**NON-INVASIVE VASCULAR LOWER EXTREMITY EXAMINATION**

Pamela Scarborough
PT, DPT, MS, CDE, CWS, CEEAA

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**Objectives**

- At the end of the presentation participants will be able to:
  - Recognize when and why lower extremity vascular screens are appropriate
  - Discuss which exams to perform based on the presentation of the limb
  - Perform each lower extremity vascular exam in a skills lab setting

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**Vascular Disease in Lower Extremity Ulcer Formation**

- Incidence of ischemia 4Xs ↑ in patients with DM
- Increase in atherosclerotic process in lower extremity contributes to ulceration; but not usually primary cause
- Wound healing in lower extremity dependent on vascularity
- Without blood flow inflammatory and proliferative phases of wound healing cannot commence

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**Arterial Insufficiency Ulcers**

**Appearance**

- Wound base - pale
- Poor granulation
- Dependent rubor
- Skin - shiny, taut, thin, dry, hair loss
- Atrophy of subcutaneous tissue
- Deep wounds
  - Wound margins even
  - Minimal exudate
  - Skin temp cool
  - Round “punched out” effect
  - Necrosis - eschar, gangrene

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**59 y/o male with h/o diabetes**

Dropped hammer on foot

Result below

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**Non-Invasive Vascular Testing/Screens**

- Pulses (Dorsalis Pedis, Posterior Tibialis)
  - Present/Absent/Quality
  - Quality (Strong, weak, bounding)
- Rubor of Dependency
- Capillary Refill
- Venous filling time test
- Ankle Brachial Index
Vascular Evaluation

- Pedal pulses
  - dorsalis pedis
  - posterior tibialis

No vascular exam is complete without palpating for pedal pulses. HOWEVER, do NOT rely on pedal pulses to inform you whether there is enough blood flow for wound healing or whether compression for venous insufficiency is safe!!

Rubor of Dependency

- Subject position supine
- Remove shoes and socks
- Elevate leg to ~ 60° for 1 minute
- Bring leg to dependent position
- Assess color of lower leg/foot
  - Dependent rubor is a dark red discoloration of the skin of the foot on dependency, a sign of severely impaired circulation

Venous Filling Time Test

- May be indicative of arterial insufficiency
- Patient supine and relaxed
- Observe superficial veins on dorsum of foot to establish baseline appearance
- Elevate leg to approximately 60° for 1-2 minutes
- Allow gravity to drain distal veins
- Quickly lower leg over edge of table/bed to dependent position (leg hanging perpendicular to floor)
- Observe superficial veins and record amount of time required for them to refill and return to baseline appearance
- Normal 5-15 seconds
- > 20 seconds indicative of moderate to severe arterial insufficiency
- If refill < 5 seconds suspect venous insufficiency

ANKLE BRACHIAL INDEX TESTING

THE STANDARD OF CARE FOR LOWER EXTREMITY WOUNDS
What is an Ankle Brachial Index?

• A quantifiable measurement of lower leg blood supply
• A comparison of the systolic pressure in the upper arm to the systolic pressure at the ankle
• The ankle pressure should be equal to or slightly higher than the arm pressure in the absence of arterial occlusive disease

Why use Doppler?

• Palpation of foot pulses is not sufficient (Moffatt 1995)
• BP measurement at the ankle using a Stethoscope are difficult (Yao 1993)
• 10% of patients have absent Dorsalis Pedis pulses (Callam 1987)

All patients presenting with a lower extremity ulcer should be screened for arterial disease by Doppler measurement of ABI by staff who are trained to undertake this measurement


Preparation of the Patient

• Explain and reassure patient of the procedure
• Ensure ambient temperature of the room is comfortable
• Remove any tight clothing from both arms and stockings socks etc. from legs
• Remove any dressings from current ulcers and cover with a clear film
• Rest the patient in supine for 10-15 minutes for blood pressure to equalize

Method for Determining ABI’s

• Obtain both brachial artery systolic blood pressures using the Doppler
• Use arm with higher systolic BP to calculate ABI
• Measure Doppler closing pressures of both the dorsalis pedis and posterior tibial arteries in feet
• Cuff must be at the ankle level (gaiter area)
• Compare both Doppler ankle pressures to highest systolic brachial pressure (Index)

Brachial Pressures

• Place the appropriate sized sphyg cuff around upper arm just above elbow
• Locate Brachial pulse by palpation and apply ultrasound gel
• Angle Doppler at 45° into direction of blood flow and place over the brachial pulse adjusting the position to pick up the best signal

Brachial Pressures

• Inflate cuff until signal disappears; deflate slowly record pressure at which signal returns
• Repeat this procedure with the other arm (Stubbing 1996)
• Use the highest of these two values to calculate the ABI
Ankle Pressures
- Place an appropriate sized cuff around ankle immediately above malleoli
- Locate Posterior Tibial and Dorsalis pedis by palpation if possible
  If unable to palpate apply ultrasound gel & locate with Doppler
- Inflate cuff and follow procedure as for arm

ANKLE SYSTOLIC PRESSURE

Ankle-Brachial Index
Systolic Blood Pressure of Dorsalis Pedis & Posterior Tibialis
Divided by
Systolic Blood Pressure of Brachial Artery
(in the arm with higher systolic BP)

Calculating ABI’s

\[
\frac{\text{Ankle Pressure}}{\text{Brachial Pressure}} = \text{ABI}
\]

Examples:
\[
\frac{105 \text{ mmHg}}{140 \text{ mmHg}} = 0.75 \quad \frac{60 \text{ mmHg}}{120 \text{ mmHg}} = 0.50
\]

Correlation of ABI’s to Severity of Arterial Ischemia

<table>
<thead>
<tr>
<th>ABI</th>
<th>Clinical Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.95 or greater</td>
<td>Normal</td>
</tr>
<tr>
<td>0.7 +/- 0.1</td>
<td>Intermittent Claudication</td>
</tr>
<tr>
<td>0.5 +/- 0.1</td>
<td>Rest Pain</td>
</tr>
<tr>
<td>0.3 +/- 0.1</td>
<td>Impending Tissue Necrosis</td>
</tr>
</tbody>
</table>

LIMITATIONS OF ABI
- Diabetes & Diabetic Vasculopathy
- Medial calcific stenosis
- Causes non-compressible vessels
- Elevated blood pressure causes falsely elevated indices
- Greater than or equal to 1.0 (typically greater than or equal to 1.2)
- Greater than 250mmHg at a given level as indicates vessel as non-compressible
Non-compressible Vessels in Lower Extremities

- More common in people with diabetes
- Often have significant calcification of plaque in vessels
- Vascular cuff cannot completely compress vessels
- Result is an artificially high ABI such as 1.4
- Typically 1.30 and above are considered a sign of calcification
- These patients should have a TBI or Toe Brachial Index or be sent for scanning and further studies with a vascular surgeon

Ankle Brachial Index (ABPI)

Calculating ABI’s

\[
\text{Ankle Pressure} = \text{ABI} \times \frac{\text{Brachial Pressure}}{\text{Arm with highest SBP}}
\]

Examples:

\[
\begin{align*}
105 \text{ mmHg} & = 0.75 \\
140 \text{ mmHg} & = 0.50
\end{align*}
\]

Repeat ABI Checks

- Recommended that the ABI is checked every 12 weeks (Simon 1994)
- HOWEVER if patients condition changes during that time i.e. pain, procedure should be repeated as necessary
- If an ulcer re-occurs, repeat the Doppler assessment
- Do not presume wound of same origin!!!!

Contra-Indications

A Doppler ABPI should not be undertaken if the patient has either of the following:

- DEEP VEIN THROMBOSIS
- CELLULITIS

Manufacturer’s Recommendations

Toe Pressures

- Calcification rarely extends to digital arteries (Vowden, 1999)
- Toe pressures directly relate to foot ulceration healing - (Carter, 1993)
- Undertake toe pressures when ABPI>1.3 (Brooks, 2001)
**Toe Brachial Pressure Index**

- Normal: TPI > 0.7
- Equivocal: TPI 0.65-0.7
- Abnormal: TPI < 0.65

(Carter, 1985)

**ABI Conclusion**

- "Measurement of ABI by hand-held Doppler is essential in the assessment of chronic leg ulcers". ([SIGN, 1998](#))
- The effective assessment and management of leg ulcers are dependent on the education, knowledge and skills of the clinician doing the Doppler study
- "The Doppler ABI must be used in conjunction with a comprehensive & medical assessment". (Moffatt, 1995)
- Systems should be in place to monitor standards and the outcomes of ABI measurements. (RCN Guidelines, 1998)
Summary

• Vascularity is required for lower extremity wounds to heal
• All legs with chronic non-healing ulcers should have vascular studies
• Non-invasive studies can guide clinicians with treatment decisions related to safety and potential for healing
• Non-invasive vascular tests can aid clinicians with decisions for referrals to vascular surgeons
• Pedal pulses are inadequate to determine ability for lower extremity wounds to heal
• The standard of care for compression to be safe and effective is for ankle brachial index studies to be performed

Thank You!!!