can be identified and quantified. These evaluations are performed to document changes in intracranial flow velocity consistent with vasospasm, focal intracranial arterial stenosis (narrowing) and collateralization. Additionally, Transcranial Doppler can identify intracranial emboli and assess vasomotor reactivity.

Appropriate Indications
Some of the more common indications for performance of a Transcranial Doppler Evaluation include:

- Diagnosis and management of intracranial occlusive disease
- Evaluation of the effects of extracranial stenosis on intracranial hemodynamics
- Identification and monitoring of vasospasm following subarachnoid hemorrhage
- Evaluation of intracranial flow following head trauma
- Intraoperative monitoring of intracranial flow during surgery to include detection and documentation of intraoperative and postoperative changes
- Assessment of vasomotor reactivity for specific indications
- Identification of, and monitoring of, intracranial vasculopathy in patients Sickle Cell Anemia
- Quantification of degree of intracranial stenosis (>65%) in the major basal cerebral arteries
- Monitor flow patterns within Arteriovenous Malformations, and identify the vascular supply to these malformations
- Assessment of the verteobasilar (posterior) circulation so that collateral and unusual pathology can be identified.

Contraindications and Limitations
- Inability to insonate, may be bilateral or unilateral
  - The Temporal bone above the zygoma usually provides a favorable “window” for TCD insonation
  - Inability to insonate occurs more frequently with advancing age, in women over 60+ years of age, with a higher incidence of failure among black/African Americans.
- Restless or uncooperative patients
- The U.S. Food and Drug Administration (FDA) power output of the transducer be reduced to the lowest power (as low are reasonably achievable) (ALARA) that allows a complete orbital examination.
- Remove contact lenses prior to the exam.
- Output power must not exceed 10% of maximum emitted power or 17 mW per cm2 or equivalent.
- In emergent or critical care situations, it may be difficult to perform a complete TCD evaluation
- TCD performance during an interventional procedure requires additional precautions for the examiner, due to the presence of radiation.
PATIENT COMMUNICATION

The technologist/sonographer/examiner should:
• Introduce self to the patient
• Explain the purpose of the Transcranial Doppler Evaluation and indicate the usual exam length
• Provide a brief summary of exam purpose and carefully explain exam procedures
• Respond to questions and address concerns expressed by the patient about the TCD exam
• Educate the patient about risk factors, symptoms of transient ischemic attacks, and stroke (when appropriate for patient condition)
• Refer specific diagnostic, treatment or outcome questions to the patient’s physician
• Explain the necessity of and remove patient’s eyeglasses and/or head-coverings

PATIENT ASSESSMENT

Patient assessment must be performed prior to the Transcranial Doppler Evaluation. It includes evaluation of the patient’s ability to tolerate the procedure and notation of any contraindications to the procedure.

The vascular technologist/sonographer/examiner should:
• Obtain a complete, pertinent patient history by interview of the patient or their representative and review the patient’s medical record, when available. A pertinent history includes:
  • Age, gender, race, and current medical status
  • Documented symptoms of cerebrovascular disease
  • Document pertinent laboratory values for hospitalized patients, which may include: hematocrit, hemoglobin, heart rate, cardiac output, blood pressure and intracranial pressure (In general, mean flow velocity changes in response to variables such as changes in CO2, blood pressure, heart rate, abnormal hematocrit, presence of fever, medications and current medical condition. These factors should be recorded for the interpreting physician, as they may impact the findings)
  • Note current medications or therapies
  • Obtain results of prior noninvasive or invasive procedures
  • Verify/confirm the requested procedure is appropriate for the patient’s presentation or suspected diagnosis.
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, orbital and sub-mandibular approach
- Turned to side with neck flexed/chin toward chest to optimize access to foramen magnum for sub-occipital (transforaminal) approach
- Alternatively, the sub-occipital exam can be performed with patient in sitting position, arms crossed and supported by stretcher or bedside table, head resting on arms so that neck is supported and relaxed
- patient should be kept awake throughout the exam due to changes in CO2 during sleep which may result in elevated TCD velocities and resulting misdiagnosis
- the TCD examiner should be positioned at the patient’s head with arms supported

INSTRUMENTATION (non-imaging TCD)

- Equipment specifically designed for TCD applications should be utilized.
- Appropriate frequencies (1.5-2.5 MHz) are needed to adequately penetrate the temporal bone.
- The equipment must have 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 (TAMM),
- peak and end diastolic velocities,
- pulsatility index,
- power output and frequency of the transducer.

INSTRUMENTATION (TCD-I)

Equipment requirements include:

- gray scale imaging,
- color flow Doppler
- range-gated pulsed Doppler (1.0-2.0 MHz frequency).

The equipment must have 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 (TAMM),
- peak and end diastolic velocities,
- pulsatility index,
- power output and frequency of the transducer.

Velocities obtained with TCD and TCDI do not use angle correction, but assume a zero to 30 degree angle of insonation. Modest differences in velocities reported by TCD and TCDI have been noted; TCDI velocities are usually 15% lower than TCD velocities. When reporting findings, it is important to validate findings and adjust diagnostic criteria.
EXAM PROTOCOL

A complete examination (either TCD or TCD-I) includes documentation from the following vessels and approaches:

TRANSTEMPORAL WINDOW
• Middle Cerebral Artery (MCA)
• Anterior Cerebral Artery (ACA)
• Bifurcation of the ICA into the MCA and ACA
• Posterior Cerebral Artery (PCA)
• Terminal ICA
• Anterior Communicating Artery (when identified as a collateral pathway)
• Posterior Communicating Artery (when identified as a collateral pathway)

ORBITAL WINDOW
• Ophthalmic Artery (OA)
• Siphonous portion of the internal carotid artery
• The orbital window is not routinely used for evaluation of pediatric patients with Sickle Cell anemia due to patient intolerance. If, however, the transtemporal exam is inadequate it may add valuable information to the clinical exam of Sickle Cell patients.

TRANSFORAMENAL (SUBOCCIPITAL WINDOW):
• Vertebral arteries (VA)
• Basilar artery (BA)

SUBMANDIBULAR WINDOW
• Retromandibular distal cervical internal carotid artery (for calculations/ratios utilized in the assessment of intracranial vasospasm)

Data is documented in hard copy and audio/video clips and presented to the physician for interpretation
EXAM PROTOCOL TCD (non-imaging)

Diagnostic criteria should be based on published criteria that are internally validated. Technical protocols 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 results the TCD should:
- Verify the presence or absence of flow in all vessels
- Identify vessels based on depth of the pulsed Doppler sample volume and flow direction
- Record mean velocity (TAMM-time averaged mean of the maximum velocity)
- Note waveform characteristics including pulsatility,
- systolic/diastolic velocities and ratios,
- flow turbulence
- systolic upstroke delays,
- side-to-side asymmetry of mean velocity
- focal increase in velocity indicative of stenosis, vasospasm or collateral effects
- Document randomly occurring high intensity signals (HITS) associated with the detection of embolic phenomenon

The standard examination protocol includes assessment of the intracranial vessels supplying the anterior and the posterior portions of the brain utilizing the transtemporal window, orbital window, transforaminal (suboccipital) window and sub-mandibular window

Transcranial Duplex Imaging (TCD-I)

- TCDI combines spectral waveform analysis
- Gray scale imaging
- Color flow Doppler imaging
- Mean flow velocity remains the primary criteria for diagnosis of intracranial hemodynamics
- Technical protocols should combine the previously noted evaluation of the basal cerebral arteries with the use of color flow imaging to identify each vessel.
- Spectral waveforms should still be assessed at 2-4 mm increments.
- Color Doppler images should be documented in each vessel,
- Gray scale imaging to document the bony landmarks (lesser wing of the sphenoid bone and petrous ridge of the temporal bone) and the cerebral peduncles.

Data is documented in hard copy and video clips and presented to the physician for interpretation
REVIEW OF THE DIAGNOSTIC EXAM FINDINGS

The technologist/sonographer/examiner should:

• Review the data acquired during the exam to ensure that a complete comprehensive evaluation has been performed and documented.

• Explain and document any exceptions (limitations, omissions, revisions) to the routine protocol

• Record all technical findings required to complete the final diagnosis in the patient’s medical record

• Document exam date, clinical indication(s), performing technologist and exam summary in the patient’s medical record

PRESENTATION OF EXAM FINDINGS

The technologist/sonographer/examiner should:

• Provide preliminary results when necessary as per internal laboratory guidelines

• Present record of diagnostic images, data, explanations, and technical worksheet to the interpreting physician for use in interpretation.

• Interpreting physician name must appear on the final report.

• Alert vascular laboratory Medical Director or appropriate health care provider when immediate medical attention is indicated based on the departmental guideline/policies and procedures.

EXAM TIME RECOMMENDATIONS

High quality, accurate results are fundamental elements of the Transcranial 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 transcranial examination; complete pre-examination paperwork and prepare the exam room and instrumentation. Prepare the patient for the exam by explaining the procedure (when appropriate for patient condition), 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 15-30 minutes

• Direct exam components include equipment optimization and the actual hands-on, examination process. Recommended time allotment is 30-45 minutes
REFERENCES


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