Peripheral Artery Disease

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Disclosure Statement of Financial Interest

- **Advisory**
  - Boston Scientific
  - Abbott Vascular
  - Atheremed
  - Endologix

- **Training/Speaking**
  - Endologix
  - Cook Medical
  - Cardinal Health

- **Royalties**
  - Cook Medical

- **Research/National PI**
  - CSI

- **Stock**
  - Embolitech
  - Enable Injections
Encompassing Vascular Disease

- PAD
- AAA
- Renal artery stenosis
- Subclavian artery stenosis
- Carotid artery disease
- Venous diseases
- Vasculitis
When To Suspect multi-organ Vascular Involvement?

ALWAYS !!!!!!
The Evolution of America
Persons Diagnosed with DM in US

Peripheral Arterial Disease

+ Patients present with
  • Classic Intermittent Claudication (~30%)
  • Atypical Symptoms (~50%)
  • Critical Limb Ischemia (~10%)
    - Ischemic Rest Pain
    - Ischemic Ulceration
    - Gangrene
  • No symptoms with abnormal arterial circulation (~10%)
Peripheral Arterial Disease

Tests Available

- Bedside Ankle-Brachial Index
- ABI, Segmental Pressures, PVR
  - Treadmill
- Arterial Duplex Ultrasonography
- Magnetic Resonance Arteriography
- CT Angiography
- Contrast Arteriography
- CO2 arteriography
APPROPRIATE USE CRITERIA

ACCF/ACR/AIUM/ASE/ASN/ICAVL/SCAI/SCCT/SIR/SVM/SVS


Overlap of Atherosclerotic Disease

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

Coronary Artery Disease

Cerebrovascular Disease

Peripheral Arterial Disease

38% overlap ≥2 vascular beds

PAD, DM, and Cardiac Mortality

474 Men Age 68 Followed Prospectively for 14 Years

No DM, PAD
+DM, -PAD
+PAD, -DM
+PAD, +DM (p<0.001)
# Differential Diagnosis of PAD

<table>
<thead>
<tr>
<th>Condition</th>
<th>Location</th>
<th>Prevalence</th>
<th>Characteristic</th>
<th>Effect of exercise</th>
<th>Effect of rest</th>
<th>Effect of position</th>
<th>Other characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calf IC</td>
<td>Calf muscles</td>
<td>3–5% of adult population</td>
<td>Cramping, aching discomfort</td>
<td>Reproducible onset</td>
<td>Quickly relieved</td>
<td>None</td>
<td>May have atypical limb symptoms on exercise</td>
</tr>
<tr>
<td>Thigh and buttock IC</td>
<td>Buttocks, hip, thigh</td>
<td>Rare</td>
<td>Cramping, aching discomfort</td>
<td>Reproducible onset</td>
<td>Quickly relieved</td>
<td>None</td>
<td>Impotence May have normal pedal pulses with isolated iliac artery disease</td>
</tr>
<tr>
<td>Foot IC</td>
<td>Foot arch</td>
<td>Rare</td>
<td>Severe pain on exercise</td>
<td>Reproducible onset</td>
<td>Quickly relieved</td>
<td>None</td>
<td>Also may present as numbness</td>
</tr>
<tr>
<td>Chronic compartment syndrome</td>
<td>Calf muscles</td>
<td>Rare</td>
<td>Tight, bursting pain</td>
<td>After much exercise (jogging)</td>
<td>Subsidies very slowly</td>
<td>Relief with elevation</td>
<td>Typically heavy muscled athletes</td>
</tr>
<tr>
<td>Venous claudication</td>
<td>Entire leg, worse in calf</td>
<td>Rare</td>
<td>Tight, bursting pain</td>
<td>After walking</td>
<td>Subsidies slowly</td>
<td>Relief speeded by elevation</td>
<td>History of iliofemoral deep vein thrombosis, signs of venous congestion, edema</td>
</tr>
<tr>
<td>Nerve root compression</td>
<td>Radiates down leg</td>
<td>Common</td>
<td>Sharp lancinating pain</td>
<td>Induced by sitting, standing or walking</td>
<td>Often present at rest</td>
<td>Improved by change in position</td>
<td>History of back problems Worse with sitting Relief when supine or sitting</td>
</tr>
<tr>
<td>Symptomatic Bakers cyst</td>
<td>Behind knee, down calf</td>
<td>Rare</td>
<td>Swelling, tenderness</td>
<td>With exercise</td>
<td>Present at rest</td>
<td>None</td>
<td>Not intermittent</td>
</tr>
<tr>
<td>Hip arthritis</td>
<td>Lateral hip, thigh</td>
<td>Common</td>
<td>Aching discomfort</td>
<td>After variable degree of exercise</td>
<td>Not quickly relieved</td>
<td>Improved when not weight bearing tax relieved by lumbar spine flexion</td>
<td>Hip arthritis</td>
</tr>
<tr>
<td>Spinal stenosis</td>
<td>Often bilateral buttocks, posterior leg</td>
<td>Common</td>
<td>Pain and weakness</td>
<td>May mimic IC</td>
<td>Variable relief but can take a long time to recover</td>
<td>May be relieved by not bearing weight</td>
<td>Symptoms variable history of degenerative arthritis Worse with standing and extending spine</td>
</tr>
<tr>
<td>Foot/ankle arthritis</td>
<td>Ankle, foot, arch</td>
<td>Common</td>
<td>Aching pain</td>
<td>After variable degree of exercise</td>
<td>Not quickly relieved</td>
<td>May be relieved by not bearing weight</td>
<td>Variable, may relate to activity level and present at rest</td>
</tr>
</tbody>
</table>
The Most Important Aspect of the Diagnostic Evaluation of PAD

+ History
  • Location of Symptoms
  • Description of Discomfort
  • Exacerbating/Ameliorating Characteristics
  • Reproducible Symptoms

+ Physical Examination
Interesting PAD Diagnoses
Identify the vascular problem:

1. Raynaud’s phenomenon
2. Spontaneous venous hemorrhage
3. Livedo reticularis
4. Acrocyanosis
Acrocyanosis

+ Symmetric reddish-blue discoloration of the hands & feet
+ Discoloration exacerbated by cold
+ Acrocyanosis extends *proximal* to the wrist and dorsal foot
+ Discoloration is *persistent* rather than episodic
+ Venous pooling of the elderly also benign and looks the same
+ Improves with limb elevation and goes to normal pink
Acrocyanosis: *Differential Diagnosis*

- Anorexia nervosa
- Mononucleosis
- Lymphoreticular/solid malignancies
- Cold agglutinin disease
- Interferon alpha
- POTS
- Methemoglobinemia
- Sulfhemoglobinemia
- Multiple sclerosis
- Myeloproliferative syndrome
- APAS
- Arsenic poisoning
- Arteritis
- Parvovirus B19
- Fabry’s disease
- Paroxysmal cold hemoglobinuria
- Spinal cord injury
- Stroke
Acrocyanosis in Anorexia Nervosa

+ Occurs in *severely* anorectic patients
+ May represent an extreme form of an energy saving mechanism
+ Sometimes associated with clubbing and swelling of the digits
+ Univ of Basle- 33%
+ Univ of Ferrara- 29%
+ Univ of Innsbruck- 56%; associated with leukopenia and low eosinophils.
Acrocyanosis: Therapy

- No evidence-based guidelines
- Eliminate underlying cause
- Reassurance
- Vasodilator therapy
A 33 y.o. non smoker presents with pruritic, swollen toes in November. What is the diagnosis?

1. Raynaud’s
2. Acrocyanosis
3. Pernio
4. Atheroemboli
Pernio

**Overview:** A superficial, localized inflammatory skin disorder

**History:** Exposure to humid, *non freezing* cold; previous hx of similar manifestations (late fall/early spring)

**Symptoms:** burning; intense pruritus

**Clinical:** erythematous/violaceous patches, plaques, and/or papules; bulbous digits; blisters, ulcerations → *Toes and/or fingers*
Pernio

**Associated Diseases:**
- Vasospastic disorders (Raynaud’s, acrocyanosis)
- Chronic ischemia (PAD, erythermalgia)
- Hyperviscosity syndromes (cryopathies, leukemia)
- Abnormal fat distribution (obesity; anorexia)
Pernio

**Laboratory:**
- Not required in uncomplicated cases
- Complicated- autoimmune & cryopathy serology

**Differential Dx:**
- Arterial ischemia (*athero/thromboemboli*)
- Vasculitis
- Vasospastic diseases

**Therapy:** supportive care; Ca$^{2+}$ channel blockers; PD III/V inhibitors; topical steroids
Now for Symptomatic PVD
Comparing Physical Health for Chronically Ill U.S. Adults

Physical Component Summary (PCS)

Source: Adapted from Ware et al., 1994.
Prognosis for CLI Patients

- Within 3 months of presentation:
  - death in 9%
  - MI in 1%
  - stroke in 1%
  - amputation in 12%
  - persistent CLI in 18%
- 1-year mortality: 21.0%
- 2-year mortality: 31.6%
The Ankle-Brachial Index

+ Simple, painless, accurate, highly reproducible examination
+ Indications
  • Any patient suspicious of PAD
  • Any patient at risk of PAD
    - Age 50 or greater with history of DM or Tobacco Use
    - Age 70 or greater regardless of risk factors
# ABI as a Screening Test

## Table 1. Effectiveness of the ABI vs Other Common Screening Tests

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pap smear(^{37})</td>
<td>30-87</td>
<td>86-100</td>
</tr>
<tr>
<td>Fecal occult blood test(^{38})</td>
<td>37-78</td>
<td>87-98</td>
</tr>
<tr>
<td>Mammography(^{39})</td>
<td>75-90</td>
<td>90-95</td>
</tr>
<tr>
<td>ABI(^{5,35,36})</td>
<td>95</td>
<td>100</td>
</tr>
</tbody>
</table>

Abbreviation: ABI, ankle-brachial index.
Indications for Treadmill Vascular Test

- Any patient with atypical exertional limb symptoms—
  - Determine IC vs Pseudoclaudication
- Measure true functional impact of PAD
- Demonstrate impact of revascularization
- May uncover occult angina pectoris/CAD
Exercise

<table>
<thead>
<tr>
<th></th>
<th>Rest</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachial BP</td>
<td>162</td>
<td>168</td>
<td>165</td>
<td>152</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Ankle BP</td>
<td>161</td>
<td>75</td>
<td>87</td>
<td>93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L Ankle BP</td>
<td>134</td>
<td>44</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R ABI</td>
<td>0.99</td>
<td>0.45</td>
<td>0.53</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L ABI</td>
<td>0.83</td>
<td>0.27</td>
<td>0.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Systolic Pressure (mm/Hg)**

- Rest: 200
- 1: 150
- 2: 100
- 3: 50
- 4: 0
<table>
<thead>
<tr>
<th>Historical Clue</th>
<th>Vascular Etiology</th>
<th>Neurogenic Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>Predictable</td>
<td>Variable</td>
</tr>
<tr>
<td>Only With Walking?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Relief With Stopping/Standing?</td>
<td>Yes</td>
<td>Variable</td>
</tr>
<tr>
<td>Absent Pedal Pulses at Rest</td>
<td>Variable</td>
<td>Variable</td>
</tr>
</tbody>
</table>
Therapy for Intermittent Claudication

**Symptom/Limb**
- Tobacco Cessation
- Foot Care
- Control of DM
- Reduction in Cholesterol
- Antiplatelet Agents
- Exercise
- Cilostazol
- Angiogenesis
- Gingko Biloba

**Life**
- Tobacco Cessation
- Control of DM
- Reduction in Cholesterol
- Reduction in BP
- Ace inhibition
- Antiplatelet Agents
- Evaluation for CAD
- Exercise
LOWER EXTREMITY REVASCULARIZATION

INDICATIONS

+ Lifestyle-interfering intermittent claudication
+ Limb-threatening ischemia
  - Ischemic rest pain
  - Non-healing ulceration
  - Gangrene
Therapeutic Crossroads (Variables)

Patient Goals
Typically in 2016 Revascularization is Endo First
Peripheral Vascular Disease

Surgical Revascularization: Currently Venus Bypass Considered Most Durable Treatment

+ Life-Style Disabling Claudication
+ Rest Pain
+ Tissue Necrosis or Infection
+ Limb-threatening Ischemia

Morbidity and Mortality Should Prevent Indications from Being Expanded
Infrainguinal Surgery

- Serious Wound Infection 1 - 6%
- Myocardial Infarction 1.9 - 3.4%
- Early graft failure 0 - 24%
- Acute leg ischemia 1.0 - 2.0%
- Op. Mortality 1.3 - 6%
- Surgical Revision rate > 20%
ENDOVASCULAR TECHNIQUES

What Can Be Accomplished in 2016

Higher Success Rates and Prolonged Patency
Tools for CTO Intervention
Success Rates > 95%
Case

- Male, Age 80, HTN and CAD. Smoker
- ABI = .32
- CLI: rest pain
- Previous; Aortobifem bypass. Femtibial bypass x2 with multiple thromboses

[Image of angiogram]
Case

- Plan combined contralateral and popliteal access
- Difficult to go contralateral with aortobifemoral bypass
- Plan utilization of popliteal access
Access and Wire manipulation

• Flipped to prone position

• 5 french popliteal ultrasound guided access

• 4 french catheter over .035 straight hydrophilic guidewire

• Traversed to area of common femoral artery

• .035 wire replaced by .014 guide wire

• CTO devices advanced
Adopted Strategy: Option 3, PTA of AT and DP arteries

**Rational**
- Further bypass futile
- Endovascular relief of symptoms higher than restenosis rate
- Discrepancy of SFA to popliteal size
- Repeatable
6 months later

+ Patient without rest pain but developed a large wound secondary to self-removal of a callous
+ ABI .6 and no palpable pulse
+ What now?
CASE

+ ABI .89
+ Palpable DP pulse
+ Still healed for 5 years before sudden death
Case

- Male, Age 60, HTN and CAD. Smoker,
- CLI: toe gangrene
- ABI .28
- CTA
  - Rt common iliac ostial 90%
  - Lt common iliac 100%
  - Lt SFA distal 100%
- Plan Contralateral access to begin and bilateral access to finish
How to proceed?

1. Conservative Treatment?
2. Aortobifemoral bypass with fempop bypass
3. Iliac stenting with SFA PTA/stent
Adopted Strategy: Option 3, Bilateral iliac stenting with Lt SFA Intervention

**Rational**
- Poor surgical candidate
- Durable iliac procedure
- Endo outpt and low risk
Adopted Strategy: Option 3, Bilateral iliac stenting with Lt SFA Intervention
Outpatient Procedure
Technology Changes that Have Improved Outcomes
Compression Resistant Stent
SUPERB TRIAL: Maintained Patency from 1 to 3 Years

Freedom From TLR

Time Post Index Procedure (Days)

12 Months 89%
24 Months 84%
36 Months 82%

Δ 3 years 7%
Improved outcomes in Severe Calcification

**Freedom From TLR (K-M)**

<table>
<thead>
<tr>
<th>Duration</th>
<th>12 Months</th>
<th>24 Months</th>
<th>36 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>94.5</strong></td>
<td><strong>91.6</strong></td>
<td><strong>87.6</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Superb Severe Calcification Subset**

- Severe calcification: 45%
- Patency (VIVA 1 year): 89%

Severe Ca++ defined as 1 cm either side vessel
Acute Effect of Resistive Stent SUPERA
VIPER: Effects of Device Sizing: Proximal

Stent graft Option: VIASTAR: Primary Patency

All Lesions

Lesions ≥ 20 cm

VIABAHN®, n = 66
BMS, n = 63

VIABAHN®, n = 37
BMS, n = 23
SG (non-heparin) Randomized Comparison to Surgical Prosthetic Bypass

N = 86 pts (100 limbs)
   Stent graft    50
   Surgical bypass 50

Mean stent graft treatment length = 25.6 cm

<table>
<thead>
<tr>
<th></th>
<th>SG</th>
<th>Bypass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1-year patency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>73.5%</td>
<td>74.2%</td>
</tr>
<tr>
<td>Secondary</td>
<td>83.9%</td>
<td>83.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SG</th>
<th>Bypass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2-year patency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>62%</td>
<td>65%</td>
</tr>
<tr>
<td>Secondary</td>
<td>73%</td>
<td>75%</td>
</tr>
</tbody>
</table>


Druge Coated Stents Now in PV as well
5-year Primary Patency

At 5 years, Zilver PTX demonstrates a 41% reduction in restenosis compared to BMS
DCB 5-yr Results: Provisional Zilver PTX vs. BMS

At 5 years, Zilver PTX has a superior rate of freedom from persistent or worsening claudication, rest pain, ulcer, or tissue loss.
**Drug Coated Balloons**

**Leaving Nothing Behind**

### ALL ITT, 12-month Clinically-driven TLR

<table>
<thead>
<tr>
<th></th>
<th>IN.PACT</th>
<th>PTA</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinically-driven TLR $^{[1]}$</td>
<td>2.4%</td>
<td>20.6%</td>
<td>$&lt;0.001$ $^{[2]}$</td>
</tr>
</tbody>
</table>

![Graph showing freedom from clinically-driven TLR](image)

- $97.5\%$ for IN.PACT
- $79.3\%$ for PTA

(p<0.001 by log-rank test)
(≥15cm) Long Lesion Subset

- TLR for long lesion subset compares favorably to full cohort
  - 2-fold increase in lesion length
  - ~2-fold increase % CTO
- Longer lesions require more use of provisional stents
## IN.PACT Global Full Cohort vs. (≥15cm) Lesion Subset 12-months Results

<table>
<thead>
<tr>
<th></th>
<th>IN.PACT Global Long Lesion subset N=227</th>
<th>IN.PACT Global N=655</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-TLR</td>
<td>11.7%</td>
<td>8.7%</td>
</tr>
<tr>
<td>CD-TVR</td>
<td>12.2%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>5.1%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Target Limb Major Amputation</td>
<td>0.0% (0)</td>
<td>0.3% (2)</td>
</tr>
</tbody>
</table>
What of the Economics of All of This?
Pass through for DCB

+ Have to use new fee code
+ Variables
  • Cost to charge ratio from hospital
  • Medicare cost factor then calculated
  • Also takes into account device offset
    - PTA approx $1830
    - Stent approx $3000
    - Atherectomy $3600
Number of revascularization procedures calculated using economic model
Risk of a second TLR is assumed to be the same as the risk of the first TLR for a given therapy
## Results: Payer Perspective

**Cost To Medicare Per Patient Over 3-Years**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cost to Medicare Per Patient Over 3-Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Metal Stent (BMS)</td>
<td>$16,158</td>
</tr>
<tr>
<td>Angioplasty (PTA)</td>
<td>$15,166</td>
</tr>
<tr>
<td>Drug Eluting Stent (DES)</td>
<td>$14,845</td>
</tr>
<tr>
<td>Drug Coated Balloon (DCB)</td>
<td>$13,421</td>
</tr>
<tr>
<td>Interwoven Nitinol Stent (INS)</td>
<td>$13,036</td>
</tr>
</tbody>
</table>

*Analysis based on 2015 Medicare national average payment rates*
Results: Provider Perspective
Hospital Remaining Payment Over 3-Years

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total Hospital Remaining Payment* (per 100 patients over 3 years)</th>
<th>Total Number of Procedures (per 100 patients over 3 years)</th>
<th>Average Hospital Remaining Payment* per Procedure (over 3 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INS</td>
<td>$1.06M</td>
<td>107</td>
<td>$9,926</td>
</tr>
<tr>
<td>BMS</td>
<td>$1.31M</td>
<td>133</td>
<td>$9,885</td>
</tr>
<tr>
<td>DES</td>
<td>$1.14M</td>
<td>122</td>
<td>$9,375</td>
</tr>
<tr>
<td>PTA</td>
<td>$1.31M</td>
<td>153</td>
<td>$8,588</td>
</tr>
<tr>
<td>DCB</td>
<td>$1.05M</td>
<td>125</td>
<td>$8,442</td>
</tr>
</tbody>
</table>

* Remaining payment = facility reimbursement – device costs
Analysis based on 100 index procedures per treatment strategy
Summary
Thank You
Lets Stay in Touch
OhioHealth Vascular Institute App
OHVI app

Home Screen
+ 9 widgets
+ Finger print sign on for Iphone
+ Bookmark tab
+ User Profile
+ Text messaging
+ Contact info and Insurance references
+ PE risk and GFR calculators
OHVI App

Instructions for Download

+ For Apple users, go to the App Store and search OHVI and download
+ For Android users, go to Google Play and search OHVI and download
+ Requires physician NPI number to register
WE lead in vascular care

OHIOHEALTH VASCULAR INSTITUTE

OhioHealth
BELIEVE IN WE™