The Science Behind ABPI

By Pamela Houghton, PT PhD

This article describes the research underlying each of the common ways an ankle brachial pressure index (ABPI) test is used in the assessment and management of people with chronic leg ulcers due to mixed arterial/venous insufficiency. It is hoped that an understanding of what research has and has not been done to validate different uses of an ABPI will help clinicians select when and where to use the test and how to interpret and make appropriate clinical decisions.

The ankle brachial pressure index (ABPI), sometimes also called ankle brachial index (ABI) is an example of a diagnostic test used commonly in wound care practice. It compares systolic pressure measured in the brachial artery to that measured in an artery located near the ankle, with the expectation that values derived from the arm and leg should be similar, yielding a ratio near 1.0 (see subsequent article for the steps involved in performing an ABPI). Determination of ABPI in normal healthy volunteers between the ages of 20 and 40 years yielded ABPI values between 1.05 and 1.2.[1]

To complete an ABPI (see page 22 for an illustrated how-to), a portable ultrasound Doppler is used to amplify the sound emitted by pulsatile blood flowing through larger arterial vessels. According to a historical review by Nayman in 1979, Strandness and colleagues were the first to apply an ultrasound Doppler in conjunction with a blood pressure cuff to detect people with stenosis or occlusion of larger arteries located in the periphery—termed *peripheral arterial disease* (PAD) or *peripheral occlusive arterial disease* (POAD).[2] Within this article both *PAD* and *POAD* are used interchangeably and refer to an occlusion or stenosis of the arteries located somewhere between the aorta and ankle.

The use of the ABPI in wound care practice has increased dramatically over the past 10 years.[3,4] Performing an ABPI test is commonly recommended practice as part of the assessment of people with chronic venous insufficiency and/or venous leg ulcers (VLUs). The ABPI has not only been recommended as a diagnostic test for PAD but also as a way to identify individuals at risk of

adverse effects caused by compression therapy, and to predict those with venous leg ulcers who are more likely to heal. This paper will discuss the research behind each of these three common uses of an ABPI in wound care practice.

ABPI as a Diagnostic Test for PAD

The ABPI was designed for the purpose of detecting or diagnosing people with PAD. A diagnostic test that detects the presence of PAD is needed in clinical practice because PAD occurs commonly in the general population (12–14%)[3] and increases in prevalence with age.[4,5] Importantly, the majority of people with PAD are asymptomatic, with less than half of people with PAD experiencing leg pain and only 10% reporting intermittent claudication (calf muscle cramps when walking). In other words, if tests for intermittent claudication alone were used to diagnose PAD, it would miss 90% of patients. In fact, many individual clinical symptoms associated with artery stenosis or occlusion (such as pulses, and trophic changes in skin, including temperature, texture and colour) are not considered valid screening tools.[6]

Furthermore, there is a strong association between damage or clogging of peripheral vessels and problems with other parts of the cardiovascular tree, including coronary arteries. It has been estimated that 68% of people with PAD also have significant heart disease.[7] Both men and women with an ABPI < 0.9 were twice as likely to have a heart attack or cardiovascular event.[8,9] In addition, a link between low ABPI values and a three-year mortality rate has been established.[9]

In 2016, the American College of Cardiologists and American Heart Association (ACC/AHA) guidelines for management of lower extremity PAD strongly recommended the use of ABPI to identify people at risk of future life-threatening cardiovascular events.[10]

ABPI Validation: Concurrent Criterion Validity

To validate a new diagnostic test, researchers compare values derived concurrently from the "new" test to the results produced by a "gold standard" test or criterion measure. A good diagnostic test should be able to detect the presence or absence of the disease as defined by the gold standard. Research that validates a diagnostic test

should involve study participants who typically have the condition—i.e. elderly men and women with risk factors for PAD, including hypertension and hypercholesterolemia. They should include in the study sample population a similar number of people with and without the disease. Researchers should be qualified to perform the diagnostic test, and be blinded to the results of the other tests. Each study subject should undergo the new test *and* the gold standard test in random order with an appropriate time in between—not too short a time (such that the initial test might influence the results of the subsequent test) and not too long a time (such that other changes could occur and therefore similar test results are no longer expected).

When the new test finds the disease is present (test positive) and this agrees with the results of the gold standard test, this is considered a *true positive*. However, if the new test indicates the disease is present but the gold standard test does not, this is considered a *false positive*.

When the new test does not detect the presence of disease (negative) and this result agrees with the gold standard test, this is considered a *true negative*. However, if the new test does not pick up that the disease even though the disease is detected by the gold standard test, this is a *false negative* (see definitions on page 13).

Using these comparisons, values for sensitivity and specificity are calculated. *Test sensitivity* is the ability of a test to correctly identify those with the disease, whereas *test specificity* is the ability of the test to correctly identify those without the disease. More in-depth statistical analysis tests can also be performed, such as positive and negative likelihood ratios, but that is beyond the scope of this introductory paper.

The new test is considered acceptable when both sensitivity and specificity are near 1.0. This suggests that the new test is interchangeable with the former gold standard test. A good diagnostic test should have high values for *both* sensitivity and specificity, since the combination assures clinicians the test is able to detect when disease is present or confirm their patient is free from disease, or "normal." High false negative results suggest the test is not sensitive. Clinicians using such a test cannot be sure their patient is free from disease. Conversely, a test with a high false positive may cause clinicians to incorrectly assume that their patient has the condition.

In 2008, a group of researchers from China evaluated 298 individuals (199 men, 99 women) who underwent an ABPI and angiography.[11] ABPI values of < 0.95 exhibited excellent agreement with digital subtraction angiography in detecting hemodynamically significant stenosis in the large vessels of the lower extremity. Sensitivity and specificity were both found to be high, at 0.91 and 0.86 respectively, suggesting the ABPI is a good non-invasive alternative to conventional angiography. Allen and colleagues compared the results of ABPIs to duplex ultrasound (US) scans of peripheral vessels (gold standard) and found the agreement depended on the cutoff value used for the ABPI, with a low ABPI (less than 0.6) at 100% agreement wherease higher ABPI values (0.9) have only 83% agreement between ABPI and US duplex.[12] Therefore, the more severe the PAD, the more likely the ABPI test will detect it. Other investigators have also reported high sensitivity and specificity (> 90%) when ABPI was determined using an ultrasound Doppler[13]—hence the endorsement of ABPIs by the AHA/ACC as a good non-invasive portable test for PAD.[10]

Definitions

Sensitivity: probability of the test correctly identifying people who actually have disease
Specificity: probability of the test correctly identifying people who DO NOT have disease
True Positive: Results of the screening (new) test agree with gold standard test that the patient actually has the disease.
True Negative: Results of the screening (new) test agree with gold standard test that the patient DOES NOT have the disease.
False Negative: New diagnostic test indicates that the disease is not present, but the gold standard test indicates the disease is present—new test does not agree with gold standard.
False Positive: New test indicates that the patient does NOT have the disease, but the gold standard test found the disease is present—new test does not agree with gold standard.

Example

One hundred patients undergo digital subtraction angiography or ultrasound duplex scan and 50 are found to have arterial obstruction or stenosis (by default that means the other 50 patients do not have PAD). When the same patients had an ABPI performed in the field, 55 of the total 100 had ABPI values below 0.95 (positive test), of which 45 also had positive angiograms/duplex scans.

		Peripheral Arterial Disease (PAD)	
		PAD Present (+)	**PAD Absent (-)**
NEW SCREENING TEST (ABPI)	**ABPI < 0.95 (low) Positive Test**	45 TRUE POSITIVE	10 FALSE POSITIVE
	ABPI = 0.95–1.2 (normal) Negative Test	5 FALSE NEGATIVE	40 TRUE NEGATIVE

Calculations

$$\text{SENSITIVITY} = \frac{\text{TRUE POSITIVE}}{\text{TRUE POSITIVE + FALSE NEGATIVE (all patients with PAD)}} = \frac{45}{45 + 5} = 0.90$$

$$\text{SPECIFICITY} = \frac{\text{TRUE NEGATIVE}}{\text{TRUE NEGATIVE + FALSE POSITIVE (all patients without PAD)}} = \frac{40}{40 + 10} = 0.80$$

Unfortunately, a recent Cochrane review concluded that evidence about the accuracy of ABPIs for the diagnosis of PAD is sparse.[14]

ABPI Validation: Reliability

Intra- and inter-rater reliability is the extent to which the same rater, or two different raters, can obtain a similar rating on subsequent testing with the same instrument, when no change has occurred. Coefficients of agreement can be calculated, with values closer to 1.0 indicating good agreement between raters (see Research 101: Wound Assessment Tools for a full description of

test reliability).[15] Reliability or reproducibility of values generated by ABPI tests have been shown to be excellent (coefficient = 0.77 to 1.0) when evaluated by trained personnel.[16] Less than 10% variation has been reported between different observers, including family doctors and nurses.[17] Bonham and colleagues compared ABPI values generated by trained nurses and found over 85% agreement with laboratory values produced by a registered vascular technician.[18]

ABPI Technical Limitations

As with all tests, the ABPI has its limitations. It is important that clinicians performing an ABPI are aware of the technical limitations—involving procedures and operator skills—as well as how to interpret findings cautiously and appropriately.[19] When a practitioner is learning how to conduct an ABPI test, time and effort should be dedicated to not only refining the skills needed to find and recognize Doppler sounds in leg vessels, but also to understanding the conditions that can alter ABPI values.

The following technical factors are known to affect the ABPI values:

- Room temperature too low, making the patient cold
- Insufficient length of rest period prior to test
- Patient not lying completely flat (supine)
- Extended time between taking arm and ankle measures
- Rapid deflation of the cuff, causing clinician to miss the maximum pressure when blood flow sounds return after inflation
- Probe moving off target vessel or away from the conductive gel
- Repeat inflations of the cuff
- Pain caused by over-inflation of the cuff or placement of the cuff over the calf muscle or other sensitive area (wound)
- Use of an inappropriate cuff size

Correct patient positioning and preparation of the test area is an important first step toward accurate and consistent ABPI values. To eliminate the added pressure exerted on leg vessels by gravity, patients need to lie completely flat (supine) for at least 15 minutes, so the level of the heart is the same for both the arm and ankle. The more extensive the person's cardiovascular disease, the longer it will take to equalize

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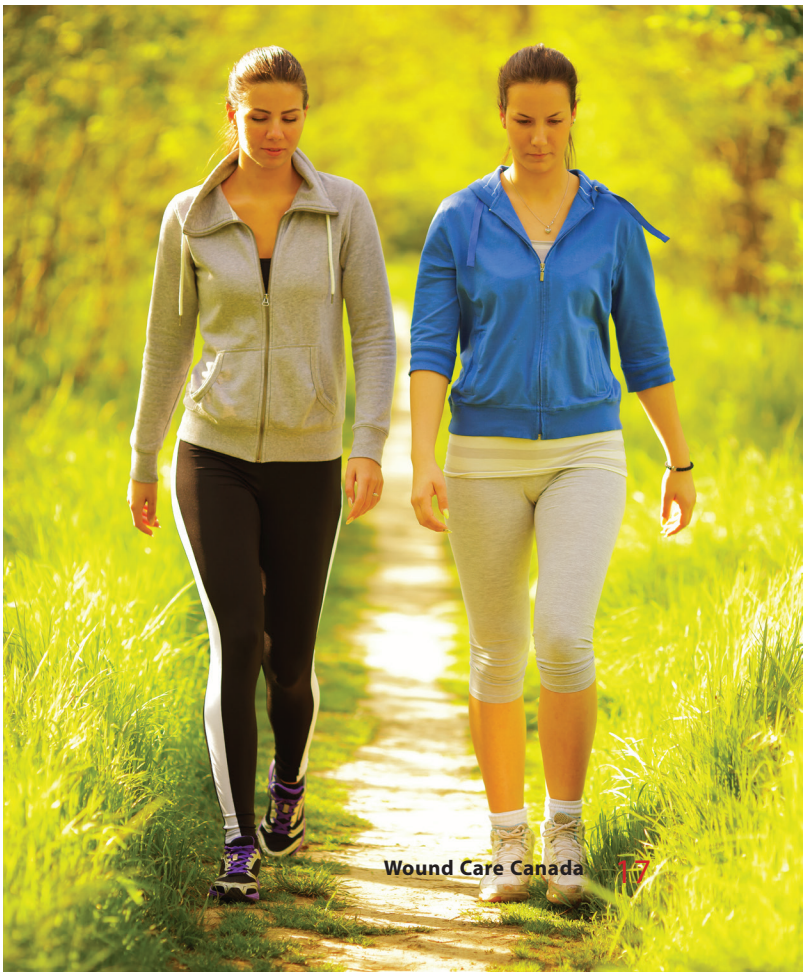
pressure across all parts of the cardiovascular system. As long as 25 minutes of complete rest in a supine position may be needed to normalize the peripheral arteries of people with PAD.[1] Note that people with chronic obstructive pulmonary disease (COPD) can become short of breath when lying with their head at the same level as their heart. It is known that systolic blood pressures vary by 3% or more with respiration; therefore, unless you use a machine that can simultaneously inflate both arm and leg cuffs, some variation in measured pressures is to be expected. Other large variations in ABPI values can result from technical problems related to positioning of the probe, causing the operator to lose the Doppler sound, or changes to the rate or amount of cuff inflation. Clinicians must use enough gel that the duplex US probe remains immersed in conductive medium throughout the test, and the probe can be placed on the skin without excessive pressure that can collapse the target artery.

Clinicians performing ABPI tests not only need to practise the skills associated with using the portable US Doppler and cuff, but they should also understand how certain characteristics and co-existing health conditions can influence systolic pressures and ABPI values. The following clinical conditions will alter ABPI values regardless of how careful and precise the operator is:

- Conditions that cause vessel calcification
  - Diabetes
  - Renal failure requiring dialysis
- Anatomical differences in peripheral vasculature
  - Absent dorsal pedal artery
  - Arterio-venous anastomoses
  - Rich collateral network
- Low systemic blood pressure (hypotension)
- Respiratory distress when lying flat for prolonged periods (e.g., COPD)
- Conditions that cause peripheral vasoconstriction
  - Anxiety, stress (e.g., white-coat phenomenon)
  - Pain
  - Recent nicotine use (e.g., patient is a smoker, or involved in nicotine replacement therapies)

With longstanding or severe arterial disease, the walls of arteries stiffen, and calcium is deposited into the walls of larger arteries. Calcification of large vessels is particularly common in people who have concomitant diabetes and/or kidney disease requiring dialysis.[1,19] With stiffer and calcified vessel walls, the pressure cuff must exert greater external pressure to obstruct blood flow, and this falsely elevates ankle systolic pressure. In 5 to 10% of cases, vessel calcification will be so extensive it prevents the pressure cuff from closing the vessel (noncompressible), and therefore ankle systolic pressure cannot be measured. Any condition that causes vessel walls to become stiffer can cause ABPI values to be falsely elevated and yield a high rate of false negatives. This will cause clinicians to miss PAD in individuals where arterial occlusion or stenosis is present.

Other conditions and medications known to affect the accuracy of ABPI values are those causing low blood pressure.[1] Lower arm systolic pressure can lead to falsely elevated ABPI values and a greater chance of missing underlying peripheral vessel disease. Last, any condition that changes peripheral vasoconstriction can alter ABPI values. These include factors such as patient anxiety or



stress, fever or cold, as well as chemicals known to alter arteriole vasoconstriction such as smoking or smoking cessation medications containing nicotine.

ABPI and Compression Therapy

Though there is research evidence supporting the use of an ABPI in detecting PAD in high-risk individuals, the link between ABPIs and the selection of compression therapies is less well established. Vowden and Vowden, in a 2001 review article, describe how the ABPI became "the holy grail of leg ulcer assessment."[20] The review authors say Cornwall was the first to suggest the use of ABPI via portable Dopplers to assess people with venous leg ulcers.[20] Cornwall suggested that "ulcers occurring in a limb of someone with ABPI < 0.9 should be considered ischemic, and those with ABPI < 0.75 had significant impact on clinical management."[21] Callam and colleagues were the first to document a case of skin necrosis and amputation in a patient receiving compression therapy, and the authors urged the clinical community to "reduce compression levels in patients with ABPI < 0.7."[22] This was followed shortly by another article published in *The Lancet*, documenting a large clinical trial of compression therapy involving participants who had venous leg ulcers but excluding individuals who had an ABPI < 0.8.[23] And so was born the ABPI < 0.8 cut-off for using "high-compression therapy." The anecdotal basis of this common clinical practice has led many reviewers to point out that a study has never been conducted showing lower compression is safe for people with ABPI < 0.8. This controversy brings to mind an article published in *The British Medical Journal* that poked fun at research processes used in systematic reviews. After an extensive literature search the authors concluded there was no randomized controlled trial available to support the use of parachutes by skydivers,[24] illustrating that direct research showing an intervention is safe is, in fact, neither feasible nor ethical.

While there is no direct evidence to link low ABPI values to compression-related complications, there is plenty of indirect evidence to suggest that judicious use of compression therapy on people with mild to moderate PAD (ABPI 0.8 – 0.5) can be beneficial,[25–27] and that adverse reactions when compression is used are rare and minor in nature.[28] Furthermore, in rare instances where tissue necrosis was reported after removal of compression bandages, it was not possible to determine whether necrosis was caused by underlying PAD or by poor bandaging technique. Additionally, increases in regional arterial blood flow have been measured in the presence of compression[29] and compression therapy has been applied without incident to patients with critical limb ischemia.[25] However, only the most experienced clinicians, who can monitor their patients daily, should use compression in this way.

The European Wound Management Association published a key article on this topic where they reviewed current guidelines related to compression therapy and ABPIs.[30] They conducted a systematic review of published and grey literature between 2009 and 2016 to find relevant guidelines, consensus documents, clinical pathways and practice algorithms that addressed risk factors, adverse events and complications when applying compression therapy to people with venous disease or venous ulcers. They found a total of 20 relevant articles, including 14 guidelines, three con-

sensus and position papers and three algorithms. Interestingly, none of these guidelines originated in Canada, including the RNAO (Registered Nurses' Association of Ontario) best practice guideline related to venous leg ulcer management.[31] They noted that all of the articles listed an ABPI ≤ 0.5 as an "absolute contraindication" for compression therapy, stating it should be avoided because of risk of serious complication. All guidelines recommended completing an ABPI in those people with venous leg ulcers, chronic edema and/or chronic venous insufficiency.[30] What was less consistent across international guidelines was what to do if ABPI values are between 0.5 and 0.8, which they termed a relative contraindication. In reality, there are many different materials and approaches to compression systems available, and sub-bandage pressures are known to change depending on whether the patient is lying down or standing and increase substantially when the calf muscle contracts during walking and other ankle movements.

Not surprisingly, most guidelines conclude more research is needed and that complications of compression therapy can almost always be prevented if clinicians perform a comprehensive assessment and are skilled in applying the compression system or bandages. This conclusion is consistent with many other review articles that caution against using a single ABPI cut-off point to drive clinical decisions.[1,19] Matching a safe and effective compression system to the patient requires advanced skill and professional judgement. Involving knowledgeable personnel in the provision of advanced therapies, like compression, is known to produce superior clinical outcomes (more venous leg ulcers healed) and be more cost effective.[32] ABPI tests should be one of a number of clinical observations used to evaluate the status of a patient's peripheral circulation. As with all medical devices, there are both risks and benefits of the intervention, and these must be weighed by a trained and well-informed health-care professional. What is most important is that the patient receiving compression therapy be provided with clear instructions, so they know what to expect and under what circumstances the compression system or bandage should be removed.

Compression and other methods of treating chronic edema is a well-recognized best practice for the treatment of venous leg ulcers. However, recent surveys have shown as few as 11% of people with leg ulcers were receiving compression therapy.[32] Therefore organizations that require an ABPI be completed by a skilled clinician prior to providing compression therapy must ensure sufficient resources and qualified personnel are in place to prevent undue delays to this mainstay treatment of venous leg ulcers.

Predicting Healing with ABPI Values

The final clinical application of ABPI values is as a predictive tool to determine the likelihood that a patient with a VLU will heal. Specifically, it is believed that people who have VLUs and have low ABPIs will not heal. Several studies have examined the relationship between ABPI values and the occurrence of non-healing and found that only at very low values of ABPI (< 0.6) is there an association between ABPI values and wound healing rates.[33,34] In fact, other factors, such as how long the ulcer is present or compliance with compression, more strongly predict who will heal or achieve complete wound closure.[33]

Clinical Implications

- ABPI is a portable vascular test recommended for use in the field by trained health-care professionals who can produce reliable and accurate assessments of systolic pressure of major arteries located in the arm and ankle region.
- Low ABPI values (less than 1.0) are known to detect PAD and agree well with more invasive vascular tests, including angiography and US duplex scans.
- People with a low ABPI should be referred to vascular specialists, since this can be a sign of significant and potentially life-threatening cardiovascular disease.
- Most international guidelines recommend performing an ABPI in people at risk of PAD, including those with chronic venous insufficiency and/or venous leg ulcers.

- If ABPI values indicate PAD is severe (ABPI 0.4–0.6), compression therapy is generally not recommended (absolute contraindication). What to do when patients have a VLU and ABPI values between 0.9 and 0.6 is less clear.
- It is difficult to predict based on an ABPI value who will and will not heal, especially for intermediate ABPI values between 0.6 and 0.9.

Conclusions

ABPI was first developed as a diagnostic test able to detect PAD in people with significant stenosis of large leg arteries. However, its use in wound care practice has expanded in recent years since it is recommended that the ABPI can be used to screen people appropriate for compression therapy and to predict whether people with a VLU will heal. Available research suggests that only very low ABPI values indicating severe PAD should be used when deciding on compression and a patient's healability.

While more research is needed, there is universal agreement that management of people with edema, open wounds and leg pain is complex and requires health providers who are well informed and able to make advanced clinical decisions based on each patient's physical and emotional needs and preferences.

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HOW TO ASSESS BLOOD FLOWING USING AN

Ankle-Brachial Pressure Index (ABPI) Assessment

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When a patient presents with lower leg problems, such as pain, edema, an ulcer or other skin breakdown, one of the first tasks is to identify what the cause or causes might be, and which factors could affect treatment strategies. After taking a thorough patient history, a clinician should consider an ankle-brachial pressure index (ABPI, or ABI) assessment, a common test to determine any impairment to the arterial blood flow to the lower extremities. An ABPI assesses the ratio of systolic blood flow in the brachial artery to that of the dorsal pedis and posterior tibia. This article discusses how to conduct an ABPI.

Why Do an ABPI?

- ✓ **To help to identify if arterial disease is a factor that is impacting leg health and wound healing**
- ✓ **To assist with goal setting and help guide treatment and referrals**
- ✓ **To protect against patient harm and clinician liability. For example, compression therapy cannot be initiated unless adequate blood flow has been demonstrated and documented (see Table 1).**
- ✓ **To help to stratify the degree of peripheral arterial disease**

Equipment Needed

- Blood pressure (BP) cuff: cuff bladder length should be approximately 80% of the circumference of the upper arm, with the width approximately 40% of the circumference of the upper arm
- Doppler (preferred) with an 8 MHz vascular probe
- Ultrasound gel
- Towels for removing gel

Steps

Step 1

1. Explain the procedure.
2. Ensure the patient has not smoked a cigarette within 24 hours of the procedure.
3. Have the patient roll up their sleeves and pant legs and remove shoes and socks.
4. Have the patient lie comfortably flat for a minimum of 15 minutes to normalize blood pressure and decrease patient anxiety.

Step 2

1. Secure the appropriate size of blood pressure cuff around the arm, loose enough for two fingers but not so loose that it slips down. Pediatric or oversized cuffs may be required.
2. Locate the brachial pulse with your fingers in the patient's antecubital fossa.
3. Apply a generous amount of ultrasound gel over the brachial pulse.
4. Slowly adjust the probe to obtain an audible signal (40- to 60-degree angle in the direction of the flow).
5. Inflate the cuff until the Doppler signal disappears, usually 20 mmHg above their normal BP, then gradually release the pressure valve until the signal returns.
6. Repeat on the other arm. (Brachial systolic pressure must always be assessed bilaterally.)
7. If you need to repeat the measure, wait one to three minutes before repeating the procedure.

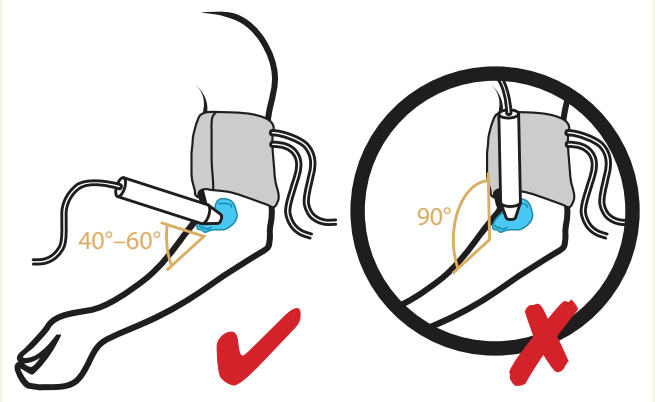

Figure 1: Correct and incorrect angles for conducting an ABPI. In a successful assessment, the higher number of the two arms is the brachial systolic pressure (B).

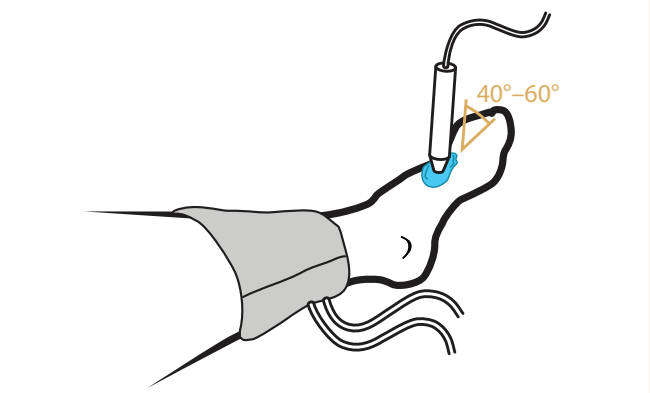

Figure 2: Proper position and probe angle for measuring ankle systolic pressure (A).

Step 3

Locate with your fingers the dorsalis pedis and posterior tibial pulses.

Step 4

1. Secure the blood pressure cuff just above the ankle, making sure it is loose enough to insert two fingers between the cuff and the calf.
2. Locate the posterior tibial, dorsalis pedis and digital artery pulse using the Doppler probe and a generous amount of gel. Move the probe with a 45- to 60-degree angle facing toward the heart until you get the loudest pulse sound. Listen carefully to the Doppler sound for each pulse and attempt to identify the waveform as triphasic, biphasic or monophasic (you may require headphones to block out environmental noise).
3. Inflate the cuff until the Doppler signal disappears, then gradually release the pressure valve until the signal returns. Repeat with the second and third pulse.

Step 5

To calculate the ABPI, divide the appropriate ankle systolic pressure by the highest brachial systolic pressure (ABPI = A/B). Record the ABPI for each artery tested.

Ankle Brachial Pressure Index

$$\text{ABPI} = \frac{A}{B}$$

where **A = ANKLE systolic pressure,** measured in the dorsal pedal artery, posterior tibial artery and digital artery (measure all three and calculate an ABPI for each)

and **B = BRACHIAL (ARM) systolic pressure,** measured in the left or right brachial artery (measure both and use the highest value found)

Calculate an ABPI for each ankle artery found using the systolic pressure from that artery. The clinician should expect the ankle and brachial pressures to be similar, yielding a ratio near 1.0.

Common Problems

If you have difficulty with this procedure, do the following:

- ✓ **Make sure you are using enough gel.**
- ✓ **Check that the Doppler probe is pointed toward the direction of blood flow (see figures 1 and 2).**
- ✓ **Check that the angle of the Doppler probe is between 40° and 60° (see figures 1 and 2).**
- ✓ **Check that the BP cuff is the correct size.**
- ✓ **Be patient. Slow down and take a breath.**
- ✓ **If necessary, ask for help from someone more experienced.**
- ✓ **If you find it hard to hear, use a headset to block out environmental noise.**

Tips

- ✓ **Prepare your equipment before beginning the procedure.**
- ✓ **In some elderly patients, the dorsalis pedis pulse is difficult to find. Move down the dorsum of the foot along the first ray and look between the first and second digit.**
- ✓ **Remember that an ABPI is only one parameter of testing. Results should be considered in relation to presented symptoms and risks, such as claudication and critical ischemia.**

Table 1: Interpreting the ABPI

Value	Interpretation	Clinical Correlation
> 1.40	Interpret with caution;may indicate calcified vessels	• Be aware of possible falsely elevated measures.
1.0 – 1.40	Normal arterial flow	• Pulses palpable and no signs of arterial disease
0.91 – 0.99	Borderline arterial flow	• Pulses palpable and no signs of arterial disease
0.70 – 0.90	Mild impairment of arterial flow	• Often have no symptoms and no clinical signs of arterial disease
0.41 – 0.69	Moderate impairment of arterial flow	• Abnormal exam • May give history of claudication pain
< 0.40	Severe impairment of arterial flow (critical limb ischemia)	• Abnormal exam • May give history of rest pain

Step 6

Discuss the results of this test and their implications with your patient. Interpretation of the value of the ABPI is shown in Table 1.

When to Conduct a Toe-Brachial Pressure Index (TBPI)

Incompressibility can occur if calcification of arteries is present. This is indicated by an abnormally high ankle systolic pressure. If there is concern about calcification of vessels, especially in the presence of diabetes, the toe-brachial pressure index (TBPI) can be obtained in a similar fashion using a toe-pressure cuff around the first digit. The Doppler is then used to obtain a systolic reading from the plantar aspect of the first digit. If there is a first-toe amputation, any digit can be used if the appropriate digit-sized cuff is used.

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