A Surgeon’s Perspective on Peripheral Arterial Disease: Endovascular and Surgical Techniques

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What is Peripheral Arterial Disease (PAD)

Plaque build up in the arteries that carry blood to the head, organs and limbs. Over time plaque hardens and narrows the arteries. This limits the flow of oxygen-rich blood to your organs and other parts of your body. Plaque is made up of fat, cholesterol, calcium, fibrous tissue and other substances in the blood.
What is Peripheral Arterial Disease (PAD)
Statistics

• As many as 20 million people in the United States suffer from PAD

• PAD affects 12-20% of Americans ages 65 and older

• Only 25% of PAD patients are undergoing treatment

*Image courtesy of www.cdc.gov*
Statistics

- Patients with one manifestation often have coexistent disease in other vascular beds.
Risk Factors

- Male Sex
- Age (per 10 y)
- Diabetes
- Smoking
- Hypertension
- Hypercholesterolemia
- Fibrinogen
- Alcohol

Odds Ratio

* ACC/AHA 2005 Guidelines for the Management of Patients with Peripheral Artery Disease
Peripheral Arterial Disease Symptoms
Severe Peripheral Arterial Disease

Intermittent Claudication:
Leg muscle discomfort provoked by exertion that is relieved by rest and reproducible over a given distance.
Peripheral Arterial Disease Symptoms
Severe Peripheral Arterial Disease

Rest pain symptoms/ Critical Limb Ischemia
Dependent Rubor, Pallor of Elevation
Thickened Nails, Shiny skin, absence of hair on the Dorsum of the feet
Peripheral Artery Disease Symptoms
Severe Peripheral Arterial Disease

- Gangrene
- Limb loss

* Images Courtesy of www.reversegangrene.com
Mortality

- Life expectancy reduced 10 years in patients with PAD

- Mortality rate
  - 25% at 5 yrs
  - 50% at 10 yrs
  - 75% at 15 yrs

- 75% of deaths caused by cardiovascular events
Differential Diagnosis of PAD

✧ Intermittent Claudication
  − Atherosclerosis
  − Non-Atherosclerotic
    ✧ TAO/Buerger’s
    ✧ FMD
    ✧ Vasculitis

✧ Neurogenic Causes
  − Lumbar Canal Stenosis
  − Peripheral Neuropathy

✧ Venous Claudication

✧ Musculoskeletal Causes
  − Arthritis
  − Bursitis
  − Tendonitis

✧ Podiatric Causes
  − Plantar Fasciitis
  − Gout

(GOUT)
Non-Invasive Diagnostic Tools

❖ **Ankle Brachial Index:**

\[
\frac{\text{Ankle systolic pressure}}{\text{Brachial systolic pressure}} = \text{ABI}
\]

❖ **Pressure Readings:**

- 1.3 \leq \text{non-compressible (diabetes mellitus, renal insufficiency)}
- 0.7 - 0.9 = mild
- 0.5 - 0.7 = moderate-severe
- < 0.4 = critical ischemia
Other Non-Invasive Diagnostic Tools

- **Pulse Volume Recording Waveforms**
- **Segmental Pressures**
Other Non-Invasive Diagnostic Tools

Arterial Ultrasound
Minimally Invasive Diagnostic Techniques: Arteriogram

Injection of dye into the arteries to obtain images of the vasculature.

Site of injections - Femoral (groin) vs Brachial (arm)

Retrograde Access vs. Antegrade Access
Minimally Invasive Diagnostic Technique

- IVUS Technology

*Images courtesy of Volcano Corp.*
Treatment Options for PAD

- Risk Factor Modification
  - Smoking cessation
  - Increased exercise regime
  - Dietary changes

- Medical Management
  - Lower blood pressure
  - Lower cholesterol
  - Close diabetic management
  - Antiplatelet therapy

- Minimally Invasive Techniques
  - Arteriogram
  - Angioplasty
  - Stent Placement
  - Atherectomy
  - Thrombectomy

- Surgical Intervention
  - Bypass Surgery
  - Endarterectomy
  - Hybrid Procedures
Treatment – Minimally Invasive Techniques

➢ Ultrasound-Guided Guidewire placement
Treatment - Minimally Invasive Techniques

➢ Balloon dilatation

➢ Percutaneous Transluminal Angioplasty
Treatment - Minimally Invasive Techniques

- Stent expansion by a balloon catheter over a guidewire
Treatment - Minimally Invasive Techniques

- Post PTA/stent placement
Treatment - Minimally Invasive Techniques

- Thrombolysis
- Post-thrombolytic infusion revealing stenosis
- Intravascular TPA
- Rheolytic Thrombectomy
Modalities for Atherectomy - Minimally Invasive Techniques

- Excisional- cutting out arterial plaque
- Rotational/Orbital- utilizing burr (drill) to remove plaque
- Laser
Mechanism of Action

Mechanical Impact

- CROSSER Catheter mechanically vibrates against the CTO
- Ultrasonic “Jackhammer”

Cavitation

- Micro-bubbles expand and implode breaking the internal fibrin structure of the plaque and eroding the solid surface of the CTO
Treatment - Minimally Invasive Techniques

Laser Atherectomy

➢ Photoablation is the use of light to break down, vaporize and remove matter.

**Photochemical**: Breaking molecular bonds
UV light pulse hits tissue for 135-billionths of a second (135ns); the duration of the laser pulse

**Photothermal**: Producing thermal energy
Absorption vibrates the molecular bonds of the plaque

**Photomechanical**: Creating kinetic energy
Expansion and collapse of vapor bubble breaks down tissue and clears byproducts away from tip
**Treatment: Minimally Invasive Techniques**

Silver Hawk/Turbo Hawk Plaque Excision System

- Forward cutting directional atherectomy device
- Consists of a rotating blade inside tubular housing with a collection area (nosecone)
- Turbohawk has 4 contoured blades
- TALON Study (Treating PeripherALS with SiLver Hawk: Outcomes CollectioN)


**Treatment - Minimally Invasive Techniques**

Rotational Atherectomy System (ROTA)
- controlled precision of a diamond-tipped burr designed to modify vessel compliance in *calcified* peripheral lesions
Old images of vein harvesting; prior to laparoscopic harvest of saphenous vein for bypass surgery
Endoscopic vein Harvest
Laparoscopic vein harvest materials
Treatment – Surgical Intervention

- Bypass grafts
- Can be either synthetic or autogenous vein
- Vein can be harvested laparoscopically
Currently saphenous vein can be harvested laparoscopically.

Minimizes the size of the incision, decreased risk of infection, increase early ambulation and speedier recovery.
• Image of open surgical intervention.

• Prior to bypass surgery, it is imperative to perform saphenous vein mapping to assess adequate conduit and plan for appropriate revascularization.
• If there is not adequate vein available, a vein cuff can be used to increase patency of bypass graft
Treatment – Surgical Intervention

- Aortobifemoral bypass graft is a huge operation which has been replaced by aortic endovascular techniques

- ICU post-op, Cell saver to be arranged for surgery, Arterial line, SG catheter, NG tube, PCA pump, etc

- Hospital Stay 5-7 days
• Endovascular Treatment of Bilateral Iliac Lesions.

• Has essentially replaced Aortobifemoral bypass graft

• Can be performed as an outpatient

• Can be performed in a hybrid procedure in conjunction with femoral to popliteal bypass graft

• Kissing Balloon Technique
- Angiogram of bilateral iliac stent placement. (Kissing balloon technique)

- Can be performed as outpatient
• Hybrid Surgical Procedures:

• Femoral Endarterectomy/ Iliac Angioplasty

• Open exposure allows for a minimally invasive procedure to be performed.
• Hybrid Surgical Procedures:
• Open Surgical Femoral Endarterectomy /SFA stent placement

• Utilizing surgical techniques as well as endovascular procedures to provide durable modified, minimally invasive procedures.

• Minimizes the size of surgical incisions, decreasing anesthesia time as well decreasing the recovery time with larger operations.

Figure 1. An open surgical femoral endarterectomy procedure (A), followed by the insertion of a 6-F sheath through the saphenous vein patch (B, C), introduction of wire and catheter (D), and completion of an angiographic femoral artery stenting procedure (E). A simple Z-suture technique was used to close the patch arteriotomy.
• Conclusions:

• The management of PAD has changed dramatically over the last 20 years.

• Advances will continue to be made to minimize the invasiveness of these procedures while utilizing standard surgical principles to change the anatomy and thus altering abnormalities in physiology.