



# Ankle Brachial Index:

Best Practice for Clinicians



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# Ankle Brachial Index: Best Practice for Clinicians

## Definition

Ankle brachial index (ABI) is a noninvasive vascular screening test to identify large vessel peripheral arterial disease by comparing systolic blood pressures in the ankle to the higher of the brachial systolic blood pressures, which is the best estimate of central systolic blood pressure (Sacks et al., 2002; Vowden & Vowden, 1996, 2001).

This tool may be used to support the diagnosis of vascular disease by providing an objective indicator of arterial perfusion to a lower extremity. In the presence of diabetes mellitus, the reading may not be accurate.

ABI is also known as ankle/arm index (AAI) and resting pressure index (RPI).

## Purpose

ABI

- detects large vessel peripheral arterial disease in lower extremities (Criqui et al, 1989; Sacks et al., 2002)
- determines adequate arterial blood flow in the lower extremities
- provides documentation of adequate arterial blood flow in lower extremities before using compression therapy.

## Assessment and Physical Findings

Before performing ABI, it is important to obtain a thorough history and physical that includes, but is not limited to the following considerations.

History/Physical Finding	Considerations	Decision to Proceed with ABI
Diabetes	Noncompressible blood vessels or calcified vessels may not give an accurate reading with the use of a blood vessel cuff.	Taking toe pressures (TP) for patients with diabetes in whom lower-extremity arterial disease (LEAD) is suspected (TP $\leq 30$ indicates LEAD) is recommended. Toe pressures are recommended if ABI $>1.3$ (WOCN Society, 2002).
Pain, including <ul style="list-style-type: none"><li>• intermittent claudication (pain that occurs with activity and is relieved by a period of rest)</li><li>• nocturnal leg pain (pain that occurs when in bed)</li><li>• resting leg pain (pain that occurs in the absence of activity and with the legs in the dependent position)</li><li>• painful ulcer</li><li>• any painful condition, such as arthritis.</li></ul>	<ul style="list-style-type: none"><li>• Pain may make obtaining blood pressures at ankles impossible if patient cannot tolerate procedure. (To rate pain levels, use a validated pain scale [e.g., Wong-Baker Faces Pain Rating Scale]).</li><li>• Clinician should ask patient what has helped alleviate pain.</li><li>• Patient may need to be premedicated before ABI.</li></ul>	<ul style="list-style-type: none"><li>• Proceed with ABI, but continuously monitor pain level by encouraging patient to notify a clinician if unable to tolerate the procedure.</li><li>• Refer to healthcare provider for further evaluation if unable to perform ABI because of pain.</li></ul>
Acute deep vein thrombosis (DVT)	Applying compression with the blood pressure cuff may dislodge clot.	Do not proceed with ABI; refer to healthcare provider for further evaluation of acute DVT.
Cellulitis	May not be able to obtain ankle pressure because of patient discomfort and/or edema.	<ul style="list-style-type: none"><li>• Proceed with ABI, but continuously monitor discomfort level by encouraging the patient to notify the clinician if unable to tolerate the procedure.</li><li>• Refer to healthcare provider for further evaluation if unable to perform ABI due to discomfort and/or edema.</li></ul>



## Assessment and Physical Findings

History/Physical Finding	Considerations	Decision to Proceed with ABI
Lower-extremity edema, lymphedema, and/or obesity	<ul style="list-style-type: none"> <li>• Extremity edema, lymphedema, and/or obesity can result in diminished sound transmission.</li> <li>• Obtaining Doppler signal (sound of pulse) may be difficult.</li> <li>• May need to use a large adult blood pressure cuff to accommodate larger extremity.</li> </ul>	Proceed with ABI if able to obtain audible signal for pressure readings.
Previous trauma or surgery to lower extremities	<ul style="list-style-type: none"> <li>• Scar tissue may interfere in obtaining pulses.</li> <li>• May increase lower-extremity edema.</li> </ul>	Proceed with ABI if able to obtain signal audible for pressure readings.
Absence of dorsalis pedis artery pulse and posterior tibial artery pulse (with Doppler)	<ul style="list-style-type: none"> <li>• Locate pulses using palpation or Doppler. Doppler is more sensitive in the presence of low flow or edema and in some cases you can hear by Doppler when palpation is unable to detect pulse. Measure both dorsalis pedis and posterior pulse and use the higher to calculate ABI.</li> <li>• Presence of palpable pulses does not rule out LEAD.</li> <li>• Absence of dorsalis pedis artery pulse and posterior tibial artery pulse is indicative of LEAD.</li> <li>• Approximately 12% of the population has a congenital absence of the dorsalis pedis pulse.</li> <li>• ABI is obtained using a Doppler and sphygmomanometer to measure systolic pressures in the brachial, dorsalis pedis, and/or posterior tibial arteries.</li> </ul>	Proceed with ABI if able to obtain signal audible for pressure readings.
History of leg ulcers and/or alterations in skin integrity	<ul style="list-style-type: none"> <li>• Previous ABI readings may be available for comparison.</li> <li>• Use a protective barrier on the patient's extremity when any alterations in skin integrity are present.</li> </ul>	Proceed with ABI.
History of tobacco, caffeine, and/or alcohol intake	<ul style="list-style-type: none"> <li>• Note degree of smoking, alcohol, and/or caffeine use before assessment. Patient should be encouraged to be free of stimuli that elevate blood pressure, such as nicotine, caffeine, and alcohol prior to the ABI procedure.</li> <li>• There may already be a documented history of vascular insufficiency.</li> </ul>	Proceed with ABI if the patient has taken blood pressure medication if prescribed. Make a notation if the patient has used nicotine, caffeine, or alcohol prior to the test if it is not feasible or practical to reschedule the test.

## Assessment and Physical Findings

History/Physical Finding	Considerations	Decision to Proceed with ABI
<p>Findings consistent with chronic venous insufficiency, including</p> <ul style="list-style-type: none"> <li>• atrophy of subcutaneous tissue</li> <li>• hardened, thickened scaly skin (lipodermatosclerosis)</li> <li>• brown discoloration of lower leg; brown sock appearance (hemosiderin)</li> <li>• brawny edema.</li> </ul>	<ul style="list-style-type: none"> <li>• Previous ABI readings may be available for comparison.</li> <li>• Cleanse, moisturize, and protect affected area. May need to apply a protective dressing to open areas to protect blood pressure cuff and use universal precautions.</li> </ul>	<p>Proceed with ABI.</p>
<p>Findings consistent with arterial insufficiency, including</p> <ul style="list-style-type: none"> <li>• loss of hair on lower leg, foot, or toes</li> <li>• thinning, shiny, taut skin</li> <li>• cyanosis/pallor on elevation</li> <li>• dependent rubor</li> <li>• paresthesias (subjective sensation of “pins and needles” or other changes in sensation)</li> <li>• skin temperature changes (cool lower extremities/feet/toes)</li> <li>• diminished/decreased pulses of lower extremities.</li> </ul>	<ul style="list-style-type: none"> <li>• May have difficulty locating pulses with either palpation or Doppler.</li> <li>• May require further vascular evaluation.</li> </ul>	<p>Proceed with ABI if able to obtain signal audible for pressure readings.</p>
<p>Hypertension</p>	<ul style="list-style-type: none"> <li>• Hypertension often has no symptoms.</li> <li>• Take caution, if brachial blood pressure readings are consistent with &gt;140 mmHg systolic or &gt;90 mmHg diastolic.</li> </ul>	<ul style="list-style-type: none"> <li>• Proceed with ABI if hypertension is controlled.</li> <li>• Refer to healthcare provider for evaluation of uncontrolled hypertension.</li> </ul>
<p>Dementia</p>	<p>Cognitive impairment may interfere with a patient’s ability to comprehensively interpret and follow ABI procedural instructions.</p>	<ul style="list-style-type: none"> <li>• Proceed with ABI if patient has ability to cooperate.</li> <li>• Refer to healthcare provider if unable to perform ABI due to dementia.</li> </ul>

## ABI Procedure

The best ABI results are obtained when the patient is relaxed, comfortable, and has an empty bladder.

To enhance the patient's relaxation and comfort

- Explain the procedure.

### Follow-Up

If the ABI is  $>0.9$ , continue to monitor clinical presentation of circulatory status and/or wound. If the ABI is  $> 1.3$ , this may be indicative of noncompressible blood vessels, as in diabetes. Suggest alternate testing methods (e.g., transcutaneous oximetry).

### Referral

- Recommend that referring healthcare provider consider referral to vascular surgeon if ABI results are borderline ( $<0.6$  to  $0.8$ ) or severe ischemia ( $<0.5$ ).
- Refer if there is a falsely elevated reading due to noncompressible blood vessels, which frequently accompanies diabetes. Suggest alternative testing methods including photoplethysmography (PPG) or transcutaneous oximetry.

### Documentation

- Document all brachial and ankle B/P readings in the medical record, noting any differences between extremities ( $>5$ – $10$  mmHg). If subclavian stenosis is present, systolic pressure differences of  $>15$ – $20$  mmHG or greater may occur.
- If a waveform is obtained with the procedure, it must be interpreted by a qualified clinician and should be placed in the medical record with the ABI results.

- Remove tight clothing so that the blood pressure cuff can be easily applied to the arms and lower legs.
- Place the patient in a flat, supine position for a minimum of 10 minutes prior to the test. Place one small pillow behind the patient's head for comfort.
- Ask patients about recent caffeine intake, alcohol intake, smoking, pain, and heavy activity as these can all affect blood pressure readings.

Periodic measurements of the ABI are indicated for nonhealing leg wounds. Patients with arterial insufficiency should have the ABI periodically reevaluated (every 3 months) as it may decrease over time.

- Notify referring healthcare provider of any significant inconsistency between ABI readings and clinical observations.
- Alert referring healthcare provider if there is inability to perform ABI for any reason.
- Describe the patient's tolerance of the procedure.
- Document the ABI value by perfusion status—normal, LEAD, borderline, severe, or critical ischemia perfusion (WOCN Society, 2002). Include an indication of the patient's understanding.
- Request for a vascular referral, if applicable.
- Schedule follow-up appointment(s).



## Guide for Performing ABI Readings

### Brachial Pressure with Doppler

Ensure proper blood pressure (BP) cuff placement on patient's upper arm:

- BP cuff bladder should be wide enough to cover 40%–50% of the upper arm circumference and long enough to cover 80% of the arm circumference. (A large, adult BP cuff may be needed to meet sizing guidelines).
- BP cuff should be wrapped around the upper arm without wrinkles and placed firmly enough to remain stationary with arm movements.
- Bottom edge of the BP cuff should be placed 2.5 cm above the antecubital space.
- The arm musculature should be relaxed, supported, and at heart level.
- Use a protective barrier on the patient's extremity when any alterations in skin integrity are present.
- Palpate brachial pulse, to determine location. To obtain an audible pulse:
- Apply conducting gel over the pulse site.
- Place the Doppler at a 45° angle toward the patient's head until an audible pulse signal is obtained.
- Inflate BP cuff 20–30 mmHg above the point that the pulse is no longer audible.
- Deflate the BP cuff at a rate of 2–3 mmHg per second noting the manometer reading at which the first pulse signal is heard and record this systolic value.
- Cleanse/remove gel from pulse site.
- Remove the BP cuff and repeat the procedure on the other arm.

Document brachial systolic readings.

Continue with procedure.

### Ankle Pressure with Doppler

Ensure proper BP cuff placement on patient's lower leg:

- BP cuff should be placed around the ankle 2.5 cm above the malleolus.
  - Use a protective barrier on the patient's extremity when any alterations in skin integrity are present.
  - Measure both dorsalis pedis and posterior pressure in each leg and use the higher pressure of each leg for the ABI.
- To obtain an audible pulse
- Apply conducting gel over the pulse site.
  - Place the Doppler probe at a 45° angle over the conducting gel toward the patient's knee until an audible pulse signal is obtained.
  - Inflate BP cuff 20–30 mmHg above the point that the pulse is no longer audible.
  - Deflate the BP cuff at a rate of 2–3 mmHg per second noting the manometer reading at which the first pulse signal is heard and record this systolic value.
  - Cleanse/remove gel from pulse site.
  - Remove the BP cuff and repeat the procedure on the other ankle.

Document the following:

- ABI
- Ankle and brachial systolic readings
- >5–10 mmHg differences in the brachial readings. If subclavian stenosis is present, systolic pressure differences of >15–20 mmHg or greater may occur.
- Patient tolerance of procedure
- An assessment of perfusion status (WOCN Society, 2002): normal, LEAD, borderline, severe, or critical ischemia perfusion. Include an indication of the patient's understanding.
- Request for a vascular referral, if applicable
- Borderline or severe ischemia
- Any significant inconsistency between ABI readings and clinical observations
- Inability to perform ABI procedure
- Follow-up appointments.

### Formula for Calculating ABI

Divide the higher of the dorsalis pedis or posterior tibial systolic pressures for each ankle by the higher of the two upper extremity brachial systolic pressures to obtain the ABI for each of the lower extremities. Upon completing calculations, compare each reading with the interpretations below.

$$\text{ABI} = \frac{\text{Highest ankle pressure}}{\text{Highest brachial arm pressure}}$$

### ABI Interpretation\*

- >1.4 Indicates noncompressible vessels
- ≥ 1.0 Normal
- ≤ 0.9 LEAD
- ≤ 0.6 to 0.8 Borderline
- ≤ 0.5 Severe ischemia

\*Note: In instances where only one extremity can be accessed, use the available systolic ankle/brachial reading for calculating ABI.



## Glossary

**Acute deep vein thrombosis (DVT):** A thrombus or the formation of a blood clot that causes an outflow obstruction in the deep veins of the extremity. Veins distal to the obstruction become distended; venous pressure increases resulting in venous stasis. Signs and symptoms include a cold, pale extremity with a bluish discoloration. The pulse below the obstruction is nonpalpable. Edema and erythema of the extremity may also be noted.

**Adult blood pressure cuff, large:** Upper extremity, large, adult blood pressure cuff, which is appropriate for an arm circumference of 32.1–43.4 cm (12.6–17.1 in.). It has a length of 64.39 cm (25.35 in.) and a width of 17.02 cm (6.70 in.).

**Arterial insufficiency:** Lack of sufficient blood flow in arteries to extremities. Can be caused by cholesterol deposits (atherosclerosis) or clots (emboli) or by damaged, diseased, or weak vessels.

**Compression therapy:** Application of sustained external pressure to the affected lower extremity to control edema and aid the return of venous blood to the heart. May be achieved by wraps or multi-layer, elastic compression therapy systems.

**Doppler scanning:** Doppler velocity waveform analysis uses continuous-wave Doppler ultrasound to record arterial pulsations in various lower-extremity arteries.

**Dorsalis Pedis Artery:** The continuation of the anterior tibial artery of the lower leg. It starts at the ankle joint, divides into five branches, and supplies

various muscles of the foot and toes. The dorsalis pedis pulse can be palpated on the mid-dorsum of the foot, between the first and second metatarsals.

**Noncompressible blood vessels:** The process in which organic tissue becomes hardened by the deposition of calcium salts in the tissues.

**Pain scale:** A means to measure the existence and intensity of pain. A standardized pain assessment instrument, such as the Wong-Baker Faces Pain Rating Scale, should be utilized.

**Petechiae:** Small, purplish, hemorrhagic spots on the skin that may be present in certain severe fevers and may be indicative of great prostration, as in typhus. Petechiae may also be due to abnormality of the blood-clotting mechanism.

**Posterior tibial artery:** One of the parts of the popliteal artery of the leg. It divides into eight branches, which supply blood to different muscles of the lower leg, foot, and toes, and is situated midway between the medial malleolus and the medial process of the calcaneal tuberosity. The posterior tibial pulse can be palpated in the groove behind the medial malleolus.

**Purpura:** A disorder with bleeding beneath the skin or mucous membranes. It causes black and blue spots (ecchymoses) or pinpoint bleeding.

**Venous insufficiency:** Failure of the valves of the veins to function that leads to decreased return of venous blood from the legs to the trunk of the body; may produce edema.

## References

- Criqui, M.H., Browner, D., Fronek, A., Klauber, M.R., Coughlin, S.S., Barrett-Connor E., et al. (1989). Peripheral arterial disease in large vessels is epidemiologically distinct from small vessel disease. *American Journal of Epidemiology*, 129, 1110–1119.
- Sacks, D., Bakal, C. W., Beatty, P. T., Becker, G. J., Cardella, J. F., Raabe, R. D., et al. (2002). Position statement on the use of the ankle brachial index in the evaluation of patients with peripheral vascular disease. *Journal of Vascular Interventional Radiology*, 13, 353.
- Vowden, K.R. & Vowden, P. (1996). Peripheral arterial disease. *Journal of Wound Care*, 5(1), 23–26.
- Vowden, K.R. & Vowden, P. (2001). Doppler and the ABPI: How good is our understanding? *Journal of Wound Care*, 10(6):197–202.
- Wound, Ostomy Continence Nurses Society. (2002). *Guideline for the management of wounds in patients with lower-extremity arterial disease*. Glenview, IL: Author.

## Suggested Reading

- Abbott, R. D., Petrovitch, H., Rodriguez, B. L., Yano, K., Schatz, I. J., Popper J. S., et al. (2000.) Ankle/brachial blood pressure in men > 70 years of age and the risk of coronary heart disease. *The American Journal of Cardiology*, 86, 280–284.
- American Pain Society. (1999). Guideline for the management of acute and chronic pain in sickle-cell disease. Glenview, IL: Author.
- Bryant, R. (Ed.). (2000). *Acute and chronic wounds: Nursing management* (2nd ed.). St. Louis: Mosby.
- Carpenter, J. P. (2000). Noninvasive assessment of peripheral vascular occlusive disease. *Advances of Skin and Wound Care*, 13(2), 84–85.
- Gardner, A. W. & Montgomery, P.S. (1998). Comparison of three blood pressure methods used for determining ankle/brachial index in patients with intermittent claudication. *Angiology*, 49, 723–738.
- Kunimoto, B. (2001). Assessment of venous leg ulcers: An in-depth discussion of a literature-guided approach. *Ostomy/Wound Management*, 47(5), 38–49.

- Kunimoto, B., Cooling, M., Gulliver, W., Houghton, P., Orsted, H., & Sibbald R. (2001). Best practices for the prevention and treatment of venous leg ulcers. *Ostomy/Wound Management*, 47(2), 34–49.
- Lunden, M., Wiksten, M., Perakytta, T., Lindfors, O., Savolainen, H., Skytta, J., et al. (1999). Distal pulse palpation: Is it reliable? *World Journal of Surgery*, 23, 252–255.
- Morison, M. J. & Moffatt, C. J. (1994). *A colour guide to the assessment and management of leg ulcers* (2nd ed.) Barcelona, Spain: Mosby, Times Mirror international Publishers Limited.
- Mosby's medical encyclopedia*. (1997). Boston: The Learning Company, Inc.
- Williams D., Patterson, D.M., & Sibbald, R.G. (2001). Vascular assessment. In *Chronic Wound Care* (3rd ed.), pp. 505–516. Philadelphia: HMP Communications.