Noninvasive Testing in Peripheral Arterial Disease

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KEYWORDS

• Vascular test • Peripheral arterial disease • Vascular ultrasound • Ankle-brachial index
• Pulse volume recording • CT angiography • Magnetic resonance angiography

KEY POINTS

- The first test to perform in patients suspected of having peripheral artery disease is the ankle-brachial index (ABI).
- Patients undergoing evaluation for exertional leg discomfort, and who have normal or minimally decreased ABIs at rest, should undergo exercise ABIs.
- The level of disease in the lower extremities can be inferred by segmental limb pressures and pulse volume recordings.
- CT and MR angiography are very useful imaging studies (and in many instances, are largely interchangeable) for procedure planning in symptomatic patients with peripheral arterial disease.

In addition to a thorough clinical evaluation, most patients with suspected or established peripheral arterial disease (PAD) should undergo noninvasive vascular testing for objective assessment of the disease. The information gathered from these studies not only helps confirm the diagnosis and stratify patients, but is also useful for procedure planning, the assessment of outcomes, and for patient follow-up.

Noninvasive vascular testing can be broadly classified as functional (or physiologic) studies that provide information on the hemodynamic effects of PAD, and anatomic studies that provide detailed information about the location and other physical characteristics related to PAD. The presence and extent of limb ischemia can be gauged through physiologic studies, which include the ankle-brachial index (ABI), segmental limb pressures, pulse volume recordings (PVRs), and photoplethysmography (PPG). Computed tomography angiography (CTA) and magnetic resonance angiography (MRA) provide anatomic data. Duplex ultrasonography provides anatomic information and hemodynamic information.

ANKLE-BRACHIAL INDEX

Ankle-brachial index is the ratio of the systolic blood pressure measured at the ankle to the pressure measured at the brachial artery. An ABI is reported for each leg. The ABI informs on the presence of hemodynamically significant disease from the brachial arteries (as a surrogate of the thoracic aorta) down to the tibioperoneal arteries, without providing specific information on the level of obstruction. The ABI is usually the first diagnostic test to be performed in the evaluation of patients with PAD. The test is noninvasive, quick and easy to perform, and has good reproducibility. The blood pressure is measured by assessing

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blood flow distal to an inflated cuff (the width of the cuff should be at least 40% of the limb circumference). The two most common methods for measuring blood pressure are using a handheld Doppler ultrasound probe to assess arterial blood flow distal to the cuff, and by oscillometry. Other methods, including pulse palpation and auscultation, or PPG, tend to be less accurate and reproducible.[1]

The bilateral brachial systolic blood pressures should be comparable; a pressure gradient between both arms greater than 15 mm Hg should alert about the possibility of innominate, subclavian, or axillary artery stenosis. The ABI of each leg should be calculated by dividing the higher of the posterior tibialis (PT) or dorsalis pedis (DP) pressure by the higher of the two brachial systolic blood pressures (**Fig. 1**). The sensitivity and specificity of the ABI for the diagnosis of PAD is approximately 72% and 96%, respectively.[1,2] ABI calculations using the lower, rather than the higher, of the DP or PT pressures results in a lower sensitivity but greater specificity for the detection of PAD. A normal ABI exists when the ratio between the ankle and brachial systolic pressures equals 1.0. Although the general consensus is that an ABI of 0.9 or less is required for the diagnosis of PAD, an ABI between 0.91 and 0.99 should be considered borderline and indicates increased cardiovascular risk (see later). An ABI of 0.4 to 0.9 reflects mild to moderate disease, whereas an ABI below 0.4 is consistent with severe PVD. The absolute ABI does not always correlate with the clinical status of the patient, and rather provides a rough index of the severity of PAD.

In addition to its value for the diagnosis of PAD, the ABI is also an independent indicator of the risk of cardiovascular events, including cardiovascular death, major coronary events, and stroke. The relationship between ABI in the *x* axis, and cardiovascular events in the *y* axis, is represented in a reverse J-shaped curve, where the lowest level of risk (normal) is from ABI 1.11 to 1.40, with increasing cardiovascular risk for ABI less than 1.10 and ABI greater than 1.40.[3]

An important pitfall of the ABI in detecting PAD is that by definition, the ABI ratio is calculated using the higher systolic pressure of the DP or PT pulses. Therefore, the more diseased artery supplying the region (or angiosome[4]) where an ischemic ulcer may be located could be missed in the ABI interpretation. For example, a patient with a nonhealing ulcer in the heel, with a brachial systolic blood pressure of 120 mm Hg, a DP systolic blood pressure of 100 mm Hg, and a PT

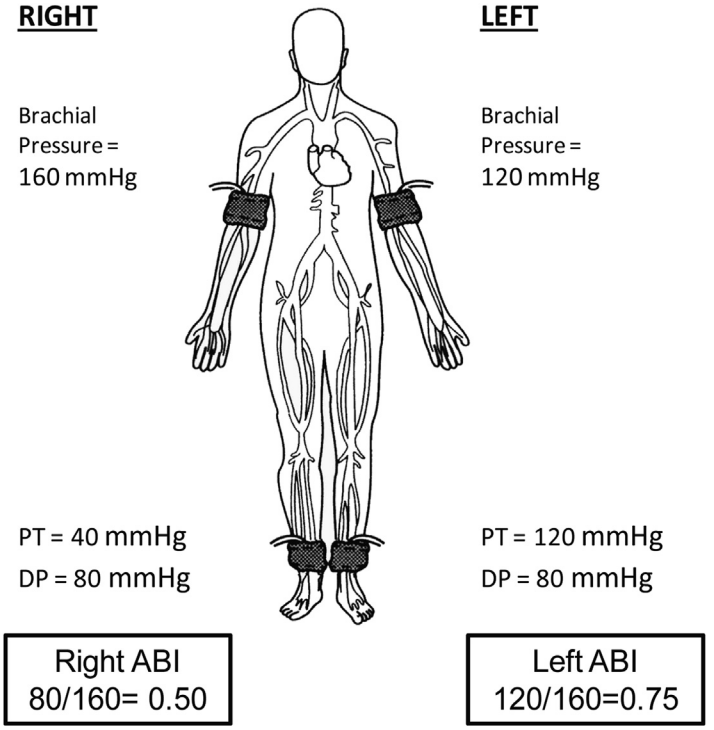

Fig. 1. Ankle-brachial index (ABI). An ABI is calculated for each lower extremity. The numerator is the ipsilateral DP or PT systolic pressure, whichever is higher. The denominator for the bilateral ABIs is the higher of the two brachial pressures.