PAD Diagnosis

Larry Diaz, MD, FSCAI
Metro Health / University of Michigan Health, Wyoming, MI

Mehdi H. Shishehbor, DO, FSCAI
University Hospitals Harrington Heart & Vascular Institute, Cleveland, OH
PAD: AN UNDERDIAGNOSED AND UNDERTREATED CHALLENGE

10.000.000 PVD Patients in US

2.500.000 Diagnosed

400.000 Treated With PVI

PVI
Dx
PAD
WHY SHALL WE BE IMPROVE OUR DIAGNOSTIC SKILLS WHEN IT COMES TO PATIENTS WITH PAD?

• 185,000 PAD-related amputations still performed every year.

• Patients with IC have a 3-fold increase in cardiovascular mortality.

• Patients with PAD face a 10-year drop in life expectancy.

PAD DIAGNOSIS

Class I Recommendations

• Patients at increased risk of PAD should undergo comprehensive history and review of symptoms to assess for claudication or other walking impairment, ischemic rest pain, and non-healing wounds.

• Patients at increased risk of PAD should undergo vascular examination, with palpation of lower extremity pulses, auscultation for femoral bruits, and inspection of legs and feet.

Individuals “At Risk” for PAD

• Age ≤ 50 years with diabetes +:
  • Smoking
  • Dyslipidemia
  • Hypertension
• 50 to 69 y/o + smoking or diabetes
• ≥ 70 years old
• Leg symptoms with exertion (IC) or ischemic rest pain
• Abnormal leg pulse on examination
• Known CAD.
• Carotid disease, RAS, AAA
Diabetes Increases the Risk of PAD

IGT: ≥140 <200 mg/dL. *P≤.05 vs normal GT
Mortality According to ABI & DM: Strong Heart Study

PARTNERS STUDY

29% of Patients Were Diagnosed With PAD Using Office-Based ABI

- Pts diagnosed with PAD: 44%
- PAD only: 56%

Association Between ABI and All-Cause Mortality

![Bar chart showing the association between ABI and total mortality.](chart)

Risk increases at ABI < 1.0 & > 1.3

N=5748

Baseline ABI

Total Mortality (%)
Cardiovascular Risk Increases with Decreases in ABI

CHD Event Outcomes per Year (%)

- >1.1: 1.4%
- 1.1–1.0: 5%
- 1.0–0.9: 2%
- 0.9–0.71: 3.8%
- <0.7: 19%

Framingham “High Risk” (20% at 10 years)
PAD = “very high risk”

Proportion Stopping During 6-Minute Walk

PAD DIAGNOSTIC TESTING

Class I Recommendations

- In patients with history or physical findings suggestive of PAD, resting ABI, with or without segmental pressures and waveforms, is recommended to establish the diagnosis.

- Resting ABI results should be reported as: abnormal (ABI ≤ 0.90), borderline (ABI 0.91–0.99), normal (1.00–1.40), or non-compressible (ABI > 1.40).

- Toe-brachial index (TBI) should be measured to diagnose patients with suspected PAD when the ABI is greater than 1.40.

Hemodynamic Noninvasive Tests

- Resting Ankle-Brachial Index (ABI)
- Exercise ABI
- Segmental pressure examination
- Pulse volume recordings

Simple, risk-free, and cost-effective approach to diagnose & follow up PAD
ABI

\[
\text{ABI} = \frac{\text{Each Ankle SBP}}{\text{Higher brachial SBP}}
\]
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

ABI

(Normal > 1.0)

Highest brachial SBP

Highest SBP
ABI Limitations

- Incompressible arteries (elderly, DM, RF)

- Normal resting values in symptomatic patients may become abnormal after exercise
• Patients with exertional non–joint-related leg symptoms and normal or borderline resting ABI (>0.90 and ≤1.40) should undergo exercise treadmill ABI to evaluate for PAD.
Exercise ABI Testing

- Confirms the PAD diagnosis
- Assesses the functional severity of claudication
- May “unmask” PAD when resting ABI is normal.
- An ABI fall post-exercise supports a PAD diagnosis.
Plantar Flexion Exercise ABI

Benefits:
- Reproduces treadmill-derived fall in ABI
- Can be performed anywhere
- Inexpensive

Limitation:
- Does not measure functional capacity

Segmental Pressures (mm Hg)

Brachial

150 150

150 150

110 146

108 100

62 84

0.41 0.56

ABI
PVR

Upper thigh

Lower thigh

Calf

Ankle

Upper thigh

Lower thigh

Calf

Ankle
TBI

• TBI: toe pressure / higher brachial pressure.
• TBI remains accurate despite non-compressible pulses.
• TBI values ≤ 0.7 = lower extremity PAD.
Non-Invasive Hemodynamics

- 2043 pts w/ ABI < 0.9.
- Specificity to detect >50% stenosis: 83-90%.
- Sensitivity: 15-79%
- Sensitivity lower in elderly and diabetics.

ABI IS SPECIFIC... BUT...

NOT SENSITIVE FOR PAD, LESS FOR CLI

Non-Invasive Hemodynamics

- 1413 pts w/ cath, underwent ABI.
- 224: traditional ABI; 282: ”Alternative ABI”.
- 862 with “Alternative ABI” >0.9: ”NoPAD”
- Alternative ABI had 49% (HR 1.49) higher risk of mortality than No PAD group.

SELECTIVE ABI INCREASES ABI SENSITIVITY

PAD DIAGNOSTIC TESTING

Class I Recommendations

• Duplex ultrasound, computed tomography angiography (CTA), or magnetic resonance angiography (MRA) of the lower extremities is useful to diagnose anatomic location and severity of stenosis for patients with symptomatic PAD in whom revascularization is considered.
Noninvasive Imaging Tests

Duplex Ultrasound

• Useful to diagnose the anatomic location and degree of stenosis of PAD.
• Recommended for routine surveillance after fem-pop or fem-tib bypass with a venous conduit.
• Minimum surveillance intervals are approximately 3, 6, and 12 months, and then yearly after graft placement.
CTA

• CTA: diagnosis of anatomic location and degree of stenosis of PAD.

• CTA: may be considered as a substitute for MRA for those patients with contraindications to MRA.
MRA

• MRA: diagnosis of anatomic location and degree of stenosis of PAD.

• MRA of the extremities should be performed with gadolinium enhancement.

• MRA : PAD patient selection for endovascular intervention.
PAD DIAGNOSIS

The Screening Connundrum

• Different organisms have different recommendations.

• Thanks to USPSTF recommendations, CMS does not cover diagnostic ABIs for asymptomatic patients, and the primary care doctors do not solicit limb complaints, leading to a vast under-diagnosis of PAD.

• Initiation of medical therapy after positive PAD screen in patients $\geq 65$, results in increased cost-effectiveness, decreased death, increased medication usage, and decreased time in hospital for PAD-related events.
<table>
<thead>
<tr>
<th>Society</th>
<th>Recommendations</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Preventive Services Task Force (USPSTF)</td>
<td>Insufficient evidence that screening for PAD leads to clinically important benefits. Risk reduction interventions are recommended for high-risk individuals with known CVD or diabetes.</td>
<td>2013</td>
</tr>
<tr>
<td>American College of Cardiology / American Heart Association</td>
<td>Resting ABI is reasonable in patients at increased risk but without history or physical findings suggestive of PAD (Class IIa).</td>
<td>2016/17</td>
</tr>
<tr>
<td>American College of Preventive Medicine</td>
<td>No routine screening is recommended; clinicians should be alert to symptoms of PAD in patients with risk factors (age ≥50, smoking history, diabetes).</td>
<td>2011</td>
</tr>
<tr>
<td>American Diabetes Association</td>
<td>Screen patients with diabetes (symptomatic or asymptomatic and &gt;50 years old or have at least one other risk factor (smoking, hypertension, hyperlipidemia, diabetes &gt;10 years).</td>
<td>2015</td>
</tr>
<tr>
<td>European Society of Cardiology</td>
<td>Consider screening in patients with coronary artery disease.</td>
<td>2011</td>
</tr>
<tr>
<td>Society for Vascular Surgery</td>
<td>Screening is reasonable to improve risk stratification, preventive care, and medical management in asymptomatic patients at increased risk (adults &gt;70, smoking, diabetes, abnormal pulse examination or cardiovascular disease).</td>
<td>2015</td>
</tr>
</tbody>
</table>
Non-Invasive Hemodynamics

- 237 pts w/ isolated IP dzs (IN.PACTDEEP).
- ABI < 0.4: 6%
- Abnormal Ankle Pressure (<50 mmHg RF 4, <70 mmHg RF 5/6): 16%
- Abnormal Toe Pressure(<30 mmHg RF4, <50 mmHg RF5/6):60% (Only 40 pts though).

ABI & ANKLE PRESSURE
FAIL TO DIAGNOSE CLI.

*Shishehbor et al. JVS 2016 (63): 1311-17*
Skin Perfusion Pressure

- Assessment of microcirculation (capillary flow) with laser Doppler. Measured in mmHg.
- SPP < 27 predicts poor healing.
- SPP > 27 predicts good chance of healing.
- SPP > 50 predicts 80% chance of healing.

Skin Perfusion Pressure

- **SPP > 50 mmHg**: Normal.
- **SPP 30 - 49 mmHg**: Refer to vascular specialist.
- **SPP < 30 mmHg**: Emergent referral.
TcPO2

- Among CLI patients considered “not eligible for revascularization” (1999):
  - TcPO2 < 25 mmHg: very poor healing potential.
  - TcPO2 > 25 mmHg: good chance of healing.
  - Sensitivity 85%, Specificity 92%, PPV: 79%
  - TcPO2 is better predictor than Toe Pressures for ulcer healing in DM patients.

SPP vs TcPO2

- 10,000 pts w/ DM.
- Markov model of probabilistic & deterministic sensitivity analyses.
- Sensitivity, Specificity, NPV, Cost-efficiency.
- 14 different diagnostic strategies evaluated combos of Physical exam, ABI, TBI, SPP, TcPO2, DSA.

**SPP & TBI: Most Cost-Effective & Sensitive**

J Vasc Surg 2016;64:1682-90
### SPP vs TcPO2

<table>
<thead>
<tr>
<th>Brief description</th>
<th>Median sensitivity</th>
<th>Median specificity</th>
<th>Median NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE: if abnl, ABI; if abnl, DSA</td>
<td>32.6 (31.6-33.6)</td>
<td>97.4 (97.2-97.6)</td>
<td>69.9 (66.5-73.5)</td>
</tr>
<tr>
<td>PE: if abnl, SPP; if abnl, DSA</td>
<td>43.7 (42.4-45.1)</td>
<td>96.5 (96.0-96.8)</td>
<td>74.0 (70.0-76.6)</td>
</tr>
<tr>
<td>PE: if abnl, TcPO2; if abnl, DSA</td>
<td>44.3 (43.0-45.7)</td>
<td>93.5 (93.2-93.9)</td>
<td>73.6 (70.0-76.2)</td>
</tr>
<tr>
<td>PE: if abnl, TBI; if abnl, DSA</td>
<td>44.8 (43.7-46.2)</td>
<td>96.1 (95.8-96.4)</td>
<td>74.3 (70.5-76.9)</td>
</tr>
<tr>
<td>PE: if abnl, DSA</td>
<td>53.3 (52.1-54.6)</td>
<td>82.6 (82.2-83.1)</td>
<td>74.7 (70.8-77.2)</td>
</tr>
<tr>
<td>ABI: if abnl, DSA</td>
<td>60.9 (59.9-62.1)</td>
<td>89.1 (88.6-90.0)</td>
<td>79.1 (75.7-81.2)</td>
</tr>
<tr>
<td>PE: if nl, ABI; if abnl, DSA</td>
<td>81.8 (81.1-82.5)</td>
<td>73.6 (73.0-74.2)</td>
<td>87.0 (84.7-88.6)</td>
</tr>
<tr>
<td><strong>SPP: if abnl, DSA</strong></td>
<td><strong>82.0 (80.0-83.6)</strong></td>
<td><strong>89.1 (88.6-89.6)</strong></td>
<td><strong>89.1 (87.0-90.7)</strong></td>
</tr>
<tr>
<td>TcPO2: if abnl, DSA</td>
<td>83.1 (81.8-84.4)</td>
<td>62.8 (61.3-64.5)</td>
<td>86.1 (83.3-87.6)</td>
</tr>
<tr>
<td>TBI: if abnl, DSA</td>
<td>84.0 (83.0-85.2)</td>
<td>77.8 (76.1-79.4)</td>
<td>88.9 (86.9-90.3)</td>
</tr>
<tr>
<td>PE: if nl, SPP; if abnl, DSA</td>
<td>91.6 (90.7-92.4)</td>
<td>65.7 (63.7-67.2)</td>
<td>92.8 (91.2-93.9)</td>
</tr>
<tr>
<td>PE: if nl, TcPO2; if abnl, DSA</td>
<td>92.1 (91.4-92.8)</td>
<td>51.9 (50.6-53.4)</td>
<td>91.7 (89.8-92.6)</td>
</tr>
<tr>
<td>PE: if nl, TBI; if abnl, DSA</td>
<td>92.6 (92.1-93.1)</td>
<td>64.2 (62.8-65.7)</td>
<td>93.4 (92.1-94.3)</td>
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</table>
There is enough data to support an update on the screening recommendations from the multi-specialty PAD guidelines to Class I for people older than 65 years of age.

In patients with ulcers, the combined used of skin perfusion pressure and toe-brachial index is the most sensitive and cost-effective strategy to diagnose PAD.

Early identification leads to early treatment, increasing medication usage and decreasing PAD-related hospital stays, amputations, and death.