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Original Research

Quantitative Assessment of Peroneal Artery Pressure at the Ankle With Noninvasive Vascular Testing

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ABSTRACT

Although the foot and ankle derives its arterial supply from a combination of the anterior tibial artery (ATA), posterior tibial artery (PTA), and peroneal artery (PA), the focus of clinical examination techniques and noninvasive vascular testing is primarily on the ATA and PTA and not on the PA. The objectives of the present investigation were to evaluate the feasibility of incorporating an assessment of the PA into a noninvasive vascular testing protocol and to collect normative data of pressure measurements of the PA at the ankle. We attempted to locate a Doppler signal of the PA posterior to the lateral malleolus in consecutive patients undergoing our institution's standard protocol for lower extremity noninvasive vascular testing using the ankle-brachial index and photoplethysmography. An audible signal of the PA with an available pressure measurement recording posterior to the lateral malleolus was found in a large majority (92.0%) of the studied legs with peripheral arterial disease. We also found pressure measurements in the PA generally equivalent to that of the ATA and PTA. The mean ± standard deviation systolic pressure of the PA was 130.33 ± 44.74 (range 54 to 255) mm Hg, with a corresponding ankle-brachial index of 0.92. The results of the present investigation provide unique information on a potentially underappreciated aspect of lower extremity vascular anatomy with the potential to affect rearfoot surgical decision making and planning.

Although the foot and ankle derives its arterial supply from a combination of the anterior tibial artery (ATA), posterior tibial artery (PTA), and peroneal artery (PA), the focus of clinical examination techniques and noninvasive vascular testing is primarily on the ATA and PTA; not on the PA. However, the PA serves as the primary source artery to 2 of the 6 angiosomes of the foot (1), and numerous foot and ankle reconstructive procedures involve a lateral rearfoot incision within these 2 angiosomes. These include, but are not limited to, calcaneal fractures, ankle and subtalar arthrodeses, posterior calcaneal translational osteotomies, lateral column lengthening, reverse sural flaps, and lateral ankle stabilizations (2–5). As a clear example of this, Bibbo et al (6) reported an 83% wound complication rate with the lateral extensile approach for open reduction and internal fixation of a calcaneal fracture in 6 patients without a preoperative Doppler signal of the PA at the ankle versus a 1% wound complication rate in 84 patients with an audible Doppler signal of the PA (Fig. 1).

Additionally, when considering the consequences of diabetic foot disease and leg salvage, the PA is the infrapopliteal vessel most likely to be spared in the presence of chronic obstructive atherosclerotic disease and might represent the primary arterial supply to the foot in many patients with diabetes, peripheral arterial disease, and tissue loss (Fig. 2) (7–9). A common illustration of this is decubitus ulceration of the heel, which most frequently occurs on the posterior–lateral aspect within the peroneal angiosome (10).

This has led us to believe that quantitative assessment of the PA could have clinical utility and influence medical decision making for physicians working with the foot and ankle. The objectives of the present investigation were to evaluate the feasibility of incorporating assessment of the PA into a noninvasive vascular testing protocol and to collect normative data of pressure measurements of the PA at the ankle.

Patients and Methods

After approval from our institutional review board (protocol no. 23164), we attempted to locate a Doppler signal of the PA posterior to the lateral malleolus in consecutive patients undergoing our institution's standard protocol for lower extremity noninvasive vascular testing using the ankle-brachial index (ABI) and photoplethysmography (Fig. 3). The patients had removed their socks and shoes in the treatment room approximately 10 minutes before undergoing testing allow their feet to

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Fig. 1. Wound dehiscence within the peroneal artery angiosome. A patient with wound dehiscence after the lateral extensile approach used for calcaneal fractures. This incision has a high reported incidence of healing complications, possibly related to inappropriate preoperative evaluation of the arterial inflow to the peroneal artery.

acclimate to the temperature of the room, and the ABI was performed on both legs of each patient (Flo-Lab 2100; Parks Medical Equipment, Las Vegas, NV). A pneumatic cuff was placed around the proximal ankle, and the Doppler device was sequentially placed over the ATA, PTA, and PA. The cuff was subsequently inflated to a pressure of approximately 200 mm Hg and then slowly deflated while listening with the Doppler device. The pressure at which the audible signal returned was recorded as the ankle pressure for each artery. The pressure in the brachial artery was also recorded to allow for calculation of the ABI. The ABI is a mathematical ratio with the systolic pressure of the brachial artery as the denominator and the systolic pressure of an ankle artery as the numerator (11–15).

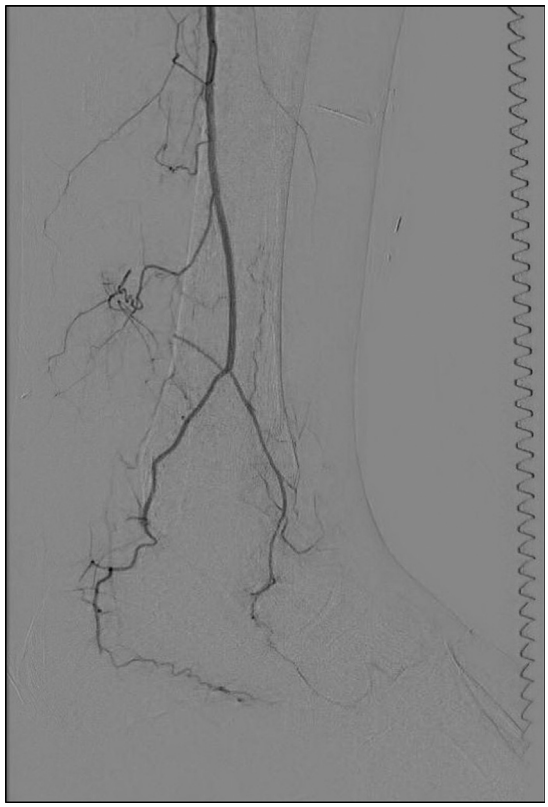

Fig. 2. Angiogram demonstrating single vessel run-off to the foot by way of the peroneal artery. The peroneal artery has been identified as the infrapopliteal vessel least likely to be affected by chronic obstructive peripheral arterial disease and might represent the only arterial inflow to the foot in many patients with the comorbidities of diabetes and peripheral arterial disease.

Fig. 3. Doppler assessment of the peroneal artery posterior to the lateral malleolus. This investigation sought to incorporate inclusion of the peroneal artery into a noninvasive vascular testing protocol by measuring the pressure of the artery posterior to the lateral malleolus.

Our initial cohort consisted of 50 legs of 25 consecutive participants presenting to our institution's vascular laboratory for completion of noninvasive vascular testing (performed by W.E.C., A.T., P.K.). These patients had previously received a diagnosis of, or were suspected of having, peripheral arterial disease, with the noninvasive testing ordered by a vascular surgeon. We also performed the noninvasive testing protocol on a cohort of 50 legs of 25 healthy volunteer participants without peripheral arterial disease or any lower extremity complaint in an attempt to establish basic normative data (performed by W.E.C., A.J.M.).

The data were collected and stored on a personal computer for subsequent analysis. All statistical analyses were performed using SAS®, version 9.2 (SAS Institute, Cary, NC) by 1 of us (A.J.M.). A frequency count was performed of the legs in both cohorts in which a systolic pressure measurement from the PA with available calculation of the ABI using the PA was possible, in addition to the descriptive statistics (mean ± standard deviation, range) of the pressure measurements for each ankle artery. Comparative statistical analyses were performed between the 2 cohorts using the independent Student *t* test for continuous variables (systolic pressure measurements for each ankle artery and participant age) and the

Table
Descriptive and comparative statistical analysis of outcome measures

Variable	Noninvasive Vascular Testing		*p* Value
	Study Group*	Control Group†	
Age (yr)	64.58 ± 11.72	26.46 ± 3.08	<.001‡,‖
Brachial artery pressure (mm Hg)			<.001‡,‖
Mean ± SD	142.04 ± 22.51	114.20 ± 12.91	
Range	110 to 204	90 to 140	
Legs with audible Doppler signal of PA (n)	46 (92)	48 (96)	.678§
PA pressure (mm Hg)			.065‡
Mean ± SD	130.33 ± 44.74	117.60 ± 17.18	
Range	54 to 255	90 to 160	
ABI calculated with PA	0.92	1.03	
ATA pressure (mm Hg)			.010‡,‖
Mean ± SD	139.73 ± 47.93	120.60 ± 18.23	
Range	58 to 255	90 to 170	
ABI calculated with ATA	0.98	1.06	
PTA pressure (mm Hg)			
Mean ± SD	138.70 ± 48.74	128.40 ± 20.04	
Range	54 to 255	90 to 180	
ABI calculated with PTA	0.98	1.12	.173‡

Abbreviations: ABI, ankle-brachial index; ATA, anterior tibial artery; PA, peroneal artery; PTA, posterior tibial artery.

* Participants with noninvasive vascular testing ordered by a vascular surgeon (n = 50 legs in 25 patients).

† Healthy participants without peripheral arterial disease or lower extremity complaints (n = 50 legs in 25 patients).

‡ Independent Student's *t* test.

§ Fisher's exact test.

‖ Statistically significant.