Transcranial Doppler Hands-on Workshop

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Disclosure

nothing to disclose
Objectives

- Understand pediatric clinical applications
- Recognize intracranial vascular anatomy
- Identify imaging windows and corresponding vascular anatomy
- Review equipment and techniques
- Distinguish waveforms, values, and criteria
Clinical Applications

- Brain Death
- Head Trauma
- Hydrocephalus
- Asphyxia and Cerebral Edema
- Stroke Screening for Sickle Cell Disease
- STOP Protocol
Cerebral Vascular Anatomy

Circle of Willis

- Anterior cerebral artery (left and right)
- Anterior communicating artery
- Internal carotid artery (left and right)
- Posterior cerebral artery (left and right)
- Posterior communicating artery (left and right)
- Basilar artery
Anterior Circulation

Arteries

- Internal Carotid (ICA)
- Middle Cerebral (MCA)
- Anterior Cerebral (ACA)
- Anterior Communicating (ACoA)
Posterior Circulation

Arteries
- Vertebral
- Basilar
- Posterior Cerebral (PCA)
- Posterior Communicating (PCoA)
Arterial Circulation of the Brain, Including Carotid Arteries

Circle of Willis
Right Middle Cerebral Artery
Basilar Artery
External Carotid Arteries
Ventral Arteries
Common Carotid Arteries
Anterior Cerebral Artery
Left Middle Cerebral Artery
Anterior Communicating Artery
Posterior Communicating Artery
Posterior Cerebral Artery
Vertebral Arteries
Internal Carotid Arteries
Middle Cerebral Artery
Anterior Cerebral Artery
Anterior Choroidal Artery
Posterior Cerebral Artery
Superior Cerebellar Artery
Pontine Arteries
Anterior Spinal Artery
Anterior Inferior Cerebellar Artery
Posterior Cerebral Artery
Posterior Inferior Cerebellar Artery
Ophthalmic Artery
Internal Carotid Artery
Cranial Windows

- Transorbital (A)
- Transtemporal (B)
- Suboccipital (C)
- Retromandibular
Transorbital

Window to evaluate:

- Ophthalmic Artery (OA)
- Internal Carotid Artery Siphon
Transtemporal

Window to evaluate:
- Middle Cerebral Artery (MCA)
- Anterior Cerebral Artery (ACA)
- Posterior Cerebral Artery (PCA)
- Distal Internal Carotid Artery (dICA)
Transtemporal
Transtemporal
Transtemporal
Transtemporal
Transtemporal
Transtemporal
Transtemporal
Transtemporal
Suboccipital

Window to evaluate:
▶ Vertebral Arteries
▶ Basilar Artery
Suboccipital
Suboccipital
Retromandibular Window to evaluate:
- Distal segment of extracranial Internal Carotid Artery
<table>
<thead>
<tr>
<th>Artery</th>
<th>Depth (mm)</th>
<th>Flow Direction*</th>
<th>Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCA</td>
<td>35-65</td>
<td>Toward</td>
<td>Temporal, Anterior/Superior</td>
</tr>
<tr>
<td>MCA/ACA Bifurcation</td>
<td>60-65</td>
<td>MCA Toward/ACA Away</td>
<td>Temporal, Anterior/Superior</td>
</tr>
<tr>
<td>ACA</td>
<td>60-75</td>
<td>Away</td>
<td>Temporal, Anterior/Superior</td>
</tr>
<tr>
<td>TICA</td>
<td>60-65</td>
<td>Toward</td>
<td>Temporal, Inferior</td>
</tr>
<tr>
<td>PCA</td>
<td>60-75</td>
<td>Toward</td>
<td>Temporal, Posterior/Inferior</td>
</tr>
<tr>
<td>Vertebral</td>
<td>65-85</td>
<td>Away</td>
<td>Foramen Magnum, Suboccipital</td>
</tr>
<tr>
<td>Basilar</td>
<td>85-120</td>
<td>Away</td>
<td>Foramen Magnum, Suboccipital</td>
</tr>
<tr>
<td>OA</td>
<td>45-60</td>
<td>Toward</td>
<td>Orbital</td>
</tr>
</tbody>
</table>

*in relation to transducer
Pitfalls

- Temporal window abnormality
- Occlusion vs. technical difficulty
- Operator dependent
- Lack of patient cooperation
- Aliasing
- Anatomic variants
Aliasing
Equipment/Technique

- Real-time imaging scanner with duplex Doppler capability
- Sector 2-MHz pulsed Doppler transducer
- No angle correction - assumed 0 degree
- Sample volume gate 4 - 6 mm
Equipment/Technique

- Data field
  - Resistive index (RI)
  - Pulsatility Index (PI)
  - Peak Systolic (PS)
  - End Diatolic (ED)
  - Time Average Mean Velocity (TAMX)
  - Sample Depth
  - Gate size
Color gain settings should be maximized so that a well defined vessel is displayed.

Doppler setting should be adjusted to obtain the highest velocity.

Doppler power output should be as low as reasonably achievable.
Patient position supine with head turned to the side

Calm and distract patient

Keep patient awake

Skilled sonographer

Audio – listening
STOP Protocol

Stroke prevention in sickle cell disease (STOP)

- Middle Cerebral Artery starting lateral obtain spectral Doppler tracings of every 2mm until you reach the bifurcation
- Bifurcation obtain spectral tracing at bifurcation (MCA and ACA)
- Distal Internal Carotid Artery
STOP Protocol cont.

- Anterior Cerebral Artery
- Posterior Cerebral Artery (P1 segment)
- Vertebral Arteries
- Basilar Artery
## STOP Protocol Criteria

<table>
<thead>
<tr>
<th>Status</th>
<th>Criteria</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>TAMMX &lt; 170 cm/s</td>
<td>Low risk for stroke</td>
</tr>
<tr>
<td>Conditional</td>
<td>TAMMX 170–199 cm/s in the MCA and/or dICATAMMMX &gt; 170 cm/s in PCA or ACA</td>
<td>Moderate risk</td>
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<tr>
<td>Abnormal</td>
<td>TAMMX ≥200 cm/s in the MCA and/or dICA</td>
<td>High risk</td>
</tr>
<tr>
<td>Inadequate</td>
<td>Unreadable or incomplete</td>
<td></td>
</tr>
</tbody>
</table>

References


• American Institute of Ultrasound in Medicine Practice Parameter; Transcranial Doppler Ultrasound for Adults and Children. AIUM.org 2012.

Thank You!