The Emerging Field of Vascular Medicine

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What is Vascular Medicine?

• Emphasis on clinical approaches to vascular disorders by physicians with special expertise and training in treating vascular disease

• Collegial interaction of community of vascular professionals including Vascular Medicine, IR, Vascular Surgery, Vascular Ultrasound, Primary Care Physicians, and other disciplines
What is Vascular Medicine?

- Society of Vascular Medicine
- American Board of Vascular Medicine
So What Do We Do?

- The goal of the Vascular Medicine specialist is to improve the care of the patient with undiagnosed or complicated vascular disease

- We specifically try to manage vascular disease “comprehensively”, including before and after interventions
So What Do We Do?

- Vasculitis and CTD
- Thrombophilia
- Venous Thromboembolism
- Upper and Lower Extremity Venous and Arterial Disease
- Perioperative Management of Vascular Surgery
- Arterial and Venous Testing
So What Do We Do?

• Medical Treatment of Vascular Disorders
• Follow Aneurysms and Stenoses
• Follow patients with unusual vascular disorders
• Focus on Secondary Prevention
• Optimize and prepare patients for vascular intervention procedures
The Burden of Vascular Disease

- Greater than 25 million people living in the US suffer from vascular disease including:
  - PAD - affects 1 in 5 males, 1 in 6 females age greater than 65
  - DVT/PE – most preventable cause of hospital death
  - MI - Aneurysms
  - CVA - Unusual Vascular Disorders
  - “Orphan Disorders – Lymphedema/CVI
The Vascular History and Physical Exam

• Usual Demographics
  – FH, occupation, current/previous illness, surgery, medications

  – The Vascular Complaint

  – Evaluating Pain
The Vascular History and Physical Exam

- Painful Extremities
  - Not necessarily the result of PVD
  - Persistent vs Intermittent
# Differential Diagnosis of Limb Pain

<table>
<thead>
<tr>
<th>Intermittent Claudication</th>
<th>Neurogenic Etiologies</th>
<th>Musculoskeletal Etiologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherosclerosis</td>
<td>Lumbosacral spine/disc disease</td>
<td>Arthritis</td>
</tr>
<tr>
<td>Popliteal artery entrapment syndrome</td>
<td>Peripheral neuropathy</td>
<td>Bursitis</td>
</tr>
<tr>
<td>Cystic adventitial disease of the popliteal artery</td>
<td>Venous claudication</td>
<td>Tendonitis</td>
</tr>
<tr>
<td>Fibromuscular dysplasia</td>
<td>Extensive iliofemoral occlusive deep venous thrombosis</td>
<td>Hamstring/quadriceps tightness</td>
</tr>
<tr>
<td>Giant cell arteritis</td>
<td></td>
<td>Plantar faciitis</td>
</tr>
<tr>
<td>Endofibrosis of the iliac artery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Vascular History and Physical Exam

• Leg Edema
  – When?
  – Painful?
  – Recede Overnight?
  – Associated cardiac symptoms?
  – Any evidence of renal disease?
  – Any evidence of chronic hepatic disease?
  – Any bowel or significant weight changes?
  – Any medications?
Regional Types of Edema

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Venous</th>
<th>Lymph</th>
<th>Lipedema</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral</td>
<td>Occasionally</td>
<td>±</td>
<td>Always</td>
</tr>
<tr>
<td>Stasis change</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Thickened skin</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Foot involved</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Toes involved</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>
Edema
Lymphedema
Lipedema
The Vascular History and Physical Exam

Skin Findings
Pulse Evaluation
Blood Pressure Evaluation
Allen Test
Bruits
ABI
Skin

- Color, temperature, hair growth
- Texture
- Xanthomas – lipid disorders
- Telangiectasias – scleroderma
- Ulcerations
- Gangrene
# Common Leg and Foot Ulcerations

<table>
<thead>
<tr>
<th></th>
<th>Ischemic (major arterial)</th>
<th>Ischemic (arteriolar)</th>
<th>Venous</th>
<th>Neurotrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onset</strong></td>
<td>Trauma</td>
<td>Spontaneous</td>
<td>Trauma</td>
<td>Trauma</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Foot, toes, heel</td>
<td>Posterolateral Lower leg</td>
<td>Medial leg</td>
<td>Plantar</td>
</tr>
<tr>
<td><strong>Pain Level</strong></td>
<td>Severe</td>
<td>Severe</td>
<td>None, unless infected</td>
<td>None</td>
</tr>
<tr>
<td><strong>Skin</strong></td>
<td>Atrophic</td>
<td>Normal</td>
<td>Stasis change</td>
<td>Callous</td>
</tr>
<tr>
<td><strong>Ulcer Edges</strong></td>
<td>Discrete</td>
<td>Serpiginous</td>
<td>Shaggy</td>
<td>Discrete</td>
</tr>
<tr>
<td><strong>Ulcer Base</strong></td>
<td>Pale; eschar</td>
<td>Eschar; ischemic</td>
<td>Healthy</td>
<td>Normal or pale</td>
</tr>
</tbody>
</table>
Pulse Evaluation

- Many grading scales
  - 0 = absent
  - 1 = diminished but palpable
  - 2 = normal
Pulse Evaluation

• Abdominal Aorta
  – Can actually measure
  – Check for pulsatile mass
  – Consider Screening for AAA!

• Radial Artery Simultaneous Palpation
  – Delayed pulsation of the radial artery with ipsilateral subclavian steal esp. important if undergoing CABG
Pulse Evaluation

• Simultaneous palpation of femoral arteries compared to radial artery also helpful in identifying coarctation

• Elevation Dependency Test for occlusive PAD

• Allen Test
Pulse Evaluation

• Bruits
  – Auscultate over large arteries i.e. carotids, subclavian, renal, aorta and femorals
  – Systolic vs Diastolic
<table>
<thead>
<tr>
<th>Cause</th>
<th>Bruits</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Systolic only</td>
<td>Diastolic only</td>
<td>Systolic and diastolic</td>
<td></td>
</tr>
<tr>
<td>Carotid atherosclerosis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Thyrotoxicosis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Transmitted cardiac murmur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic stenosis</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic insufficiency</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arteriovenous fistula</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Venus hum</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Ankle Brachial Index

- Important primary care diagnostic tool
- Easy to perform in the office
- Can do with rest and exercise
- Great screening tool for PAD
- What to do if abnormal?
- Reimbursable for different diagnosis
- Office machines readily available
PAD Diagnostic Pathway

- **Resting ABI/TBI with Waveform**
  - **Abnormal** - < 0.96
    - **Segmental Pressures**
    - **Symptoms disproportionate to resting ABI and pressure study**
    - **Treadmill exercise study**
    - **Duplex if flow-limiting lesion indicated by exercising study**
  - **Ankle Pressures > 250 mmHg**
  - **Brachial Pressures > 200 mmHg**
  - **ABI > 1.30**
    - **If Toe/Brachial Index abnormal**
      - Perform Segmental PVR Study
      - **Duplex if clinically indicated**
  - **Normal** - > 0.96
    - **No claudication symptoms... Finished.**
    - **Post Exercise Treadmill Study for Patients with Claudication**
    - **Duplex if flow-limiting lesion indicated by exercising study**
The Vascular Lab

- Arterial and Venous Testing
- Arterial can be Direct or Indirect
- Indirect
  - Pressure Measurement (ABI/TBI)
  - Treadmill Exercise Test
  - Plethysmography (PVR)
The Vascular Lab

- Duplex Scanning/Direct Testing
  - Carotids/Transcranial Doppler
  - Visceral including Aorta, Mesenterics and Renal Arteries
  - Lower and Upper Extremity Arterial
  - Specials including imaging of bypass grafts, stents, and dialysis access grafts
The Vascular Lab

• Venous Testing
  – DVT Protocol
  – Venous Insufficiency Protocol
The Vascular Lab

• Numerous modalities to diagnosis vascular disease
• Physiologic testing sometimes necessary to unmask disease
• Surveillance regimens are important
  – Carotid artery stenting and endartectomy
  – Peripheral artery bypasses and stents
  – EVAR and Dialysis access grafts
Normal Pulse Volume Recording
Abnormal LE PVR
Carotid Artery Duplex
Normal Carotid Duplex
Normal Color Flow
B Flow Imaging
Doppler Color Power Angio
Normal Carotid Duplex
Mild Atherosclerosis
Moderate Atherosclerosis
Severe Atherosclerosis
Carotid Stents
Carotid Stents
Carotid Stents
Carotid Stents
Carotid Stents
Stent Failure
CEA Myointimal Hyperplasia
Occluded SFA
Distal SFA Aneurysm
Distal SFA Aneurysm
SFA Stent with Aneurysm
SFA Stent
SFA Stent with Color Flow
AAA with Thrombus
AAA with Color Flow
EVAR Endoleak
Venous Compression Images
DVT CFV
Jugular Vein VTE
Medical Management of Vascular Problems

• Basic Management Goals
  – Primary and Secondary Prevention
  – Diagnosis and Treatment
  – Surveillance and Utilization of the Vascular Lab
  – Communication with referring providers and the Vascular Team
Medical Management of Vascular Problems

- Carotid Artery Disease
- Aneurysms
- Peripheral Artery Disease
- Chronic Venous Insufficiency
- VTE and Thrombophilia
- Vasculitis including Takayasu’s
- Unusual Vascular Disorders
Takayasu Arteritis

- Chronic large vessel vasculitis
- Affects aorta and its branches
- Greatest prevalence is in Asians, mostly female under 30 years old
- Systemic symptoms common in early phase with fatigue, weight loss, etc
- HTN, decreased peripheral pulses, AR
- HTN may be due to coarctation or RAS
Takayasu Arteritis

- Subclavian artery involvement common
- Stenosis proximal to origin of the vertebral artery can lead to syncope and steal syndrome
- Unequal blood pressures, diminished asymmetrical pulses
- Elevated ESR/CRP
- Negative ANA/ANCA/dsDNA Ab
Takayasu Arteritis

- Diagnose by imaging of the involved arterial tree with angio/aortogram or MRA/CTA
- Smooth tapering lesions
- Can cause both stenosis and occlusion of aorta
Takayasu Arteritis
Takayasu Arteritis

• ACR Classification (need at least 3)
  – Age at onset ≤ years
  – Claudication of the extremities
  – Decrease pulsation of one or both brachial arteries
  – Difference of 10 mmHg or in SBP between arms
  – Bruit of one or both subclavian arteries or aorta
  – Arteriographic narrowing or occlusion
Takayasu Arteritis

- FMD – more focal, no systemic symptoms
- Ehlers-Danlos syndrome – usually see multiple aneurysms
- Giant Cell (temporal) arteritis – older age and different distribution of lesions
- Glucocorticoids are first line therapy
- Cytotoxic agents
- Vascular procedures if refractory
Unusual Vascular Disorders

- Hypercoagulable States/Thrombophilias
- Thermal Disorders including Frostbite, Pernio, Cryoglobulinemia, Acrocyanosis, Erythromelalgia
- Non-Atherosclerotic Vascular Disorders such as Fibromuscular Dysplasia, Popliteal Artery Entrapment Syndrome, Cystic Adventitial Disease, External Iliac Artery Endofibrosis, TAO/Buerger’s disease (think of these disorders in young patients with no risk factors for ASO)
- Uncommon arteriopathies such as radiation arteritis, pseudoxanthoma elasticum, and drug abuse/drug induced associated arteriopathies
Pernio or Chillblains

- History Important – moderate or non-freezing cold-induced
- All ages, young women and children
- Late Fall, early-late winter
- Damp, moderate cold climates
- Affects toes, fingers, less commonly ears, nose and thigh
- Erythematous, purplish or cyanotic lesions, associated with yellow blisters/ulcers
Pernio

- Itching, burning pain
Pernio

- Treatment is to avoid cold or damp exposure
- Avoid expensive work up if clear cut diagnosis
- Can use CCB’s
- Dress warm when going outside
- Differential Diagnosis includes atheroemboli and vasculitis,
Erythromelalgia

- Aggravated by heat and exercise
- Triad: Erythema, temperature, pain
  - Erythros –red, Melos – extremity, Algos– pain
- Hands, feet, less often face and ears
- Chronic course, reduced quality of life
- Increases morbidity and mortality
- Symmetrical, usually LE greater than UE
- Affects all age groups
Erythromelalgia
Erythromelalgia

- Primary and Secondary
- Secondary Associated with Myeloproliferative Disorders, MS, RA, CTD/SLE and medications like CCB’s, cyclosporine, and bromocriptine
- Small fiber neuropathy and vasculopathy, dysfunctional Na+ channels
Erythromelalgia Treatment

- Educate
- Avoid aggravating conditions
- Cool using ice packs, cold water
- Secondary form may respond to ASA
- NSAIDS, tricyclic antidepressants, lidocaine patch, mexilite, transdermal amytriptyline
Fibromuscular Dysplasia

- Nonatherosclerotic, non inflammatory vascular disease
- Affects small to medium sized vessels
- Affects young to middle aged women but men affected also
- Aneurysm and dissection are possible disease progressions
- Pathogenesis unknown
FMD

• Renal
  – 60 – 75% of cases
  – HTN most usual manifestation

• Cerebrovascular
  – 25-35% of cases
  – ASx or headache, tinnitus, vertigo, syncope, TIA, CVA or intracranial aneurysm

• Visceral
  – Abdominal pain, weight loss, epigastric bruit

• Extremities
  - Claudication, CLI, ischemia, embolization
FMD “String of Beads”
FMD

• **Diagnosis**
  – Duplex Ultrasound
  – CTA/MRA
  – Angiography

• **Treatment**
  – Antiplatelet agents
  – Antihypertensive meds
  – Endovascular (PTA preferred)
  – Surgery
Popliteal Artery Entrapment Syndrome

- Rare, often misdiagnosed
- Athletic young males (15:1)
- Exercise induced claudication
- Onset often sudden
- Nocturnal cramps, parasthesias, ALI/CLI
PAES

- Congenital anatomical abnormality between popliteal artery and medial head of gastrocnemius muscle
- Results in stenosis, occlusion, or aneurysmal degeneration can occur
- Diagnoses with passive dorsiflexion of foot against resistance and will vascular lab testing
PAES

- Treatment includes surgery to release muscle to free entrapped artery
- SVG sometimes necessary
- Thrombolysis for ALI to restore patency
- No role for PTA or stenting
Cystic Adventitial Disease

- Young to middle aged men
- Intermittent Claudication
- Unilateral
- Popliteal Artery mostly
- Mucin containing cysts
Cystic Adventitial Disease

- Mucin cysts develop in adventitial layer
- Luminal narrowing compresses the artery
- Diagnose with obliteration of the pedal pulse on flexion of the knee (Ishikawa’s sign)
- Smooth tapering hourglass stenosis on angiography with no underlying ASO
Cystic Adventitial Disease

- Treatment is ultrasound or CT guided needle aspiration
- PTA and stenting unsatisfactory results
- Thrombolytic surgery if artery occluded
- Surgery to evacuate cyst, resect affected segment, or bypass surgery
External Iliac Artery Endofibrosis

• Seen in highly trained athletes including cyclists, endurance runners, rugby players
• Left common iliac artery most common
EIAE

- Usually unilateral (85%)
- Related to aerodynamic posturing and flexed thigh leading to hemodynamic stress on vessel wall
- Can see kinking due to excessive iliac artery length and psoas muscle hypertrophy
- Fibrotic thickening and eventually stenosis of vessel wall
- Dissection uncommon
EIAE

- Symptoms:
  - Exercise-induced leg pain usually thigh
  - Feeling a “lack of power”
  - Swollen thigh, cramping
  - Numbness, parasthesias
  - Symptoms relieved with rest
  - Compromised training, early retirement
EIAE

- Physical exam usually normal at rest
- May have muscle wasting in thigh
- Can hear post exercise bruit
- Diagnosis with ABI before and after maximal exercise with bicycle ergometer
- ABI less than 0.5 in 85%
- Can use duplex, angio, MRA
EIAE

• Treatment
  – Conservative, change activity
  – Patients used to high function, expect a full recovery
  – PTA possible with stenting
  – Endarectomy and vein patch possible
  – Resection and bypass also an option
Atherosclerotic Risk Factors
Secondary Prevention

• Interaction of Risk Factors with the arterial wall initiates the atherosclerotic process

• Four major categories
  – Conventional
  – Predisposing
  – Conditional
  – Emerging (Novel)

• 60+ identified at the present time
Risk Factors

- Conventional include smoking, diabetes, hyperlipidemia, and hypertension
- Predisposing include advanced age, obesity, physical activity, and family history
- Conditional include homocysteine, CRP, Lipoprotein a, fibronogen
- Emerging
Recent Interesting Vascular Case

- 28 year old female with swollen left leg
- Sudden onset
- Painful calf and hurts to walk
- Was "sick in bed" for the last couple weeks with nausea and vomiting
- PE shows swollen LLE, calf circumference 2.5 cm greater, no cords, + Homan’s, pulses intact
Case #1

- Duplex ultrasound shows extensive LLE occlusive DVT from posterior tibial vein to common femoral vein
Case #1

- Duplex ultrasound shows extensive LLE occlusive DVT from posterior tibial vein to common femoral vein
- “Oh, by the way, I’m 8 weeks pregnant”
Case #1

- Duplex ultrasound shows extensive LLE occlusive DVT from posterior tibial vein to common femoral vein
- “Oh, by the way, I’m 8 weeks pregnant”
- “Oh, by the way, I’m Amish and I have no health insurance”
DVT and Pregnancy

- Pregnancy and peripartum period well established risk factor for VTE
- Warfarin generally not used, esp in the first trimester, because it may be teratogenic
- Paucity of safety data for fondaparinux and idraparinux
- Monitoring of anticoagulant activity tends to be more vigilant because less is known about the dosing in pregnancy
DVT and Pregnancy

- ACCP 2008 Guidelines
- SC LMWH, IV UFH, SC UFH
- SC LMWH preferred, probably more efficacious with a better safety profile although a lot of the data extrapolated from the non pregnant population
- Dosing- weigh adjusted with more vigilant monitoring
DVT and Pregnancy

• Enoxaparin at 1 mg/kg q 12 hours with anti Xa levels 0.6 – 1.0 IU/mL
• Measure anti Xa levels 6 hours after third or fourth dose
• IV UFH 80 units/kg bolus, followed by infusion of 18/kg per hour, anti Xa goal is 0.3-0.7 IU/mL
DVT and Pregnancy

- SC UFH reasonable dose is 17,500 units SQ q 12 hours, titrate to anti Xa level same as IV UFH. aPTT measures six hours after second dose, most adjustments about 10-30 % increase or decrease

- During last weeks of pregnancy, more frequent monitoring is recommended for all regimens
DVT and Pregnancy

- Treatment should be discontinued 24 – 36 hours before delivery if time is predictable, i.e. C-section or induction of labor.
- High risk VTE patients can have IV UFH regimen until 6 hours prior to delivery or if really concerned consider IVC filter.
- Neuraxial anesthesia should not be given if unexpected delivery and still anticoagulated.
DVT and Pregnancy

- Restart heparin regimen 12 hours after C section or 6 hours after vaginal birth if no significant bleeding
- Continue at least 6 weeks postpartum
- Can use warfarin as doesn’t accumulate in breast milk but need to bridge for at least 5 days
- Thrombolytic therapy should be reserved for life threatening acute PE – no controlled thrombolytic trials in pregnant women
Back to Case #1....

- Husband at the pharmacy, 30 injections of enoxaparin is $2400 which means total treatment cost of over $32,000

- We need another treatment option

- Refuse hospital stay for IV UFH transitioned over to SC UFH

- Start outpatient SC UFH regimen and enlist the support of all our resources
Back to Case #1

- “Oh, but we have no phone and not sure how we can go to the lab to get my blood drawn”
- Team effort!
- Last aPTT and anti Xa was therapeutic
Thank You!