Peripheral Artery Disease

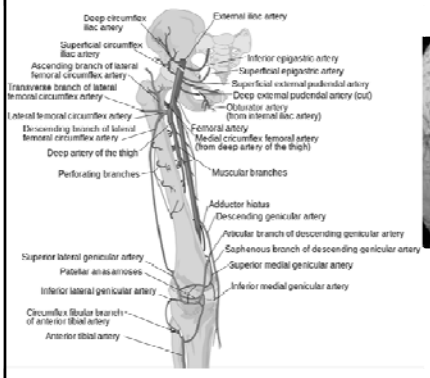
Michael R. Go, MD
Assistant Professor
Division of Vascular Diseases and Surgery
Department of Surgery
The Ohio State University Wexner Medical Center

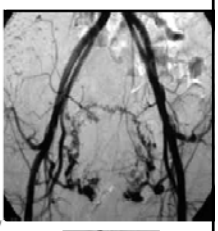
Disclosures

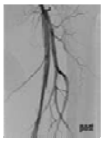
- **None**

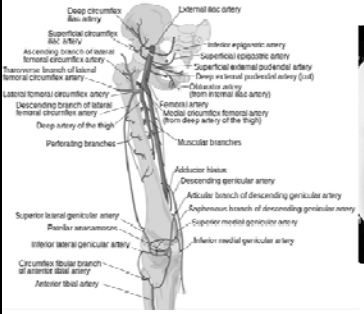
Objectives

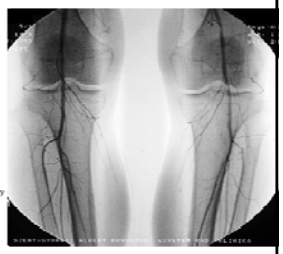
- **Anatomy**
- **Pathophysiology**
- **Demographics**
- **Diagnosis**
- **Treatment**











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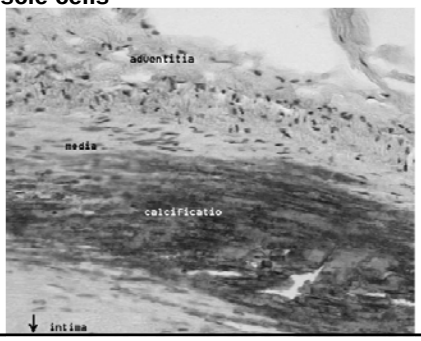
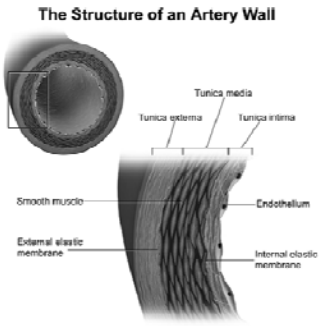
Intima

- Luminal surface to IEL
- Endothelial cells
- Few leukocytes, connective tissue fibers, smooth muscle cells



Media

- IEL to EEL and adventitia
- Smooth muscle cells
- Elastin
- Collagen – type III

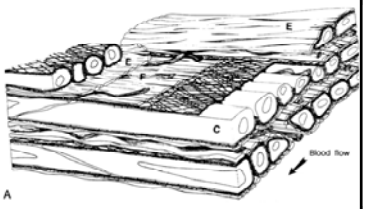


Author: BruceBlaus CC BY 3.0

Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762.

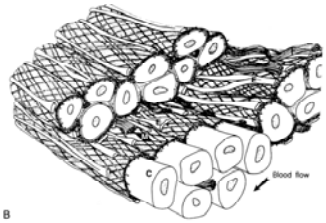
Elastic Arteries

- Prominent elastic fibers in proximal vessels
- High compliance
- Recoil
- Interspersed with type I collagen bundles



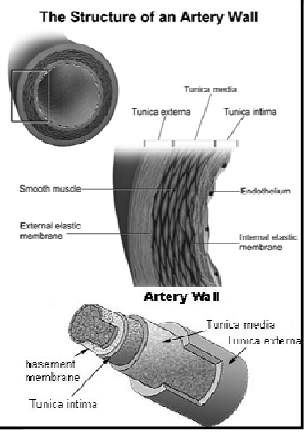
Muscular Arteries

- Smaller distal vessels
- Less collagen and elastin, more smooth muscle cells
- Constrict and dilate more effectively



Adventitia

- Fibrocellular connective tissue
- Vasa vasorum
- Some collagen and elastin
- Normally does not contribute to tensile strength
- In atherosclerosis, a diseased media relies on adventitia for tensile strength



Vasa Vasorum

- Diffusion supports 0.5 mm or 30 musculoelastic bundles
- Vasa vasorum supply the rest

Atherosclerosis

- Most common cause of peripheral arterial occlusive disease
- Preferentially involves the internal carotid, infrarenal aorta, and superficial femoral arteries
- Typically occurs at bifurcations

Pathology

- Intimal thickening
- Fatty streaks
- Fibrous plaques
- Plaque complication

Intimal Thickening

- Increased wall tensile stress
- Increased wall thickness
- Occurs at bifurcations and areas of redistribution of wall stress in fetuses
- No lipid accumulation
- Occurs in same places as plaque, but not necessarily a precursor

Fatty Streaks

- Intimal accumulation of foam cells
- Affect all ages
- Do not compromise lumen
- Abnormal overlying endothelial cells
- Occurs throughout vascular tree
- Not necessarily a precursor of plaque

Fibrous Plaques

- Earliest definitive atherosclerotic lesion
- Appear by second decade
- Subendothelial smooth muscle
- Fibrous cap of connective tissue
- Intact but fragile endothelium
- Attenuated media

Plaque Complications

- Necrotic core of lipid, macrophages, and smooth muscle cells
- Calcification
- Endothelial disruption
- Ulceration
- Hemorrhage
- Embolism

Pathophysiology

- Atherosclerosis may cause symptoms via:
  - stenosis or occlusion
  - thromboembolism
    - cardiogenic
    - arterioarterial
    - thrombosis of complicated plaque
- Inadequate tissue perfusion

Collateralization

- Collateralization refers to the formation of multiple arterial pathways that develop around a diseased axial vessel
- Resistance is always higher through collaterals than through axial vessels
- Axial vessel occlusions cause more severe symptoms if collaterals are undeveloped, which is why acute axial vessel occlusions may cause more profound ischemia

Important Collateral Pathways

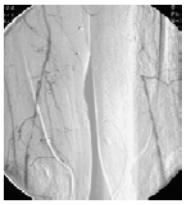
- External carotid
- Internal iliac, lumbar, internal mammary, and epigastric
- Profunda femoris
- Geniculate

Risk Factors

- Tobbaco use
- Diabetes
- Hyperlipidemia
- Genetics
- Hypertension

Infrainguinal Arterial Occlusive Disease

- Affects 17% of people over 70
- Asymptomatic
- Claudication
- Critical limb ischemia



Rutherford: Vascular Surgery, 6th ed.

Claudication

- Pain in the large muscle groups distal to an arterial lesion after exercise
- Cramping, heaviness, fatigue
- Occurs consistently after a certain distance of walking
- Reliably abates when patient stops
- The patient is asymptomatic at rest because there are adequate collaterals for perfusion without increased metabolic demand

Bloor K. Natural history of arteriosclerosis of the lower extremities. *Ann R Coll Surg Engl* 1961; 28: 36-51

- Affects 5% of the population over 50
- 75% of claudicants will remain stable
- 25% will deteriorate
  - 7 - 9% in first year
  - 2 - 3% per year after first year
- 5% will progress to critical limb ischemia
- 2% will progress to major amputation

Claudication

- 90% have concomitant CAD
- 5 year overall amputation 5%
- 5 year incidence of symptomatic coronary artery disease 23%
- 5 year incidence of stroke 13%
- 5 year mortality 20%
- 10 year mortality 50%
- 15 year mortality 70%

Critical Limb Ischemia

- Ischemic rest pain
  - intense pain across distal foot and arch
  - burning, stabbing, constant
  - worsened with elevation
  - dependent rubor
- Ulceration
- Gangrene
  - dry
  - wet

Critical Limb Ischemia

- 500 – 1000 / 1 million new cases annually
- 1 – 3% of PAD population
- 150,000 amputations per year attributable to CLI

Outcomes of CLI

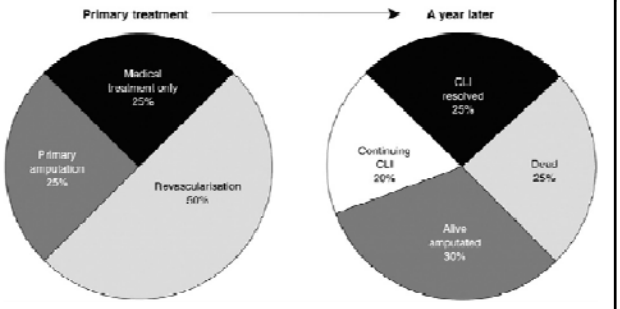
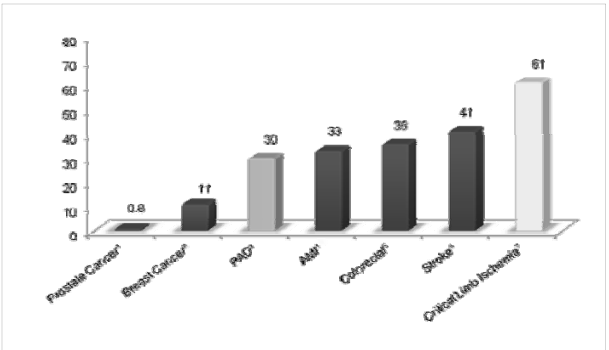


Fig. A5. Fate of the patients presenting with chronic critical leg ischemia. CLI – critical limb ischemia.

Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II)
Norgren, L. et al.
Journal of Vascular Surgery , Volume 45 , Issue 1 , S5 - S67

Five Year Mortality



Diabetic Foot Problems

- **Diabetic foot ulcers and amputations cost US health care providers over 10 billion dollars per year**

Diabetic Foot Problems

- **24 million diabetic patients in the US**
- **90% are type 2**
- **15% will require hospitalization for some complication**
- **7.8% will account for > 60% of all non-traumatic foot amputations**

Diabetic Foot Problems

- **Lifetime risk of ulcers or gangrene is 15 - 25%**
- **> 15% of patients with ulcers will end up with an amputation**
- **Every 30 seconds a leg is amputated somewhere in the world as a consequence of diabetes**

Diabetic Foot Problems

- 85% of amputations in diabetics are preceded by foot ulcerations
- Theoretically, improvement in foot ulcer therapy will decrease limb loss…
- However, no industrialized country has seen a decrease in diabetic limb loss in the modern era of medicine

Diabetic Foot Problems

- Highest incidence in ethnic minority groups
  - Native Americans
  - Hispanics
  - African Americans
- A problem requiring intensive follow up and management is compounded by difficult access to care

Diabetic Foot Problems

- Neuropathy
- Deformity
- Trauma
- Ischemia
- Infection

Neuropathy

- Sensory nerves affected first
- Small diameter pain and temperature fibers are initially damaged
- Predisposes to pressure related trauma and minor skin Injuries

Neuropathy

- Motor neuropathy is late
- Affects both long fibers innervating both intrinsic muscles of the foot and leg muscles

Neuropathy

- Atrophy of intrinsic foot muscles
- Preserved flexor muscle strength results in "clawed position"
- Abnormal pressure points emerge at tips of toes
- Metatarsal heads relax

Neuropathy

- Calluses form which later may ulcerate
- Small muscles of the foot atrophy

Autonomic Neuropathy

- Dry skin
- Loss of sweat and oil gland function
- Dry skin predisposes to fissures
- Calluses and fissures breakdown
- Portals of entry for bacteria

Ischemia

- Neuropathy causes shunting of blood through AV connections in the microcirculation
- Results in decreased tissue perfusion even with normal axial vessels
- Cutaneous oxygen saturation is decreased
- Compounded with neuropathy, ulceration results

Ischemia

- Diabetes causes structural and functional changes in the capillary bed
- Thickened basement membrane
- Impaired migration of leukocytes
- Impaired vasodilation response to injury
- Blunted inflammatory response to injury

Ischemia and Infection

- Because of this blunted inflammatory response, diabetic patients lack a crucial component of the body's first line defense against pathogens and thus are more susceptible to foot infection

Diabetes and PAD

- Diabetic foot problems, particularly in combination with PAD, are serious
- Even in the absence of axial vessel disease, they can be difficult to heal

Differential

- Neurogenic claudication
  - spinal stenosis or nerve root compression
  - history of back pain
  - burning or shooting pain radiating down posterior leg
  - numbness or paresthesias
- Neuropathy
- Arthritis
- Neuropathic ulceration

History

- Coronary artery disease
  - MI
  - CHF
  - arrhythmia
  - recent cardiac evaluation
- DM
- Smoking
- Hypertension
- Hypercholesterolemia
- Family history of atherosclerotic disease
- Cerebrovascular disease
  - stroke
  - TIA
  - amaurosis

Physical Exam

- Complete heart and lung exam
- Neurologic exam
  - carotid bruits
  - superficial temporal pulses
  - cranial nerves
  - motor
  - sensory

Vascular Exam

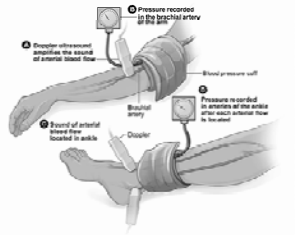
- Complete bilateral pulse exam
  - Doppler
    - monophasic
    - multiphasic
  - 0, 1+, 2+, 3+, widened pulses
  - Bruits and thrills

Vascular Exam

- Dependent rubor
- Shiny skin
- Loss of hair
- Diminished nail growth
- Ulceration and gangrene

Vascular Lab Testing

- Segmental pressures and ABI
- Can be affected by vascular calcification or edema



ABI

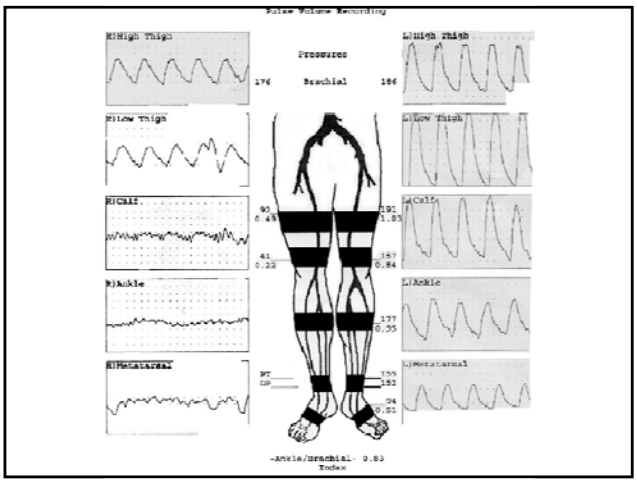
- Claudication 0.6
- Rest pain 0.3
- Tissue loss 0.2

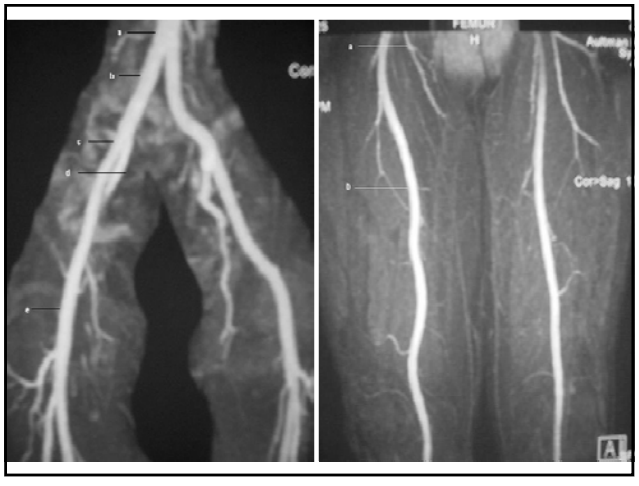
Exercise Testing

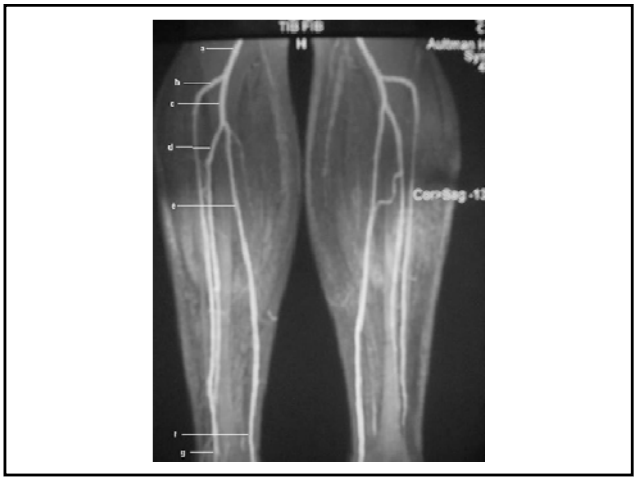
- Treadmill or calf raises decrease peripheral resistance
- Flow increases based on Ohm's law
- If there is a proximal stenosis, flow increase is limited and pressure will drop

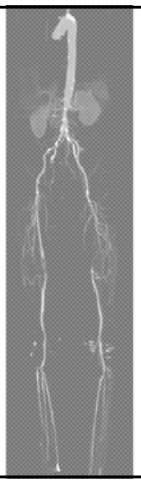
Vascular Lab Testing

- Pulse volume recordings
  - normal
  - blunted
- Doppler waveforms
  - multiphasic
  - monophasic
- Digital pressures
- Not limited by vessel calcification
- Complements pressure testing



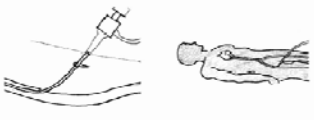


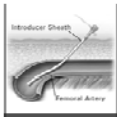




Angiography

- Diagnostic
- Therapeutic
- Complications
  - nephrotoxicity
  - contrast allergy
  - arterial injury
  - embolization
  - hematoma
  - pseudoaneurysm





Treatment of Claudication

- Risk factor modification
  - smoking cessation
  - hypertension
  - hyperlipidemia
  - diabetes
- Cilostazol
  - rheologic agent
  - increases walking distance
  - contraindicated in CHF
- Supervised exercise program
  - 30 minutes of cardiovascular exercise daily
  - 5 days per week

Treatment of Claudication

- Procedural intervention for claudication is reserved for patients with lifestyle-limiting claudication and failure of medical therapy
- Often, this is related to single level, proximal disease
  - aortoiliac
  - femoral
  - ABI 0.6

Treatment of Rest Pain or Tissue Loss

- Risk factor modification
- Restoration of in-line vascular flow
- Management of the wound
- Often, this is related to multi level or distal disease
  - popliteal
  - tibial
  - ABI 0.3

Peripheral Artery Disease

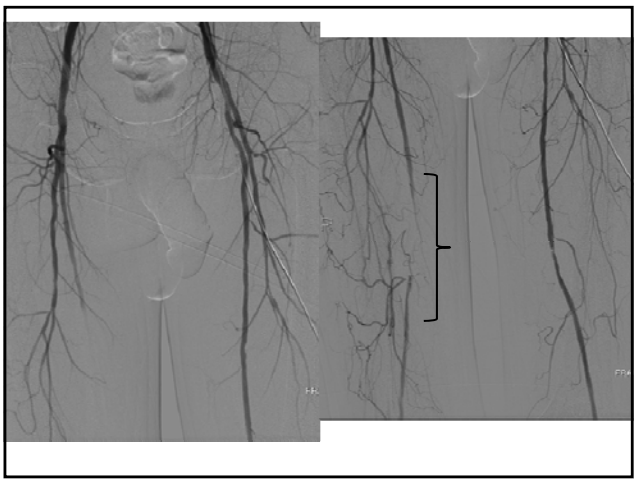
Mounir J. Haurani, MD
Assistant Professor - Clinical
Division of Vascular Diseases and Surgery
Department of Surgery
The Ohio State University Wexner Medical Center

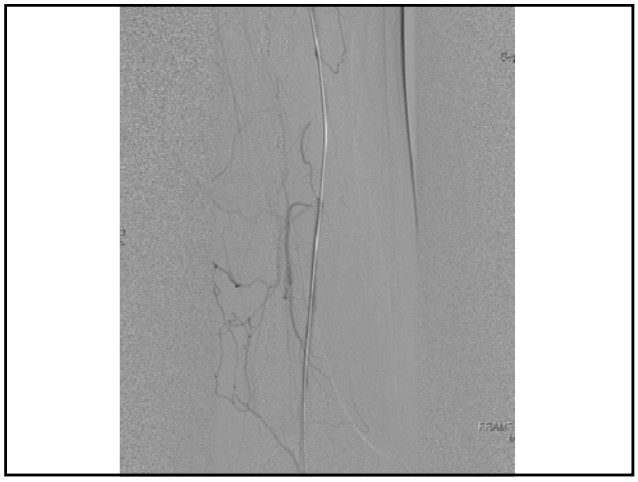
Open vs. Surgery; Decision Making

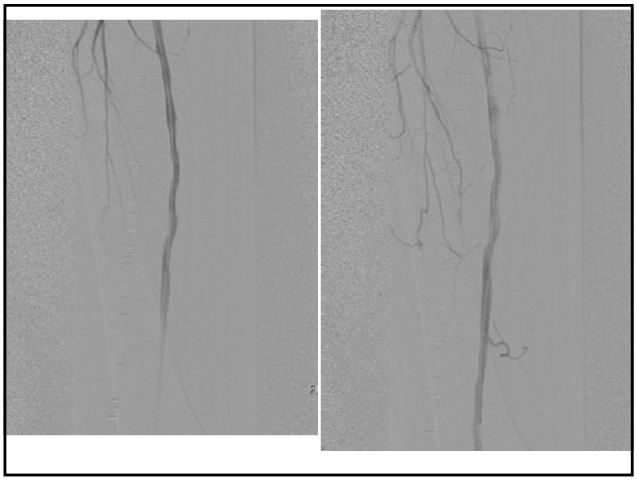
- Anatomy
- CLI vs. Claudication
- Overall health of the patient

Percutaneous / Endovascular

- **Balloon Angioplasty**
- **Stents**
- **Debulking (atherectomy)**







Percutaneous Treatment Results Are Better…

- Proximal vessels (aorta > iliacs > SFA > tibials)
- Short lesions
- Focal lesions
- Stenosis > occlusions

Percutaneous Treatments Are Worse…

- Distal or smaller vessels
- Long lesions
- Diffuse lesions
- Occlusions
- At joints or bifurcations
  - common femoral
  - profunda
  - popliteal

Percutaneous Treatments

- Local anesthesia
- Fewer cardiac and pulmonary complications
- Outpatient procedure

Percutaneous Treatments

- Radiation
- Nephrotoxicity
- Arterial injury
- Embolization
- Hematoma
- Pseudoaneurysm
- Rarely as durable as bypass or open repair

Surgery

- Procedural intervention for claudication is reserved for patients with lifestyle-limiting claudication and failure of medical therapy
- Rest pain
- Tissue loss

Surgical Options

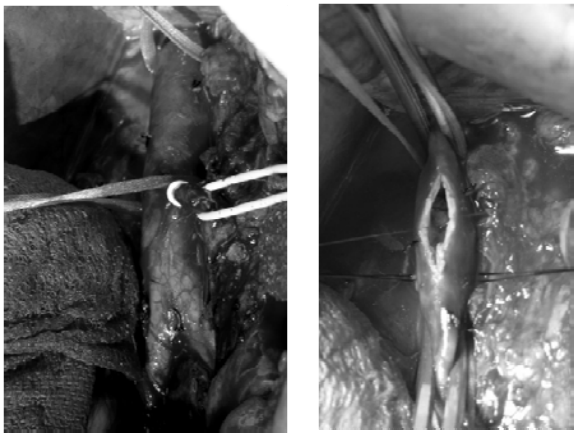
- Endarterectomy
- Bypass
  - normal inflow
  - normal outflow

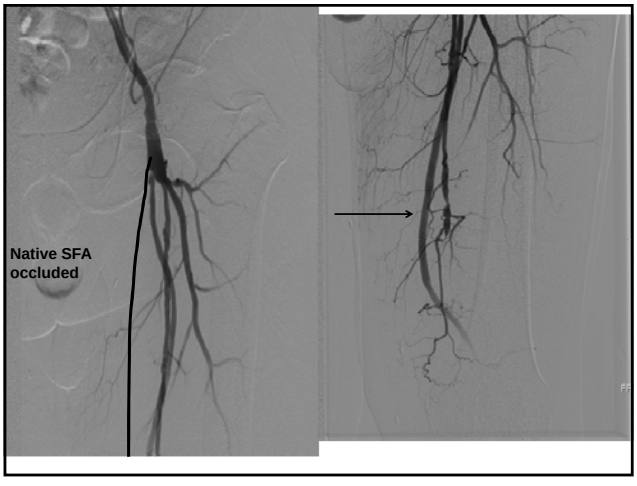
Levels of Disease Determines Options

- Aortoiliac
  - aortoiliac endarterectomy
  - aortofemoral bypass
  - axillary femoral bypass
- Femoropopliteal
  - femoral endarterectomy
  - femoropopliteal bypass
- Tibial
  - femorotibial bypass
  - popliteal tibial or pedal bypass

Contraindications to Surgery

- Prohibitive medical comorbidities
  - coronary
  - pulmonary
- Unreconstructible vessels
- Nonambulatory status (consider primary amputation)
- Extensive tissue loss (consider primary amputation)




Native SFA
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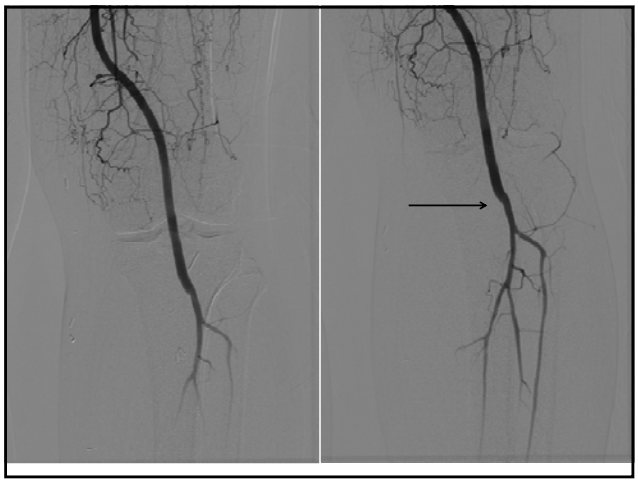


Bypass Conduit

- Greater saphenous vein
- Other autogenous vein
  - lesser saphenous
  - cephalic
  - basilic
- Prosthetic (polyester or Polytetrafluoroethylene)

Primary Amputation

Amputation

- Nonambulatory patients with CLI
- Patients with extensive tissue loss
- Unreconstructible patients
  - foot sepsis
  - intractable pain

Level Selection

- Goals of amputation
  - Eliminate infected, necrotic, and painful tissue
  - Wound that heals successfully
  - Residual limb that can accommodate prosthesis

Level Selection; Energy Expenditure

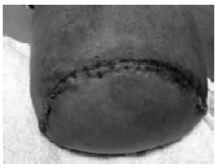
- Unilateral below-knee amputees
  - 10% to 40% increase
  - 50-100% Prosthetic use
- Above-knee amputees
  - 50% to 70% increase
  - 10-30% prosthetic use
- True ambulation rates decrease significantly at 5 years

Level Selection

- Physical findings
  - First step
  - Extent of gangrene and infection dictates
  - Dependent rubor = gangrene
  - Palpable pulse immediately proximal = nearly100% healing rate
- Clinical judgment
  - 80-90% accurate

Amputation

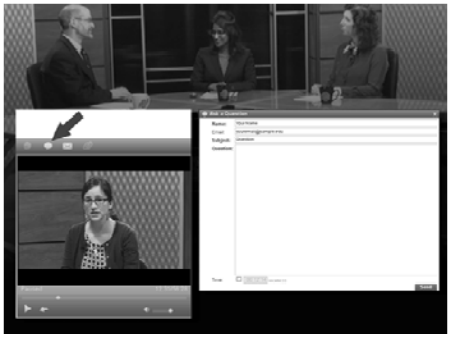
- Digit
- Transmetatarsal
- Below knee
- Above knee



Amputation

- Overall mortality
  - BKA 30 day: 6% 3 year: 40%
  - AKA 30 day: 13% 3 year: 60%
- 50% of patients will need contralateral amputation in 3 years

Remember to e-mail us your questions.



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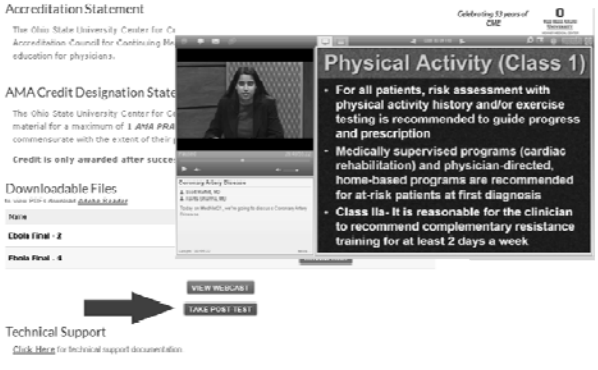

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