SCREENING OF PAD

Dr. Hafidz Bin Abd Hadi
Clinical Fellow Cardiology
Institut Jantung Negara

Learning Objectives

Importance of PAD
Need for screening
Methods and tools for screening and diagnosis
Peripheral arterial disease (PAD) is part of a global vascular problem of diffuse atherosclerosis.

PAD affects 12%–14% of the general population and its prevalence increases with age affecting up to 20% of patients over the age of 75\(^{(1)}\).

Exceptionally high risk for cardiovascular events and the majority will eventually die of a cardiac or cerebrovascular etiology.\(^{(2)}\)
A diagnosis of PAD presents the opportunity to initiate secondary prevention by instituting atherosclerosis risk factor modification, and thus reducing the risk of cardiovascular complications.\(^3\)

Factors postulated to be responsible for the current under-diagnosis of PAD include the asymptomatic nature of most PAD, the inappropriate use of recommended screening and diagnostic tools, and poor awareness of the prevalence, natural history and prognostic significance of PAD among public and medical communities.\(^3\)
Aim

- To create awareness on screening for lower extremity PAD in the general practice setting, understand.
- To provide recommendations based upon evidence for best practice on screening PVD.

Prevalence of peripheral arterial disease (PAD) by age. (Reprinted with permission from Criqui MH, Fronck A, Barrett-Connor E, et al. The prevalence of peripheral arterial disease in a defined population. Circulation 1985;71:510-515.)
Figure 1
Hazard ratios (HRs) for incident peripheral artery disease (PAD) according to individual and joint clinical risk factors. HRs are adjusted for age, height, aspirin use, parental history of myocardial infarction at age 50 years or younger, geographical region, body mass index, physical activity, alcohol consumption and each of the other three clinical risk factors. The reference group for each of the individual risk factors was the remainder of the cohort without the individual risk factor. Population attributable risk percent (PAR%) for each individual risk factor were calculated using pooled logistic regression models and were adjusted for the same factors mentioned above. The linear trend for the joint risk factors was obtained by treating the number of risk factors as a continuous variable.
Abbreviations: HT, Hypertension; HC, hypercholesterolemia; T2D, type 2 diabetes.

Associations between Conventional Cardiovascular Risk Factors and Risk of Peripheral Artery Disease in Men
Whom should be screened

- All patients aged 65 years and above (regardless of risk factor status)
- Age of 50 to 65 with cardiovascular risk factor (particularly diabetes or smoking).
- All patients who have leg symptoms with exertion (claudication) or ischemic rest pain and non healing ulcers.
- Age less than 50 years, with diabetes and one other atherosclerosis risk factor (smoking, dyslipidemia, hypertension, hyperhomocysteinemia). (5)
- Abnormal lower extremity pulse examination. (5)
- Known atherosclerotic coronary, carotid, or renal artery disease. (5)

What/when/who/ where

<table>
<thead>
<tr>
<th>Table 1. Guidelines relating to screening for PAD</th>
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<tbody>
<tr>
<td>Guidelines</td>
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<tr>
<td>American College of Cardiologists and the American Heart Association (ACC/AHA)</td>
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<tr>
<td>TransAtlantic InterSociety Consensus (TASC-II)</td>
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<td>United States Preventive Services Task Force²</td>
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<td>National Health and Medical Research Council² [rescinded 2004]</td>
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Screening Methods

- History
- Examination
- Investigation

About 20% of patients with mild PAD may be asymptomatic. \(^6\)

PAD causes intermittent claudication, which is a painful, aching, cramping, uncomfortable, or tired feeling in the legs that occurs during walking and is relieved by rest.

The pain may be burning, tightening, or aching, although this finding is nonspecific.

Claudication usually occurs in the calves but can occur in the feet, thighs, hips, buttocks, or, rarely, arms.

Rest pain is usually worse distally, is aggravated by leg elevation (often causing pain at night), and lessens when the leg is below heart level.
Fontaine Classification of Chronic Limb Ischemia

<table>
<thead>
<tr>
<th>Stage</th>
<th>Symptoms</th>
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<tbody>
<tr>
<td>I</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>II</td>
<td>Intermittent claudication</td>
</tr>
<tr>
<td>IIa</td>
<td>Pain-free; claudication walking &gt; 200 m</td>
</tr>
<tr>
<td>IIb</td>
<td>Pain-free; claudication walking &lt; 200 m</td>
</tr>
<tr>
<td>III</td>
<td>Rest pain and nocturnal pain</td>
</tr>
<tr>
<td>IV</td>
<td>Necrosis, gangrene</td>
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Key Components of the Vascular Physical Examination

- Measurement of **blood pressure** in both arms and notation of any inter-arm asymmetry.
- The shoes and socks should be removed, the feet **inspection** of the feet, the color, temperature, and integrity of the skin, distal hair loss, trophic skin changes, hypertrophic nails, and ulcerations.
Continue..

- **Palpation** of the carotid pulses, and notation of the carotid upstroke and amplitude, and presence of bruits.
- **Palpation** of the abdomen and notation of the presence of the aortic pulsation and its maximal diameter.
- **Palpation** of pulses at the brachial, radial, ulnar, femoral, popliteal, dorsalis pedis, and posterior tibial sites.
- **Auscultation** of the abdomen and flank for bruits.
Measurement and Interpretation of the Ankle-Brachial Index

- Ratio of systolic blood pressure (SBP) measured at the ankle to the measured at the brachial artery.

\[ ABPI_{Leg} = \frac{P_{Leg}}{P_{Arm}} \]

- \( P_{Leg} \) is the systolic blood pressure of dorsalis pedis or posterior tibial arteries
- \( P_{Arm} \) is the highest of the left and right arm brachial systolic blood pressure

- Indicator of arterosclerosis and prognostic marker for CV events

ABI: A Marker for CVD Risk and Events (7)

Figure 1. Hazard ratios for total mortality in men and women by ankle-brachial index at baseline for all studies combined in the ABI Collaboration. Reproduced from Fowkes et al. with permission from the publisher. Copyright © 2008, American Medical Association.
Conditions for the Measurement of the ABI

- The Patient
- The Cuff
- The Measurement of the ABI

Patient

- Patients should be lying flat for an accurate ABI measurement, with the head and heels fully supported, and not hanging over the end of the examination table.
- Patient should be asked to refrain from smoking for at least 2 hours prior to testing to decrease the chance of peripheral vascular constriction.

Measurement and Interpretation of the Ankle-Brachial Index: A Scientific Statement. Circulation. published online November 16, 2012;
The Cuff

- Appropriate cuff size to avoid inaccurate measurements
- The width of the cuff should be at least 40% of the limb circumference
- Parallel wrapping

Method of Pressure Measurement

- Primarily Doppler ultrasound
- Uses a continuous-wave Doppler probe for detection of arterial flow.
- The SBP is determined with a pneumatic cuff, which is first inflated until flow ceases and then deflated slowly until there is reappearance of the flow signal.
- The corresponding cuff pressure is the SBP
MEASUREMENT OF THE BRACHIAL SYSTOLIC PRESSURE

- **Step 1**: Wrap the cuff firmly around the upper arm, as high as possible, with the bladder of the cuff over the brachial artery (ie over the antecubital fossa).
- **Step 2**: Cover the end of the probe with ultrasonic gel. Hold the probe like a pencil and rest the lateral edge of the hand against the patient’s bare skin (which helps to keep the probe absolutely still). Locate the signal from the brachial artery (see figure 1). The brachial artery will often be located in the small groove at the medial edge of the distal biceps muscle. Make very small and subtle adjustments in both position and angulation of the probe until the Doppler signal sounds at its strongest.
- To achieve the optimum Doppler signal, an angle of 45 – 60° between the direction of the arterial flow and the ultrasound beam is required (see figure 2).

**Location of brachial artery**
If the signal is not sharp and triphasic but damped, this arm should not be used to measure the brachial pressure. Damped signals suggest that the patient has subclavian or axillary artery disease, and the pressure maintained will not be a true representation of the systemic pressure.

Step 3: Keep the probe absolutely still and inflate the cuff until the artery is occluded and the Doppler signal disappears. The signal should not get softer – if it does, the probe is probably slipping off the artery. If you do slip off the artery, stop inflating the cuff, readjust the probe to find the best signal and then continue to inflate the cuff. There is no need to deflate the cuff and start again from zero pressure.

As the artery occludes glance at the pressure dial and make a mental note of the reading. In order to be sure of cessation of flow, the cuff should be inflated at least 20 mm Hg above the pressure at which the last Doppler arterial signal was heard.
Step 4: Deflate the cuff slowly (ie approximately 4 mm Hg per second). Slower deflation rates will be needed for patients with bradycardia or an irregular heartbeat. The arterial Doppler signal should return suddenly and sharply as the systolic blood pressure equals, and then exceeds the pressure in the cuff. At this point, note the pressure reading from the pressure gauge and deflate the cuff.

The pressure at which the Doppler signal returns on deflation of the cuff is often lower than the pressure at which the Doppler signal disappears on inflation. It is the former that is the true measurement of the systolic pressure – only in the deflation mode is cuff pressure truly representative of arterial pressure within the limb.

Do not move the probe. You should still be able to hear the Doppler signal, which will reassure you that you have not slipped off the artery.

Step 5: Deflate the cuff completely and remove it. Make a written record of the pressure measurement.

Step 6: Repeat steps 1-5 on the other arm. Use the highest reading of the two when calculating ankle brachial pressure index.
MEASUREMENT OF THE ANKLE SYSTOLIC PRESSURE

- **Step 1**: Place the cuff around the right ankle, just above, but not covering, the malleolus.

- **Step 2**: Locate the posterior tibial artery (PTA). It is usually found behind or along the posterior edge of the medial malleolus on a line between the medial malleolus and the heel (see figure 4A).

- Adjust the probe on the skin to achieve the best Doppler signal but remember that, around the ankle, the arteries may not run parallel to the skin surface and what may look like a poor angle of interrogation may actually be very good.

Place the cuff around the right ankle, just above, but not covering, the malleolus.
Figure 2. Ankle pressure measurement with a Doppler probe: posterior tibial (A) and dorsalis pedis (B) arteries.

Figure 4A: Location of right posterior tibial artery.

Figure 4B: Doppler probe fits snugly into soft spot behind medial malleolus. Note angulation of probe to achieve a good angle of interrogation.

Figure 5: Illustration of how skin surfaces may be misleading with regard to direction of artery.

Looks like a good angle, but signal is poor because Doppler beam is actually at 90° to flow.

Looks like poor angle, but signal is good because artery curves away and Doppler beam is actually at a good angle to flow.
Angulation between Doppler beam and arterial blood flow

If the signal is not sharp and triphasic but damped, this arm should not be used to measure the brachial pressure. Damped signals suggest that the patient has subclavian or axillary artery disease, and the pressure maintained will not be a true representation of the systemic pressure.

continue

- **Step 3**: Hold the probe absolutely still and inflate the cuff until the artery is occluded (and the Doppler signal disappears). Make a mental note of the pressure at which this occurs. Now inflate the cuff at least 20 mm Hg above the pressure at which the Doppler arterial signal was heard in order to be sure of cessation of flow.

- **Step 4**: Slowly deflate the cuff, making sure not to move the Doppler probe, and note the pressure reading when the Doppler signal returns.
continue

- **Step 5**: Rapidly deflate the cuff. Make a written record of the Doppler pressure reading.
- **Step 6**: Locate the dorsalis pedis artery (DPA) (*see figure 6*) usually found either: in the soft spot between the base of the hallux and the second toe (position a) on top of the arch of the foot (position b). or the anterior tibial artery (ATA) – usually found on the creaseline between the foot and the leg (position c).
- Take a pressure reading from the best of these sites.
- **Step 7:** If no signal can be found at either the PTA or DPA/ATA sites, locate the peroneal artery (PERA) – usually found either: on the lower leg just above the lateral malleolus on the foot arch. Take an ankle pressure reading from the peroneal artery as described previously for other arteries.

- **Step 8:** For the ankle brachial pressure index (ABPI) calculation use the highest pressure reading obtained at the ankle (whether it comes from the PTA, DPA/ATA or PERA) in order to quantify objectively the optimal source of blood flow to the foot.

- **Step 9:** Repeat steps 1-8 on the left leg
How to calculate the ankle-brachial index

Right arm:
Systolic pressure

Left arm:
Systolic pressure

Right ankle:
Systolic pressure
Pedial (PT)
Tibial (TP) mm Hg

Left ankle:
Systolic pressure
Pedial (PT)
Tibial (TP) mm Hg

Right ABI equals ratio of:
Higher of the right ankle pressure (PT or TP) or higher arm pressure (right or left arm)

Left ABI equals ratio of:
Higher of the left ankle pressure (PT or TP) or higher arm pressure (right or left arm)

* The lower of these numbers is the patient’s overall ankle-brachial index. Overall ankle-brachial index.

1.30 ≤ ABI
Ankle blood pressure is somewhat high.

1.00 ≤ ABI ≤ 1.29
Normal range

0.91 ≤ ABI ≤ 0.99
Borderline normal

0.41 ≤ ABI ≤ 0.90
Slight/mild occlusion, or stenosis suspected

ABI ≤ 0.40
Severe occlusion, or stenosis suspected

AHA/ACC Guideline 2008
Ankle Brachial Pressure Index (ABPI): An update for practitioners

Mo Al-Qaisi, David M Nott, David H King, Sam Kaddoura

PMCID: PMC2762432

ABPI issues

- ABPI is known to be unreliable on patients with arterial calcification.
- Resting ABPI is insensitive to mild PAD.
- Lack of protocol standardization, which reduces intra-observer reliability.
- Skilled operators are required for consistent, accurate results.

Table 1
Interpretation of ABPI

<table>
<thead>
<tr>
<th>Resting ABPI</th>
<th>Severity of disease</th>
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<tbody>
<tr>
<td>&gt;1.4</td>
<td>Calcification may be present</td>
</tr>
<tr>
<td>&gt;1.0</td>
<td>Probably no arterial disease</td>
</tr>
<tr>
<td>0.81–1.00</td>
<td>No significant arterial disease, or mildly significant disease</td>
</tr>
<tr>
<td>0.5–0.80</td>
<td>Moderate disease</td>
</tr>
<tr>
<td>&lt;0.5</td>
<td>Severe disease</td>
</tr>
<tr>
<td>&lt;0.3</td>
<td>Critical ischemia</td>
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</tbody>
</table>

Abbreviation: ABPI, Ankle Brachial Pressure Index.
In patients with noncompressible vessels, segmental plethysmography can be used to determine underlying arterial occlusive disease. Cuffs placed at different levels on the leg detect changes in leg volume and produce a pulse volume recording (PVR) when connected to a plethysmograph (Fig. 2). To obtain accurate PVR waveforms the cuff is inflated to 60 to 65 mmHg to detect volume changes without causing arterial occlusion. Pulse volume tracings are suggestive of proximal disease if the upstroke of the pulse is not brisk, the peak of the wave tracing is rounded, and there is disappearance of the dicrotic notch.

Although isolated segmental limb pressures and PVR measurements are 85% accurate when compared with angiography in detecting and localizing significant atherosclerotic lesions, when used in combination, accuracy approaches 95%. For this reason, it is suggested that these two diagnostic modalities be used in combination when evaluating PAD.
The Brachial Index

Figure 4A. Normal ankle and digit waveforms and pressures.

Figure 4B. Abnormal ankle and digit waveforms and pressures indicating arterial occlusive disease.
Duplex ultrasound

- Combines both B-mode ultrasound and colour doppler ultrasound to identify haemodynamically significant lesions
- Duplex ultrasound can produce a map of significant stenotic disease from aorta to feet.
- The technique is operator dependent and there is a shortage of trained operators.
CT Tomographic Angiography

- Rapid and safe assessment for vascular disease.
- Spiral acquisition and multidetector CT scanners in recent years has dramatically improved arterial resolution and a moving tabletop enables examination from aorta to feet in a single contrast injection.
- Contrast injected at approximately 1.5 to 3 or 4 mls per second for total of 100 mls to 150 mls via superficial vein in the upper extremities using power injector
Computed tomography-angiography (CTA) of the lower extremity. (A) shows total occlusion from the left common iliac artery ostium to the distal femoral artery with a reasonably collateralized circulation; after percutaneous transluminal angioplasty, the follow-up CTA revealed no residual stenosis from the common iliac artery to the distal femoral artery as shown in (B).

**Advantage**

- Volumetric acquisition which allows visualization of anatomy from multiple angles and planes, improve visualization of soft tissues and other adjacent structure, less invasive and less complication.
- Visualizes calcification and metallic implants well compared to MRA
- Disadvantages – exposure to radiation and potentially nephrotoxic iodinated contrast.
Magnetic resonance angiography

Magnetic resonance angiography, in comparison with DSA and CTA, eliminates exposure to ionising radiation and there is no risk of contrast nephropathy when gadolinium is used in recommended doses. Unlike ultrasound and CTA it is unaffected by arterial calcification.

Magnetic resonance angiography is performed as a fast non-invasive outpatient procedure (<15 minutes). Three dimensional images of the whole arterial tree are presented in a maximum intensity projection format produced on a workstation.

Relative disadvantages include a tendency to overestimate stenosis, although this will err in the patient's favour. Venous contamination can obscure arteries below the knee.

A significant number of patients are too claustrophobic to tolerate the examination and the presence of some metallic implants (such as pacemakers) or foreign bodies may preclude the examination or produce artefacts.
Diagnosing PAD

Individual at risk/ Symptomatic

Perform ABI

 ABI>0.9

ABI<0.9

No PAD

Confirm Peripheral Arterial Disease

Diagnosis and Treatment of Asymptomatic PAD and Atypical Leg Pain

ACCF/AHA Pocket Guideline November 2011, Management of Patients With Peripheral Artery Disease (Lower Extremity, Renal, Mesenteric, and Abdominal Aortic)
**Diagnosis of Claudication and Systemic Risk Treatment**

**Cardiovascular disease remains the major cause of mortality in the developed world.**

Despite the attendant cardiovascular risk associated with even asymptomatic disease, PAD is under-diagnosed and under-treated.

**Early detection offers the advantage of early intervention to reduce the risk of future cardiovascular events.**
References

- ACC/AHA Pocket Guideline November 2011, Management of Patients With Peripheral Artery Disease (Lower Extremity, Renal, Mesenteric, and Abdominal Aorta)
- Diagnosis and management of peripheral arterial disease. A national clinical guideline October 2006 Scottish Intercollegiate Guidelines Network