Vascular Wounds and Limb Salvage

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Disclosures

Deanna L. Nelson, MD has no conflicts of interest to disclose.
Learning Objectives

1. Identify critical limb ischemia
2. Differentiate venous & arterial wounds
3. Learn about endovascular interventions for limb salvage.
Wound healing

The four phases of acute wound healing:
<table>
<thead>
<tr>
<th>Arterial</th>
<th>vs</th>
<th>Venous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cause:</strong> Insufficient blood supply, embolism</td>
<td></td>
<td><strong>Cause:</strong> Venous hypertension</td>
</tr>
<tr>
<td><strong>History:</strong> Smoking, diabetes, HTN, claudication</td>
<td></td>
<td><strong>History:</strong> DVT, Varicose veins, valve incompetence</td>
</tr>
<tr>
<td><strong>Characteristics:</strong> -Crater like, deep -Pale, shiny skin, hair loss -Dry, eschar ** Dependent rubor</td>
<td></td>
<td><strong>Characteristics:</strong> -Shallow, superficial, irregular borders. -Edema, lipodermatosclerosis - Fibrin, exudate</td>
</tr>
<tr>
<td><strong>Location:</strong> Distal or pressure points</td>
<td></td>
<td><strong>Location:</strong> Gaiter region</td>
</tr>
<tr>
<td>Arterial</td>
<td>vs</td>
<td>Venous</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Pain: relieved by dangling</td>
<td></td>
<td>Pain: Relieved by elevation</td>
</tr>
<tr>
<td>ASA, statin, anticoagulation?</td>
<td></td>
<td>Compression, elevation</td>
</tr>
<tr>
<td>Diagnostic WU:</td>
<td></td>
<td>Diagnostic WU:</td>
</tr>
<tr>
<td>- Non-invasive ABI, Duplex ultrasound</td>
<td></td>
<td>- Non-invasive DVT ultrasound</td>
</tr>
<tr>
<td>- CTA</td>
<td></td>
<td>- Venous insufficiency</td>
</tr>
<tr>
<td>- Angiogram</td>
<td></td>
<td>- CT venogram</td>
</tr>
<tr>
<td>Wound care:</td>
<td></td>
<td>If it’s wet keep it dry if it’s dry keep it wet.</td>
</tr>
<tr>
<td>- Betadine,</td>
<td></td>
<td>- Wet to dry w/comp</td>
</tr>
<tr>
<td>- Wet to dry</td>
<td></td>
<td>- Mepilex AG</td>
</tr>
<tr>
<td>- Dakins</td>
<td></td>
<td>- Unna boot</td>
</tr>
</tbody>
</table>
Arterial Insufficiency (PAD)
### Rutherford Criteria

**Table 1. Fontaine or Rutherford classification systems of peripheral arterial disease**

<table>
<thead>
<tr>
<th>Fontaine classification</th>
<th>Rutherford classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade</td>
</tr>
<tr>
<td>Stage</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0</td>
</tr>
<tr>
<td>IIa</td>
<td>I</td>
</tr>
<tr>
<td>IIb</td>
<td>I</td>
</tr>
<tr>
<td>III</td>
<td>I</td>
</tr>
<tr>
<td>IV</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>III</td>
</tr>
</tbody>
</table>
Diagnostic Imaging

- ABI’s +/- exercise
- Duplex Ultrasound
- CT Angiogram
- Conventional Angiography
 ABI

- **Ankle-Brachial Index**

  **Interpretation of ABI:**
  
<table>
<thead>
<tr>
<th>ABI Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1.30</td>
<td>Noncompressible</td>
</tr>
<tr>
<td>1.00–1.29</td>
<td>Normal</td>
</tr>
<tr>
<td>0.91–0.99</td>
<td>Borderline (equivocal)</td>
</tr>
<tr>
<td>0.41–0.90</td>
<td>Mild to moderate peripheral arterial disease</td>
</tr>
<tr>
<td>0.00–0.40</td>
<td>Severe peripheral arterial disease</td>
</tr>
</tbody>
</table>

  ![Diagram of ABI measurement](image)
Arterial Duplex
CT Angiogram
Angiogram
Treatment Options

- Angioplasty
- Stenting
- Atherectomy
- Endarterectomy
- Traditional Bypass
- Amputation
Case #1

- 48 yo male with CHF, Cirrhosis, Chronic non-healing ulcers of both feet and heels. Uncontrolled edema. Ambulates less than 20 ft. Being treated at a wound care center. Non-compliant with wound care and appointments due to transportation. No femoral pulses.
Distal Aortic and bilateral iliac occlusions.
Post operative image
Case #2

- 67 yo male with left leg pain for 6 months. + tobacco and HTN. Cramping in the thigh and calf. Progressively worse and difficulty going to work. No significant medical history, no PCP visit in >10 years. Got a splinter in his foot and now the spot has turned black.
Left Common Iliac Occlusion
Case #3

- 68 yo male with right BKA who presents with wet gangrene of his left 2\textsuperscript{nd} and 3\textsuperscript{rd} toes. HTN, DM, +tobacco. Had been lost to follow up.
Diffuse tibial disease
Recanalization and Angioplasty
Case #4

- 52 yo male with rest pain in his left foot. 2 cracks in the skin at the heel that have failed to heal. He had a femoral to PT bypass 2 years ago for similar symptoms and it appears that has thrombosed. He continues to smoke and does not take his aspirin. Admittedly, he has been quite non-compliant, but is now having such bad rest pain that he hasn't slept in days.
Bypass with vein
Primary amputation
Venous Insufficiency
CEAP Classification

Clinical

- $C_1$: No clinical signs
- $C_2$: Small varicose veins
- $C_3$: Large varicose veins
- $C_4$: Edema
- $C_5$: Skin changes without ulceration
- $C_6$: Skin changes with healed ulceration
- $C_7$: Skin changes with active ulceration

Etiology

- $E_1$: Congenital
- $E_2$: Primary
- $E_3$: Secondary (usually due to prior DVT)

Anatomy

- $A_1$: Superficial veins
- $A_2$: Deep veins
- $A_3$: Perforating veins

Pathophysiology

- $P_1$: Reflux
- $P_2$: Obstruction

Clinical Classifications with examples

- $E_1$: Varicose veins
- $E_2$: Ulcer
- $E_3$: Venous eczema
- $E_4$: Venous ulcers

Early application of compression should be performed to correct swelling and progressive scarring and to initiate the healing process by improving the venous microcirculation.


Anatomy

The Venous Anatomy of the Legs:
Deep System - light blue  Superficial System - dark blue
Diagnostic Imaging

- Venous duplex
- Venous Insufficiency Study
- CT Venogram
- Venogram +/- IVUS
Venous Duplex

<table>
<thead>
<tr>
<th>Direct signs</th>
<th>Indirect signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intramural thrombus</td>
<td>Loss of phasicity: Proximal thrombosis</td>
</tr>
<tr>
<td>Incompressibility</td>
<td></td>
</tr>
<tr>
<td>+ Vein diameter</td>
<td></td>
</tr>
<tr>
<td>No flow in pulse Doppler</td>
<td>Loss of augmentation: Distal thrombosis</td>
</tr>
<tr>
<td>No flow in color Doppler</td>
<td></td>
</tr>
</tbody>
</table>

![Duplex ultrasound images]
Venous Insufficiency Study
CT Venogram
Venogram
Treatment Options

- Depends on pathophysiology and Anatomy
  - Reflux vs Obstruction
  - Deep vs Superficial
- Compression
- Angioplasty and stenting
- Thrombolysis
- Bypass
- Ablation/Closure

EVERYBODY!

Deep, Obstructive

Superficial, Reflux
Case #1- Venous

- 59 yo otherwise healthy male s/p IVC filter placement 10 years ago as prophylaxis after spinal fusion. No clotting disorders. 3 weeks prior was in a motorcycle accident and developed abrupt severe BLE edema and pain 2 weeks later. Has been to the ED multiple times in the past 2 weeks.

- Extensive BLE DVT's
Occluded IVC Filter
Case #2 Venous

- 38 yo female with a history of traumatic sacral fracture in 2011. Since then has had intermittent leg and pelvis pain as well as varicose veins. Diagnosed with May Thurner in Sioux Falls by venogram with no intervention. Pt declined second procedure for stent placement and has since moved to Knoxville. Over the past 2 weeks she has begun to feel ill with myalgias and now has dyspnea and pleuritic chest pain.
May Thurner Syndrome
Case #3

- 68 yo male with history of post traumatic DVT in Right femoral and popliteal veins. Deep and superficial reflux, non-healing surgical wound after ankle fracture.
Conclusion

- Arterial and venous disease can both cause non-healing wounds
- Different characteristics, anatomic locations
- Disease can be mixed
- Questions?