Cardiovascular Block

Physiology Team 430

12th Lecture

Arterial blood pressure

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Arterial blood pressure :

B.P. is the force exerted by blood against a vessel wall.

- **It maintains blood flow through capillaries. It depends on :**

1- blood volume
2- compliance (distensibility) of blood vessels.

- **Arterial B.P. is not constant it :**

- **rises** during ventricular systole
- **falls** during ventricular diastole.

Systolic B.P. :-
Is the peak B.P. measured during ventricular systole = 120 mmHg, in a young person at rest.

Diastolic B.P. :-
Is the minimum B.P. at the end of ventricular diastole = 80 mmHg, in a young person at rest.

Pulse pressure :-
Is the difference between systolic and diastolic B.P

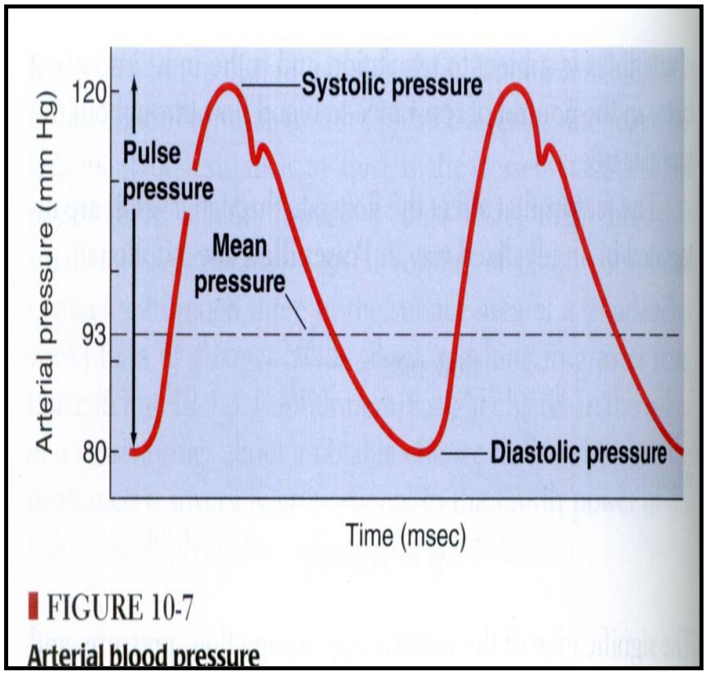


FIGURE 10-7
Arterial blood pressure

Mean B.P. :

Calculated by adding one-third of the pulse pressure to the diastolic B.P.

$$\text{The mean B.P.} = \text{Diastolic P} + \frac{(\text{systolic P} - \text{diastolic P})}{3}$$

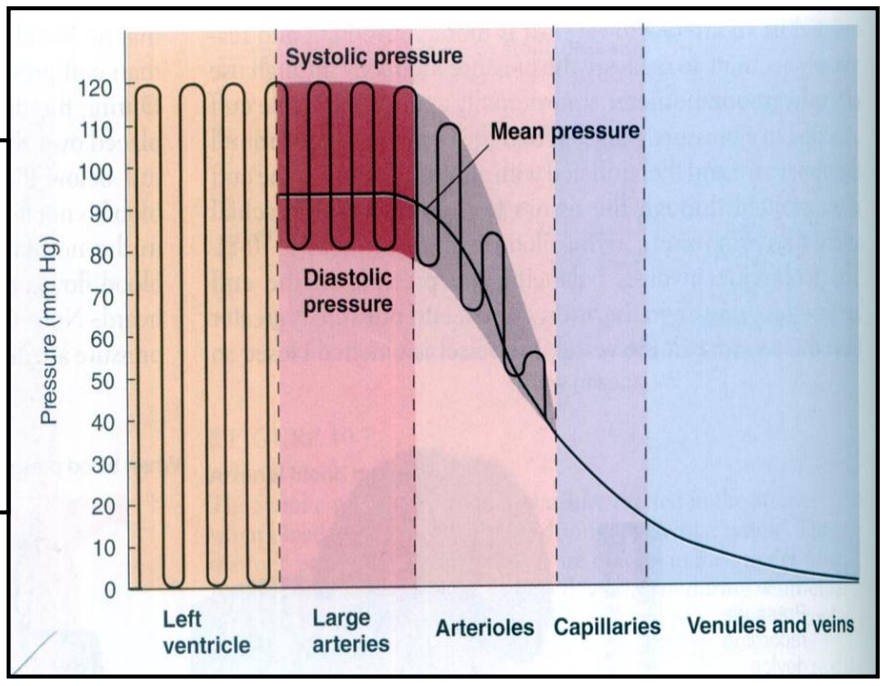
If B.P. = 120/90 mmHg.

$$\text{The mean B.P.} = 90 + \frac{(120 - 90)}{3} = 90 + 10 = 100\ mmHg$$

Pressures in different vessels of the systemic circulation.

Pulse pressure is greatest in the aorta and large arteries.

The greatest drop in pressure occurs in the arteries.



Elastic rebound :

■ During systole :

the arterial walls expand to accommodate the extra amount of blood pumped by the ventricles.

■ During diastole :

the B.P. falls, the arteries recoil to their original dimensions (Elastic rebound) → Maintains blood flow in the arteries when the ventricle is in diastole.

Haemodynamics

Is the branch of physiology concerned with the physical principles governing:-

Pressure, Flow, Resistance, Volume, and Compliance as they relate to the CVS.

Resistance to blood flow results from :

1- the inner friction (between blood and vessels

2- viscosity of blood.

Mean arterial B.P. = C.O. x total peripheral resistance.

1- Cardiac output mainly determines systolic B.P.

Systolic hypertension :

↑ systolic pressure (without change in diastolic P) → ↑ C.O → B.P.

2- Total Peripheral Resistance mainly determines diastolic B.P.

Diastolic hypertension :

↑ diastolic pressure (without change in systolic P) → ↑ TPR →↑ B.P.

■ **Ohm's Law** : relation between Pressure flow and resistance

$$Q = \Delta P / R$$

$$R = V \times L / r^4$$

So ,

$$Q = \Delta P \times r^4 / V \times L$$

Q = blood flow.

ΔP = the pressure difference between the two ends of the vessel.

R = Resistance.

- $Q \propto r^4$
- $R \frac{1}{\propto} r^4$

■ **Resistance depends on :**

1- the radius and length of the blood vessel

2- the viscosity of blood (Poiseuille's law).

Length does not change**, and viscosity** rarely changes enough to have a significant effect on resistance.

There for small changes in arteriolar radius can cause large changes in blood flow.

The influence of tube length and radius on flow :

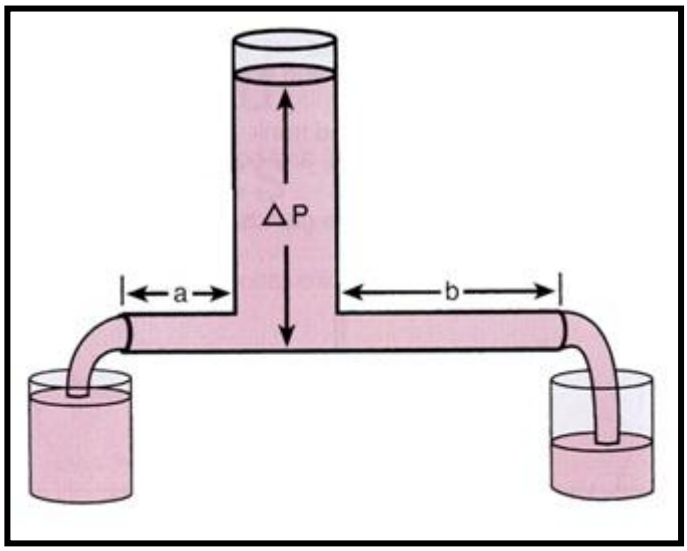
$$Flow = \frac{1}{Length}$$

$$Length\ a = 1\ , \qquad Length\ b\ = 2$$

$$Flow\ in\ a\ = 2 \times Flow\ in\ b$$

small changes in arteriolar length cause small changes in blood flow

- **changes in blood vessel length do not occur over short periods of time and are not involved in the physiological control of blood flow**



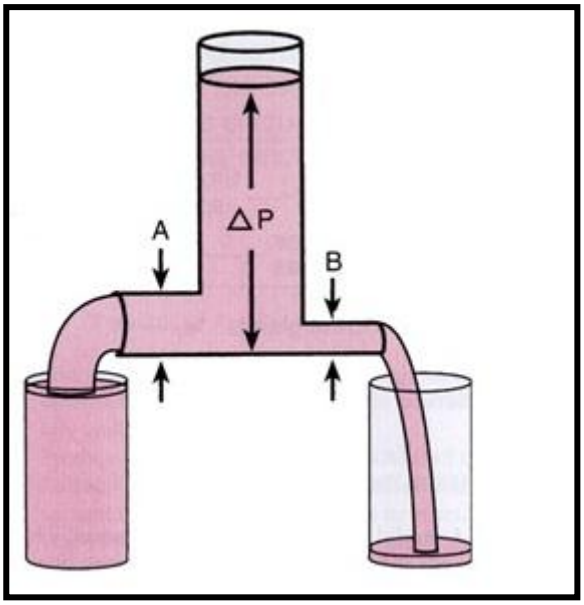
$$\boldsymbol{Flow = r^4}$$

$$\boldsymbol{radius\ a = 2\ , \qquad radius\ b\ = 1}$$

$$\boldsymbol{Flow\ in\ A\ = 16 \times Flow\ in\ B}$$

- **small changes in arteriolar radius can cause large changes in blood flow**

Because flow is determined by the fourth power of the radius, small changes in radius have a much greater effect than small changes in length



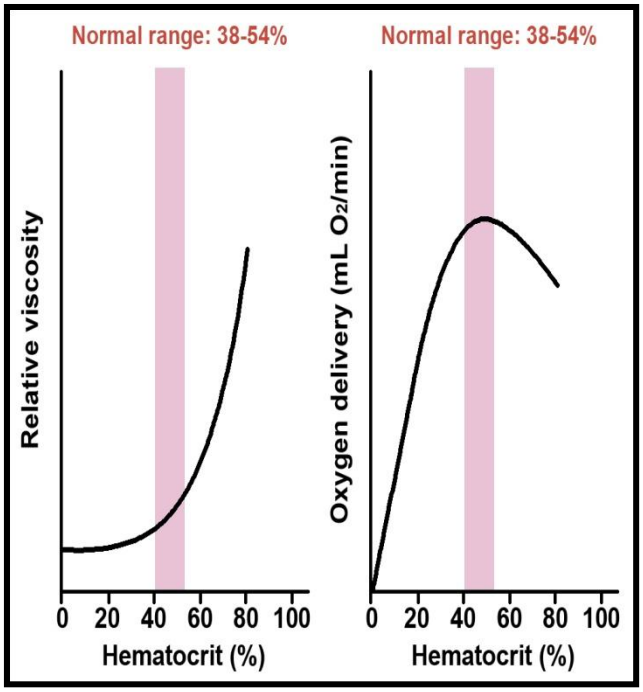
The pressure difference (ΔP) driving flow is the result of the height of the column of fluid above the openings of tubes A and B

■ Effect of hematocrit on blood viscosity :

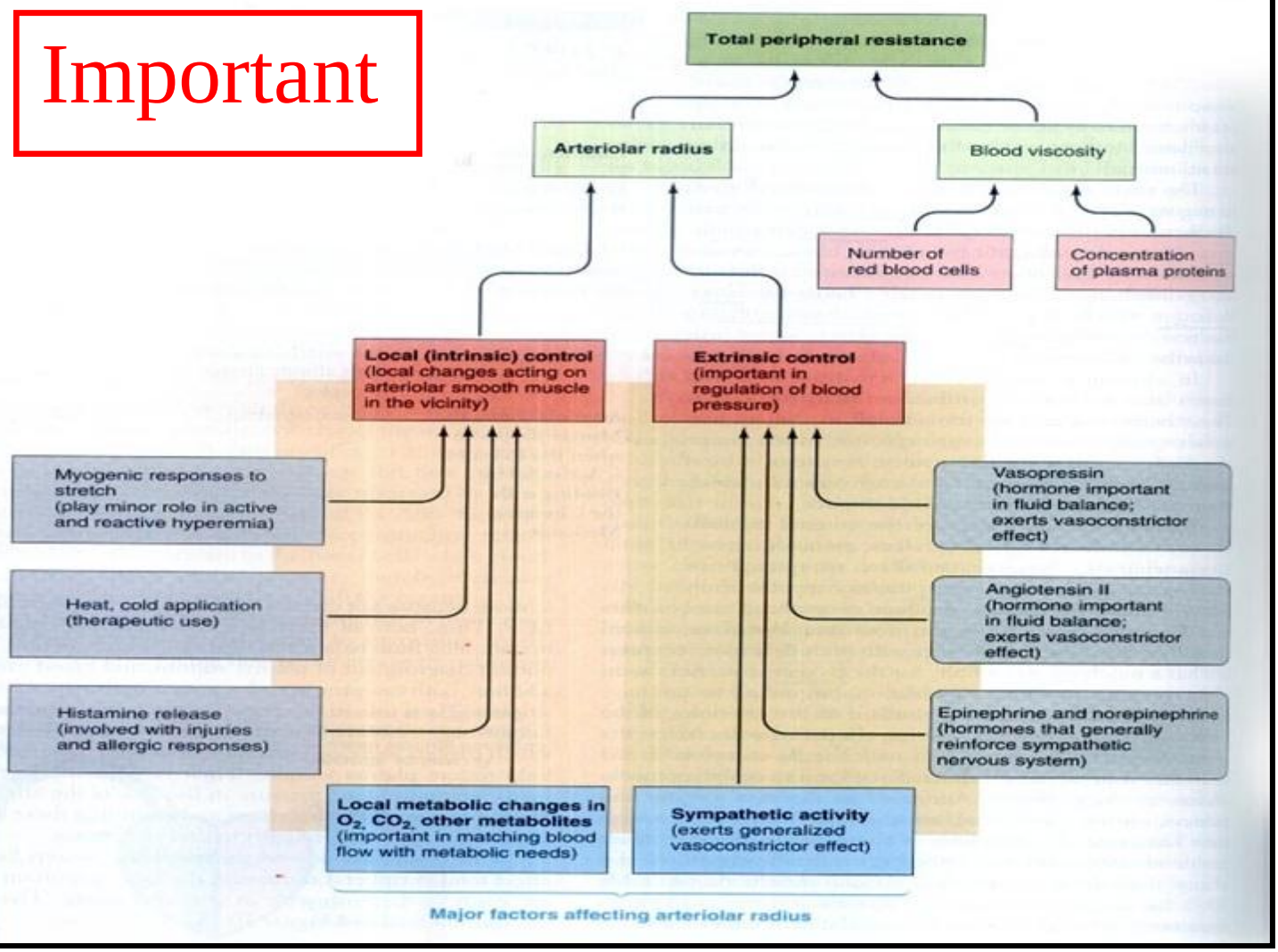
Above-normal hematocrits produce a sharp increase in viscosity.

Because increased viscosity raises vascular resistance, hemoglobin and oxygen delivery may fall when the hematocrit rises above the normal range.

(↑RBC , ↑ plasma proteins → ↑ viscosity)



Important



■ Increase Resistance cause :

1- increase (Δ P , Length and **viscosity**)

2- decrease (Blood Flow and radius)

■ ↑ length → ↑ **viscosity**

■ **Arteriolar radius :** (vasoconstriction effect)

1- Sympathetic

2- Vasopressin (ADH)

3- Angiotensin II

All of them ↑ TRP , cause ↓ radius and ↑ Blood Pressure

■ **Local control of blood flow by the tissues & humoral regulation** :

- **Local vasodilator substances :-**

1- ↓ Tissue oxygen, or ↑ carbon dioxide levels.

2- Nitric oxide (NO) released from endothelial cells.

3- Lactic acid or other acids released by tissues.

4- ↑ Potassium or Hydrogen ions.

5- ↑ Local temperature.

6- Histamine.

■ Adenosine is the most important of theLocal Vasodilators.

- **Local vasoconstrictors :-**

Prostaglandins & thromboxanes rleased by activated platelets & WBS and endothelins by damaged endothelial cells.

- **Humoral (vasoconstrictor) factors :-**

1- Nor epinephrine → strong vasoconstrictor.

2- Epinephrine → less powerful.

3- Angiotensin II.

3- Vasopressin (ADH).

- **Vasodilator agents :-**

1- Bradykinin.

2- Histamine.

■ Types of blood flow:

- Laminar (Streamline) flow :- (**blood flow in ONE DIRECTION , NO MIXING**)

Smooth flow at a steady rate. The central portion of blood stays in the center of the vessel → Less friction.

- Turbulent flow :-(blood flow in Backward and forward with mixing)

High flow rate of red blood cells in all directions

(Mixing) → increase resistance & slow flow rate.

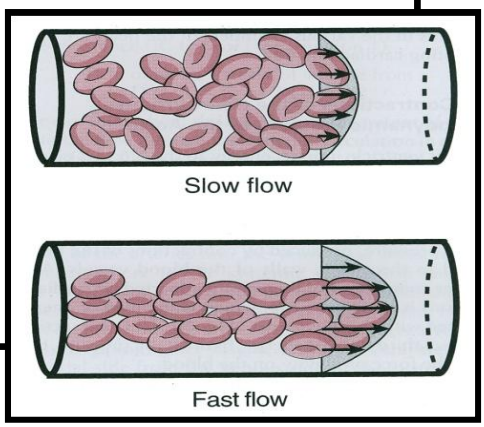
في حالة أي ضرر في valve يظهر صوت ناتج عن turbulent

اما في حاله لايوجد أي صوت ظاهر فانه الوضع طبيعي وهو laminar

■ **In restricted blood flow or valvular lesions bruits or murmurs can be heard.**

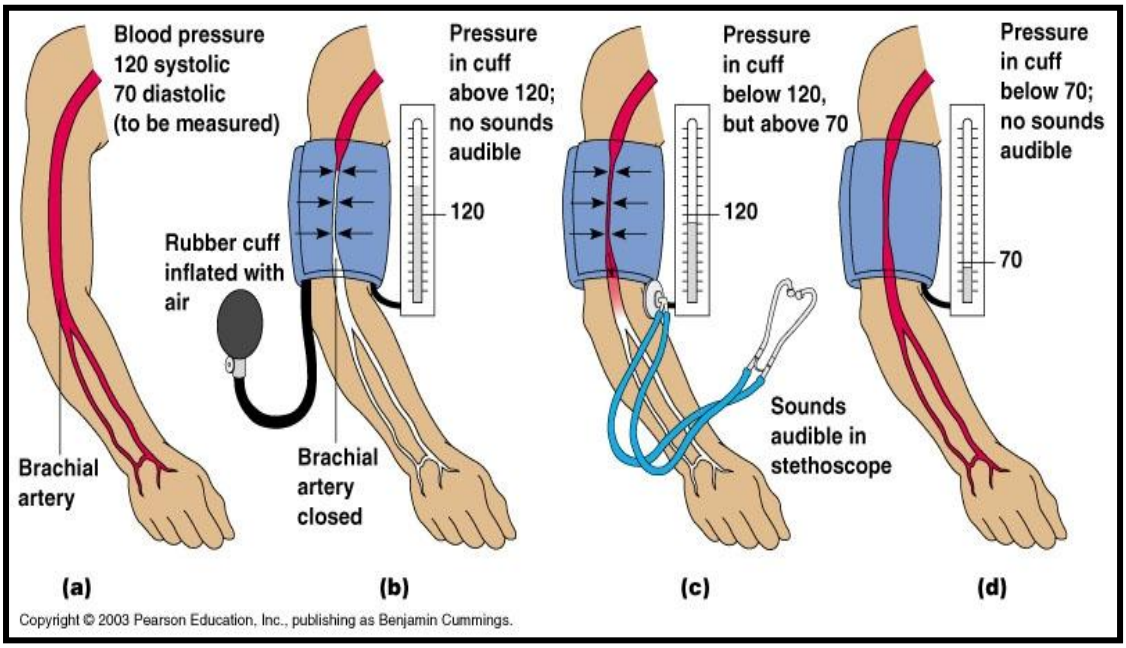
■ **Turbulent blood flow is greater in larger blood vessels compared to smaller ones.**

■ **Increased blood viscosity decreases turbulent flow**



For practical :

Measurement of B.P:



Physiological variations affecting BP: (imp)

1. **AGE:** for normal adult 120/80 the blood press is increase during elderly to 160/90 because of less elastic vessle wall
2. **SEX:** female is lower blood press than males
3. **RACE**
4. **Stress and emotions:** sympathetic stimulation Vasoconstriction → ↑ BP
5. **Pregency :** there in increace in the water salt retention ↑ Blood volume ↑ BP
6. **Muscular exercise:** There is increace in HR and SBP(systolic blood press)
   - DBP is decreasd or unchanged
7. **Gravity:** (decease BP)
8. **Sleep :** (decease BP)

9.Respiratory movment :

a. During inspiration

the intrathrocic press become **more –ve** while the intrabdominal become **more +ve** → the press gradient will increase → the systemic VR to the right atrium → increase right CO which goes to pulmonary vessel

The more negative intrathorasic pressure dilate the pulmonary vessels → leading to stasis of the blood in them → that will decrease pulmonary venous return to the left atrium → decrees left CO → decrease the BP

b.during expiration:

the intrathoracic pressure become less negative → leading to squeeze of pulmonary vessel → increase pulmonary venous return to the left atrium increase left CO → increase **BP**

-- Hypertension in adults is a B.P. greater than 140/90.

-- B.P. at or below 120/80 is normal.

-- Values between 121/81 and 139/89 indicate a state of pre-hypertension.

-- Hypertension increases the work load of the heart → enlargement of the left ventricle → ↑ muscle mass → ↑ oxygen demand.

-- Insufficient coronary circulation → symptoms of ischemic heart disease.

-- ↑ arterial B.P. → strokes, heart attacks & heart failure.