

When you can't rely on ABIs

The ankle-brachial index can be deceptive in patients with advanced diabetes.



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One of the worst fears of a wound care clinician is inadvertently compressing a leg with critical limb ischemia—a condition marked by barely enough blood flow to sustain tissue life. Compression (as well as infection or injury) could lead to necrosis, the need for amputation, or even death. The gold standard of practice is to obtain an ankle-brachial index (ABI) before applying compression. However, recent research and expert opinion indicate an elevated or normal ABI is deceptive in patients with advanced diabetes. What's worse, in the diabetic foot, skin may die from chronic capillary ischemia even when total blood perfusion is normal. For information on how to perform an ABI and interpret results, click on this [link](#).

This article explains why ABIs can be deceptive when considering the safety of compression and wound-healing potential in diabetic patients. As a wound care clinician, you need to stay alert for both falsely elevated and false-normal ABIs—and when these occur, suspect underlying peripheral artery disease (PAD).

Falsely elevated ABIs

Most wound care clinicians are familiar with a falsely elevated ABI. But do you understand what it means? ABI compares blood pressure measured at the ankle with blood pressure measured at the arm. Traditionally, an ABI of 1.3 or more has been deemed falsely elevated. But a **2011 guideline from the American College of Cardiology and the American Heart Association** raised the false-elevation threshold to 1.4.

Falsely elevated ABI stems from calcification of the arterial wall and is common in patients with diabetes. Yet such calcification doesn't automatically indicate plaque in the lumen of that artery; nor does a normal ABI indicate absence of plaque. A 2008 study of 1,762 patients found atherosclerotic plaque in 62% of those with falsely elevated ABIs, whereas the other subjects had normal blood flow. PAD was significantly more prevalent in patients with the clinical indicators of resting pain, ulcers, or gangrene. Also, PAD risk was 10 times higher in patients with chronic renal failure, three times higher in those with coronary artery disease, and five times higher in those with a history of smoking. Therefore, these concurrent diagnoses and clinical indicators can serve as distinguishing factors when arterial calcification obscures underlying PAD.



Download Ankle-brachial index tool

In calculating ABI, the higher measurement of the dorsalis pedis and posterior tibial arteries is used.

False-normal ABIs

False-normal ABIs are more problematic than falsely elevated ABIs. An otherwise diseased and occluded artery may calcify just enough to raise the ABI to a normal range before reaching falsely elevated levels. Therefore, a normal ABI (from 1.0 to 1.3) isn't sufficient to rule out PAD, according to a 2011 study.

In calculating ABI, the higher measurement of the dorsalis pedis and posterior tibial arteries is used. This in itself can lead to false-normal ABIs in diabetic patients. Diabetes commonly causes segmental arterial disease, in which one artery may be occluded while the other isn't. Therefore, blood supply to one area of the foot may be ischemic while blood supply to another is patent. If the more patent artery is used to calculate ABI, blood flow to the limb could appear normal even if significant occlusion and ischemia are present.

In a 2012 study, 8 of 30 legs with diabetic gangrene were found to have PAD, even though the patients' ABIs were normal. In one shocking case, a 69-year-old man had a normal ABI of 0.99, yet his an-

giogram showed complete occlusion of the distal peroneal and distal posterior tibial arteries and near-total occlusion of the anterior tibial artery.

Alternative tests for patients with falsely elevated ABI

Because the smaller arteries of the toes are less likely to become calcified, a toe brachial index (TBI) typically is used to detect PAD in patients with falsely elevated ABIs.

- TBI above 0.7 is normal.
- TBI below 0.64 indicates PAD.
- TBI of 0.64 to 0.7 is borderline.

However, a normal TBI doesn't necessarily mean blood flow is sufficient to promote healing of diabetic foot ulcers. TBI and total blood perfusion can be normal in the diabetic foot even if the skin has chronic ischemia. This condition (possibly caused by abnormal autonomic innervation of the vessels) occurs when blood is routed through arteriovenous shunts, bypassing capillaries. Because blood fails to deliver oxygen and nutrients via capillaries, the skin becomes chronically ischemic and wounds fail to heal. Keep this in mind when interpreting ABI and TBI results, because it may help reconcile discrepancies between what we see in wound healing and what seems like good blood flow in patients with diabetes.

View: TBI exam with PPG pressure



Transcutaneous oxygen pressure measurements

Unlike TBI, transcutaneous oxygen pres-

sure measurements (TcPO₂) indicate the wound-healing potential of diabetic foot ulcers. (However, TcPO₂ testing is less readily available than TBI.) Sensors are placed on the skin around the wound to determine actual capillary perfusion via oxygen delivery to the skin.

- TcPO₂ above 40 mm Hg indicates wound-healing potential.
- TcPO₂ of 20 to 30 mm Hg predicts chronic wound-healing complications.
- TcPO₂ below 20 mm Hg signals critical limb ischemia and the possible need for amputation.

TcPO₂ is used widely in hyperbaric oxygen therapy for patients with wounds and is gaining wider use in predicting potential candidates for this therapy.



View: hyperbaric oxygen therapy

When you must measure TcPO₂

When a patient's ABI is falsely elevated, standard practice is to obtain a TBI. But a normal TBI isn't definitive proof of adequate blood flow through the capillaries. When wound healing doesn't correspond with apparently sufficient blood flow in the diabetic foot, the patient may have arteriovenous shunting and chronic capillary ischemia. In this case, TcPO₂ measurements can help determine actual capillary perfusion and wound-healing potential. ■

Selected references

Aboyans V, Ho E, Denenberg JO, Ho LA, Natarajan L, Criqui MH. The association between elevated ankle systolic pressures and peripheral occlusive arterial disease in diabetic and nondiabetic subjects. *J Vasc Surg.* 2008;48(5):1197-203.

Aerden D, Massaad D, von Kemp K, et al. The ankle-brachial index and the diabetic foot: a troublesome marriage. *Ann Vasc Surg.* 2011;25(6):770-7.

Arsenault KA, McDonald J, Devereaux PJ, Thorlund K, Tittley JG, Whitlock RP. The use of transcutaneous oximetry to predict complications of chronic wound healing: a systematic review and meta-analysis. *Wound Repair Regen.* 2011 Nov;19(6):657-63. PubMed PMID: 22092835.

Bjork R. Bedside ankle-brachial index testing: time-saving tips. *Wound Care Advisor.* 2013;2(1):22-6.

Jörneskog G. Why critical limb ischemia criteria are not applicable to diabetic foot and what the consequences are. *Scand J Surg.* 2012;101(2):114-8.

Potier L, Abi Khalil C, Mohammadi K, Roussel R. Use and utility of ankle brachial index in patients with diabetes. *Eur J Vasc Endovasc Surg.* 2011; 41(1):110-6.

Park SC, Choi CY, Ha YI, Yang HE. Utility of toe-brachial index for diagnosis of peripheral artery disease. *Arch Plast Surg.* 2012;39(3):227-31.

Rooke TW, Hirsch AT, Misra S, et al; American College of Cardiology Foundation; American Heart Association Task Force; Society for Cardiovascular Angiography and Interventions; Society of Interventional Radiology; Society for Vascular Medicine; Society for Vascular Surgery. 2011 ACCF/AHA focused update of the guideline for the management of patients with peripheral artery disease (updating the 2005 guideline). *Vasc Med.* 2011; 16(6):452-76.

Singh PP, Abbott JD, Lombardero MS, et al; Bypass Angioplasty Revascularization Investigation 2 Diabetes Study Group. The prevalence and predictors of an abnormal ankle-brachial index in the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) trial. *Diabetes Care.* 2011;34(2): 464-7

Suominen V, Rantanen T, Venermo M, Saarinen J, Salenius J. Prevalence and risk factors of PAD among patients with elevated ABI. *Eur J Vasc Endovasc Surg.* 2008;35(6):709-14.

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