Peripheral Artery Disease: Diagnosis and Management

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Introduction

- PVD/PAD effects 27 million people over 55 yrs in North America and Europe.

- PAD often occurs in concert with CAD

- CAD is leading cause of death in patients with PAD (75% of deaths)

- Patients with PAD are at increased risk of atheroembolic events and 6 times more likely to die than patients without PAD
Cardiologists and PAD

Rationale

- Coexistence of CAD & PAD
- Common risk factors & modification
- Expertise in clinical evaluation of the patient
- Expertise in risk factor adjustment
- Interest in longitudinal follow-up and global approach to patient’s disease
Overlapping of Atherosclerotic Disease

Patients with one manifestation often have coexistent disease in other vascular beds

N= 1802 patients
Mean age = 80 yrs (60-102)

Prevalence of PAD

In a primary care population defined by age and common risk factors, the prevalence of PAD was approximately one in three patients.

NHANES=National Health and Nutrition Examination Study;
PARTNERS=PAD Awareness, Risk, and Treatment: New Resources for Survival [program].
PARTNERS: Prevalence of PAD and Other CVD in Primary Care Practices

29% of Patients in a Target Population Were Diagnosed With PAD Using An Office-Based ABI

ABI=ankle-brachial index; CVD=cardiovascular disease.

Prevalence of PAD Increases With Age

Rotterdam Study (ABI <0.9)¹  San Diego Study (PAD by noninvasive tests)²

 Patients With PAD (%)  

Age (years)  
55-59  60-64  65-69  70-74  75-79  80-84  85-89

Prevalence of PAD Increases With Age

ABI=ankle-brachial index

Gender Differences in the Prevalence of PAD

6880 Consecutive Patients (61% Female) in 344 Primary Care Offices

Prevalence (%)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>70-74</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>75-79</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>80-84</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>&gt;85</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>

Adapted from Diehm C. Atherosclerosis. 2004;172:95-105 with permission from Elsevier.
Risk Factors for PAD

- Smoking
- Diabetes
- Hypertension
- Hypercholesterolemia
- Hyperhomocysteinemia
- C-Reactive Protein

Relative Risk:
- Reduced
- Increased
Physical Exam Findings of Lower Extremity PAD

The Physical Exam Should Be Performed With Patient’s Pants/Shoes Off

Limb examination (and comparison with the opposite limb) includes:

- Absent or diminished femoral or pedal pulses (especially after exercising the limb)
- Arterial bruits
- Hair loss
- Poor nail growth (brittle nails)
- Dry, scaly, atrophic skin
- Dependent rubor
- Pallor with leg elevation after 1 minute at 60 degrees (normal color should return in 10 to 15 seconds; longer than 40 seconds indicates severe ischemia)
- Ischemic tissue ulceration (punched-out, painful, with little bleeding), gangrene

Elevation Pallor/Dependent Rubor
Elevation Pallor/Dependent Rubor
Gangrene
ABI Procedure

Using the ABI

Right ABI
80/160=0.50

Brachial SBP
150 mm Hg

PT SBP 40 mm Hg
DP SBP 80 mm Hg

Left ABI
120/160=0.75

Brachial SBP
160 mm Hg

PT SBP 120 mm Hg
DP SBP 80 mm Hg

Highest brachial SBP

ABI
(Normal >0.90)

Highest of PT or DP SBP
## Interpreting the Ankle-Brachial Index

<table>
<thead>
<tr>
<th>ABI</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00–1.29</td>
<td>Normal</td>
</tr>
<tr>
<td>0.91–0.99</td>
<td>Borderline</td>
</tr>
<tr>
<td>0.41–0.90</td>
<td>Mild-to-moderate disease</td>
</tr>
<tr>
<td>≤0.40</td>
<td>Severe disease</td>
</tr>
<tr>
<td>≥1.30</td>
<td>Noncompressible</td>
</tr>
</tbody>
</table>

Adapted from Hirsch AT, et al. J Am Coll Cardiol. 2006;47:e1-e192. Figure 6.

Normal values: Ankle pressure > Brachial; ABI after Exercise: Fall < 20%; Proximal thigh pressure 30 mmHg higher than brachial; Segmental Pressure < 20 mmHg drop between levels
Cardiovascular Risk Increases With Decreases in Ankle-Brachial Index

Framingham “High Risk” = 20% at 10 years
Every patient with PAD is at “very high risk”

<table>
<thead>
<tr>
<th>ABI</th>
<th>5-year risk</th>
<th>10-year risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1.1</td>
<td>1.4%</td>
<td>10%</td>
</tr>
<tr>
<td>1.1–1.01</td>
<td>1.4%</td>
<td>10%</td>
</tr>
<tr>
<td>1.0–0.91</td>
<td>2%</td>
<td>19%</td>
</tr>
<tr>
<td>0.9–0.71</td>
<td>2%</td>
<td>19%</td>
</tr>
<tr>
<td>&lt;0.7</td>
<td>3.8%</td>
<td>19%</td>
</tr>
</tbody>
</table>

*Fatal or nonfatal MI. ABI=ankle-brachial index; CHD=chronic heart failure

Exercise ABI Testing

- Confirms the PAD diagnosis
- Assesses the functional severity of claudication
- May “unmask” PAD when resting the ABI is normal
- Aids differentiation of intermittent claudication vs. pseudoclaudication diagnoses

Normal values: Ankle pressure > Brachial; ABI after Exercise: Fall < 20%; Proximal thigh pressure 30 mmHg higher than brachial; Segmental Pressure < 20mm Hg drop between levels
Segmental Pressures (mm Hg)

Greater than 20-30mm Hg = significant disease

Decrease in pressure between 2 levels > 30mm Hg = stenosis proximal to cuff
Pulse Volume Recordings

Normal waveform is rapid systolic upstroke and rapid downstroke with prominent dicrotic notch. With increasing PAD severity the waveform is attenuate and widened with ultimate flat or non-pulsatile waveform.
Arterial Duplex Ultrasound Testing

- Diagnose anatomic location and degree of stenosis of peripheral arterial disease.

- Duplex ultrasound of the extremities can be used to select candidates for:
  (a) endovascular intervention  
  (b) surgical bypass, and  
  (c) to select the sites of surgical anastomosis.
Magnetic Resonance Angiography (MRA)

- MRA has virtually replaced contrast arteriography for PAD diagnosis
- No ionizing radiation
- Non-iodine-based intravenous contrast medium
- ~10% of patients cannot utilize MRA because of:
  - Claustrophobia
  - Pacemaker/implantable cardioverter-defibrillator
  - Obesity
- Gadolinium use in individuals with an eGFR <60 mL/min has been associated with nephrogenic systemic fibrosis (NSF)/nephrogenic fibrosing dermopathy
MRA in PAD
Computed Tomographic Angiography (CTA)

- Requires iodinated contrast
- Requires ionizing radiation
- Produces an excellent arterial picture
Right Fem-Pop BPG

Left SFA Stenosis

CTA

DSA (Pre-PTA)
### Two Major Goals in Treating Patients With PAD

<table>
<thead>
<tr>
<th><strong>Limb outcomes</strong></th>
<th><strong>Cardiovascular morbidity and mortality outcomes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved ability to walk</td>
<td>• Decrease in morbidity from non-fatal MI and stroke</td>
</tr>
<tr>
<td>Increase in peak walking distance</td>
<td>• Decrease in cardiovascular mortality from fatal MI and stroke</td>
</tr>
<tr>
<td>Improvement in quality-of-life</td>
<td></td>
</tr>
<tr>
<td>Prevention of progression to CLI and amputation</td>
<td></td>
</tr>
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**Limb outcomes**
- Improved ability to walk
- Increase in peak walking distance
- Improvement in quality-of-life
- Prevention of progression to CLI and amputation

**Cardiovascular morbidity and mortality outcomes**
- Decrease in morbidity from non-fatal MI and stroke
- Decrease in cardiovascular mortality from fatal MI and stroke
### Treatment of Claudication: Therapeutic Choice & Evidence

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Benefit on Treadmill/QoL</th>
<th>Limitations</th>
<th>PAD Cohort Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>100% / Improved</td>
<td>Availability</td>
<td>50%-85%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivation</td>
<td></td>
</tr>
<tr>
<td>Cilostazol</td>
<td>50% / Improved</td>
<td>CHF</td>
<td>50%-85%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medication</td>
<td></td>
</tr>
<tr>
<td>Angioplasty</td>
<td>Improvement</td>
<td>Proximal</td>
<td>10%-15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>arteries best</td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td>150% / Improved</td>
<td>Graft failure</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Morbidity, mortality</td>
<td></td>
</tr>
</tbody>
</table>
Effects of Exercise Training on Claudication


**Meta-analysis of 21 Studies**

- **Exercise Training**
- **Control**

Change in Treadmill Walking Distance (%)

- Onset of Claudication Pain
  - Exercise Training: *P < 0.05*
  - Control: Lower

- Maximal Claudication Pain
  - Exercise Training: *P < 0.05*
  - Control: Lower

*P < 0.05*
Cilostazol vs. Pentoxifylline:
Relative Efficacy to Improve Walking Distance in Claudication

Cilostazol 100 mg 2 times/day (n=227)
Pentoxifylline 400 mg 3 times/day (n=232)
Placebo (n=239)

MWD=maximal walking distance.
*P<0.001 vs pentoxifylline.

Effect of Cilostazol on Quality of Life

Medical Outcome Scale SF-36

Placebo  
Cilostazol 100 mg bid

Physical Summary Score

Wk 4  Wk 8  Wk 16  Wk 20  Wk 24

*
Tools of the trade for Infrainguinal Endovascular Intervention

- Hydrophilic & “coronary” guidewires
- Nitinol S-E Stents (flexible, strong)
- Atherectomy (remove plaque)
- Thrombolytic Therapy
- Laser
- Cryoplasty
60 y.o woman has chest pain, HTNsive crisis. Also complains of LE claudication

- Abnormal adenosine myocardial perfusion scan

- Coronary Angiogram: sequential LCX stenosis and occluded mid LAD that fills via collateral vessels

- Patient refusing CABG
60 y.o woman with CAD, HTN and dyslipidemia presents with HTNsive crisis, ACS, claudication (LE) and renal insufficiency. Cr ~ 1.5 → 2.5 → 7.6.
Angiogram of innominate and left subclavian artery

Pressure difference of 60mmHg between aorta & right brachial artery
Pressure difference of 40 mmHg between aorta and left brachial artery
Angiogram of innominate and left subclavian artery

Pressure difference of 60mmHg between aorta & right brachial artery
Pressure difference of 40 mmHg between aorta and left brachial artery
Final angiogram of left renal artery
Final angiogram of right renal artery
Creatinine back to baseline at 6 month follow up
SFA Intervention

Mid SFA lesion

After angioplasty
66 y.o man with CAD, DM, PAD and severe claudication. Three years after intervention-no further claudication
Tibio-Peroneal Trunk Atherectomy
56 y.o male patient with PAD, CAD and tobacco use. Presents with recurrent disabling RLE claudication.

Noted to have hemodynamically significant in-stent restenoses within the previously-stented Right SFA