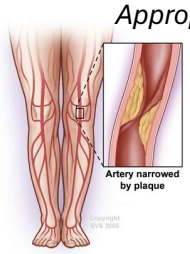
MANAGING THE PATIENT WITH PERIPHERAL ARTERIAL OCCLUSIVE DISEASE (PAD): STRENGTHS AND WEAKNESSES OF THE DIAGNOSTIC TECHNIQUES, WHO NEEDS WHICH TESTS AND WHEN
What About CTA And MRA?

Peripheral Artery Disease
Appropriate Use of Diagnostic Testing



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Vascular Surgeon

Objective Assessment Needed

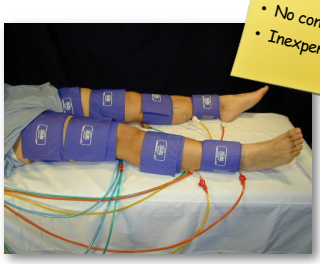
"A vascular surgeon is someone who can palpate pulses in an artificial limb."

Anonymous
ca. 1966

Diagnostic Modalities

- Indirect tests
- Duplex scanning
- CT angiography
- MR angiography
- Digital subtraction angiography

Physiologic Testing



Pitfalls of Arterial Physiologic Testing

ABI may be invalid

- Vessel calcification and incompressibility
  - Diabetes
  - Renal failure
- Edema or Bandages
- Positioning
- Error/inexperience

Toe pressures

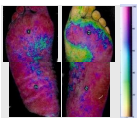
- Greater variability than ankle pressures
- Affected by environmental and physiologic factors
- Isolated digit infarction

Other Non-invasive Options: Physiologic (Indirect) Testing

Pedal (plantar) acceleration time

Transcutaneous oxygen partial pressure

Laser Doppler



Hyperspectral imaging

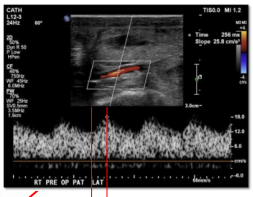
Near infrared spectroscopy

Duplex Scanning of Pedal Arteries

- Duplex scanning used as an indirect test
- Changes in pulsed Doppler waveform indicative of proximal occlusive disease and its severity:
  - *Tardus* waveform
  - Delay from onset of systole to peak
  - Quantified by measurement of Acceleration Time (AT)

Plantar Acceleration Time: A Novel Technique to Evaluate Arterial Flow to the Foot

Sommerset J, Karmy-Jones R, Dally M, Feliciano B, Vea Y, Teso D. Plantar Acceleration Time: A Novel Technique to Evaluate Arterial Flow to the Foot. Ann Vasc Surg. 2019 Oct;60:308-314. PMID: 31075481.



Acceleration time
(time from onset of systolic upstroke to peak)

Sommerset J, et al. Plantar Acceleration Time. Ann Vasc Surg. 2019.

Guidelines for Asymptomatic PAD and Claudication

Society for Vascular Surgery (SVS)

- Includes guidelines on use of imaging for:
  - Diagnosis
  - Treatment planning

Society for Vascular Surgery practice guidelines for atherosclerotic occlusive disease of the lower extremities: Management of asymptomatic disease and claudication

Society for Vascular Surgery Lower Extremity Guidelines Writing Group; Conte MS, Pomposelli FB, Clair DG, Geraghty PJ, McKinsey JF, Mills JL, Moneta GL, Murad MH, Powell RJ, Reed AB, Schanzer A, Sidawy AN; Society for Vascular Surgery. Society for Vascular Surgery practice guidelines for atherosclerotic occlusive disease of the lower extremities: management of asymptomatic disease and claudication. J Vasc Surg. 2015 Mar;61(3 Suppl):2S-41S. doi: 10.1016/j.jvs.2014.12.009. Epub 2015 Jan 28. Erratum in: J Vasc Surg. 2015 May;61(5):1382. PMID: 25638515.

Clinical Categories of Chronic Limb Ischemia (PAD)

Grade	Category	Clinical Description	Objective Criteria
0	0	Asymptomatic—no hemodynamically significant occlusive disease	Normal treadmill or reactive hyperemia test
I	1	Mild claudication	Completes treadmill exercise†; AP after exercise >50 mm Hg but at least 20 mm Hg lower than resting value
	2	Moderate claudication	Between categories 1 and 3
	3	Severe claudication	Cannot complete standard treadmill exercise†; AP after exercise <50 mm Hg

†Five minutes at 2 mph on a 12% incline

AP, Ankle pressure; *PVR*, pulse volume recording; *TP*, toe pressure; *TM*, transmetatarsal

	Grade	Level of evidence
ABI is first-line noninvasive test to establish a diagnosis of PAD in individuals with symptoms or signs. When ABI is borderline or normal (>0.9) and symptoms of claudication are suggestive, we recommend an exercise ABI.	1	A
Don't screen for PAD without risk factors, history, signs, or symptoms.	2	C
For asymptomatic patient with elevated risk (age >70, smoker, diabetes, abnormal pulse examination, other established cardiovascular disease), PAD screening is reasonable for risk stratification, preventive care, and medical management.	2	C
In symptomatic patients who are being considered for revascularization, use physiologic non-invasive studies (segmental pressures and pulse volume recordings) to determine severity and level of obstruction.	2	C
In symptomatic patients in whom revascularization is considered, anatomic imaging studies, such as arterial duplex ultrasound, CTA, MRA, and contrast arteriography.	1	B

	Advantages	Disadvantages
DSA	• Gold standard • Pressure measurements • Often combined with intervention	• Invasive • Iodinated contrast (nephropathy, allergies) • Access site and other complications
CTA	• Resolution nearly the same as DSA • Availability • Post-processing in various formats	• Intravenous contrast • Image degradation and artifact due to calcification
MRA	• Images not degraded by calcium • Image quality enhanced by use of gadolinium contrast	• Cost • Availabilty • Poorer resolution • Gadolinium use contraindicated with renal impairment (nephrogenic systemic fibrosis) • Cannot be used in patients with pacemakers or other implants

Appropriate Use Criteria
Claudication

- Primacy of medical management, exercise, smoking cessation
- Selective use of revascularization
- Choice of therapy and risk:benefit ratio varies by anatomic distribution
- No role for tibial revascularization

Woo K, Siracuse JJ, Klingbeil K, Kraiss LW, Osborne NH, Singh N, Tan TW, Arya S, Banerjee S, Bonaca MP, Brothers T, Conte MS, Dawson DL, Erben Y, Lerner BM, Lin JC, Mills JL Sr, Mittleider D, Nair DG, O'Banion LA, Patterson RB, Scheidt MJ, Simons JP; Society for Vascular Surgery Appropriateness Committee. Society for Vascular Surgery appropriate use criteria for management of intermittent claudication. J Vasc Surg. 2022 Jul;76(1):3-22.e1. doi: 10.1016/j.jvs.2022.04.012. Epub 2022 Apr 22. PMID: 35470016.

Clinical Categories of Chronic Limb Ischemia
Chronic limb Threatening Ischemia CLTI)

Grade	Category	Clinical Description	Objective Criteria
II*	4	Ischemic rest pain	Resting AP <40 mm Hg, flat or barely pulsatile ankle or metatarsal PVR; TP <30 mm Hg
III*	5	Minor tissue loss—nonhealing ulcer, focal gangrene with diffuse pedal ischemia	Resting AP <60 mm Hg, ankle or metatarsal PVR flat or barely pulsatile; TP <40 mm Hg
	6	Major tissue loss—extending above TM level, functional foot no longer salvageable	Same as category 5

AP, Ankle pressure; PVR, pulse volume recording; TP, toe pressure; TM, transmetatarsal

*Grades II and III, categories 4, 5, and 6, are embraced by the term chronic critical ischemia

CLTI Diagnosis

- Clinical presentation is important
- Challenges:
  - Multi-factorial causes for wounds (neuropathy, infection, ischemia)
  - Pain may not be due to ischemia
  - Pain may be absent with severe ischemia
- CTA or MRA can be helpful

Global Vascular Guidelines

- Definition, evaluation, and management
- Staging the severity of limb threat based on grading of **W**ounds, **I**schemia, and **f**oot **I**nfection (WIfI)
- Evidence-based revascularization (EBR) based on: **P**atient risk, **L**imb severity, and **AN**atomic complexity (PLAN)

Conte MS, Bradbury AW, Kolh P, White JV, Dick F, Fitridge R, Mills JL, Ricco JB, Suresh KR, Murad MH; GVG Writing Group. Global vascular guidelines on the management of chronic limb-threatening ischemia. J Vasc Surg. 2019 Jun;69(6S):3S-125S.e40. doi: 10.1016/j.jvs.2019.02.016. Epub 2019 May 28.

WIfI Ischemia Classification

Grade	ABI	Ankle systolic pressure	$TcPO_2$
0	≥0.80	>100 mm Hg	≥60 mm Hg
1	0.6-0.79	70-100 mm Hg	40-59 mm Hg
2	0.4-0.59	50-70 mm Hg	30-39 mm Hg
3	≤0.39	<50 mm Hg	<30 mm Hg

Mills JL, et al. on behalf of the Society for Vascular Surgery Lower Extremity Guidelines Committee. Practice Guidelines: Threatened Limb Classification System: Risk stratification based on Wound, Ischemia, and foot Infection (WIfI). *J Vasc Surg* 2014;59:220-34.

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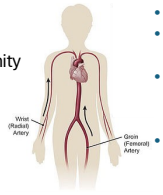
Duplex Scan Guides Planning

- Information about disease location and extent can be considered when assessing risks and benefits of medical, surgical, or interventional therapies
- Patient may be counseled about options
  - Endovascular treatment most effective for focal lesions
  - Endovascular treatment of long occlusions less durable
- Vein mapping to assess autologous conduit
  - "Good vein" makes for good bypass
  - "Bad vein" may prompt decision for use of prosthetic graft or endovascular therapy

Selection of Access Site For Interventions

- Femoral
  - Retrograde
  - Antegrade
- Upper extremity
  - Axillary
  - Brachial
  - Radial
- Other
  - Popliteal
  - Tibiopedal

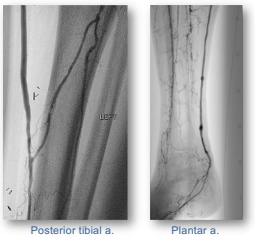


Consider:
- *Target lesion*
- *Status of access site*
- *Status of access vessels*
- *Prior surgery or interventions*

Duplex scanning also reduces need for complete angiographic

Duplex Scanning and Bypass Surgery

- Indications
- Planning
- Conduit
- Completion assessment
- Surveillance



CTA Prior to Arteriography or Revascularization

- Evaluation of aortic or peripheral artery aneurysms
- Non-palpable femoral pulses
  - Upper extremity access
  - Femoral endarterectomy
- Marginal candidate for revascularization
  - Frail, limited life-expectancy, neurocognitive disorder, other candidate for palliative care
  - Claudication with femoropopliteal occlusion

Evaluation by a non-surgeon (primary care, emergency medicine, etc.

MRA Prior to Arteriography or Revascularization

- Local resources permit
- Younger patients
- Evaluation of vessel wall features
- Severe contrast allergy

DSA Prior to Arteriography or Revascularization

- Routine in my practice
- Vein graft is "high resource" procedure
  - Patient morbidity and rehabilitation
  - Vein is limited resource
  - Functional impact of failure is substantial
- Less limited by calcification and other artifacts
- Accuracy dependent on technique
- Billing for diagnostic study may require justification if MR or CT already obtained

The Royal Sonesta Kaua'i Resort Lihue

Details coming soon – Q1 2026

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