

# Lower-Extremity Allen Test in Critical Limb Ischemia: A Case Study



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## Introduction

- According to the CDC, 6.5 million people over the age of 40 have peripheral artery disease (PAD).
- Your History and Physical is the first line of defense in assessing for this disease process.
- The lower-extremity Allen test (LEAT) can serve as one of the physical exam modalities to assess the relative vascular contribution to the distal perfusion of the lower extremity.
- **The primary purpose of this report is to illustrate how clinical examination using a simplified LEAT can aid in the diagnosis of PAD as well as determine the relative vascular contributions to the foot.**

## Literature Review

### Risk Factors for PAD:

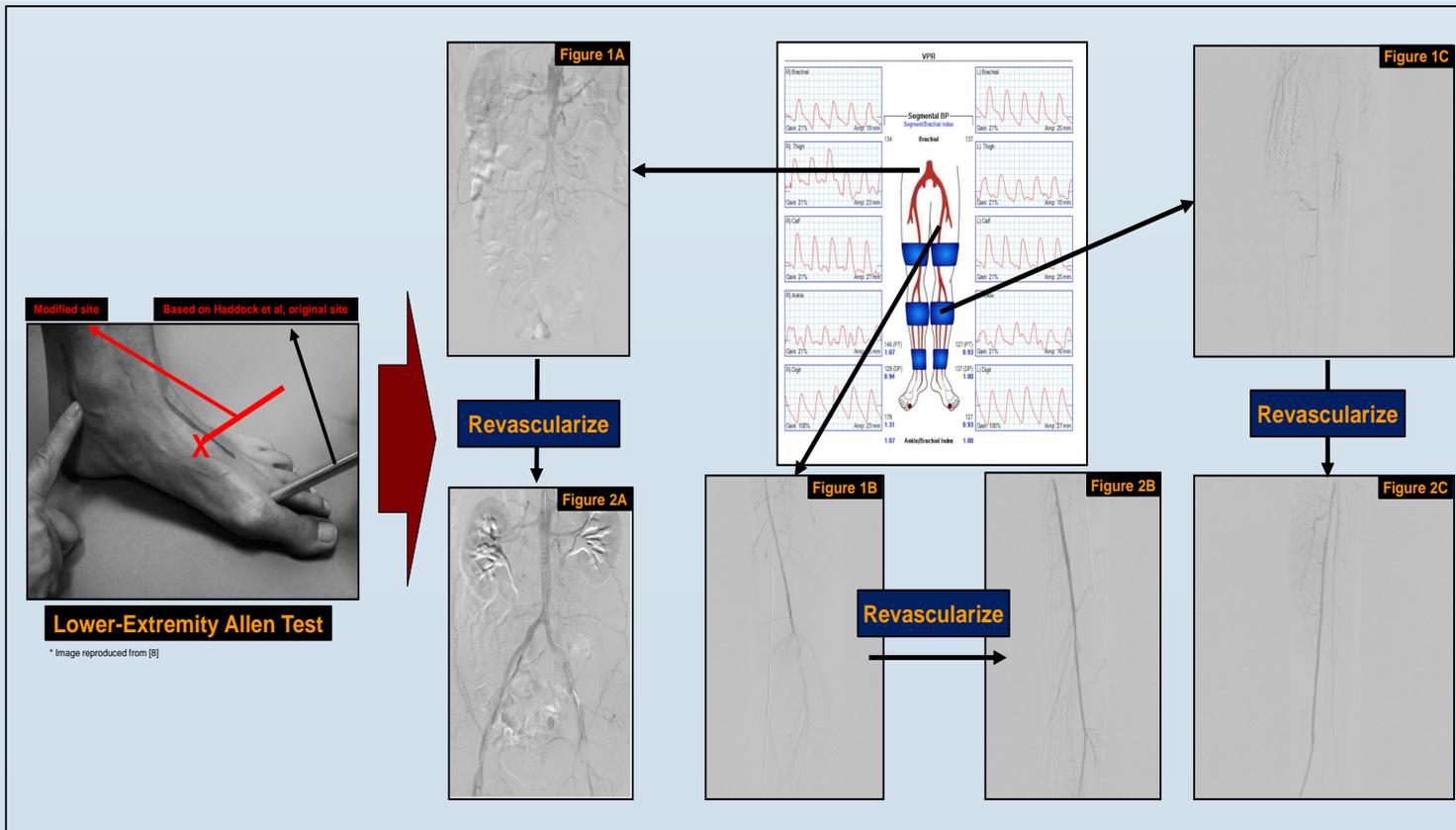
- PAD is defined as atherosclerotic stenosis or occlusion of peripheral arteries.
- **Smoking is widely regarded as one of the strongest risk factors for PAD.**
  - A systematical review (2015) showed that current smoking resulted in a 1.9 to 3.4 times higher chance of developing PAD compared to individuals that never smoked or were former smokers. [1]
  - Cessation of smoking is an important first step in treating PAD and it has been shown to improve symptoms in patients with claudication. [2]
- Diabetic mellitus (DM) is also one of the major risk factors for PAD.
  - Due to a decreased rate of smoking in western countries, DM is considered a pivotal contributor to the development and progression of PAD. [3]
- **DM is associated with more severe below-the-knee PAD (e.g., popliteal, anterior tibial, peroneal, and posterior tibial arteries), whereas smoking is associated with more proximal PAD in the aorto-ilio-femoral vessels.** [4, 5]

### Allen Test and Lower-Extremity Allen Test:

- The LEAT was described by Haddock et al. and based on the concept of the Allen test to assess the relative vascular contributions to the distal perfusion of the lower extremity and to determine the dominant circulation in a functional manner. [8]
- LEAT utilizes a hand-held Doppler ultrasound placed at the first dorsal metatarsal artery while the opposing hand compresses the dorsalis pedis (DP) and posterior tibial (PT) artery. If the doppler signal persists, perfusion to the distal foot is DP-dependent. If the doppler signal is absent, the DP is subsequently released. Return of signal indicates that perfusion to the distal foot is DP-dependent. If the doppler signal is absent, the PT artery is released. Return of signal indicates that perfusion to the distal foot is PT-dependent. [8]
- Unlike other modalities for evaluating the vascular status of the lower extremity such as ankle brachial index (ABI), toe pressure, and magnetic resonance angiography, LEAT can guide interventionalists to determine the functional consequence of arterial selection. [8]



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## Case Report

- A 56-year-old African American woman presented with increasing pain, swelling, and numbness in her bilateral hallux toes for 2 weeks duration.
- Past medical history was significant for chronic radiculopathy. Patient reports smoking 0.5 packs per day for 30 years. Patient denied any recent trauma to the bilateral foot.
- On vascular examination, DP and PT pulses were faintly palpable (+1) bilaterally. Doppler exam showed bilateral monophasic signal on DP and biphasic signal on PT.
- **Due to a difference in pitch between the DP and the PT, we employed a simplified LEAT, where a doppler is placed on the DP at the level of talonavicular joint while the opposing hand compresses the PT, the faint monophasic doppler signals on the DP disappeared immediately following compression of the PT.**
- Neurological status was grossly intact.
- Dermatological exam revealed rubor discoloration of the bilateral forefoot and moderate edema around the bilateral hallux with no signs of open wounds.
- Non-invasive vascular studies such as ABI and pulsed volume recording (PVR) were unremarkable and did not suggest PAD:
  - ABI is 1.07 for the right lower extremity (LE) and 1.00 for the left LE. PVR were within normal.
- Further angiographic testing revealed occlusions at multiple levels of the lower extremity:
  - Computed tomography angiography showed occluded distal aortoiliac arteries and thrombotic occlusion of the left popliteal artery.
  - Peripheral angiogram with bilateral lower extremity runoff revealed significant infrarenal aortic disease with subtotal aortic occlusion, ostial calcified bilateral common iliac artery (CIA) stenosis [Figure 1A], and thrombotic occlusion of the distal left superficial femoral artery (SFA) [Figure 1B] and popliteal arteries with minimal filling of the tibial vessels [Figure 1C]. Among tibial vessels, both left PT and anterior tibial (AT) vessels were occluded, but severity of occlusion was more prominent in left AT vessel.
- Surgical Revascularization
  - Covered stents were placed in the distal aorta and bilateral CIA for reconstruction of the aorto-iliac bifurcation [Figure 2A]
  - Retrograde crossing of the left PT, popliteal artery, and SFA was performed, followed by thrombectomy, angioplasty, and stenting of the distal SFA, popliteal, and PT arteries (distal SFA [Figure 2B] and tibial vessels [Figure 2C])

## Discussion

- During clinical diagnosis of PAD, the pedal pulse test alone may be misleading, as a palpable DP pulse may be due to retrograde flow from the PT.
- Normally, the flow along the DP to the distal foot is antegrade and compression at the PT will not obliterate pulse or signal at the DP. Obliteration of pulse or signal at the DP following compression at the PT suggests a PT-dependent foot, where flow along the DP is retrograde and supplied by the PT via anastomoses between the plantar and dorsal feet.
- Non-invasive vascular tests such as ABI and PVR have limitations in localizing vascular stenoses and detecting PAD in symptomatic patients who present with normal resting ABIs. [9, 10]
- Normal ABI and PVR do not imply that there is no occlusive disease due to collateralization of arterial vessels. [11, 12]
- On the other hand, angiograms can be valuable in evaluating the severity of occlusion in specific vessels, but are not routinely performed unless surgical intervention is considered.
- **The lower-extremity Allen test (LEAT) can be a useful clinical vascular examination maneuver in establishing the relative contribution of arteries to the distal foot in the diagnosis and management of critical limb ischemia and the simplified LEAT can be applied for efficient bedside medical decision-making process.**

## References

- [1] Criqui MH, Aboyans V. Epidemiology of Peripheral Artery Disease. *Circulation Research*. 2015;116(9):1509-1526. doi:https://doi.org/10.1161/circresaha.116.303849
- [2] Ratchford EV. Medical management of claudication. *Journal of Vascular Surgery*. 2017;66(1):275-280. doi:https://doi.org/10.1016/j.jvs.2017.02.040
- [3] Thiruvoipati T. Peripheral artery disease in patients with diabetes: Epidemiology, mechanisms, and outcomes. *World Journal of Diabetes*. 2015;6(7):961. doi:https://doi.org/10.4239/wjcd.v6.i7.961
- [4] American Diabetes Association. Peripheral arterial disease in people with diabetes. *Diabetes Care*. 2003;26(12):3333-3341. doi:10.2337/diacare.26.12.3333
- [5] Jude EB, Oyibo SO, Chalmers N, Boulton AJM. Peripheral Arterial Disease in Diabetic and Nondiabetic Patients: A comparison of severity and outcome. *Diabetes Care*. 2001;24(8):1433-1437. doi:https://doi.org/10.2337/diacare.24.8.1433
- [6] ALLEN EV. Thromboangitis obliterans: methods of diagnosis of chronic occlusive arterial lesions distal to the wrist with illustrative cases. *The American Journal of the Medical Sciences*. 1929;178(2):237-243. doi:https://doi.org/10.1097/0000441-192908000-00009
- [7] Cable DG, Mullany CJ, Schaff HV. The Allen test. *The Annals of Thoracic Surgery*. 1999;67(3):876-877. doi:https://doi.org/10.1016/s0003-4975(99)00095-8
- [8] Haddock N, Garfein E, Saadeh P, Levine J. The Lower-Extremity Allen Test. *Journal of Reconstructive Microsurgery*. 2009;25(07):399-403. doi:https://doi.org/10.1055/s-0029-1220861
- [9] Wang S, Brooke BS, Black JH. Clinical Vascular Examination. *Image-Guided Interventions*. Published online 2020:16-23.e1. doi:https://doi.org/10.1016/b978-0-323-61204-3.00003-8
- [10] Stein R, Hriljac I, Halperin JL, Gustavson SM, Teodorescu V, Olin JW. Limitation of the resting ankle-brachial index in symptomatic patients with peripheral arterial disease. *Vascular Medicine*. 2006;11(1):29-33. doi:https://doi.org/10.1191/1358863x06vm663oa
- [11] Gray BH. Endovascular Treatment of Lower Extremity Arterial Occlusive Disease. *Comprehensive Vascular and Endovascular Surgery*. Published online 2009:151-175. doi:https://doi.org/10.1016/b978-0-323-05726-4.00010-x
- [12] Sorber R, Almeida JJ, Raines JK, Abularrage CJ. Pulse Volume Recording in the Diagnosis of Peripheral Vascular Disease. *Noninvasive Vascular Diagnosis*. Published online 2021:1-13. doi:https://doi.org/10.1007/978-3-030-49616-6\_23-1