Introduction to Peripheral Artery Disease

Dr. Tee Chee Hian
Outline of Lectures

- Arteries of the Lower Limb
- Pathophysiology
- Prevalence
- Clinical presentation/ Types
- Critical limb ischemia
- PAD History and examination
- Summary
Arteries of the Lower Limb

- Ext Iliac $\rightarrow$ Common Fem
  - Crosses under Inguinal Ligament

- Profunda Femoris artery. (biggest branch)
  - Continue as Superficial Femoral Artery
External Iliac Artery
Inguinal Ligament
Common Femoral Artery
Profunda Femoris Artery
Superficial Femoral Artery
Profunda Femoris Artery

- Biggest Branch of Common Femoral artery
- 5cm distal to Ing. Ligament
- 6 BRANCHES
  - 2 Circumflex Femoral
    - Medial
    - Lateral
  - 4 Perforating Arteries (4)
Superficial Femoral Artery

- Passes in Adductor Canal
  - Between Vastus Med / Adductors / Sartorius
  - Through Adductor Hiatus
- Into Popliteal Fossa ➔ Popliteal Artery
Popliteal Artery

- Divides at lower border of Knee Joint
  - Tibioperoneal Trunk
  - Anterior Tibial artery
Popliteal Artery
Inferior Lateral Genicular Artery
Anterior Tibial Artery
Tibioperoneal Trunk
Peroneal Artery
Posterior Tibial Artery
Tibioperoneal Trunk

- Peroneal Artery
- Posterior Tibial Artery
Posterior Tibial Artery

- Passes downwards and behind the medial malleolus.
- It divides into medial and lateral plantar arteries.
Peroneal Artery

- Descends to lie posteromedially of the fibula
- Runs behind tibiofibular joint
- Ends as Calcaneal Branch
Peroneal Artery

Calcaneal Branch of Peroneal artery
Anterior Tibial Artery

- Passes above upper margin of interosseus membrane
- Descends anterior to membrane
- Continues as Dorsalis Pedis Artery
- Passes between 1st and 2nd metatarsals to join plantar arch
Pathophysiology

- **Form of atherosclerosis**

- **Progressive disease**
  - May occur suddenly if an embolism occurs or when a blood clot rapidly develops in a blood vessel restricted by an atherosclerotic plaque, and the blood flow is quickly cut off.
**What is PVD?**

**Definition:**
- Also known as PAD or PAOD.
- Occlusive disease of the arteries of the lower extremity.
- Most common cause:
  - Atherothrombosis
  - Others: arteritis, aneurysm + embolism.
- Has both ACUTE and CHRONIC Px

**Pathophysiology:**
- Arterial narrowing \(\rightarrow\) Decreased blood flow = Pain
- Pain results from an imbalance between supply and demand of blood flow that fails to satisfy ongoing metabolic requirements.
Prevalence
Prevalence of PAD

In a primary care population defined by age and common risk factors, the prevalence of PAD was approximately one in three patients.
Prevalence of PAD Increases With Age

Rotterdam Study (ABI <0.9)¹  San Diego Study (PAD by noninvasive tests)²

ABI=ankle-brachial index

Diabetes Increases the Risk of PAD

Impaired glucose tolerance was defined as oral glucose tolerance test value ≥140 mg/dL but <200 mg/dL.

*P ≤.05 vs. normal glucose tolerance.

CRP as Predictor of Incident PAD

hs-CRP (mg/dL)

None | 0.1
Intermittent Claudication | 0.13
Peripheral Artery Surgery | 0.17

CRP = C-reactive protein; hs-CRP = high-sensitivity C-reactive protein

Risk Factors for PAD

- Smoking: Reduced
- Diabetes: Reduced
- Hypertension: Reduced
- Hypercholesterolemia: Reduced
- Hyperhomocysteinemia: Reduced
- C-Reactive Protein: Increased
PARTNERS: Prevalence of PAD and Other CVD in Primary Care Practices

29% of Patients in a Target Population Were Diagnosed With PAD Using An Office-Based ABI

ABI=ankle-brachial index; CVD=cardiovascular disease.

Risk Factors:

Typical Patient:
- Smoker (2.5-3x)
- Diabetic (3-4x)
- Hypertension
- Hx of Hypercholesterolemia/AF/IHD/CVA

Based on the epidemiologic evidence base, an “at risk” population for PAD can be objectively defined by:

- Age ≥ 70 years.
- Age 50 - 69 years with a history of smoking or diabetes.
- Age 40 - 49 with diabetes and at least one other risk factor for atherosclerosis.
- Leg symptoms suggestive of claudication with exertion or ischemic pain at rest.
- Abnormal lower extremity pulse examination.
- Known atherosclerosis at other sites (eg, coronary, carotid, or renal artery disease).
Clinical Presentation

- Asymptomatic
- Classic claudication
- “Atypical” leg pain
- Critical limb ischemia
- Acute limb ischemia
Individuals With PAD Present in Clinical Practice With Distinct Syndromes

- **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.
This guideline recognizes that:

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

- **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

- **Classic (Typical) Claudication**: ~15%
- **Atypical Leg Pain (functionally limited)**: ~33%
- **Asymptomatic**: 50%
- **Critical Limb Ischemia**: 1%-2%
Critical Limb Ischemia

- Subset of PVD patients
- Prevalence is 1-2% of patients with PVD over the age of 50
Critical Limb Ischemia

- Blood flow is insufficient to meet tissue oxygen demands
- Ischemic injury occurs in tissues with the least blood supply and results in necrosis
- Local and systemic inflammatory response
- Compensatory mechanisms:
  - post stenotic arteriolar vasodilatation
  - collateral circulation
Critical Limb Ischemia

- Acute ischemia – sudden decrease in blood flow that causes a potential threat to limb viability – rest pain, ischemic ulcers, and/or gangrene who present within 2 weeks of event.

- Chronic ischemia – similar manifestations as acute ischemia but > 2 weeks.
Critical Limb Ischemia

- Mortality approaches 25% at 1 year after diagnosis
- Additional 25% require major amputation
- Amputation increases morbidity and mortality – 50% mortality at 5 years
Factors That Increase Risk of Limb Loss in Patients With Critical Limb Ischemia

- 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

Also see Table 5 of Hirsch AT, et al. *J Am Coll Cardiol.* 2006;47:e1-e192.
Chronic PAD History:

**INTERMITTENT CLAUDICATION**
- Derived from the Latin word ‘to limp’
- “Reproducible pain on exercise which is relieved by rest”
- Pain can also be reproduced by elevating the leg
- “my legs get sore at night and feel better when I hang them over the edge of the bed”

**Other Symptom/Signs:**
- A burning or aching pain in the feet (especially at night)
- Cold skin/feet
- Increased occurrence of infection
- Non-healing Ulcers
- Asymptomatic

**Critical Stenosis = >60%, impending acute ischemic limb:**
- rest pain
- ischemic ulceration
- gangrene
Thigh Claudication

- 60% Upper 2/3 Calf Claudication
- Lower 1/3 Calf Claudication
- Foot Claudication

30% Buttock & Hip Claudication

±Impotence – Leriche’s Syndrome

Thigh Claudication

60% Upper 2/3 Calf Claudication

Lower 1/3 Calf Claudication

Foot Claudication


**DDx of Leg Pain**

1. **Vascular**
   a) DVT (as for risk factors)
   b) PVD (claudication)

2. **Neurospinal**
   a) Disc Disease
   b) Spinal Stenosis (*Pseudoclaudication*)

1. **Neuropathic**
   a) Diabetes
   b) Chronic EtOH abuse

2. **Musculoskeletal**
   a) OA (variation with weather + time of day)
   b) Chronic compartment syndrome
### Claudication vs. Pseudoclaudication

<table>
<thead>
<tr>
<th>Characteristic of discomfort</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cramping, tightness, aching, fatigue</td>
<td>Same as claudication plus tingling, burning, numbness</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of discomfort</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buttock, hip, thigh, calf, foot</td>
<td>Same as claudication</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Exercise-induced</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Variable</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistent</td>
<td>Variable</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Occurs with standing</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action for relief</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand</td>
<td>Sit, change position</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time to relief</th>
<th>Claudication</th>
<th>Pseudoclaudication</th>
</tr>
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<tbody>
<tr>
<td>&lt;5 minutes</td>
<td>≤30 minutes</td>
<td></td>
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</tbody>
</table>

Also see Table 4 of Hirsch AT, et al. *J Am Coll Cardiol.* 2006;47:e1-e192.
## Physical Examination:

<table>
<thead>
<tr>
<th>Examination:</th>
<th>What do to:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inspection</strong></td>
<td>• Thick Shiny Skin</td>
</tr>
<tr>
<td>Expose the skin and look for:</td>
<td>• Hair Loss</td>
</tr>
<tr>
<td></td>
<td>• Brittle Nails</td>
</tr>
<tr>
<td></td>
<td>• Colour Changes (pallor)</td>
</tr>
<tr>
<td></td>
<td>• Ulcers</td>
</tr>
<tr>
<td></td>
<td>• Muscle Wasting</td>
</tr>
<tr>
<td><strong>Palpation</strong></td>
<td>• Temperature (cool, bilateral/unilateral)</td>
</tr>
<tr>
<td></td>
<td>• Pulses: ?Regular, ?AAA</td>
</tr>
<tr>
<td></td>
<td>• Capillary Refill</td>
</tr>
<tr>
<td></td>
<td>• Sensation/Movement</td>
</tr>
<tr>
<td><strong>Auscultation</strong></td>
<td>• Femoral Bruits</td>
</tr>
<tr>
<td><strong>Ankle Brachial Index (ABI)</strong></td>
<td>= Systolic BP in ankle</td>
</tr>
<tr>
<td></td>
<td>Systolic BP in brachial artery</td>
</tr>
<tr>
<td><strong>Buerger’s Test</strong></td>
<td>• Elevate the leg to 45° - and look for pallor</td>
</tr>
<tr>
<td></td>
<td>• Place the leg in a dependent position 90° &amp; look for a red flushed foot before returning to normal</td>
</tr>
<tr>
<td></td>
<td>• Pallor at &lt;20° = severe PAD.</td>
</tr>
</tbody>
</table>
### 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

Also see Table 10 of Hirsch AT, et al. *J Am Coll Cardiol.* 2006;47:e1-e192.
# Differential Diagnosis of Common Foot Ulcers

<table>
<thead>
<tr>
<th>Neuropathic Ulcer</th>
<th>Neuroischemic Ulcer</th>
</tr>
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<tbody>
<tr>
<td>Painless</td>
<td>Painful</td>
</tr>
<tr>
<td>Normal pulses</td>
<td>Absent pulses</td>
</tr>
<tr>
<td>Typically punches-out appearance</td>
<td>Irregular margins</td>
</tr>
<tr>
<td>Often located on sole or edge of foot or metatarsal head</td>
<td>Commonly located on toes</td>
</tr>
<tr>
<td>Presence of calluses</td>
<td>Calluses absent or infrequent</td>
</tr>
<tr>
<td>Loss of sensation, reflexes, and vibration sense</td>
<td>Variable sensory findings</td>
</tr>
<tr>
<td>Increase in blood flow</td>
<td>Decrease in blood flow</td>
</tr>
<tr>
<td>(arteriovenous shunting)</td>
<td></td>
</tr>
<tr>
<td>Dilated veins</td>
<td>Collapsed veins</td>
</tr>
<tr>
<td>Dry, warm foot</td>
<td>Cold foot</td>
</tr>
<tr>
<td>Bone deformities</td>
<td>No bony deformities</td>
</tr>
<tr>
<td>Red appearance</td>
<td>Pale, cyanotic</td>
</tr>
</tbody>
</table>

Summary

- The prevalence: >55 years is 10%–25%
- Nearly 50% of affected individuals are asymptomatic
- PAD pt’s = 4X more likely to die within 10 years than pt’s without the disease.
- The ankle–brachial pressure index (ABPI) is a simple, non-invasive bedside tool for diagnosing PAD — an ABPI <0.9 = diagnostic for PAD
- Patients with PAD require medical management to prevent future coronary and cerebral vascular events.