

**PAD**  
**Clinical Presentations**

# Anatomy of femoral & popliteal arteries

**Common femoral artery** (4-6 cm long) Lies

*superficially in the groin*

*Divides to SFA & PFA*

**Superficial femoral artery**

*Extends down medial thigh*

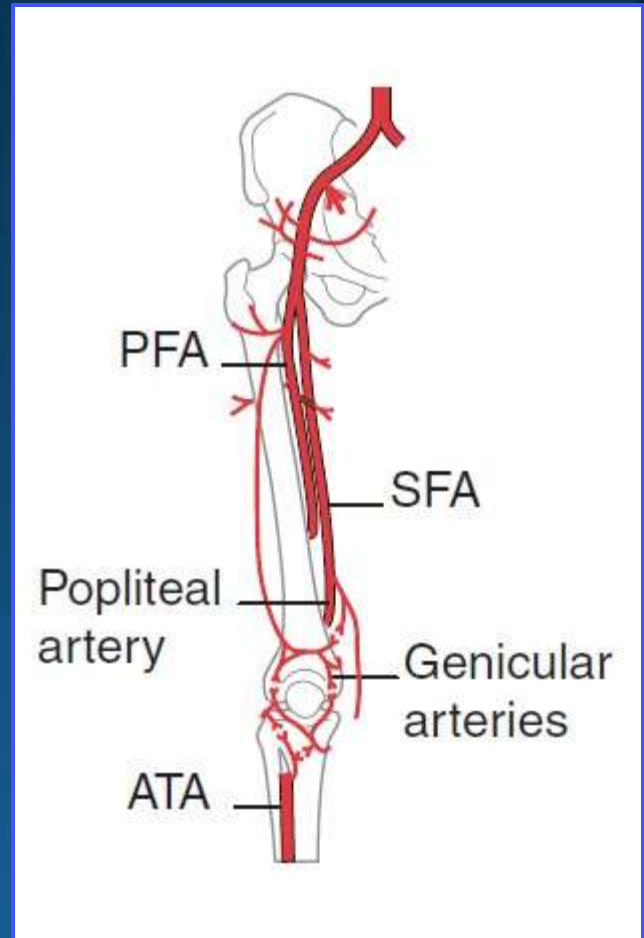
*Passes deep through adductor hiatus*

**Popliteal artery**

*Commences below adductor hiatus*

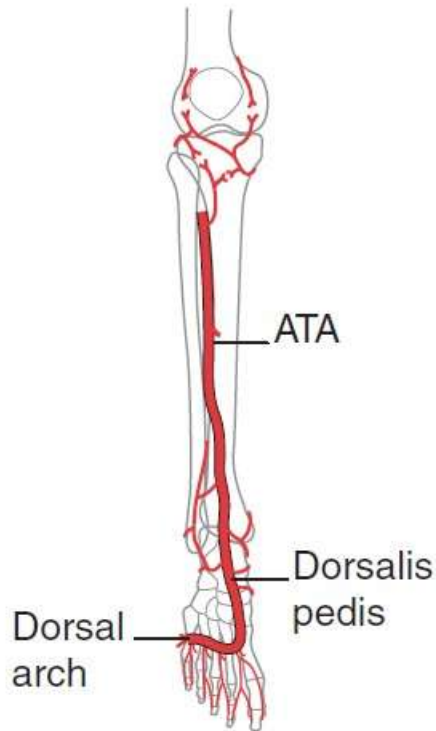
*Passes vertically through popliteal fossa*

*Divides to tibio-peroneal trunk & ATA*

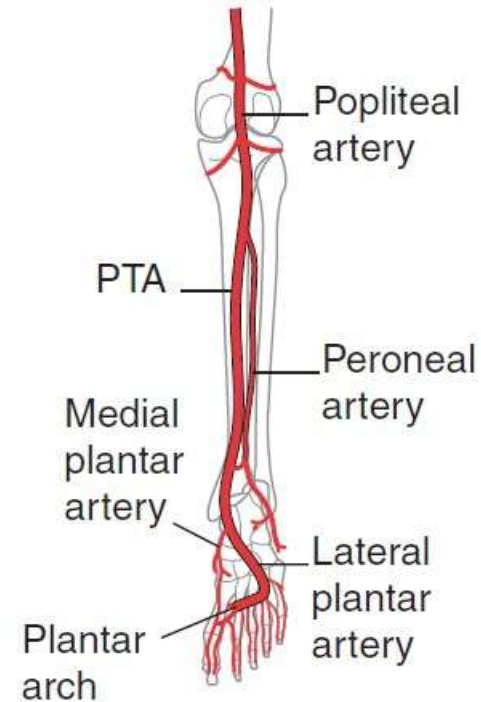


# Anatomy of Crural Arteries

Anterior view

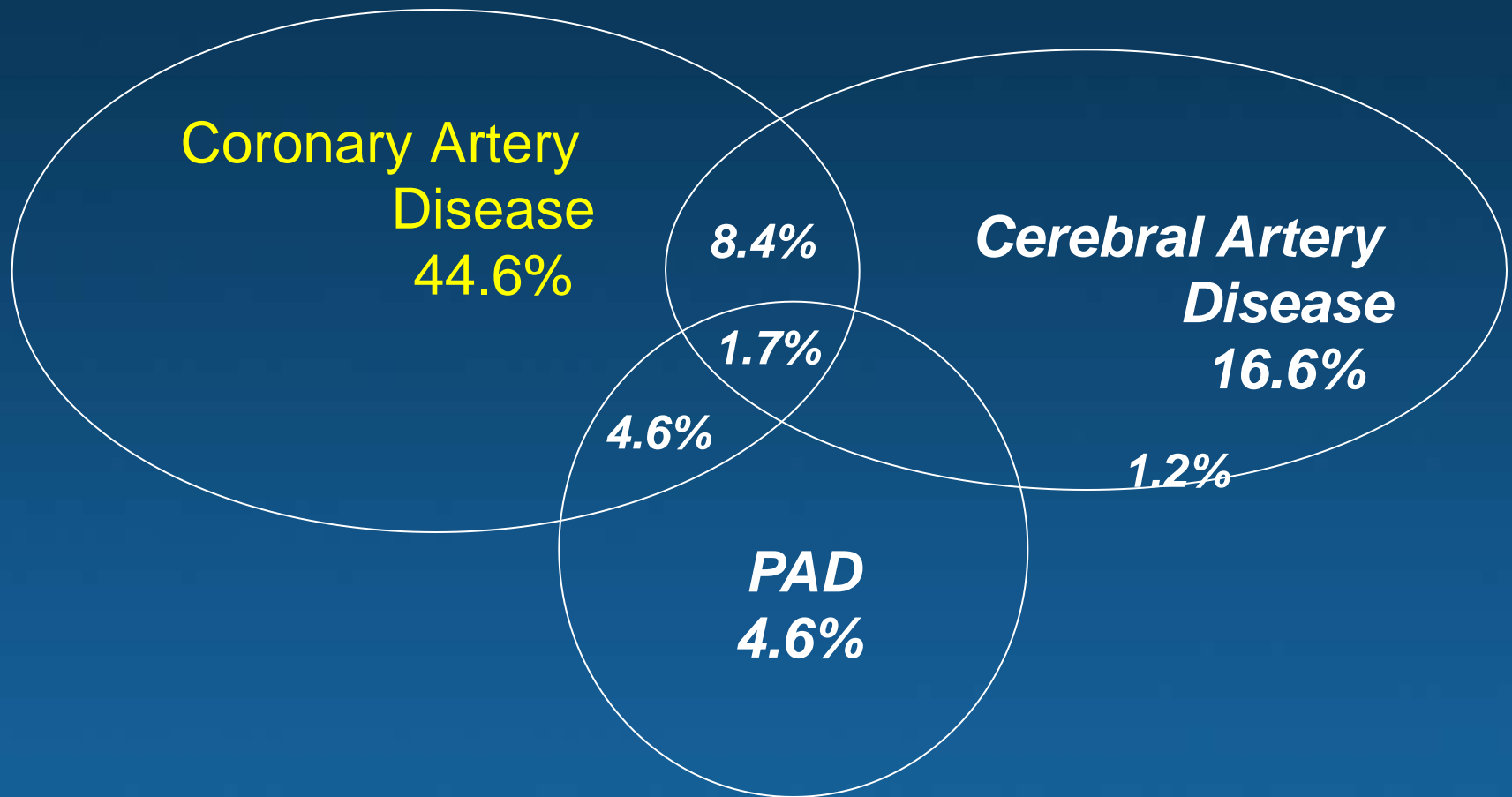


Posterior view



*There are several interconnection  
So that each artery can supply all regions*

# Vascular Disease Overlap



*TASC II Recommendation,  
2007*

*This guideline recognizes that:*

## **Individuals With PAD Present in Clinical Practice With Distinct Syndromes**

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*Asymptomatic:* Without obvious symptomatic complaint (but usually with a functional impairment).

*Classic claudication:* Lower extremity symptoms confined to the muscles with a consistent (reproducible) onset with exercise and relief with rest.

*“Atypical” leg pain:* Lower extremity discomfort that is exertional but that does not consistently resolve with rest, consistently limit exercise at a reproducible distance, or meet all “Rose questionnaire” criteria.

*This guideline recognizes that:*

## Individuals With PAD Present in Clinical Practice With Distinct Syndromes

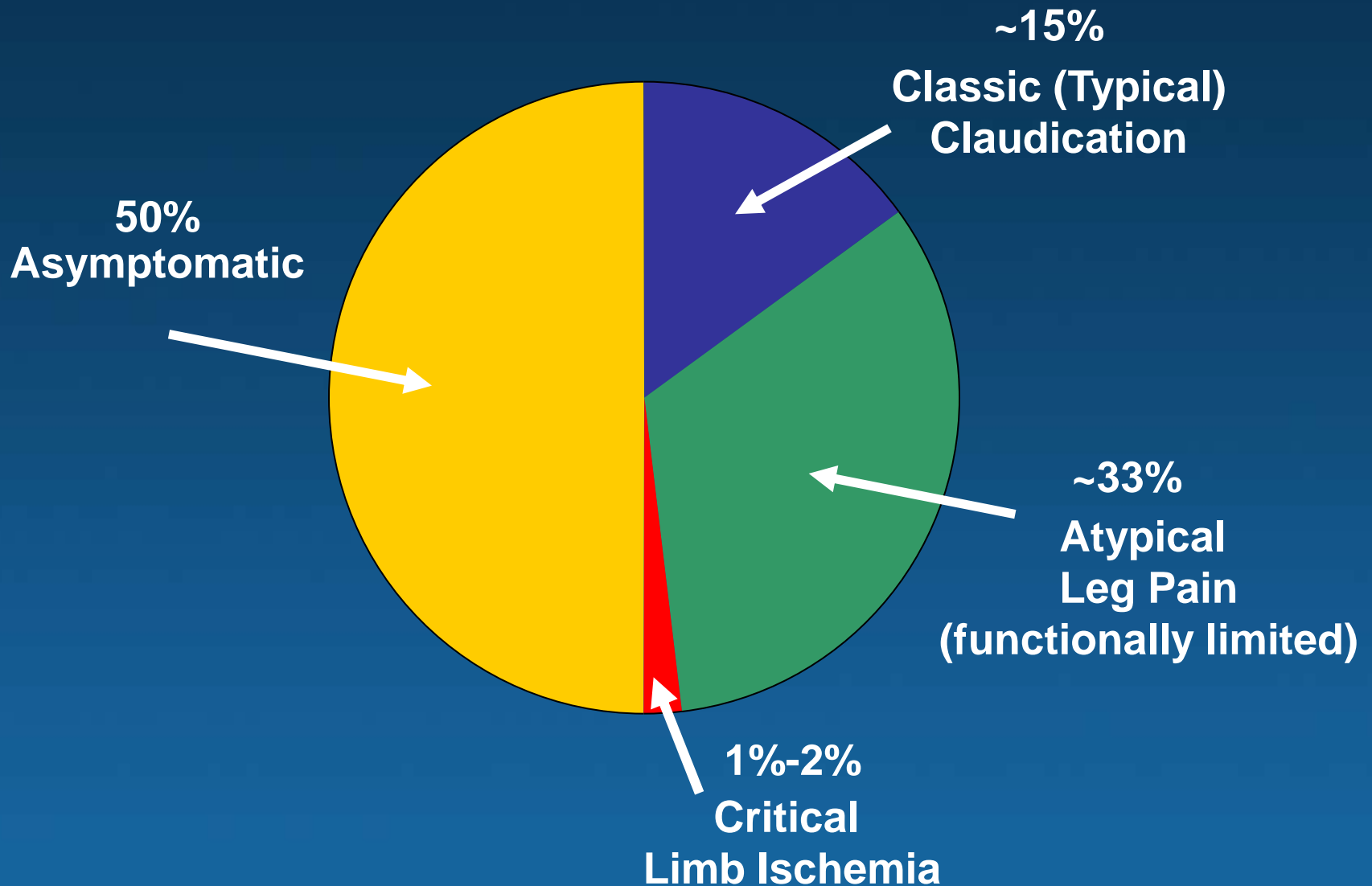
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*Critical limb Ischemia:* Ischemic rest pain, nonhealing wound, or gangrene/

*Acute limb ischemia:* The five “P”s, defined by the clinical symptoms and signs that suggest potential limb jeopardy:

- Pain
- Pulselessness
- Pallor
- Paresthesias
- Paralysis (& polar, as a sixth “P”).

# Clinical Presentations of PAD



# Claudication vs. Pseudoclaudication

|                                     | <b>Claudication</b>                  | <b>Pseudoclaudication</b>                             |
|-------------------------------------|--------------------------------------|---|
| <b>Characteristic of discomfort</b> | Cramping, tightness, aching, fatigue | Same as claudication plus tingling, burning, numbness |
| <b>Location of discomfort</b>       | Buttock, hip, thigh, calf, foot      | Same as claudication                                  |
| <b>Exercise-induced</b>             | Yes                                  | Variable  |
| <b>Distance</b>                     | Consistent                           | Variable  |
| <b>Occurs with standing</b>         | No                                   | Yes   |
| <b>Action for relief</b>            | Stand                                | Sit, change position                                  |
| <b>Time to relief</b>               | <5 minutes                           | ≤30 minutes   |



# Leg Pain Has a Differential Diagnosis

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- Spinal canal stenosis
- Peripheral neuropathy
- Peripheral nerve pain
  - Herniated disc impinging on sciatic nerve
- Osteoarthritis of the hip or knee
- Venous claudication
- Symptomatic Baker's cyst
- Chronic compartment syndrome
- Muscle spasms or cramps
- Restless leg syndrome

# Factors That Increase Risk of Limb Loss in Patients With Critical Limb Ischemia

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- Factors that reduce blood flow to the microvascular bed
  - Diabetes
  - Severe renal failure
  - Severely decreased cardiac output (severe heart failure or shock)
  - Vasospastic diseases or concomitant conditions (e.g., Raynaud's phenomenon, prolonged cold exposure)
  - Smoking and tobacco use
- Factors that increase demand for blood flow to the microvascular bed
  - Infection (e.g., cellulitis, osteomyelitis)
  - Skin breakdown or traumatic injury

# Differential Diagnosis of Common Foot Ulcers

## Neuropathic Ulcer

Painless

Normal pulses

Typically punches-out appearance

Often located on sole or edge of foot or metatarsal head

Presence of calluses

Loss of sensation, reflexes, and vibration sense

Increase in blood flow (arteriovenous shunting)

Dilated veins

Dry, warm foot

Bone deformities

Red appearance

## Neuroischemic Ulcer

Painful

Absent pulses

Irregular margins

Commonly located on toes

Calluses absent or infrequent

Variable sensory findings

Decrease in blood flow

Collapsed veins

Cold foot

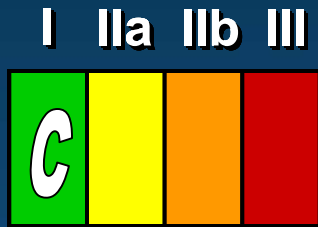
No bony deformities

Pale, cyanotic

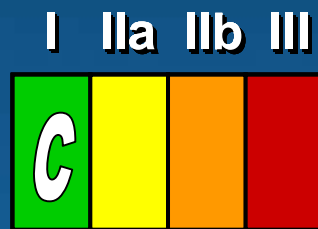
# Etiologic Classification of Foot and Leg Ulcers

- Venous obstruction and insufficiency
- Arterial etiologies
  - Larger arteries
  - Atherosclerotic lower extremity PAD
  - Thromboemboli, atheroemboli
  - Thromboangiitis obliterans
- Microcirculatory
  - Diabetic microangiopathy
  - Vasculitis
  - Collagen vascular diseases
- Neuropathic
  - Diabetes mellitus
- Infectious
  - Leprosy
  - Mycotic
- Hematologic
  - Sickle cell anemia
  - Polycythemia
  - Thrombocytosis
- Malignancy
  - Squamous cell carcinoma
  - Kaposi's sarcoma
- Artifactual or factitious

# The Vascular History and Physical Examination



Individuals at risk for lower extremity PAD should undergo a vascular review of symptoms to assess walking impairment, claudication, ischemic rest pain, and/or the presence of nonhealing wounds.



Individuals at risk for lower extremity PAD should undergo comprehensive pulse examination and inspection of the feet.

# Identification of the Asymptomatic Patient With PAD



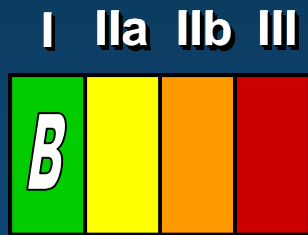
A history of walking impairment, claudication, and ischemic rest pain is recommended as a required component of a standard review of systems for adults  $\geq 50$  years who have atherosclerosis risk factors, or for adults  $\geq 70$  years.



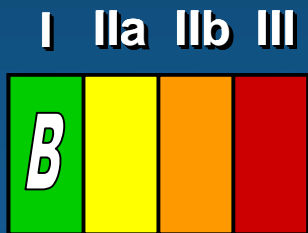
Individuals with asymptomatic PAD should be identified in order to offer therapeutic interventions known to diminish their increased risk of myocardial infarction, stroke, and death.

# Identification of the Symptomatic Patient With Intermittent Claudication

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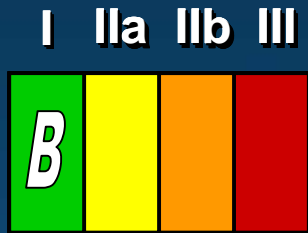


Patients with symptoms of intermittent claudication should undergo a vascular physical examination, including measurement of the ABI.

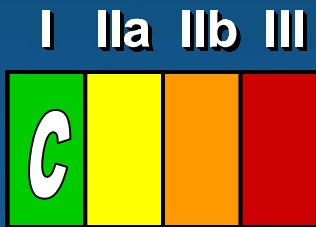


In patients with symptoms of intermittent claudication, the ABI should be measured after exercise if the resting index is normal.

# Evaluation of the Patient With Critical Limb Ischemia



Patients at risk of CLI (ABI less than 0.4 in a nondiabetic individual, or any diabetic individual with known lower extremity PAD) should undergo regular inspection of the feet to detect objective signs of CLI.



The feet should be examined directly, with shoes and socks removed, at regular intervals after successful treatment of CLI.



# *Guideline for the Management of Patients with PAD*

## *Smoking Cessation*

# Recommendations for Smoking Cessation



**NEW**

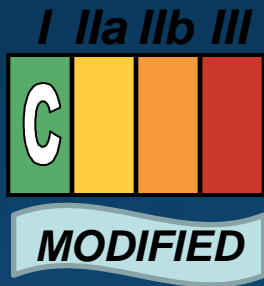
Patients who are smokers or former smokers should be asked about status of tobacco use at every visit.



**NEW**

*Patients should be assisted with counseling and developing a plan for quitting that may include pharmacotherapy and/or referral to a smoking cessation program.*

# Recommendations for Smoking Cessation



Individuals with lower extremity PAD who smoke cigarettes or use other forms of tobacco should be advised by each of their clinicians to stop smoking and offered behavioral and pharmacological treatment.



*In the absence of contraindication or other compelling clinical indication, 1 or more of the following pharmacological therapies should be offered: varenicline, bupropion, and nicotine replacement therapy.*

# Comprehensive Vascular Examination

Key components of the vascular physical examination include:

- Bilateral arm blood pressure (BP)
- Cardiac examination
- Palpation of the abdomen for aneurysmal disease
- Auscultation for bruits
- Examination of legs and feet
- Pulse Examination
  - Carotid
  - Radial/ulnar
  - Femoral
  - Popliteal
  - Dorsalis pedis
  - Posterior tibial
- Scale:
  - 0=Absent
  - 1=Diminished
  - 2=Normal
  - 3=Bounding (aneurysm or AI)

# The First Tool to Establish the PAD Diagnosis: *A Standardized Physical Examination*

Pulse intensity should be assessed and should be recorded numerically as follows:

- 0, absent
- 1, diminished
- 2, normal
- 3, bounding

Use of a standard examination should facilitate clinical communication



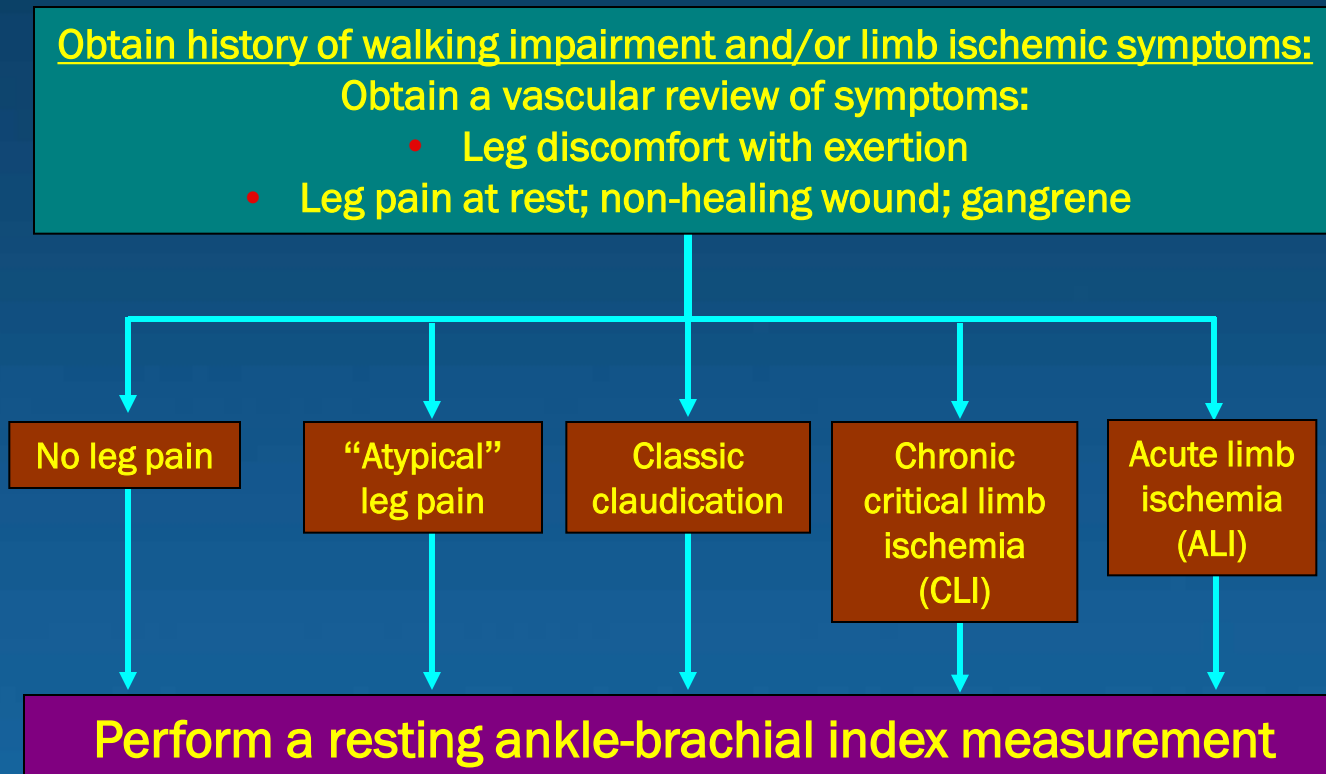
# Differential Diagnosis of PAD

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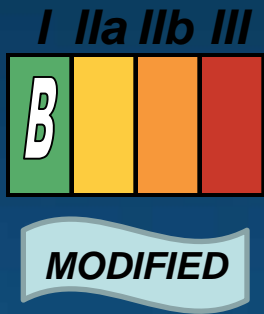
- Atherosclerosis
- Vasculitis
- Fibromuscular dysplasia
- Atheroembolic disease
- Thrombotic disorders
- Trauma
- Radiation
- Popliteal aneurysm
- Thromboangiitis obliterans (Buerger's disease)
- Popliteal entrapment
- Cystic adventitial disease
- Coarctation of aorta
- Vascular tumor
- Iliac syndrome of the cyclist
- Pseudoxanthoma elasticum
- Persistent sciatic artery (thrombosed)

# ACC/AHA Guideline for the Management of PAD: Steps Toward the Diagnosis of PAD

Recognizing the “at risk” groups leads to recognition of the five main PAD clinical syndromes:



# Recommendations for ABI, Toe-Brachial Index, and Segmental Pressure Examination



The resting ABI should be used to establish the lower extremity PAD diagnosis in patients with suspected lower extremity PAD, defined as individuals with 1 or more of the following: exertional leg symptoms, nonhealing wounds, age  $\geq 65$  years, or  $\geq 50$  years with a history of smoking or diabetes.



# Recommendations for ABI, Toe-Brachial Index, and Segmental Pressure Examination



The ABI should be measured in both legs in all new patients with PAD of any severity to confirm the diagnosis of lower extremity PAD and establish a baseline.

# Recommendations for ABI, Toe-Brachial Index, and Segmental Pressure Examination



The toe-brachial index should be used to establish the lower extremity PAD diagnosis in patients in whom lower extremity PAD is clinically suspected but in whom the ABI test is not reliable due to noncompressible vessels (usually patients with long-standing diabetes or advanced age).



*Leg segmental pressure measurements are useful to establish the lower extremity PAD diagnosis when anatomic localization of lower extremity PAD is required to create a therapeutic plan.*

# Recommendations for ABI, Toe-Brachial Index, and Segmental Pressure Examination



ABI results should be uniformly reported with noncompressible values defined as  $>1.40$ , normal values  $1.00$  to  $1.40$ , borderline  $0.91$  to  $0.99$ , and abnormal  $\leq 0.90$ .

# How to Perform an ABI Exam

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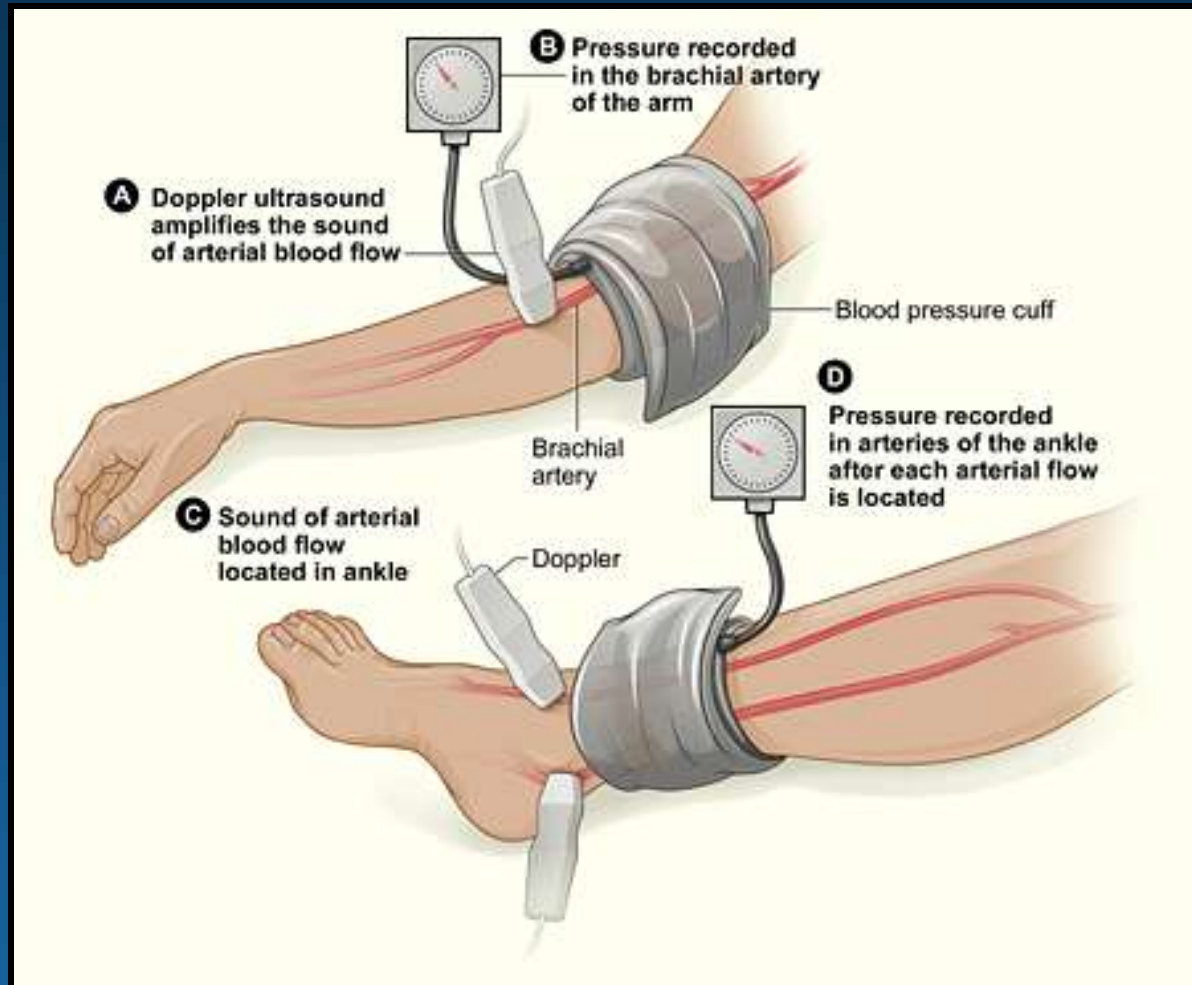
- Performed with the patient resting in the supine position
- All pressures are measured with an arterial Doppler and appropriately sized blood pressure cuff (edge 1-2 inches above the pulse; cuff width should be 40% of limb circumference).
- Systolic pressures will be measured in the right and left brachial arteries followed by the right and left ankle arteries.

# ABI Procedure

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- Step 1: Apply the appropriately sized blood pressure cuff on the arm above the elbow (either arm).
- Step 2: Apply Doppler gel to skin surface.
- Step 3: Turn on the Doppler and place the probe in the area of the pulse at a 45-60° angle to the surface of the skin, pointing to the shoulder.
- Step 4: Move the probe around until the clearest arterial signal is heard.

# ABI Procedure



# ABI Procedure

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- **Step 5:** Inflate the blood pressure cuff to approximately 20 mmHg above the point where systolic sounds are no longer heard.
- **Step 6:** Gradually deflate until the arterial signal returns. Record the pressure reading.
- **Step 7:** Repeat the procedure for the right and left posterior tibial and dorsalis pedis arteries. Place the probe on the pulse and angle the probe at 45° toward the knee.
- **Step 8:** Record the systolic blood pressure of the contralateral arm.

# Understanding the ABI

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The ratio of the higher brachial systolic pressure and the higher ankle systolic pressure for each leg:

$$\text{ABI} = \frac{\text{Ankle systolic pressure}}{\text{Higher brachial artery systolic pressure}}$$



# Calculate the ABI

1. For the left side, divide the left ankle pressure by the highest brachial pressure and record the result.
2. Repeat the steps for the right side.
3. Record the ABIs and place the results in the medical record.

## Right Leg ABI

$$\frac{\text{Right Ankle Pressure}}{\text{Highest Arm Pressure}}$$

## Left Leg ABI

$$\frac{\text{Left Ankle Pressure}}{\text{Highest Arm Pressure}}$$

## ABI Interpretation

**$\leq 0.90$  is diagnostic of peripheral arterial disease**

# The Ankle-Brachial Index

$$\text{ABI} = \frac{\text{Lower extremity systolic pressure}}{\text{Brachial artery systolic pressure}}$$

- The ankle-brachial index is 95% sensitive and 99% specific for PAD
- Establishes the PAD diagnosis
- Identifies a population at high risk of CV ischemic events
- The “population at risk” can be clinically and epidemiologically defined:
  - Age less than 50 years with diabetes, and one additional risk factor
  - Age 50 to 69 years and history of smoking or diabetes
  - Age 70 years and older
  - Leg symptoms with exertion (suggestive of claudication) or ischemic rest pain
  - Abnormal lower extremity pulse examination
  - Known atherosclerotic coronary, carotid, or renal artery disease
- Toe-brachial index (TBI) useful in individuals with non-compressible pedal pulses



# Interpreting the Ankle-Brachial Index

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| <b>ABI</b> | <b>Interpretation</b>    |
|------------|--------------------------|
| 1.00–1.29  | Normal                   |
| 0.91–0.99  | Borderline               |
| 0.41–0.90  | Mild-to-moderate disease |
| ≤0.40      | Severe disease           |
| -----      | -----                    |
| ≥1.30      | Noncompressible          |

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# Using the ABI: An Example

**Right ABI**  
 $80/160=0.50$

**Left ABI**  
 $120/160=0.75$

**ABI**  
(Normal  $>0.90$ )

**Brachial SBP**  
150 mm Hg

**Brachial SBP**  
160 mm Hg

**Highest**  
**brachial SBP**

**PT SBP 40 mm Hg**  
**DP SBP 80 mm Hg**

**PT SBP 120 mm Hg**  
**DP SBP 80 mm Hg**

**Highest of PT**  
**or DP SBP**



# ABI Limitations

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- Incompressible arteries (elderly patients, patients with diabetes, renal failure, etc.)
- Resting ABI may be insensitive for detecting mild aorto-iliac occlusive disease
- Not designed to define degree of functional limitation
- Normal resting values in symptomatic patients may become abnormal after exercise
- Note: “Non-compressible” pedal arteries is a physiologic term and such arteries need not be “calcified”

# Toe-Brachial Index Measurement



- The toe-brachial index (TBI) is calculated by dividing the toe pressure by the higher of the two brachial pressures.
- TBI values remain accurate when ABI values are not possible due to non-compressible pedal pulses.
- TBI values  $\leq 0.7$  are usually considered diagnostic for lower extremity PAD.

# Hemodynamic Noninvasive Tests

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- Resting Ankle-Brachial Index (ABI)
- Exercise ABI
- Segmental pressure examination
- Pulse volume recordings

*These traditional tests continue to provide a simple, risk-free, and cost-effective approach to establishing the PAD diagnosis as well as to follow PAD status after procedures.*

# Segmental Pressures (mm Hg)

150      Brachial      150

150      150

110      146

108      100

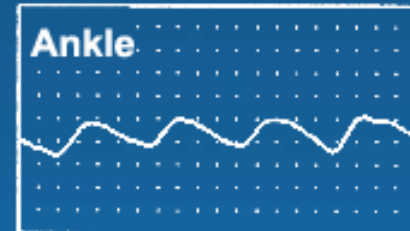
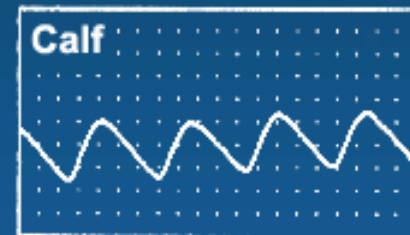
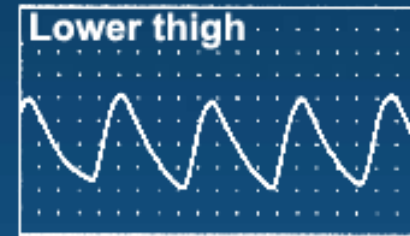
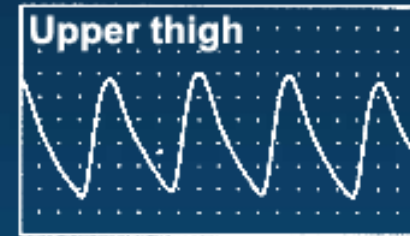
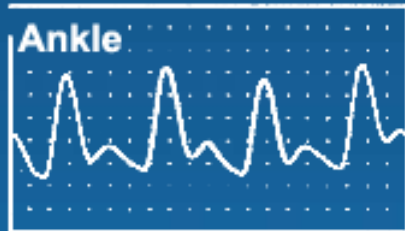
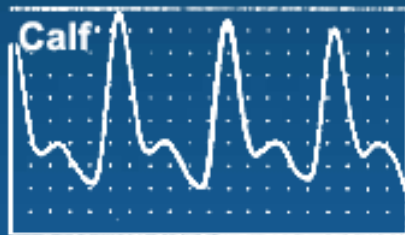
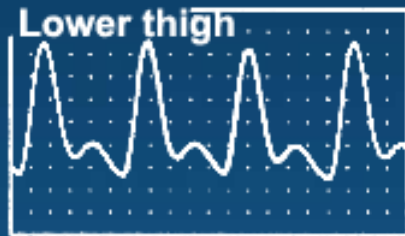
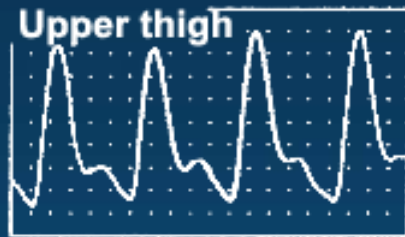
62      84

0.54      ABI      0.44





# Pulse Volume Recordings



# Exercise ABI Testing

- Confirms the PAD diagnosis
- Assesses the functional severity of claudication
- May “unmask” PAD when resting the ABI is normal
- Aids differentiation of intermittent claudication vs. pseudoclaudication diagnoses



# Exercise ABI Testing: Treadmill

- Indicated when the ABI is normal or borderline but symptoms are consistent with claudication;
- An ABI fall post-exercise supports a PAD diagnosis;
- Assesses functional capacity (patient symptoms may be discordant with objective exercise capacity).



# The Plantar Flexion Exercise ABI



## Benefits:

- Reproduces treadmill-derived fall in ABI
- Can be performed anywhere
- Inexpensive

## Limitation:

- Does not measure functional capacity

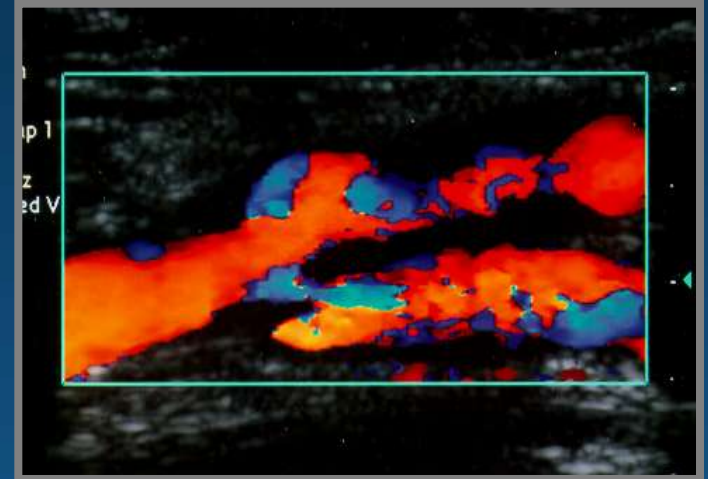


# Color Duplex Ultrasonography



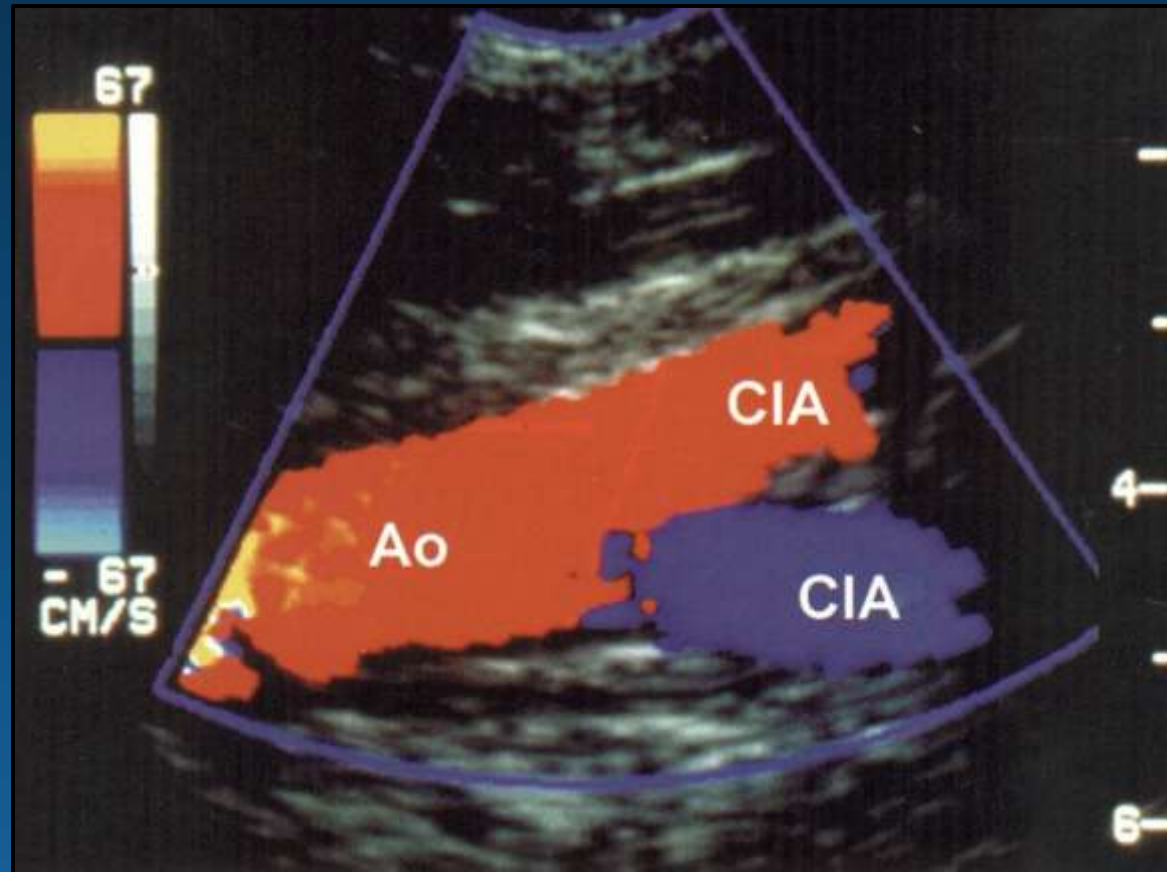
# Arterial Duplex Ultrasound Testing

- Duplex ultrasound of the extremities is useful to diagnose anatomic location and degree of stenosis of peripheral arterial disease.
- Duplex ultrasound is useful to provide surveillance following femoral-popliteal bypass using venous conduit (but not prosthetic grafts).
- Duplex ultrasound of the extremities can be used to select candidates for:
  - (a) endovascular intervention
  - (b) surgical bypass, and
  - (c) to select the sites of surgical anastomosis.



However, the data that might support use of duplex ultrasound to assess long-term patency of PTA is not robust.

# Normal Aortic Bifurcation





# Noninvasive Imaging Tests

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## Duplex Ultrasound

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**I IIa IIb III**

|          |  |  |  |
|----------|--|--|--|
| <b>A</b> |  |  |  |
|----------|--|--|--|

Duplex ultrasound of the extremities is useful to diagnose the anatomic location and degree of stenosis of PAD.

**I IIa IIb III**

|          |  |  |  |
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Duplex ultrasound is recommended for routine surveillance after femoral-popliteal or femoral-tibial-pedal bypass with a venous conduit.

Minimum surveillance intervals are approximately 3, 6, and 12 months, and then yearly after graft placement.

# Magnetic Resonance Angiography (MRA)

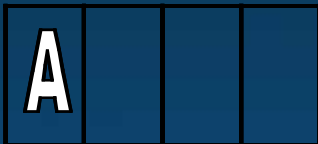
- MRA has virtually replaced contrast arteriography for PAD diagnosis
- Excellent arterial picture
- No ionizing radiation
- Noniodine-based intravenous contrast medium rarely causes renal insufficiency or allergic reaction
- ~10% of patients cannot utilize MRA because of:
  - Claustrophobia
  - Pacemaker/implantable cardioverter-defibrillator
  - Obesity
- Gadolinium use in individuals with an eGFR <60 mL/min has been associated with nephrogenic systemic fibrosis (NSF)/nephrogenic fibrosing dermopathy



# Noninvasive Imaging Tests

## Magnetic Resonance Angiography (MRA)

I IIa IIb III



MRA of the extremities is useful to diagnose anatomic location and degree of stenosis of PAD.

I IIa IIb III



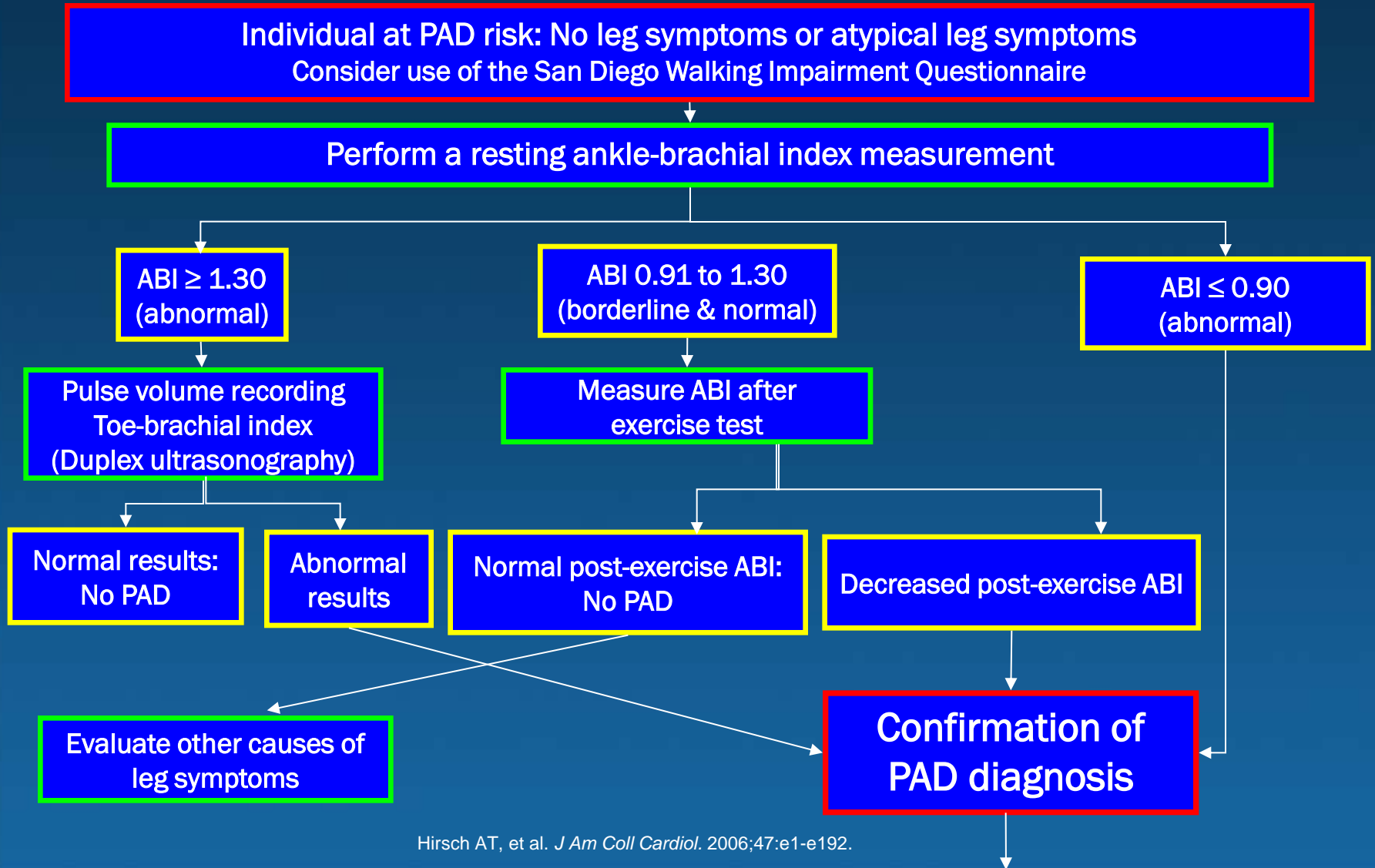
MRA of the extremities should be performed with gadolinium enhancement.

I IIa IIb III

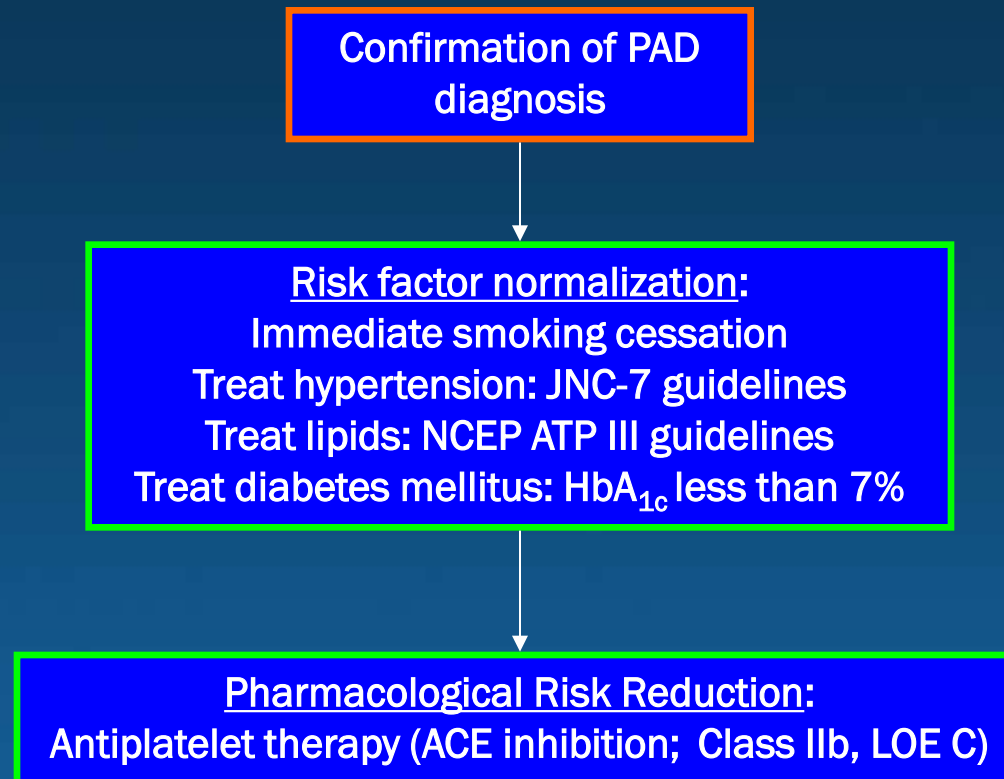


MRA of the extremities is useful in selecting patients with lower extremity PAD as candidates for endovascular intervention.

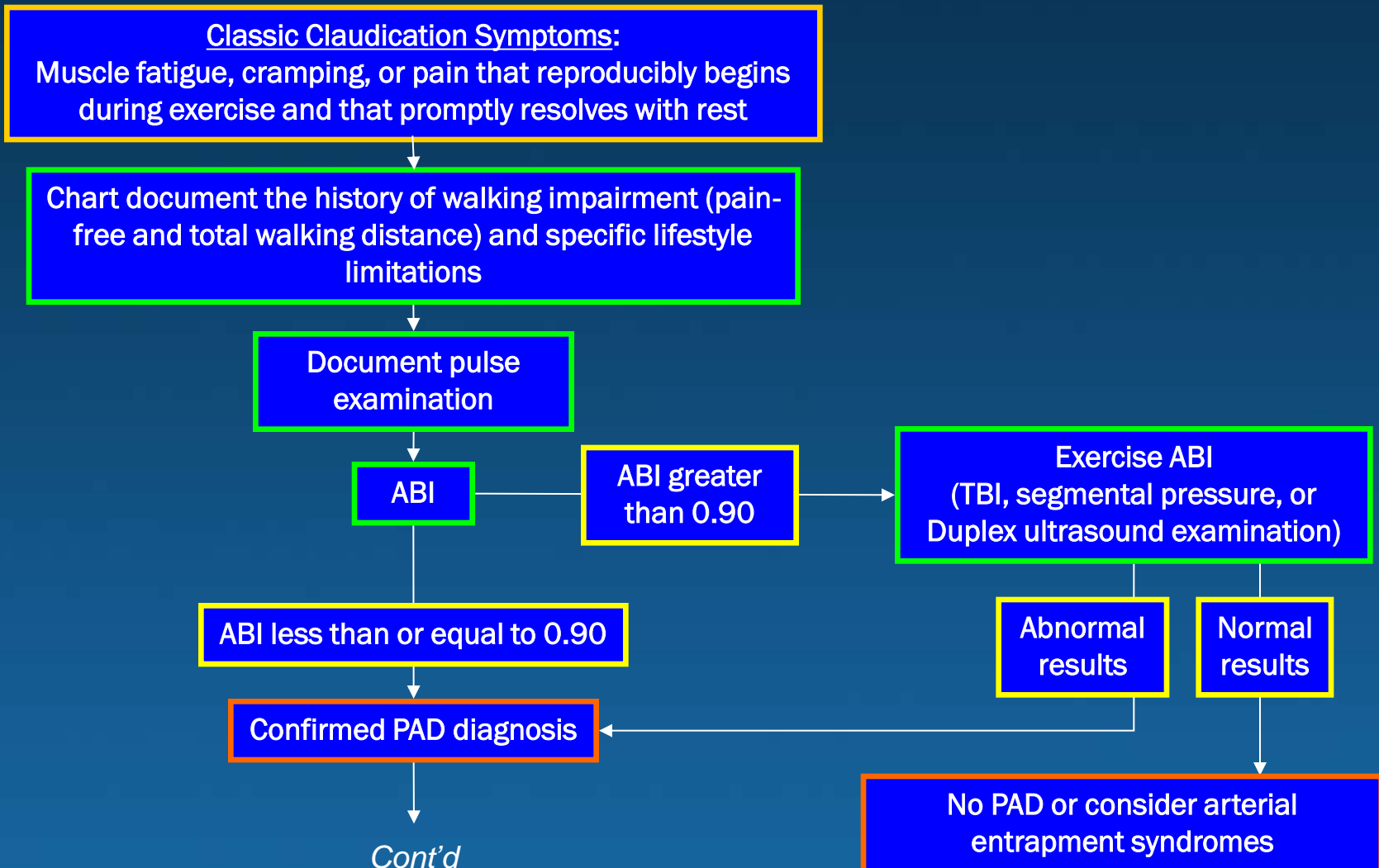
# ACC/AHA Guideline for the Management of PAD: Diagnosis and Treatment of Asymptomatic PAD



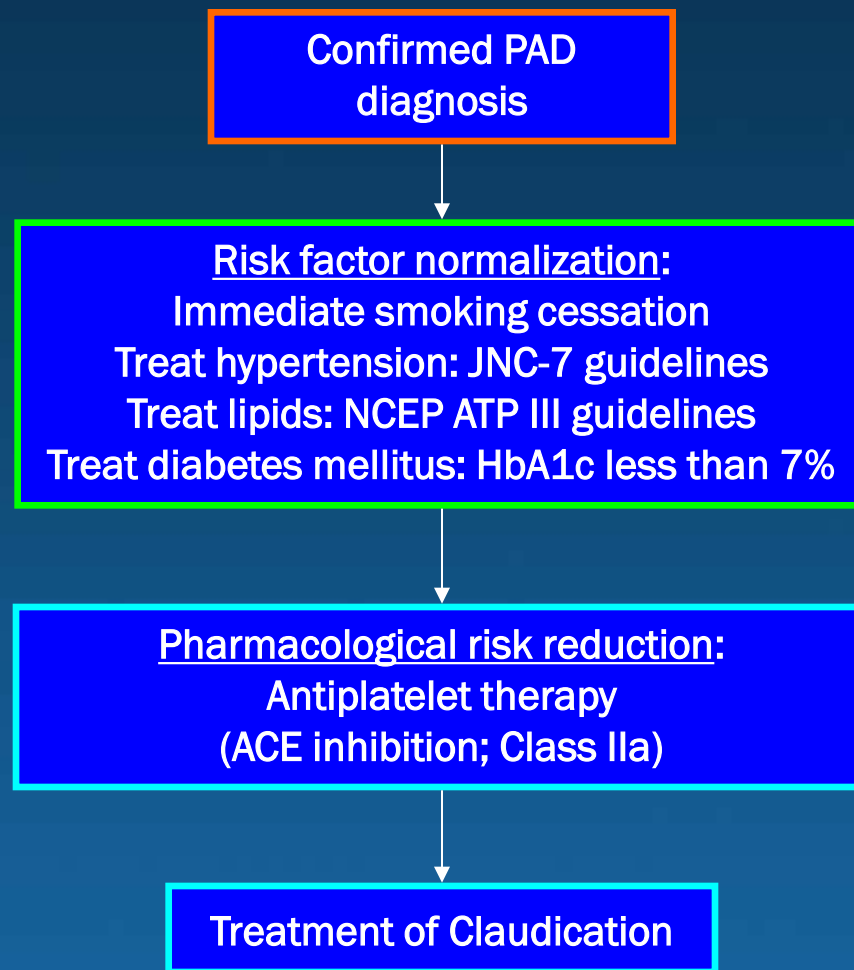
# ACC/AHA Guideline for the Management of PAD: Diagnosis and Treatment of Asymptomatic PAD



# ACC/AHA Guideline for the Management of PAD: Diagnosis of Claudication and Systemic Risk Treatment



# ACC/AHA Guideline for the Management of PAD: Diagnosis of Claudication and Systemic Risk Treatment



# *Guideline for the Management of Patients with PAD*

## *Antiplatelet and Antithrombotic Drugs*



# Recommendations for Antiplatelet and Antithrombotic Drugs

I IIa IIb III



**MODIFIED**

Antiplatelet therapy is indicated to reduce the risk of MI, stroke, and vascular death in individuals with symptomatic atherosclerotic lower extremity PAD, including those with intermittent claudication or CLI, prior lower extremity revascularization (endovascular or surgical), or prior amputation for lower extremity ischemia.

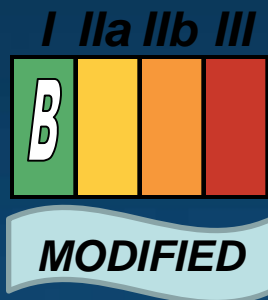
I IIa IIb III



**MODIFIED**

***Aspirin, typically in daily doses of 75 to 325 mg, is recommended as safe and effective antiplatelet therapy to reduce the risk of MI, stroke, or vascular death in individuals with symptomatic atherosclerotic lower extremity PAD, including those with intermittent claudication or CLI, prior lower-extremity revascularization (endovascular or surgical), or prior amputation for lower-extremity ischemia.***

# Recommendations for Antiplatelet and Antithrombotic Drugs



Clopidogrel (75 mg per day) is recommended as a safe and effective alternative antiplatelet therapy to aspirin to reduce the risk of MI, ischemic stroke, or vascular death in individuals with symptomatic atherosclerotic lower-extremity PAD, including those with intermittent claudication or CLI, prior lower-extremity revascularization (endovascular or surgical), or prior amputation for lower-extremity ischemia.



***Antiplatelet therapy can be useful to reduce the risk of MI, stroke, or vascular death in asymptomatic individuals with an ABI  $\leq 0.90$ .***

# Recommendations for Antiplatelet and Antithrombotic Drugs

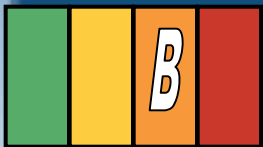
I IIa IIb III



NEW

The usefulness of antiplatelet therapy to reduce the risk of MI, stroke, or vascular death in asymptomatic individuals with borderline abnormal ABI, defined as 0.91 to 0.99, is not well established.

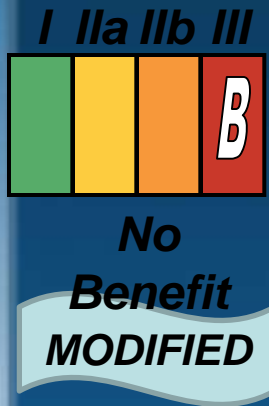
I IIa IIb III



NEW

*The combination of aspirin and clopidogrel may be considered to reduce the risk of cardiovascular events in patients with symptomatic atherosclerotic lower-extremity PAD, including those with intermittent claudication or CLI, prior lower-extremity revascularization (endovascular or surgical), or prior amputation for lower-extremity ischemia and who are not at increased risk of bleeding and who are at high perceived cardiovascular risk.*

# Recommendations for Antiplatelet and Antithrombotic Drugs



In the absence of any other proven indication for warfarin, its addition to antiplatelet therapy to reduce the risk of adverse cardiovascular ischemic events in individuals with atherosclerotic lower extremity PAD is of no benefit and is potentially harmful due to increased risk of major bleeding.