Overview of Today’s Lecture

- Brief Review of Blood Vessels
- Hypertension
- Atherosclerosis
- Aneurysms and Dissections
- Vasculitis and Raynaud’s Syndrome
- Diseases of the veins
- Tumors of the blood vessels and lymphatic vessels

Review of Blood Vessels
Hypertensive Vascular Disease

• Hypertension (Primary, Secondary)
  – Isolated systolic hypertension—becoming prevalent in all age groups
    • *Elevations of systolic pressure are caused by increases in cardiac output, total peripheral vascular resistance, or both
  
• Primary hypertension
  – Essential or idiopathic hypertension
  – Genetic and environmental factors
  – Affects 92% to 95% of individuals with hypertension
  – Environmental risk factors:
    • High sodium intake
    • Natriuretic peptide (ANP) abnormalities
    • Obesity & Insulin resistance; Lack of Exercise
    • Smoking

Table 8.1: JNC7 Classification of Blood Pressure in Adults

<table>
<thead>
<tr>
<th>Classification</th>
<th>BP (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;120 (systolic) and 80 (diastolic)</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>120–139 (systolic) or 80–89 (diastolic)</td>
</tr>
<tr>
<td>Stage 1</td>
<td>140–159 (systolic) or 90–99 (diastolic)</td>
</tr>
<tr>
<td>Stage 2</td>
<td>≥160 (systolic) or ≥100 (diastolic)</td>
</tr>
</tbody>
</table>

JNC, Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.
**Pathophysiology of Primary Hypertension**

- **Genetics - Environment**
  - Insulin resistance
  - Dysfunction of the SNS, RAA, aldosterone, and natriuretic hormones
  - Inflammation
  - Vasoconstriction
  - Renal salt and water retention
  - Increased peripheral resistance
  - Increased blood volume
  - Sustained hypertension

**Endothelial Injury & Release of ‘Damage’ Factors**

**Vascular Lesions (Atherosclerosis, Thrombosis)**

**Proliferation/Migration of Smooth Muscle; Scar-like Accumulation of matrix/cells**

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**Hypertensive Vascular Disease**

- **Secondary hypertension**
  - Caused by a systemic disease process that raises peripheral vascular resistance or cardiac output
  - Renal artery stenosis
  - Renal parenchymal disease
  - Pheochromocytosis
  - Drugs
- **Complicated hypertension**
  - Chronic hypertensive damage to the walls of systemic blood vessels
- **Malignant hypertension**
  - Rapidly progressive hypertension; Life threatening
  - Diastolic pressure is usually >140 mm Hg

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**Hypertensive Vascular Disease**

- **Hypertension Damages Arteries and Organs**
  - Adverse effects are directly related to high BP
  - Hypertension is a key risk factor for atherosclerosis
  - Other effects: cardiac hypertrophy, heart failure, kidney failure, retinopathy, stroke
  - Atherosclerosis in small blood vessels

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Hypotension

- Hypotension
  - Reduced BP (approx. < 90/60 mm Hg)
  - Example: Orthostatic (postural) hypotension
    - Decrease in both systolic and diastolic blood pressure upon standing
    - Lack of normal blood pressure compensation in response to gravitational changes on the circulation
    - Acute orthostatic hypotension
    - Chronic orthostatic hypotension
  - Reduced perfusion may cause organ dysfunction or tissue necrosis

Arteriosclerosis

- Arteriosclerosis
  - Chronic disease of the arterial system
  - Abnormal thickening and hardening of the vessel walls
  - Smooth muscle cells and collagen fibers migrate to the tunica intima

Atherosclerosis

- Atherosclerosis
  - A form of arteriosclerosis
  - Thickening and hardening caused by accumulation of lipid-laden macrophages in the arterial wall
  - Plaque development (next slide)
  - Begins in CHILDHOOD and progresses
Progression/Results of Atherosclerosis

- Progression/Pathogenesis (See next slide)
  - Inflammation of endothelium
  - Cellular proliferation
  - Macrophage migration and adherence
  - LDL oxidation (foam cell formation)
  - Fatty streak
  - Fibrous plaque
  - Complicated plaque

- Risk factors include hyperlipidemia/dyslipidemia, diabetes, smoking, hypertension

- Results in inadequate perfusion, ischemia, necrosis:
  - Most common: MI, stroke, aortic aneurysm, peripheral vascular disease
  - Angina, temporary/transient ischemic attack (TIA), intermittent claudication

Atheroma Formation

Blood Flow and Progression of Atherosclerosis
**Atherosclerosis: Best Treatment is Prevention**

<table>
<thead>
<tr>
<th>Lipid</th>
<th>Optimal/Borderline Serum Concentration</th>
<th>Borderline Serum Concentration</th>
<th>High Risk Very High Risk Serum Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC, mg/dL</td>
<td>≤200</td>
<td>200-230</td>
<td>≥240</td>
</tr>
<tr>
<td>LDL-C, mg/dL</td>
<td>&lt;100 (optimal)</td>
<td>100-199</td>
<td>≥200</td>
</tr>
<tr>
<td>Apo B, mg/dL</td>
<td>&lt;100</td>
<td>100-199</td>
<td>≥200</td>
</tr>
<tr>
<td>HDL-C, mg/dL</td>
<td>≥40 (optimal)</td>
<td>≥40</td>
<td>≥60</td>
</tr>
<tr>
<td>TR, mg/dL</td>
<td>&lt;50</td>
<td>50-199</td>
<td>≥200</td>
</tr>
<tr>
<td>Glycemia</td>
<td>&lt;100</td>
<td>100-199</td>
<td>≥200</td>
</tr>
</tbody>
</table>

**Aneurysms**

- **Aneurysm**
  - Local dilation or outpouring of a vessel wall or cardiac chamber
  - True aneurysms (all three layers)
    - Berry; saccular (A)
    - Fusiform aneurysms; elongated (B)
  - Vascular dissection (dissecting hematoma)
    - Longitudinal tearing (C)
  - Aorta most susceptible, especially abdominal
    - Causes include atherosclerosis, hypertension; trauma; syphilis; congenital
    - Can lead to aortic dissection or rupture
    - Death occurs in seconds

**Vasculitis**

Figure Source: Porth, C.M., Essential Pathophysiology, 4th ed., Elsevier, 2015

Raynaud Syndrome

- Common condition
- Exaggerated vasomotor activity
  - Small arteries and arterioles
  - Hands and feet
  - Functional disease, not anatomical
  - Occasionally affects nose, earlobe, lips
  - Women more than men
  - Blanching of affected parts
    - May become cyanotic, numb
    - Rewarmed part becomes hyperemic

- Primary Raynaud Syndrome accounts for 80%
- Secondary usually in conjunction with autoimmune disease, e.g. systemic sclerosis, SLE

Diseases of Veins - Varicose Veins

- Varicose veins
  - A vein in which blood has pooled
  - Distended, tortuous, and palpable veins
  - Caused by trauma or gradual venous distention
  - Risk factors:
    • Age
    • Female gender
    • Family history
    • Obesity
    • Pregnancy
    • Deep vein thrombosis
    • Prior leg injury
    • Standing for long periods

- Hemorrhoids – varicose veins of anus

Diseases of Veins - Thrombophlebitis

Thrombophlebitis

- Formation of venous thrombi accompanied by inflammation

- Deep veins of leg about 90% of cases
  - Deep venous thrombosis (DVT)
    - Risk factors:
      • Increased venous pressure; sluggish blood flow
      • Prolonged immobilization most common cause
  - Usually silent (can grow up to two feet long w/o problems appearing)
  - Thrombi embolize to lungs; infarcts/death
Blood vessel tumors – hemangiomas
- Usually found in skin as small, red, blood-filled lesions
- Usually capillary-sized blood vessels
- Often appear in skin of children
- Spider angiomas – pulsatile; assoc with high estrogen
- Cavernous angiomas; deep: brain, liver

Lymphatic vessel tumors - lymphangiomas
- Kaposi Sarcoma (intermediate; immunosuppressed patients)
- Angiosarcoma – rare malignant tumor of endothelium