Updated or New Carotid Assessment Techniques, Technology or Concepts:

Pitfalls in the Sole Use of Duplex Scans in Decision Making for the Treatment of Carotid Lesions

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Carotid Duplex Assessment

Disclosures
• No financial disclosures

Carotid Duplex Assessment

Use of Carotid Duplex

• Primary means of characterizing carotid stenosis
• Often sole methodology used to determine whether carotid reconstruction should be undertaken

Carotid Duplex Assessment

Objectives

• Assess the adequacy of DUS in characterizing carotid stenosis for/not Treating Carotid Lesions
• Pitfalls:
  - Tardis Parvis
  - Pseudo-normalization
  - Acoustic Shadow
  - Non-stenotic, Symptomatic carotid
  - Internal Carotid Occlusion

Carotid Duplex Assessment

Post-Stenotic Fall-Off

Carotid Duplex

Tardis Parvis Waveform

• Latin for “Late and Small”
• Denotes Proximal Lesion
• Heart to Interrogation Point
  Aortic Stenosis
  Vessel Stenosis
  ECMO
**Carotid Duplex**
*Tardis Parvis Waveform*

Severe Proximal Common Carotid Artery Stenosis

**Carotid Duplex**
*Pseudo-normalization*

Longitudinal B mode: Stenosis in ICA

**Carotid Duplex**
*Pseudo-normalization*

Transverse B mode: Stenosis in ICA

**Carotid Duplex**
*Pseudo-normalization*

Normal Velocity and waveforms: ??

**Carotid Duplex**
*Pseudo-normalization*

CTA verifies stenosis Identifies also severe siphon stenosis → pseudonormalization

**Carotid Duplex**
*Acoustic Shadow*

- Calcified plaque reflects U/S waves, preventing penetration into vessel lumen
- This appears as an acoustic shadow on DUS
- Formally defined as a ≥5mm segment of shadowing
Carotid Duplex

**Acoustic Shadow Stenosis**

- Criteria Severity of Stenosis
- DUS percent stenosis
  - ≤ 150 cm/s → mild
  - 151-250 cm/s → moderate
  - > 250 cm/s → severe
- Determine Stenosis in an area not able to be interrogated by DUS

**Carotid Duplex

CTA Comparative Reference**

- CTA to measure lumen cross-sectional area
- Windows: width (W) 700, level (L) of 300 all CTA
- Optimize distinction calcified plaque and luminal contrast, and minimize pixel averaging

**Carotid Duplex

Acoustic Shadow**

8517 DUS studies performed (18 months)
- 550 with acoustic shadowing (incidence 6.1%)
85 Lesions available for comparative measurement lesions, DUS characterized:
  - 37 mild
  - 31 moderate
  - 17 severe

**Carotid Duplex

Acoustic Shadow Results**

<table>
<thead>
<tr>
<th>Duplex Parameter</th>
<th>CTA-NASCET Method</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-severe</td>
<td>Severe</td>
</tr>
<tr>
<td>Non-severe</td>
<td>41</td>
<td>27 (67.5%)</td>
</tr>
<tr>
<td>Severe</td>
<td>4</td>
<td>13</td>
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<tr>
<td>Total</td>
<td>45</td>
<td>40</td>
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<table>
<thead>
<tr>
<th>Duplex Parameter</th>
<th>CTA-ECST Method</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-severe</td>
<td>Severe</td>
</tr>
<tr>
<td>Non-severe</td>
<td>17</td>
<td>51 (77.2%)</td>
</tr>
<tr>
<td>Severe</td>
<td>2</td>
<td>15</td>
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<tr>
<td>Total</td>
<td>19</td>
<td>66</td>
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</table>

**Carotid Duplex

DUS Waveform Predictors**

<table>
<thead>
<tr>
<th>PSV</th>
<th>Mild (n=24)</th>
<th>Moderate (n=21)</th>
<th>Severe (n=40)</th>
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<tbody>
<tr>
<td></td>
<td>57.3 – 255.40</td>
<td>50.5 – 474.0</td>
<td>36.8 – 586.80</td>
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</table>

There is no PSV cut-off in the presence of acoustic shadow, necessitating CTA imaging to determine degree of stenosis

**Carotid Duplex

Assessment**

ICA “Occlusion”
Carotid Duplex Assessment

ICA “Occlusion”

CTA neck with delay views

Carotid Duplex Assessment

ICA “Occlusion”

Ascending Pharyngeal Artery

Carotid Duplex

“Normal” Carotid Duplex

Juxtaluminal Black Area (Hypoechoic) ACSRS

Carotid Duplex

CTA 3D Reconstruction

Carotid Duplex

CTA Plaque Characterization

Conclusions

- There are some scenarios where DUS may indicate likelihood of additional vascular pathology necessitating axial imaging: Tardis Parvis, Pseudo-normalization
- DUS is not capable verifying grade stenosis in presence of Acoustic Shadow or determining a ICA occlusion
- In the presence of symptomatic carotid, a Juxtaluminal Black Area (hypoechoic) area may not impart by DUS a "severe" stenosis but may be the offending lesion causing the stroke. CTA may verify this hypoechoic lesion
Carotid Duplex
Thank you