



PHYSIOLOGY TEAM 432

LECTURE : 11

Arterial Blood Pressure

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OBJECTIVES

By the end of this lecture the students are expected to:

- Understand the concept of mean blood pressure, systolic, diastolic, and pulse pressure.
- Calculate mean BP
- Understand normal variations in ABP.
- Understand the relationship between CO, BP and total peripheral resistance.
- Describe and understand factors determining blood pressure
- Regulation of arterial blood pressure.

Green color is for the notes which are taken from Dr.Eman

MIND MAP

Arterial Blood Pressure

Physiological variation

Determinants of arterial blood pressure

- TPR and vessel diameter
- factors affecting the vessels diameter

1-CO
2-Elasticity of BV
3-Blood Volume

4-Total peripheral resistance:

Systolic blood pressure

Maximum pressure exerted in the arteries
when blood is ejected into them
during systole

(120 mm Hg)

Diastolic blood pressure

Minimum pressure within the arteries
when blood is drained off from them during
diastole

(80 mm Hg)

Pulse pressure

The difference between
systolic and diastolic pressures

$$(120 - 80 = 40 \text{ mm Hg})$$

Pulse Pressure

It is determined by two factors

1- stroke volume

(↑ **SV** → ↑ PP) e.g.: exercise

(↓ **SV** → ↓ PP) e.g.: shock

2. The compliance of the arterial system

(↑ **Compliance** ↓ PP) e.g.: nitric oxide + histamine

(↓ **Compliance** ↑ PP) e.g.: atherosclerosis + Vascular Calcification

The compliance is determined by the elasticity of the arterial system. Flexible arteries that expand easily have a high compliance. Stiff arteries have a low compliance.

Chronic hypoxia decreases arterial and venous compliance

Mean Arterial Pressure

Average pressure which drives
blood forward into the tissues

diastolic pressure + $(1/3 \times (\text{systolic} - \text{diastolic pressure}))$

$$80 + 13 = 93 \text{ mm Hg}$$

Physiological variation in arterial blood pressure:

BP range: 90-140/60-90 mmHg.

Note that (90-140)= systolic BP range, while (60-90)= diastolic BP range

➤ **Age:**

- At birth: 50/30
- Adult : 120/80
- Old age 170/90

➤ **Sex:** males have higher BP than Female before menopause.*

➤ **Body built:** increase in obese.^

- Emotions. (BP ↑)
- Exercise. (BP ↑) (increases)
- Meals.(BP ↑)#
- Sleep (BP ↓) (decreases)

➤ **Gravity:**

□ The pressure in any vessel below heart level is increased while decreases in a vessel above heart level due to effect of Gravity.\$ Gravitational effect = 0.77 mmHg/cm at the density of normal blood.

- In adult human up right position, if mean BP at heart level = 100 mmHg,
- the mean pressure in an artery at the head (50 cm above heart) = $100 - [0.77 \times 50] = 62$ mmHg.

- * Because estrogen increase the elasticity of the blood vessels which will lead to a decrease in the BP.
- ^ Adipose tissue secrete smth call adipocytokines, some of them has effect in the BV and can raise BP.
- # Meals due to the increase in the CO.
- \$ The blood goes down and due to the effect of gravity (pulling) this will increase the BP.

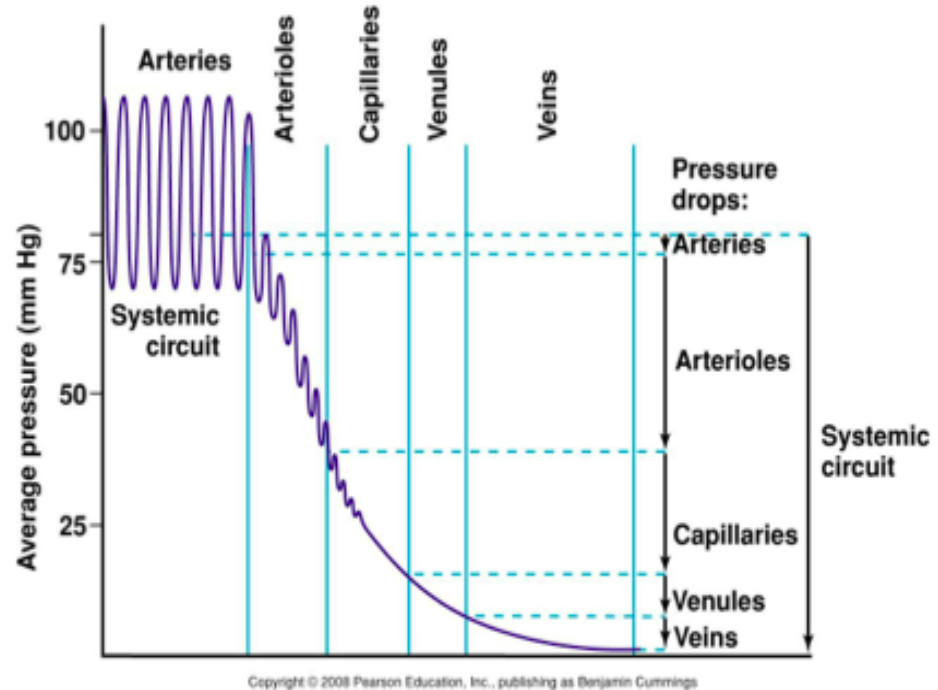
- **Meals ► Slight increase**
- **Posture ► Decrease on standing (postural hypotension!)**
- **Exercise ► SBP increases and DBP is maintained in mild to moderate. (Therefore DBP is more imp)**
- **Anxiety ► Increases**

SBP is dependant on CO and DBP is dependant on TPR. TPR is responsible for DBP and forward flow of blood

Blood pressure

➤ Definitions:

- Pulse Pressure: $PP = SP - DP$
- Mean arterial blood pressure (MABP)
 - $MABP = \text{Diastolic} + PP/3$
- $CO = ABP / TPR$
- $ABP = CO \times TPR$



MABP : Mean arterial blood pressure ,ABP : arterial blood pressure, TPR :Total peripheral resistance , SV: stroke volume , CO : cardiac output, SP&DP : systolic and diastolic pressure

Determinants of arterial blood pressure:

1-Cardiac output:

- $ABP = CO \times TPR$
- $CO = HR \times SV$

$$\rightarrow ABP = HR \times SV \times TPR$$

heart rate, stroke volume and peripheral resistance affect MABP

- Extreme changes in the heart rate (the increase to the level that the heart cannot pump blood) will decrease the CO which will reduce APB.
- Increase in the stroke volume will increase the APB while the decrease in the stroke volume will decrease the APB.
- People with hyperthyroidism, they have high blood pressure specifically (the systolic PB) it will become (very high). In other words, (Cardiac compression , heart rate and stroke volume) are all increased in those patients which will eventually increase the CO and lead to the increase of systolic BP.

MABP : Mean arterial blood pressure ,ABP : arterial blood pressure, TPR :Total peripheral resistance , SV: stroke volume , CO : cardiac output, SP&DP : systolic and diastolic pressure

Determinants of ABP, continued,..

2- Elasticity of blood vessels:

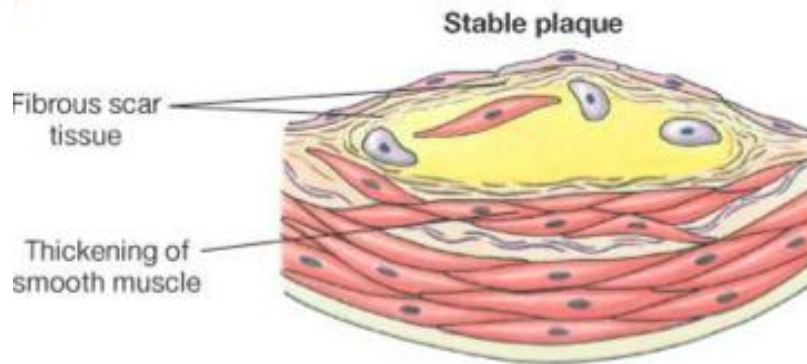
- Changes in great vessels elasticity affects BP. Atherosclerosis makes blood vessel like a tube, so during systole as blood is ejected into the arteries, they don't distend and pressure increases significantly.

3- Blood volume:

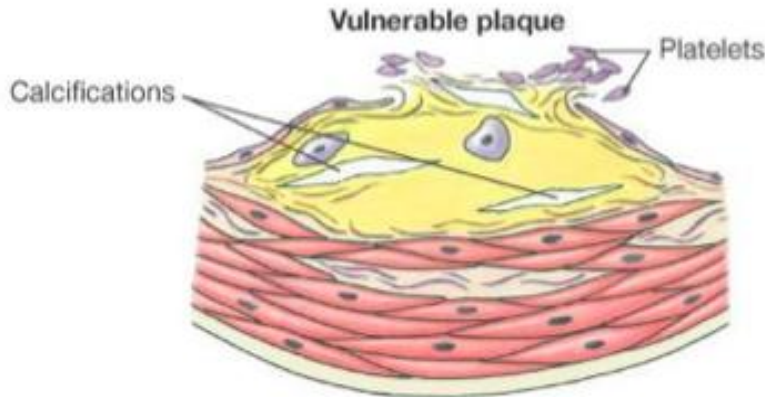
- An increase in blood volume= increase CO increase ABP.
- A decrease in blood volume as in Hege, dehydration- decrease VR- decrease CO decrease ABP.
- ✓ During systole , the aorta expand to prevent the increase in the blood pressure while during diastole the aorta recoil to prevent the drop in the aorta pressure.

MABP : Mean arterial blood pressure ,ABP : arterial blood pressure, TPR :Total peripheral resistance ,
SV: stroke volume , CO : cardiac output, SP&DP : systolic and diastolic pressure ,VR venous return

Atherosclerosis: decreases elasticity



(c) As cholesterol accumulates, fibrous scar tissue forms around it. Migrating smooth muscle cells divide, thickening the arterial wall and narrowing the lumen of the artery. This stage is known as a fibrous plaque.



(d) In the advanced stages of atherosclerosis, calcified scar tissue will form. If the endothelium is damaged and collagen is exposed, platelets stick to the damaged area and a blood clot (thrombus) forms. If blood flow in the coronary blood vessel is stopped, a heart attack is the result.

MABP : Mean arterial blood pressure ,ABP : arterial blood pressure, TPR :Total peripheral resistance , SV: stroke volume , CO : cardiac output, SP&DP : systolic and diastolic pressure

Determinants of ABP, continued,..

4-Total peripheral resistance:

APB is directly proportional to TPR

- **TPR is determined by:**

1. diameter of blood vessel (r).

2. Blood viscosity:

- a. Red cells

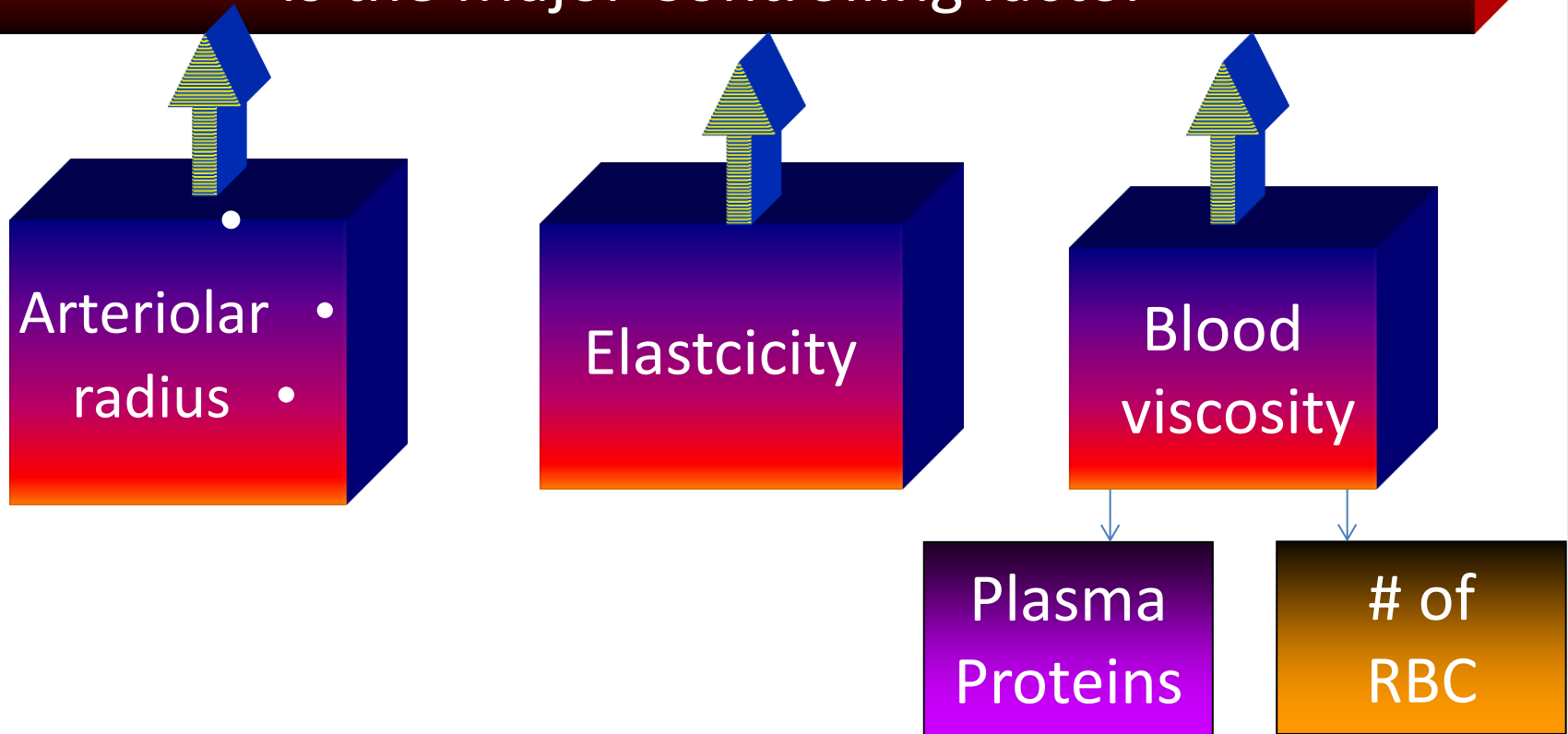
Polycythemia increases viscosity.

- b. Plasma proteins:

Hypoproteinemia decreases viscosity.

When you see the walls of aorta and great vessels you will find many elastic • tissues while in the small blood vessels (arterioles) you will find smooth blood vessels so that any stimulation will increase or decrease the diameter. Note that the arterioles are the site of the resistance not the capillaries, veins, aorta nor the great vessels.

Total peripheral resistance Is the Major Controlling factor



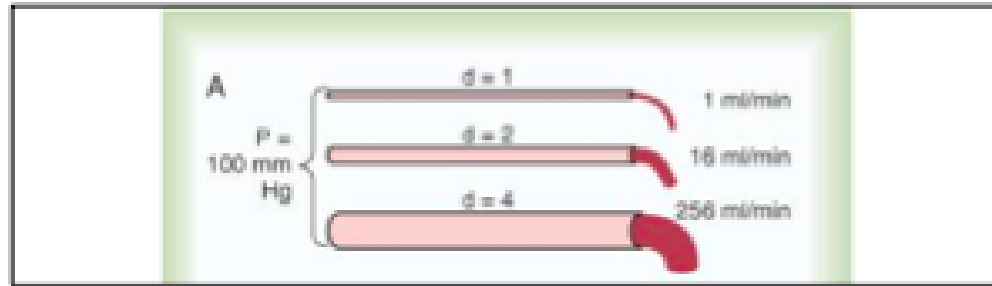
RBC, PLASMA PROTEINS (Albumin), E.g. Polycythemia viscosity is high so high DBP and in Anemia SBP is high

Total peripheral resistance:

- ABP is directly proportional to TPR
- Change in blood vessels' diameter by increase or decrease will affect blood pressure.
- TPR is inversely proportional to blood vessel diameter :
- $R \propto 1/r^4$
- If r is doubled, TPR is reduced by 16, and so on.....

R= Total peripheral resistance, r= radius

TPR and vessel diameter :



- Slight changes in the diameter of a vessel cause tremendous changes in the vessel's ability to conduct blood when the blood flow is streamlined
- Although the diameters of these vessels increase only fourfold, the respective flows are 1, 16, and 256 ml/min, which is a 256-fold increase in flow. Thus, the conductance of the vessel increases in proportion to the fourth power of the diameter.

Factors affecting vessel diameter:

Vasodilator agents:	Vasoconstrictor agents:
<ul style="list-style-type: none">■ Nitric oxide.■ Histamine.■ Atrial natriuretic peptide (ANP).■ Prostacyclin	<ul style="list-style-type: none">■ Norepinephrine.■ Angiotensin II.■ Vasopressin.■ Endothelin-I■ Thromboxane A.

Note that these factors affect the smooth muscles (the site of action)

SUMMARY

General notes taken from Dr. Eman :

- Arterial blood pressure = MABP (Mean arterial blood pressure) = Mean Pressure.
- The pressure in the Great arteries is different than the pressure of the small arteries, which means that the systolic blood pressure is higher than the diastolic blood pressure.
- ABP : increases with systole and decreases with diastole
- The posture affects the blood pressure i.e (supine, or erect) or even right or left arm.
- Sometimes when you measure the patient's blood pressure and it's not normal, you have to take consideration of gravity , exercise..etc.
- When someone stands up for a long time the the VR decreases due to gravity , then CO will decrease which will lead to a decrease in the PB.

resistance, MABP : Mean arterial blood pressure ,ABP : arterial blood pressure, TPR :Total peripheral SV: stroke volume , CO : cardiac output, SP&DP : systolic and diastolic pressure, VR venous return

SUMMARY

Arterial Blood Pressure

Physiological variation :

1. Age
2. Sex
3. Emotions
4. Exercise
5. Gravity
6. Sleep
7. Body built

Determinants of arterial blood pressure :

- 1-CO
- 2-Elasticity of BV
- 3-Blood Volume
- 4-Total peripheral resistance

Total peripheral resistance:

1.TPR and vessel diameter :

- Change in blood vessels' diameter by increase or decrease will affect blood pressure.
- TPR Is inversely proportional to blood vessel diameter(r)

2. factors affecting the vessels diameter :

- **Vasodilator agents:** NO, Histamine...etc
- **Vasoconstrictor agents:** NE, Angiotensin II...etc.

Arterial blood pressure

Blood pressure is the force the blood exerts against the walls of the blood vessels

Systolic pressure

Maximum pressure during systole

120mmHg

Diastolic pressure

Minimum pressure during diastole

80 mmHg

Pulse pressure

Systolic pressure – diastolic pressure

40 mmHg

Mean pressure

Diastolic pressure + (1/3 pulse pressure)

93 mmHg

Mean arterial pressure is the main driving force for blood flow

THE END

**If there are any problems or suggestions
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THANK YOU

Actions speak louder than Words