بسم الله الرحمن الرحيم

Arterial blood pressure

Definitions:

1) **Arterial blood pressure (ABP):-** is the lateral pressure (force) exerted by the blood on the arterial wall.
2) **Systolic blood pressure:-** Is the maximum pressure reached in the arteries during ventricular systole.

   Normal value = 120 mmHg . Normal range =90 -150 mmHg.
3) **Diastolic blood pressure:-** Is the minimum pressure reached in arteries during ventricular diastole.

   Normal value = 80 mmHg. Normal range = 60-90 mmHg.
4) **Pulse pressure:-** It is the difference between systolic and diastolic blood pressure =systolic B.P. – Diastolic B.P. = 120 - 80 = 40 mmHg.
5) **Mean systemic arterial blood pressure.** It is the average pressure in the arteries throughout the cardiac cycle.

   = Diastolic B.P. + 1/3 pulse pressure.

   = 80 + 1/3 x 40 = 90 mmHg (nearly).

Measurement:- In human.

1) Direct by cardiac catheter.
2) Indirect:- Using the sphygmomanometer (look the practical).

Importance of ABP:-

1) Maintenance of tissue perfusion:- i.e. it maintain blood flow through different tissues.
2) Tissue fluid formation:- ABP is the force that produces capillary blood pressure. The capillary blood pressure is the filtration force in tissue fluid formation.

Physiological factors that affect ABP:-

1) **Age:-** Rises with age.

- Newborn (first 2 years of age)= 80/40 mmHg.
- At 5 years (children) = 100/60 mmHg.
- At 20 Years (adults) = 120/80.
- At 60 years (old age) = 150/90.

The increase in ABP with age is due to decrease elasticity of arteries (arteriosclerosis). The systolic B.P. tend to rise 10 mmHg every 10 years.

2) **Sex:-**

- Before puberty: - Girls and boys has the same ABP.
- From puberty till age of 45 years (age of menopause in females):- ABP is 5 mmHg less in females than males (due to effect of estrogen hormone).
- After menopause:- ABP is 5 mmHg more in females than males (due to ↓ estrogen).

3) **Body built:-**

ABP is usually 10-15 mmHg higher in obese persons.

4) **Meals:-**

After meals there increase in ABP (by 10 – 15 mmHg) especially the systolic B.P. this is due to the vasodilation in the splanchnic area which increase venous return and C.O.P.

5) **Emotions:-**

Emotions increase ABP (mainly systolic). This is due to increased C.O.P and vasoconstrictor tone.

6) **Sleep: -**

Deep quite sleep decrease ABP due to ↓ vasoconstrictor tone.

7) **Exercise:-** During exercise.

- Systolic BP. Is increased (may reach 180 mmHg) due to ↑ C.O.P and ↑ vasoconstrictor discharge.
- Diastolic B.P. is nearly normal or even it is slightly decreased due to vasodilatation in the active muscles.

8) **Gravity:-**

- During standing ABP increases in vessels below the heart level and decreases in vessels above the heart level due to effect of gravity.
- The rise or the decrease in pressure is equal to the weight of blood column from the vessel to the heart. Each 1 cm column blood below heart level → 0.77 mmHg increase in ABP.
- Thus in vessels below the heart

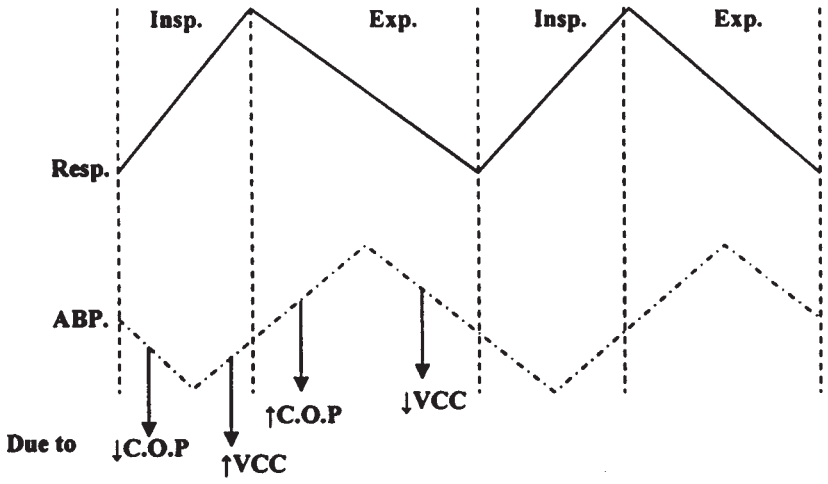
  The rise in pressure = distance from vessel to the heart x 0.77 mmHg e.g. the pressure in large artery in foot about 100 Cm below the heart = 100 (ABP at heart level) + 100Cm x 0.77 mmHg = 177 mmHg.
- ***Note:*** **-** For measuring ABP in any blood vessel without the effect of gravity the person should be in recumbent position and the vessel should be at level of the heart.

9) **Respiration: -**

- During each respiratory cycle, the ABP shows rhythmic fluctuation (within 10 mmHg) known as respiratory pressure waves or traube Hering waves.
- During these respiratory pressure waves ABP increases during late part of inspiration and early part of expiration and decreases during late part of expiration and early part of inspiration.
- ***Explanation: -***
  - *Inspiration:-* In early part the negative intrapleural pressure ↑→↑ capacity of pulmonary circulation. Thus, inspite of ↑ venous return, the blood returning to left ventricle decreases →↓ C.O.P and ↓

ABP. However in late part, the active inspiratory center stimulates VCC → ↑ ABP.

- *Expiration:-* Has reverse effect. At early part ↓ IPP. →↓ capacity of pulmonary circulation →↑ blood returning to left ventricle →↑ C.O.P. and ↑ ABP. However in late part ABP decreases due to decreased discharge to VCC.



10) Thermal stress:-

- Heat stress:- on exposure to heat ABP decreases (mainly the diastolic) due to cutaneous vasodilatation.
- Cold stress:- on exposure to cold ABP increases (mainly the diastolic) due to cutaneous vasoconstriction.

★Factors that determine and maintain ABP:-

Pressure = Flow x resistance.

ABP = COP x total peripheral resistance.

= H.R. x stroke volume x total peripheral resistance

1) Cardiac output:-

- The ABP is directly proportionate to C.O.P. provided all other factors affecting ABP remains constant.

- C.O.P. = stroke volume x heart rate.
- ↑ stroke volume → ↑ systolic B.P more than diastolic → ↑ pulse pressure.
- ↑ heart rate → ↑ diastolic B.P. more than systolic as less time is allowed for drop of pressure because diastole is shortened (this ↓ pulse pressure). during diastole

2) Total peripheral resistance (TPR).

- It is the resistance which the blood meets during its passage through the peripheral blood vessels.
- ABP is directly proportionate with TPR provided other factors affecting ABP remains constant. It affects mainly diastolic B.P.
- ***Peripheral resistance is determined by:-***

1. ***Diameter of the arterioles:-*** Arterioles offer the greatest part of resistance to the blood stream, while the capillaries and veins participate to much less extent. TPR is inversely proportionate with the fourth power of the radius (diameter) of arterioles TPR $\alpha \frac{1}{r4}$
2. ***Viscosity of the blood:-***
   - Viscosity is a property of fluid by which they resist a change in their shape. It represents the force with which the fluid particles adhere to each other and resist their separation.
   - TPR is directly proportional to blood viscosity.
   - Blood viscosity is affected by:-
     a. RBCs.
     b. Plasma proteins.

3) Elasticity (distensibility of arteries):-

Elasticity of aorta and its large branches buffer excessive changes in ABP during systole and diastole: -

- It prevents marked ↑ in pressure during systole because the arteries distend to accommodate the ejected blood.
- It prevents marked ↓ in pressure during diastole because of the elastic recoil of arteries on the blood inside it.

4) Volume of blood in relation to capacity of circulation: -

ABP is directly proporationate to blood volume and inversely proportionate to capacity of circulation.

Regulation of arterial blood pressure

By three mechanisms

1) Rapidly acting mechanism (Nervous mechanism):-

- Acts within second or few minutes and lasts for few hours then decline markedly or disappear completely.
- It adjusts vascular resistance and capacity.

2) Intermediate acting mechanism:-

- Acts within minutes or few hours and lasts for few days.
- It adjusts resistance, capacity and blood volume.

3) Slowly acting mechanism (hormonal mechanism):-

- Acts within hours or few days and lasts as long as it is required (blood pressure is low).
- Adjusts blood volume through action on the kidney.

Rapidly acting mechanism

(Nervous regulation)

- **Medullary cardiovascular centers (vasomotor centers):-**
  - Located in reticular formation of medulla and lower third of pons.