Physical Exam & Associated Pathology
Part IV – Cardiovascular & Peripheral Systems

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Contents

The Cardiovascular System ........................................................................................................... 2
   Events in the Cardiac Cycle ........................................................................................................ 2
   Areas of Auscultation .................................................................................................................. 3
The Peripheral Vascular System .................................................................................................. 4
   Venous Diseases .......................................................................................................................... 4
   Screening for Peripheral Arterial Disease (PAD): The Ankle-Brachial Index (ABI) .............. 6
   Pitting Edema ............................................................................................................................ 7
Thrombophlebitis of the Deep Veins .......................................................................................... 8
References ........................................................................................................................................ 9
The Cardiovascular System

- The nutritional signs of deficiency
  - Palpitations and arrhythmia: B1, magnesium, calcium, co-enzyme Q-10
  - Hypertension: calcium, magnesium, potassium

- The right ventricle occupies most of the anterior cardiac surface. The inferior border of the right ventricle lies below the junction of the sternum and the xiphoid process. The right ventricle narrows superiorly and joins the pulmonary artery at the level of the sternum or ‘base of the heart’.

- The left ventricle forms the left lateral margin of the heart. Its inferior tip is called the cardiac ‘apex’. In supine patients the diameter of the PMI may be as large as a quarter, approximately 1 to 2.5 cm. A PMI greater than 2.5 cm is evidence of left ventricular hypertrophy (LVH), or enlargement.

- Events in the cardiac cycle
  - Systole is the period of ventricular contraction
  - Diastole is the period of ventricular relaxation

  ▪ First heart sound: \( S_1 \) - Closure of the mitral valve produces the first heart sound. During systole, the left ventricle starts to contract and ventricular pressure rapidly exceeds left atrial pressure, shutting the mitral valve.

  ▪ Second heart sound: \( S_2 \) – As the left ventricle ejects most of its blood, ventricular pressure begins to fall. When left ventricular pressure drops below aortic pressure, the aortic valve shuts. Aortic valve closure produces the second heart sound, \( S_2 \), and another diastole begins.

  ▪ Third heart sound: \( S_3 \) - After the mitral valve opens, there is a period of rapid ventricular filling as blood flows early in diastole from left atrium to left ventricle. In children and young adults, a third heart sound, \( S_3 \), may arise from rapid deceleration of the column of blood against the ventricular wall. In older adults, an \( S_3 \), sometimes termed ‘an \( S_3 \) gallop’, usually indicates a pathologic change in ventricular compliance.

  ▪ Fourth heart sound: \( S_4 \) - Although not often heard in normal adults, a fourth heart sound, \( S_4 \), marks atrial contraction. It immediately precedes \( S_1 \) of the next beat and also reflects a pathologic change in ventricular compliance.
The Cardiovascular System (con’t)

• The splitting of heart sounds
  o Because pressures on the right side are lower than the pressures on the left side, a splitting heart sound of S1 and S2 may be heard.

• Heart murmurs
  o Heart murmurs are distinguishable from heart sounds by their longer duration. Turbulent blood flow causes their sound, which may be benign, as noted in younger patients, or diagnostic of valvular heart disease.
  o A stenotic valve has an abnormally narrowed valvular opening that restricts blood flow.
  o A valve that fails to fully close allows for retrograde flow and produces a regurgitant murmur.

• Areas of Auscultation
  o Second right interspace - aortic area
  o Second left interspace – pulmonic area
  o Lower left sternal border – tricuspid area
  o Apex – mitral area
  o The diaphragm is better for picking up the high-pitched sound of S1 and S2, the murmurs of aortic and mitral regurgitation, and pericardial friction rubs.
    ▪ The bell is more sensitive to the low-pitched sounds of S3 and S4 and the murmur of mitral stenosis.
  o It is recommended that listening to the heart is a part of every patient exam. Doing so will promote recognition of both normal and abnormal heart sounds.
  o Electronic stethoscopes are available and produce excellent sound quality, helping to hear more of the necessary sounds, and less of what is not. They use a two-position frequency selection switch that allows for listening of either high or low frequencies; easily picking up low diastolic murmurs or high-pitched pulmonary sounds. Accessories are also available for electronic capturing and recording of sounds.
    ▪ An analyzer allows for connection of a stethoscope to a computer for recording an exam. The software combines a phonocardiogram with a synchronized ECG signal, allowing for documentation of any unusual findings, or to monitor a patient’s progress. Files may be e-mailed or stored in a patient’s file.
  o From a functional medicine perspective, the phonocardiography feature on the analyzer will allow for documentation of evaluation of the heart sounds during periods of cardiovascular nutritional treatment.
    ▪ i.e. a depressed S1 heart sound may be indicative of a B1 deficiency.
The Peripheral Vascular System

- Arteries contain three concentric layers of tissue: the intima, the media, and the adventitia
  - Intima
    - Surrounding the lumen of all blood vessels is the intima, a single continuous lining of endothelial cells with remarkable metabolic properties. Intact endothelium synthesizes regulators of thrombosis like prostacyclin, plasminogen activator, and heparin-like molecules. It produces prothrombotic molecules and modulates blood flow and vascular reactivity through synthesis of vasoconstrictors like endothelin and angiotensin-converting enzymes and vasodilators such as nitric oxide and prostacyclin. The intimal endothelium also regulates immune and inflammatory reactions through elaboration of interleukins, adhesion molecules, and histocompatibility antigens.
  - Media and Adventitia
    - The media is composed of smooth muscle cells that dilate and constrict to accommodate blood pressure and flow. Its inner and outer boundaries are membranes of elastic fibers, or elastin, called internal and external elastic laminae. Small arterioles called the vasa vasorum perfuse the media. The outer layer of the artery is the adventitia, connective tissue containing nerve fibers and the vasa vasorum.

- Veins
  - Unlike arteries, veins are thin-walled and highly distensible, with a capacity for up to two-thirds of circulating blood flow.
  - Because of their weaker wall structure, the leg veins are susceptible to irregular dilatation, compression, ulceration, and invasion by tumors and warrant special attention.

- Venous Disease
  - Venous diseases are acute or chronic disorders of the veins and include
    - Venous Thromboembolism (VTE)
      - Common, potentially life threatening
      - Treatable and largely preventable
      - Includes:
        - Deep vein thrombosis (DVT)
          - Abnormal clotting of the blood in one or more veins, most commonly in the legs
        - Pulmonary embolism (PE)
          - Occurs with DVT breaks free from its original site and travels through the heart then into the lungs
  - Chronic venous insufficiency
  - Post-thrombotic syndrome
  - Varicose veins
• **Arterial/Venous Insufficiency**

  o **Arterial**
    - Claudication/pain at rest
    - Decreased pulse
    - Pale color
    - Cool skin
    - Absent or mild edema
    - Hair loss/thick nails/thin shiny skin
    - Ulcers usually on toes or trauma spots on feet
    - Gangrene may occur

  o **Venous**
    - No pain to achiness
    - Normal pulse
    - Normal or cyanotic
    - Normal temp
    - Marked edema
    - May have petechiae/brown pigmentation/thick skin
    - Ulcers usually on ankles
    - Gangrene does not occur

  o **Signs and Symptoms**
    - Pain in the arms or legs
    - Intermittent claudication
    - Cold, numbness, pallor in the legs; hair loss
    - Swelling in calves, legs, or feet
    - Color change in fingertips or toes in cold weather
    - Swelling with redness or tenderness

  o *Atherosclerosis* can cause symptomatic limb ischemia with exertion; distinguish this from spinal stenosis, which produces leg pain with exertion that may be reduced by leaning forward (stretching the spinal cord in the narrowed vertebral canal) and less readily relieved by rest.

  o Hair loss over the anterior tibiae occurs with decreased arterial perfusion. ‘Dry’ or brown-black ulcers from gangrene may ensue.

  o Fatigue, aching, numbness, or pain that limits walking or exertion in the legs; if present, identify the location. Ask also about erectile dysfunction.
Arterial/Venous Insufficiency (con’t)

Symptom location suggests the site of arterial ischemia:

- Buttock, hip; aortoiliac
- Erectile dysfunction: iliac-pudendal
- Thigh: common femoral or aortoiliac
- Upper calf: superficial femoral
- Lower calf: popliteal
- Foot: tibial or peroneal

Abdominal pain, ‘food fear’, and weight loss suggest intestinal ischemia of the celiac or superior or inferior mesenteric arteries.

Screening for Peripheral Arterial Disease (PAD): The Ankle-Brachial Index (ABI)

- PAD is a common manifestation of atherosclerosis, affecting from 12% to 29% of community populations.

Ankle-Brachial Index

\[
\text{ABI} = \frac{\text{Lower extremity systolic pressure}}{\text{Brachial artery systolic pressure}}
\]

Interpreting the Ankle-Brachial Index

<table>
<thead>
<tr>
<th>ABI</th>
<th>Interpretation</th>
</tr>
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<tbody>
<tr>
<td>1.00-1.29</td>
<td>Normal</td>
</tr>
<tr>
<td>0.91-0.99</td>
<td>Borderline</td>
</tr>
<tr>
<td>0.41-0.90</td>
<td>Mild-to-moderate disease</td>
</tr>
<tr>
<td>≤0.40</td>
<td>Severe disease</td>
</tr>
<tr>
<td>≥1.30</td>
<td>Non-compressible</td>
</tr>
</tbody>
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Keys components of the peripheral arterial examination

- Measure blood pressure in both arms
- Palpate carotid upstroke, auscultate for bruits
- Auscultate for aortic, renal, and femoral bruits; palpate aorta and determine maximal diameter
- Palpate brachial, radial, ulnar, femoral, popliteal, dorsalis pedis, and posterior arteries.
- Inspect ankles and feet for color, temperature, skin integrity; note any ulcerations; check for hair loss, trophic skin changes, hypertrophic nails
Examination of the Legs

- Inspect both legs from the groin and buttock to the feet
  - Size, symmetry, and any swelling
  - The venous pattern and any venous enlargement
  - Pigmentation, rashes, scars, or ulcers
  - The color and texture of the skin, the color of the nail beds, and the distribution of hair on the lower legs, feet, and toes.
  - Palpate the superficial inguinal nodes
  - Palpate the pulses to assess the arterial circulation
    - The femoral pulse
      - A diminished or absent pulse indicates partial or complete occlusion proximally
      - An exaggerated, widened femoral pulse suggests a femoral aneurysm, a pathologic dilatation of the artery.
    - The popliteal pulse
      - An exaggerated, widened popliteal pulse suggests an aneurysm of the popliteal artery. Popliteal and femoral aneurysms are not common. They are usually caused by atherosclerosis and occur primarily in men older than 50 years.
    - The dorsalis pedis pulse
      - Decreased or absent pedal pulses with normal femoral and popliteal pulses suggest occlusive disease in the lower popliteal artery or its branches – often seen in diabetes mellitus.
  - The posterior tibial pulse

- Checking for pitting edema
  - Press firmly but gently with your thumb for at least 5 seconds (1) over the dorsum of each foot, (2) behind each medial malleolus, and (3) over the shins. Look for pitting – a depression caused by pressure from your thumb. Normally, there is none. The severity of edema is graded on a four-point scale, from slight to very marked.
Compression stockings are an important part of the maintenance of treatment in CVI, treatment and prevention of venous ulcers, and for prevention of DVT. To be effective, compression needs to be in excess of 35 mm Hg.

Evidence shows that patient non-compliance (due to the discomfort associated) with use of compression stockings hinders the success of treatment.

Important: about a fifth of patients with venous ulcers also have arterial disease, so compression can cause necrosis, resulting in amputation in some cases. Compression with an ankle-brachial index below 0.9 is contraindicated.

**Thrombophlebitis of The Deep Veins**

- Pain in the calf or thigh, often associated with edema. 50% of patients are asymptomatic
- History of congestive heart failure, recent surgery, trauma, neoplasia, oral contraceptive use, or prolonged inactivity
- Physical signs unreliable
- Duplex ultrasound is diagnostic

**General considerations**

- DVT affects as many as 800,000 new patients per year.
- Treatment is estimated to cost $1-2.5 billion per year, not including costs associated with long-term sequelae
- Virchow’s triad (stasis, vascular injury, and hypercoagulability) defines the events that predispose a vein to development of thrombophlebitis. Within 7-10 days this thrombus becomes adherent to the vein wall; secondary inflammatory changes develop and is ultimately invaded by fibroblasts, resulting in neovascularization and scarring of the vein wall and destruction of the valves.
- Certain operations, e.g. Hip replacements, are associated with higher incidences of thromboembolic complications.
Thrombophlebitis of The Deep Veins (con’t)

Signs and symptoms

• 50% of patients with thrombophlebitis and 60-70% with acute pulmonary embolism have no signs or symptoms.
• Physical exam may disclose slight edema of the calf, a palpable cord, distention of the superficial venous collaterals, or low-grade fever and tachycardia.
• Homans’ sign (pain on passive dorsiflexion of the ankle) is positive in only 50% of cases.

Diagnostic testing

Because of the difficulty in making a precise diagnosis by history and physical examination and because of the morbidity associated with treatment, diagnostic studies should be used liberally.
• Duplex ultrasonography
• Because of its high sensitivity, specificity, and reproducibility, has supplanted venography as the most widely used test in initial evaluation. Includes both B mode image and Doppler flow analysis
• Ascending contrast venography
• D-dimer test
• Recent evidence suggests that a negative D-dimer test in a patient suspected of having DVT is sufficient to omit ultrasound testing

Differential diagnosis

• Localized muscle strain or contusion of Achilles tendon rupture can often mimic thrombophlebitis.
• Cellulitis may have similar clinical presentation: edema, localized pain, and erythema.
• Other causes of unilateral leg edema and bilateral leg edema must be excluded.

Treatment

• Standard is systemic anticoagulation with heparin

Note: The majority of cardiovascular and peripheral vascular disease can be attributed to chronic inflammation. This will be covered in detail throughout future lessons.

References:

All reference material is listed at the conclusion of the Physical Examination and Associated Pathology lessons.