ARTERIAL PULSE

By

Dr. Sumaira Iqbal
## Blood Vessels

<table>
<thead>
<tr>
<th>Feature</th>
<th>Arteries</th>
<th>Arterioles</th>
<th>Capillaries</th>
<th>Veins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number</strong></td>
<td>Several hundred*</td>
<td>Half a million</td>
<td>Ten billion</td>
<td>Several hundred*</td>
</tr>
<tr>
<td><strong>Special Features</strong></td>
<td>Thick, highly elastic, walls; large radii*</td>
<td>Highly muscular, well-innervated walls; small radii</td>
<td>Very thin walled; large total cross-sectional area</td>
<td>Thin walled compared to arteries; highly distensible; large radii*</td>
</tr>
<tr>
<td><strong>Functions</strong></td>
<td>Passageway from heart to organs; serve as pressure reservoir</td>
<td>Primary resistance vessels; determine distribution of cardiac output</td>
<td>Site of exchange; determine distribution of extracellular fluid between plasma and interstitial fluid</td>
<td>Passageway to heart from organs; serve as blood reservoir</td>
</tr>
</tbody>
</table>

**Relative thickness of layers in wall**

- **Endothelium**
  - Arteries
  - Arterioles
  - Capillaries
  - Veins

- **Elastic fibers**
  - Arteries
  - Arterioles
  - Capillaries
  - Veins

- **Smooth muscle**
  - Arteries
  - Arterioles
  - Capillaries
  - Veins

- **Collagen fibers**
  - Arteries
  - Arterioles
  - Capillaries
  - Veins
DISTENSIBILITY

• Fractional increase in volume for increase in pressure
• Measure of elasticity of vessel
• Aorta is more distensible than distal arteries
• Decrease distally
• More the content of elastic tissue more will be distensibility
COMPLIANCE

• Increase in volume for unit rise in pressure
  
  Compliance = \Delta V / \Delta P

• Depends upon the elastic tissue and volume of segment
COMPLIANCE VS DISTENSIBILITY

For $\Delta P$ rise in pressure, rise in volume (vol) = $\Delta V$

For unit rise in pressure, rise in vol (compliance) = $\frac{\Delta V}{\Delta P}$

For original vol, rise in vol per unit rise in pressure = $\frac{\Delta V}{\Delta P}$

For unit volume, rise in vol per unit rise in pressure = $\frac{\Delta V}{\Delta P \times \text{original vol}}$

Distensibility = $\frac{\Delta V}{\Delta P \times \text{original vol}}$

Distensibility = Compliance / original volume

Compliance = Distensibility $\times$ original volume
VASCULAR TONE

• Partial state of contraction of vessels
• Basis of arteriolar resistance
• 2 factors contribute
  – Sufficient calcium both cytosolic and calcium channels on membrane
  – Sympathetic supply to arteriolar smooth muscles
DELAYED COMPLIANCE

When there is an increase in volume it exhibits increase in pressure with a further decrease in pressure without change in volume

STRESS RELAXATION

BENEFIT:
Accommodate extra volumes of blood

REVERSE STRESS RELAXATION
Arterial Pressure Pulse

- Pressure changes generated in arteries when the blood is ejected from left ventricle into aorta
- Recorded in the form of waves
- Can be felt from a superficial artery
Arterial Pressure

- **Systole** occurs when the heart contracts to pump blood out
- **Diastole** occurs when the heart relaxes after contraction
Arterial Pressure

• Systolic Pressure
  – The maximum pressure exerted in the arteries, when blood is ejected in to them during systole
  – Averages 120mmHg

• Diastolic Pressure
  – The minimum pressure within the arteries, when blood is draining off in to the rest of vessels during diastole
  – Averages 80mmHg
Arterial Pressure Pulse

PRESSURE PULSE CONTOURS

Anacrotic Limb
Upstroke of limb due to rise in pressure during systole

Catacrotic Limb
Down stroke of limb due to fall in pressure during diastole

Catacrotic Notch
Backflow of blood during closure of semilunar valves
Also called incisura
Arterial Pressure Pulse

- Arterial pulse depends upon pulse pressure
  
  Pulse pressure = Systolic pressure – Diastolic pressure
  
  Pulse pressure = 120 – 80 = 40 mmHg
Mean Arterial Pressure

- Mean arterial pressure = Diastolic pressure + 1/3 pulse pressure
- At 120/80mmHg, mean arterial pressure will be
  \[ = 80 + \frac{1}{3} \times 40 \]
  \[ = 93.33 \text{mmHg} \]
Arterial Pressure Pulse

• Pulse pressure depends upon
  – Directly related
    • Stroke volume output—more the blood that is accommodated, more will be rise and fall during systole and diastole
  – Indirectly related
    • Compliance of arteries—less the compliance more will be pulse pressure
    • ARTERIOSCLEROSIS in old age
Arterial Pressure Pulse

• Factors affecting
  • Stroke volume output
  • Compliance of arteries
  • Character of ejection (slow or fast rising anacrotic limb)
Arterial Pressure Pulse

- Abnormal contours
  - Arteriosclerosis
  - Aortic stenosis
  - Aortic regurgitation
  - Patent ductus arteriosus
Arterial Pressure Pulse

Abnormal contours

• Arteriosclerosis
  – ↑↑↑↑ systolic pressure
  – ↑ diastolic pressure
  – ↑ pulse pressure
Arterial Pressure Pulse

Abnormal contours

- Aortic stenosis

    **ANACROTIC PULSE**

    - ↓ systolic pressure
    - Slow rising anacrotic limb
    - Normal diastolic pressure
    - ↓ pulse pressure
Arterial Pressure Pulse

Abnormal contours
• Aortic regurgitation

WATER HAMMER/COLLAPSING PULSE
• ↑ systolic pressure
• ↓ diastolic pressure
• ↑ pulse pressure
• Rapid upstroke
• Rapid downstroke
• Absence of incisura
Aortic regurgitation
Arterial Pressure Pulse

Abnormal contours

• Patent ductus arteriosus

   WATER HAMMER/COLLAPSING PULSE
   • ↑ systolic pressure
   • ↓ diastolic pressure
   • ↑ pulse pressure
   • Rapid upstroke
   • Rapid downstroke
Arterial Pressure Pulse

TRANSMISSION OF PULSE

• Spread of pulse pressure from aorta to peripheral arteries
• Felt as pulsation over the superficial arteries
DAMPING OF PULSE

• Progressive diminution of pulse pressure in peripheral arteries
• In small arteries, arterioles and capillaries
  – Pulse pressure damps
  – Pressure fluctuation abolish
  – Non pulsatile smooth blood flow continues
BLOOD VESSELS

WINDKESSEL EFFECT:

• Interaction between stroke volume, compliance of vessels and resistance of vessels for account of arterial pressure waveform
• Recoiling effect of aorta and elastic arteries convert pulsatile flow in to continuous flow in capillaries
• Aorta and large arteries act as a SECOND PUMP
Damping of pressure pulse
DAMPING OF PULSE

• Factors affecting damping
  – Compliance of vessel
  – Resistance offered
ARTERIAL PULSE

PULSE DEFICIT
• Pulse rate < heart rate
  – Atrial fibrillation

PULSUS PARADOXSUS
• Variation in strength of pulses with phases of respiration
  – Strong during expiration
  – Weak during inspiration
ARTERIAL PULSE

THREADY PULSE

• Low volume pulse
• Hypovolemic shock
PULSE POINTS

- Superficial temporal artery
- Facial artery
- Common carotid artery
- Brachial artery
- Radial artery
- Femoral artery
- Popliteal artery
- Posterior tibial artery
- Dorsalis pedis artery
Blood Pressure

• Arterial blood pressure can be defined as the pressure exerted by the moving column of blood on the walls of the arteries.
• Methods to measure
  1. Direct
  2. Indirect
     1. Palpatory
     2. Auscultatory
1. The patient should be relaxed and the arm must be supported.
   Ensure no tight clothing constricts the arm.

2. The cuff must be level with heart.
   If arm circumference exceeds 33 cm, a large cuff must be used.
   Place stethoscope diaphragm over brachial artery.

3. The column of mercury must be vertical.
   Inflate to occlude the pulse. Deflate at 2 to 3 mmHg. Measure systolic (first sound)
   and diastolic (disappearance) to nearest 2 mmHg.
Korotkoff Sounds

- Audible sound during blood pressure heard through stethoscope is known as korotkoff sound

<table>
<thead>
<tr>
<th>SBP (mm Hg)</th>
<th>Tapping sound 1</th>
<th>Murmurish 2</th>
<th>Banging sound 3</th>
<th>Muffling sound 4</th>
<th>No sound 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THANK YOU