Peripheral Arterial Disease & Arterial Ulcers

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The Comprehensive Wound Care Review Course

Endorsed:
Prevalence of PAD

- PAD prevalence rates by noninvasive testing:
  - 2.5% at ages 40 to 59 years
  - 8.3% at ages 60 to 69 years
  - 18.8% at ages 70 to 79 years
  - Prevalence has been shown to be higher in men than in women

- Critical Limb Ischemia 1% > 70 years

Criqui MH, Denenberg JD, Langer RD, Fronek A. The epidemiology of peripheral arterial disease: importance of population at risk. Vasc Med 1997;2:221-6
Criqui MH, Denenberg JD, Langer RD, Fronek A. The epidemiology of peripheral arterial disease: importance of identifying the population at risk. Vasc Med 1997;2:221-6
Definitions

➢ Arteriopathy
➢ Arteriosclerosis
➢ Atherosclerosis
Arteriopathy

➢ ar·te·ri·op·a·thy (är-tîr-p-th) n.
➢ A disease of the arteries.
Arteriosclerosis

➢ ar·te·ri·o·scler·o·sis (är-tîr--skl-rss) n.
➢ Any of a group of chronic diseases in which thickening, hardening, and loss of elasticity of the arterial walls result in impaired blood circulation. Also called arterial sclerosis.
Atherosclerosis

- ath·er·o·scle·ro·sis (th-r-sk1-rss) n.
- A form of arteriosclerosis characterized by the deposition of atheromatous plaques containing cholesterol and lipids on the innermost layer of the walls of large and medium-sized arteries.
Atherosclerosis

- Affects up to 10% of the Western population older than 65 years
- Expected to increase 22% by the year 2040
  - Population > 65 years
- Expected to have a huge financial impact on medicine.
- Using claudication is used as an indicator
  - 2% of the population aged 40-60 years
  - 6% of the population older than 70 years
Ischemic Ulcers
Death Rates By Disease

➢ The likelihood of a diabetic being dead five years after an amputation is nearly 50%. This is more than double the chance of death from prostate or breast cancer.

PAD Associated Mortality

PAD Risk Factors

- **Established**
  - Hypercholesterolemia
  - Cigarette Smoking
  - Hypertension
  - Diabetes Mellitus

- **Relative**
  - Advanced age
  - Male gender
  - Hypertriglyceridemia
  - Hyperhomocysteinemia
  - Sedentary Lifestyle
  - Family history
Risk Factor Modification

➢ **Lipid management**
  - LDL < 100mg/dl
  - HDL > 35 mg/dl
  - TG < 200 mg/dl

➢ **Weight Reduction**
  - < 120% ideal body weight by activity and diet

➢ **Smoking**
  - Complete cessation behavior modification, counseling, nicotine analogues

➢ **Blood Pressure**
  - < 140/90 mmHg, weight control, physical activity, Na+ restriction, antihypertensive meds

➢ **Physical Activity**
  - 30 min moderate exercise 3-4 times/wk
Smoking Cessation

Image Source: www.hypnosisnetwork.com
PAD Comorbid Conditions

➢ Cardiovascular Disease
  - CAD present in 29% of patients with PAD
  - CAD present in 11% of patients without PAD
  - Cardiovascular disease can be detected in as many as 90% of patients with intermittent claudication

➢ Studies have consistently shown a high mortality rate in patients with PAD and intermittent claudication
  - In a Swedish study of 439 men, ABI of less than 0.9 associated with a 2.4-fold higher mortality rate and a twofold higher CAD event
  - Other studies showing a 2-4 fold increased risk of mortality in patients with intermittent claudication, predominantly due to CAD

Criqui MH, Denenberg JO, Langer RD, Fronek A. The epidemiology of peripheral arterial disease: importance of identifying the population at risk. Vasc Med 1997;2:221-6
PAD Comorbid Conditions

➢ Cerebrovascular Disease
  - CVD is present in 50-75% of PAD patients, 5% overlap between PAD, CAD, and CVD in men and women aged 62 years and older.

➢ Intermittent Claudication and Mortality Rate
  - 5 year mortality 30%
  - 10 year Mortality 50%
  - 15 year mortality rates 70%
  - Cardiovascular cause estimated to be responsible for 70% to 80% of deaths

Criqui MH, Denenberg JO, Langer RD, Fronek A. The epidemiology of peripheral arterial disease: importance of identifying the population at risk. Vasc Med 1997;2:221-6
Anatomy
Anatomy

Image Source: www.yoursurgery.com
Angiosome
The angiosome concept divides the body into three-dimensional vascular territories supplied by specific source arteries and drained by specific veins.

Five distinct angiosomes of the lower leg:
- medial sural artery
- lateral sural artery
- posterior tibial artery (PTA)
- anterior tibial artery (ATA)
- peroneal artery (PA)

Foot and ankle area has six distinct angiosomes arising from the PTA, ATA, and peroneal artery.

Regional Perfusion Defect

- ABI 0.9
- SPP
  - Dorsum 42
  - Plantar 28

Stenting Dorsalis Pedis Artery

- Post SPP
  - Dorsum 91
  - Plantar 82

Symptoms
Chronic Arterial Insufficiency

- Claudication
  - Reproducible Exertional Muscle Pain / Ache / Heaviness
- Rest Pain
- Distal Pain at Rest
  - Often Improved with Dependency
- Numbness
  - May be Rest Pain Equivalent
- Ulceration
- Gangrene
Clinical Presentation
Chronic Arterial Insufficiency

➢ Accompanying Physical Signs
➢ Absent Pulses
➢ Pallor
➢ Dependent Rubor
➢ Coolness
➢ Absent Hair
➢ Dry Skin
➢ Odor of Tobacco
➢ Prior Amputations

Image Source: www.presentdiabetes.com
5 P’s of Acute Limb Ischemia
Chronic Arterial Insufficiency

➢ **Pain:**
  - time of onset, location and intensity, change over time

➢ **Pulselessness:**
  - pedal pulse palpation is highly variable
  - absent pulse findings are suggestive but not diagnostic
  - palpable pulses alone do not rule it out
  - Evaluate with doppler and measure ABI
  - Absence of pulse with doppler highly consistent with Acute Limb ischemia

➢ **Pallor:**
  - change in color and temperature
  - is a common finding in ALI
  - important when different from the contralateral limb
  - Venous filling may be slow or absent

➢ **Paresthesia:**
  - numbness occurs in more than half of patients

➢ **Paralysis:**
  - is a poor prognostic sign
Ulcer Characteristics

➢ Location
  • Typically distal

➢ Appearance
  • +/- necrosis
  • +/- dry
  • Typically shallow

➢ Pain
  • Typically painful
Vascular Evaluation
Wound Care Clinic

- Physical Examination
- Ankle/brachial index (ABI)
  - Toe Brachial Index (TBI)
- Transcutaneous oxygen tension (TCOM)
- Skin Perfusion Pressure (SPP)
Vascular Evaluation
Vascular Center Referral

➢ Non-Invasive
  • Exercise ABI
  • Ultrasound Doppler wave forms
  • Pulse Volume Recording (PVR)

➢ Invasive
  • Angiography
  • CT Angiography
  • Magnetic Resonance Angiography
Vascular Assessment: Pulses
 Clinical Research and Methods 

An Absent Pulse Is Not Sensitive for the Early Detection of Peripheral Arterial Disease 

Tracie C. Collins, MD, MPH; Maria Suarez-Almazor, MD, PhD; Nancy J. Petersen, PhD 

Background: This study’s objective was to determine the test characteristics of pedal pulse palpation in the diagnosis of peripheral arterial disease (PAD) when compared to the more widely recommended screening tool, the ankle-brachial index (ABI). Methods: We screened patients ≥ 50 years of age for PAD within primary care clinics in Houston. PAD was diagnosed by an ABI of <0.9. At each visit, pedal pulse palpation was performed for each leg. Of the patients who screened positive for PAD by ABI, we determined the sensitivity, specificity, and positive predictive value of pulse palpation.
Palpable Pulses!

➢ In patients with PAD (as detected by ABI) 74% had a palpable pulse
➢ More than two thirds of the patients within the study group with evidence PAD had a palpable pulse
➢ The sensitivity of a non-palpable pulse for the diagnosis of PAD was 26%
➢ Pulse palpation is not sensitive for the detection of PAD when compared to ABI
Vascular Assessment: ABI

➢ Ankle-Brachial Index

Index = \[
\text{Highest of DP or PT pressures} \\
\text{Highest of R or L Brachial Pressures}
\]

Calculated For Each Leg Separately
Vascular Assessment: ABI

- **Ankle-Brachial Index**
  - < 0.9 suggests atherosclerotic vascular disease with 95% sensitivity and 99% specificity
  - Falsely elevated when arteries heavily calcified as is seen in diabetes

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Vascular Assessment: ABI

- Ankle-Brachial Index Reference values
  - 0.9 – 1.2 Normal
  - 0.8 – 0.9 Mild Ischemia
  - 0.4 – 0.8 Moderate Ischemia
  - < 0.4 Severe Ischemia
  - > 1.2 Non-Compressible Arterial Calcinosis

WB Saunders CO., Orlando FL 1995
Vascular Assessment: TCOM
Transcutaneous Oximetry

Is not the same as Pulse Oximetry!
TCOM Clinical Guidelines

- TCOM > 40 mmHg in Diabetic Patient
  - predicts likelihood of healing
- TCOM > 30 mmHg in Non-Diabetic Patient
  - predicts likelihood of healing
- Identifies islands of ischemia in extremity
- TCOM can be used to measure response to oxygen during hyperbaric therapy
TCOM Clinical Guidelines

- 37 Patients undergoing BKA
- Preoperative TCOM evaluation
- $P_{TCO_2} = 0$ torr / All Failed
- $P_{TCO_2} 30 - 40$ torr / 15 of 19 Healed
- $P_{TCO_2} > 40$ torr / All Healed

TCOM Clinical Guidelines

- 20 patients with previously non-healing wounds treated with HBO therapy. TCOM values 2.4 ATA

- $P_{TCO_2} < 50$ torr / All Failed
- $P_{TCO_2} 50 - 100$ torr / Most Healed
- $P_{TCO_2} > 100$ torr / All Healed

Wattel, et al  Angiology 1990
Skin Perfusion Pressure

- A distal arterial perfusion test
- Utilizes laser Doppler to evaluate reactive hyperemia
- Measures in millimeters of mercury (mmHg) the pressure at which blood flow first returns to capillaries following controlled release of occlusion
- SPP value is highly effective in detecting PAD, predicting healing potential and disease severity.
SPP Clinical Guidelines

➢ Sensilase

Diamond marks:
- Return of blood flow
- SPP value

Capillary occlusion

Controlled cuff release
Assessing The Probability Of Healing With SPP

- Ischemic Wound
- Marginal Ischemia (PAD)
- Unlikely (CLI)
- Healing is
- Not Ischemic Wound
- Wound

Vascular Assessment
Vascular Center - Referral

- Exercise ABI
- Duplex Ultrasonography
- Contrast Angiography
Non-Invasive Vascular Testing

- **MICRO Circulation**
  - TcPO2, TCOM (trans-cutaneous oxygen)
  - SPP (skin perfusion pressure)

- **MACRO Circulation**
  - ABI (ankle-brachial index)
  - PVR (pulse volume recordings)
  - Segmental pressures
Segmental Pressures

- Segmental arterial pressures is a test that measures the blood pressures at different levels in the legs to evaluate blood flow.
- Dense calcifications and inability to compress vessels make segmental pressures assessment less accurate.
Pulse Volume Recording

➢ A PVR study is a non-invasive vascular test in which blood pressure cuffs and a handheld Doppler or transducer obtain arterial pressure tracings at intervals on the arms or legs

➢ Determine the presence, severity and general location of peripheral arterial occlusive disease

➢ PVR is a vascular study and may also be called a Doppler segmental pressure study
Non-Invasive Testing - Macro

Image Source: angiologist.com / bedahunmuh.wordpress.com / cmbi.bjmu.edu.cn
Duplex Ultrasonography

Objective, Noninvasive, Direct imaging tool
- Provides an anatomical “Roadmap” to guide decisions regarding potential endovascular intervention
- Provides follow-up information regarding success and patentcy of vascular interventions

Detection of occlusions and stenoses in correlation with contract angiography
- Sensitivity US 95% - Angiography 92%
- Specificity US 99% - Angiography 97%

Rutherford Classification

A more recent classification by Rutherford consists of three grades and six categories:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Category</th>
<th>Clinical</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>Mild Claudication</td>
</tr>
<tr>
<td>I</td>
<td>2</td>
<td>Moderate Claudication</td>
</tr>
<tr>
<td>I</td>
<td>3</td>
<td>Severe Claudication</td>
</tr>
<tr>
<td>II</td>
<td>4</td>
<td>Ischemic Rest Pain</td>
</tr>
<tr>
<td>III</td>
<td>5</td>
<td>Minor Tissue Loss</td>
</tr>
<tr>
<td>III</td>
<td>6</td>
<td>Major Tissue Loss</td>
</tr>
</tbody>
</table>

## Fontaine Classification

<table>
<thead>
<tr>
<th>Stage</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>IIA</td>
<td>Mild Claudication</td>
</tr>
<tr>
<td>IIB</td>
<td>Moderate to Severe Claudication</td>
</tr>
<tr>
<td>III</td>
<td>Ischemic Rest Pain</td>
</tr>
<tr>
<td>IV</td>
<td>Ulceration or Gangrene</td>
</tr>
</tbody>
</table>

Pharmacotherapy

➢ Antiplatelet and lipid-lowering therapies are effective in decreasing the risk of cardiovascular morbidity and improving long-term survival.

• Antiplatelet Agents appear to prevent ischemic events
  • Aspirin, Dipyridamole, Ticlopidine, Clopidogrel

• Intermittent Claudication
  • Cilostazol is of proven benefit
  • Pentoxifylline of questionable benefit
  • Only these drugs are approved by the FDA for treatment of intermittent claudication.

Exercise therapy is a recommended adjunct to pharmacotherapy

- A recent meta-analysis of 21 supervised exercise programs showed that training for at least 6 months, by walking to near-maximum pain tolerance, significantly improved pain-free and maximum walking distance.
- The only controlled trial comparing an exercise program with percutaneous transluminal angioplasty found that exercise was better.
- Exercise programs are cheaper than percutaneous transluminal angioplasty or surgery, although long-term compliance seems poor.
Endovascular Intervention

➢ Balloon dilatation and stenting
➢ Laser arthrectomy and stenting
➢ Cutting devices and stenting
Endovascular Intervention
PTA and Stent
Endovascular Intervention
Atherectomy
Endovascular Intervention
PTA and Stent

Anterior Tibial Artery

99% Stenosis

Dorsalis Pedis Artery
Combined Intervention
## Patency Rates

### Femoral Popliteal Intervention

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Disease</th>
<th>1 Year Patency Rate</th>
<th>3 Year Patency Rate</th>
<th>5 Year Patency Rate</th>
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</thead>
<tbody>
<tr>
<td>PTA</td>
<td>Stenosis</td>
<td>77</td>
<td>61</td>
<td>55</td>
</tr>
<tr>
<td>PTA</td>
<td>Occlusion</td>
<td>65</td>
<td>48</td>
<td>42</td>
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<tr>
<td>PTA &amp; Stent</td>
<td>Stenosis</td>
<td>75</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>PTA &amp; Stent</td>
<td>Occlusion</td>
<td>73</td>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

Surgical Revascularization

➢ Still considered the “gold standard” by most
➢ Operative series have consistently demonstrated 5 year limb salvage rates of 80% or greater
➢ Major morbidity occurs in at least 10% patients
➢ Morbidity may compromise functional outcomes as less than 50% patients report a return to “normal” by 6 months postoperatively
➢ Reintervention rates are 25% to sustain limb salvage and secondary graft patency
Surgical Bypass Patency

5 year % patency estimates

- Ao-bi-fem (limb)
- Cross Fem
- Fem-pop-BK vein
- Ax-bi-fem
- Iliac-PTA
- Fem-pop-PTA sten
- Ax-uni-fem
- Fem-pop-PTAocc
- Plantar
- Fem-pop-BK pros

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Patency (5Yr)</th>
<th>Limb Salvage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortofemoral</td>
<td>70-88%</td>
<td>Limb Salvage 90%</td>
</tr>
<tr>
<td>SFA Reversed Vein</td>
<td>75-80%</td>
<td>Limb Salvage 84%</td>
</tr>
<tr>
<td>SFA In Situ Vein</td>
<td>80%</td>
<td>Limb Salvage 84%</td>
</tr>
<tr>
<td>Re-operative</td>
<td>60%</td>
<td>Limb Salvage 72%</td>
</tr>
</tbody>
</table>

Critical Limb Ischemia

➢ Progression of PAD can lead to CLI
➢ Manifested by ischemic pain at rest or in breakdown of the skin (ulcers or gangrene)
➢ Severe PAD can result in tissue ischemia in the lower extremities, causing gangrene and requiring amputation in 3% to 8% of patients
➢ Aggressive investigation for revascularization options, either surgical or percutaneous, are warranted in such instances
➢ Only a small proportion of patients with severe disease ultimately requires a major amputation
Limb Salvage Procedures

➢ Amputation of some part of the foot
  ➢ Digit
    • partial or total
  ➢ Ray
    • digit and metatarsal
  ➢ Midfoot
    • transmetatarsal, tarso-metatarsal, transverse tarsal
  ➢ Symes
    • ankle
Limb Salvage Procedures

- Second category of foot salvage involves the debridement of the wounds, including excision of bone.
- These procedures permit the foot to keep its general outward appearance intact, while disturbing the internal architecture that is causing the increased pressure.
- Foot salvage procedures, short of amputation, that can be used in the revascularized foot include exostectomy, arthroplasty, metatarsal head excision and calcanectomy.
## BKA Prosthetic Outcomes

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Patients = N</th>
<th>Percent Fitted</th>
<th>Percent Ambulator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruckley (1991)</td>
<td>191</td>
<td>80</td>
<td>74</td>
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<tr>
<td>Siriwardena (1991)</td>
<td>267</td>
<td></td>
<td>63</td>
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<td>Hagberg (1992)</td>
<td>24</td>
<td>100</td>
<td>96</td>
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<tr>
<td>Stimemann (1992)</td>
<td>126</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>McWhinnie (1994)</td>
<td>61</td>
<td>66</td>
<td>52</td>
</tr>
</tbody>
</table>

Management of Arterial Ulcers

➢ Correct Ischemia (if possible)
➢ Pain Control
➢ Behavioral Modification/Pharmacology
➢ Local Wound Care
  • Maintain dry eschar until revascularized
  • Debridement and moist dressings after revascularization
  • Manage Infection and Control Bioburden
➢ Consider Amputation (non viable tissues/digits)
Management of Arterial Ulcers
Quality Measure 2012

“Screen all patients with lower extremity skin breakdown with Laser Doppler, TCOM or ABI/TBI.”
Thank You....