Use of the Vascular Laboratory to Evaluate Patients with Peripheral Arterial Disease

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Outline

• Arterial non-invasive studies
• Exercise stress testing
• Duplex examinations

Non-invasive Arterial Testing

• Confirm
• Localize
• Severity
• Qualitative
Non-invasive Arterial Testing

- Should detect moderate to severe disease
  - Claudication
  - Tissue Loss
  - Rest pain
- May miss mild disease
  - Exercise stress testing
- Calcified vessels
  - Toe pressures important

Segmental Arterial Pressures

- Use BP cuff to stop flow
- Pressure recorded is the pressure at the first appearance of systolic wave
- Customary to use the strongest signal (ie, DP vs. PT)
- Level of measurement is determined by the cuff,….not the probe!
- If brachial artery pressures are different, use the highest

Segmental Arterial Pressures

- Two, three or four cuff system
  - High thigh (HT)
  - Low thigh (LT)
  - Below knee (BK)
  - Ankle (A)
Sequential Arterial Pressures

- Cuff width > 50% of the diameter of limb
- Use PPG for toe pressures if Doppler signal is not obtainable
- Expect < 20 mm Hg difference between levels
- >30 mm Hg difference between levels suggests occlusion

Segmental Pressure Interpretation

<table>
<thead>
<tr>
<th>ABI’s</th>
<th>Normal variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0.95–1.1</td>
</tr>
<tr>
<td>1 level disease</td>
<td>0.8–0.95</td>
</tr>
<tr>
<td>2 level disease</td>
<td>0.5–0.8</td>
</tr>
<tr>
<td>&gt;2 level disease</td>
<td>0.3–0.5</td>
</tr>
<tr>
<td>ABI &lt;0.3 (&lt;0.4 DM)</td>
<td>Rest pain or tissue loss</td>
</tr>
<tr>
<td>ABI &gt;1.5</td>
<td>Calcification</td>
</tr>
</tbody>
</table>

Interventions

- >0.2 increase = significant improvement
- <0.2 increase = minimal improvement
Toe Pressures

Toe/Brachial Ratio
- Normal: 0.8-0.9
- Claudication: 0.2-0.5
- Rest pain: 0.0-0.2

Ulcer Healing
- <29% if TP < 20 mmHg
- 50% if TP 20-30 mmHg
- 91% if TP > 30 mmHg

Lower Extremity Arterial Study

- Segmental limb pressures (SLP)
- And
- Doppler waveforms (DW)
- Or
- Pulse volume recording (PVR)

Pulse Volume Recordings

- Air plethysmography waveform
  - Normal: Sharp upstroke/dicrotic notch
  - Mild: Absent notch/bowed downstroke
  - Moderate: Flattened peak, up/down equal
  - Severe: Low amplitude, slow rise

NORMAL SEVERE
Pulse Volume Recordings

- Air Plethysmography
  - Amplitude
  - Cardiac Output
  - Blood Volume
  - Vasomotor Tone
  - Size/Position of Extremity/Air in Cuff

Doppler Waveform Analysis

- Waveforms reflect the vascular bed of the end organ
- The flow characteristics give us our “signature” triphasic signal
Doppler Waveform

- Three components
  - Large forward flow velocity peak = systole
  - Brief phase of flow reversal = early diastole
  - Low-frequency forward flow = late diastole

Doppler Waveform

- Reflects changes in resistance
- Will be effected by
  - Body heat
    - Vasodilation with heat – lower resistance
    - Vasoconstriction with cold – higher resistance
  - Exercise
- Make sure patient rests for 5-10 min before obtaining measurements

Doppler Waveform

- Distal to a stenosis
  - Loss of flow reversal
  - Lower velocity
Exercise Testing

• 2 mph at 12% grade for 5 min
• Measure ankle pressures Q2 min x 5

Exercise Testing

• Little or no decrease in pressure from baseline = Normal
Exercise Testing

- Pressure drop, but normalizes within 2-6 min = Stenosis or occlusion at 1 level
- Large pressure drop, and remains low for up to 12 min = Multilevel disease
- Large pressure drop, and remains low for >12-15 min = Ischemic rest pain

Changes in Ankle Index after Treadmill Exercise

- Treadmill Time: 5 min
- Ankle Index: A = 100, B = 80, C = 60

Arterial Duplex

- Know the goal
- Know the anatomy (native vs. bypass)
- Identify hemodynamic lesions
- Identify plaques and calcium
Quantitative Doppler Velocity Measurements
- Quantitative
- Time consuming
- Difficult
- “Blind spots”

Qualitative Doppler Velocity Measurements
- Velocity increases at stenosis due to increased pressure gradient driving flow
- Turbulent flow is noted post-stenosis
- Severe lesions “top-out” at 400-600 cm/sec
- Quantitative measurements are made using pulsed doppler guided by color flow

Pulsatility Changes
- Proximal to stenosis
  - Increased pulsatility
  - Decreased velocity overall due to decreased flow
- Distal to stenosis
  - Decreased acceleration time
  - Broad systolic peak
  - Increased diastolic flow
  - Decreased peripheral resistance
  - Decreased velocity
**Arterial Duplex Normal Values**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Diameter (cm)</th>
<th>Velocity (cm/sec)</th>
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</thead>
<tbody>
<tr>
<td>EIA</td>
<td>0.6-0.9</td>
<td>98-141</td>
</tr>
<tr>
<td>CFA</td>
<td>0.6-0.9</td>
<td>90-138</td>
</tr>
<tr>
<td>SFA</td>
<td>0.48-0.72</td>
<td>77-104</td>
</tr>
<tr>
<td>Pop</td>
<td>0.4-0.6</td>
<td>55-82</td>
</tr>
</tbody>
</table>

**Doppler Waveform (Peripheral)**

- **Normal**
  - Triphasic

- **1-19% Stenosis**
  - Triphasic
  - Minimal spectral broadening
  - PSV < 30%
  - Normal distal WF

- **20-49% Stenosis**
  - Triphasic
  - Loss reverse flow
  - Marked spectral broadening
  - PSV 30 to 100%
  - NL distal WF