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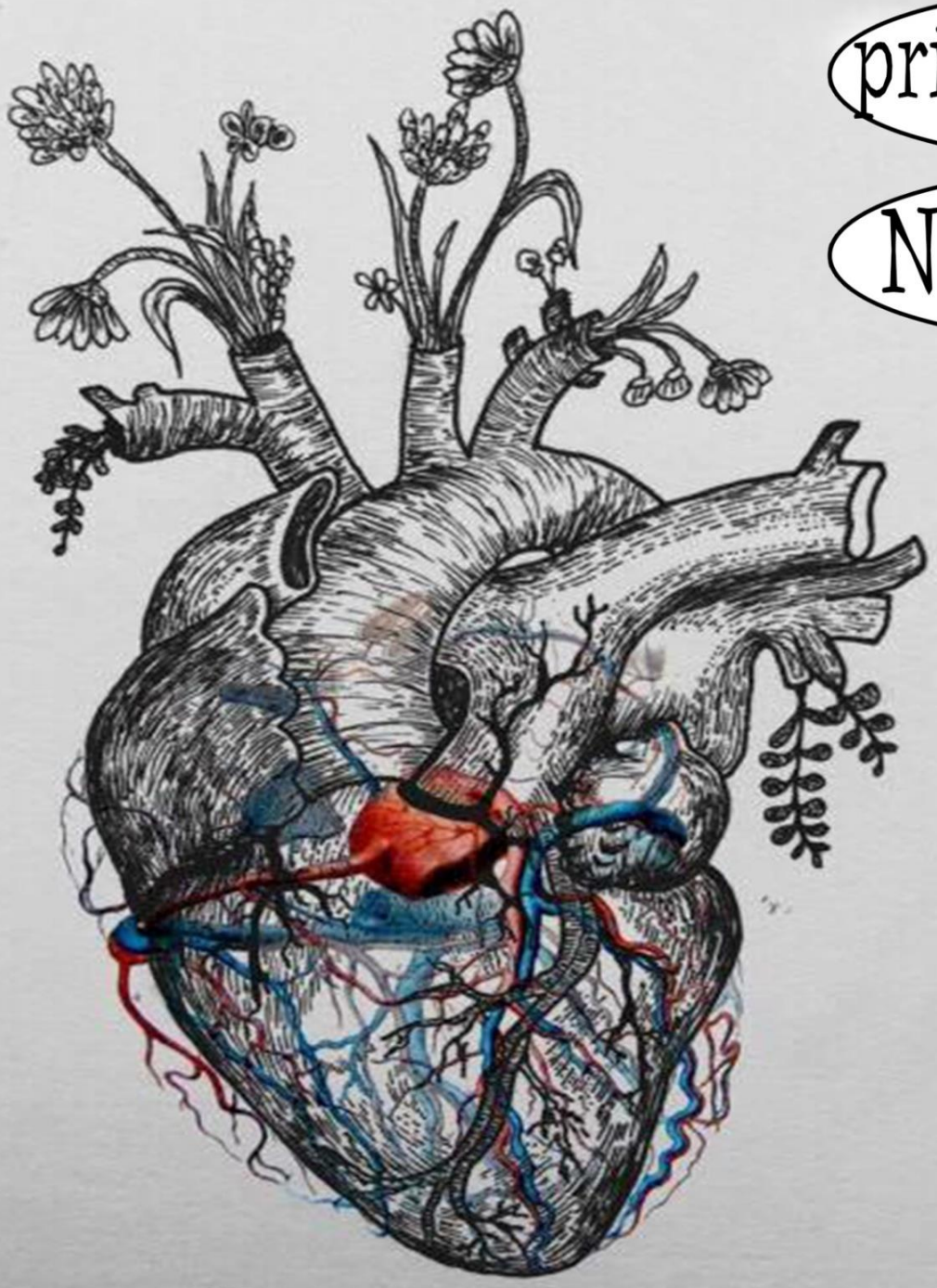


CVS

sub-system: Physiology - 9

lecture: Hemodynamics-2

Doctor: د. محمد جعفر

Date: 24/3/2016

Done by: Turquoise Team

HEMOYNAMICS II

In the previous lecture we talked about measuring the blood pressure using Auscultatory method but there is another method we didn't mention which is the palpation method:

In this method we are not going to use the stethoscope instead we will increase the pressure in the cuff and feel the pulse of the radial artery as long as there is a flow we feel the pulse, when the flow stops there isn't pulse, when we reduce the pressure in the cuff the first part of the blood pass you can feel it and that's the systolic blood pressure.

In the palpation method we can measure the systolic but not the diastolic (we can't feel it)
in auscultation method can measure both.
Keep in mind while doing the experiment when you know the pressure for example 120 the next time for auscultation you inflate the cuff you increase it to 125 or 130(increase it slightly more than the systolic pressure) and when you inflate be ready stethoscope with you and you know where the brachial artery is, you are not going to inflate and then look for the stethoscope because this is harmful for the patient.

RESISTANCE

Sympathetic tone: is how much signals are coming to the vessels of the cardiovascular system.

Normally there is a 100 of sympathetic signals, when it increase in number it will cause vasoconstriction and increase the blood pressure, when someone goes to bed the number will decrease as well as the tone.

Conclusion:
An increase in the tone will cause vasoconstriction (without doing an exercise or hypoxia), while a decrease in the tone will decrease the vasoconstriction or at least prevent it to reduce the blood pressure.

Resistance: Vascular **resistance** refers to the **resistance** that must be overcome to push **blood** through the circulatory system and create **flow.**

The Slide:

- The impediment to blood flow in a vessel.
- Can't be measured.
- Instead calculated from measurement of blood flow & pressure difference.

The pre-load is the diastolic volume. (*Preload is the end diastolic pressure that stretches the cardiomyocytes of the ventricles prior to contraction and causes filling them with blood*) ~ was not mentioned by the doctor.

The after-load is the peripheral resistance (it is in the arterioles because they have thick muscle fibers) which the left ventricle have to overcome. ((The force that the left ventricle needs to push the blood)).
When the arterioles are distended the blood easily flows through them, but if they were rigid "atherosclerosis" the blood will not flow easily due to the high resistance so the effort by the heart will be more.

SOMEONE ASKED "WHY DOES BLOOD PRESSURE INCREASE DURING EXERCISE?" I GUESS

During exercise the blood flow increase by vasodilatation not vasoconstriction, supposed to be sympathetic stimulation but there isn't vasoconstriction due to hypoxia (due to increased consumption of oxygen by skeletal muscle "metabolism") and vasodilatation even in the presence of high sympathetic tone,

it will increase the heart contraction (heart rate and cardiac output) ultimately increase the blood pressure. So during exercise there will be an increase in the systole pressure rather than diastole which will be normal or slightly decreased because of the vasodilatation. ***(Diastole pressure depends on the peripheral resistance)***

But in atherosclerosis the diastolic and systolic pressures are increased.

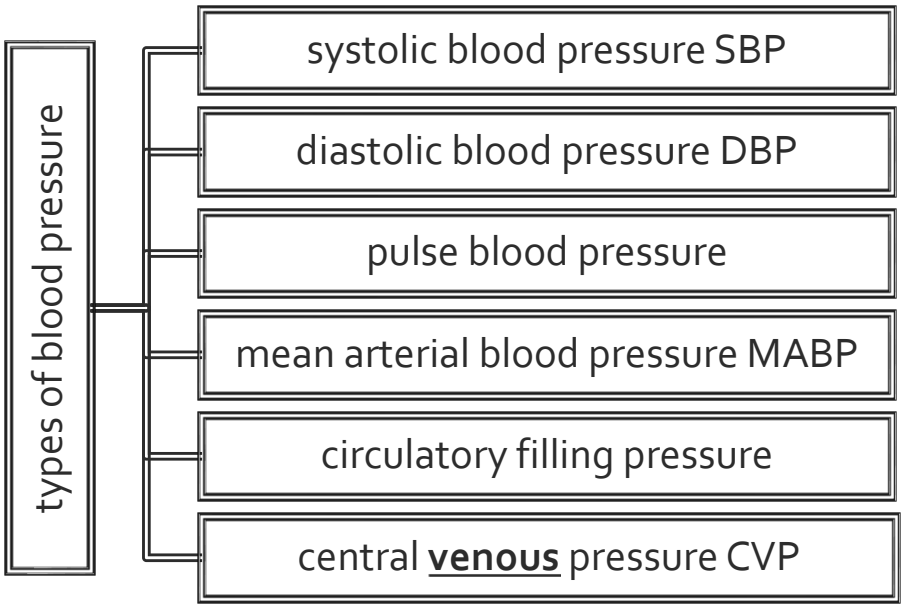
Conclusion: during exercise the blood pressure increases due to the increment in the blood flow not the resistance.

If you are interested about this question you can read more about it here: http://www.newhealthguide.org/Blood-Pressure-During-Exercise.html

And for the bold point about the diastolic pressure it's important to read about it here: http://www.ncbi.nlm.nih.gov/pubmed/19397007

In general the blood pressure increases either by resistance or blood flow or even both of them.

TYPES OF BLOOD PRESSURE



CVP: the same as right atrial pressure because the blood is collected in the right atrium of the heart, normally it's about zero but it can increase slightly up to 5 mmHg but not more than that if it was more than 5 mmHg then it is heart failure.

In case of heart failure, the right atrium pressure can be measured but we have to use catheters and connect it to manometer of **water** because it's easier to see the change (its column will be large), if you use mercury the used column will be smaller and harder to observe the change. (1mmHg= 13.6 mm H_2O)

Circulatory filling pressure imagine if the heart stopped then the cardiovascular system is turned off, any vessel have a fluid has a load or a force so it is the filling load/pressure.

That's all what the doctor mentioned about them and he said you already know them, so here is a quick review for them:

Systolic pressure

- is the highest arterial pressure during a cardiac cycle.
- is measured after the heart contracts (systole) and blood is ejected into the arterial system.

Diastolic pressure

- is the lowest arterial pressure during a cardiac cycle.
- is measured when the heart is relaxed (diastole) and blood is returned to the heart via the veins.

Pulse pressure

- is the difference between the systolic and diastolic pressures.
- the most important determinant of pulse pressure is **stroke volume.** As blood is ejected from the left ventricle into the arterial system, arterial pressure increases because of the relatively low capacitance of the arteries. Because diastolic pressure remains unchanged during

ventricular systole, the pulse pressure increases to the same extent as the systolic pressure.

- Decreases in capacitance, such as those that occur with the **aging** process, cause **increases in pulse pressure.**

Mean arterial pressure

- is the average arterial pressure with respect to time.
- can be calculated approximately as **diastolic pressure plus one-third of pulse pressure.**

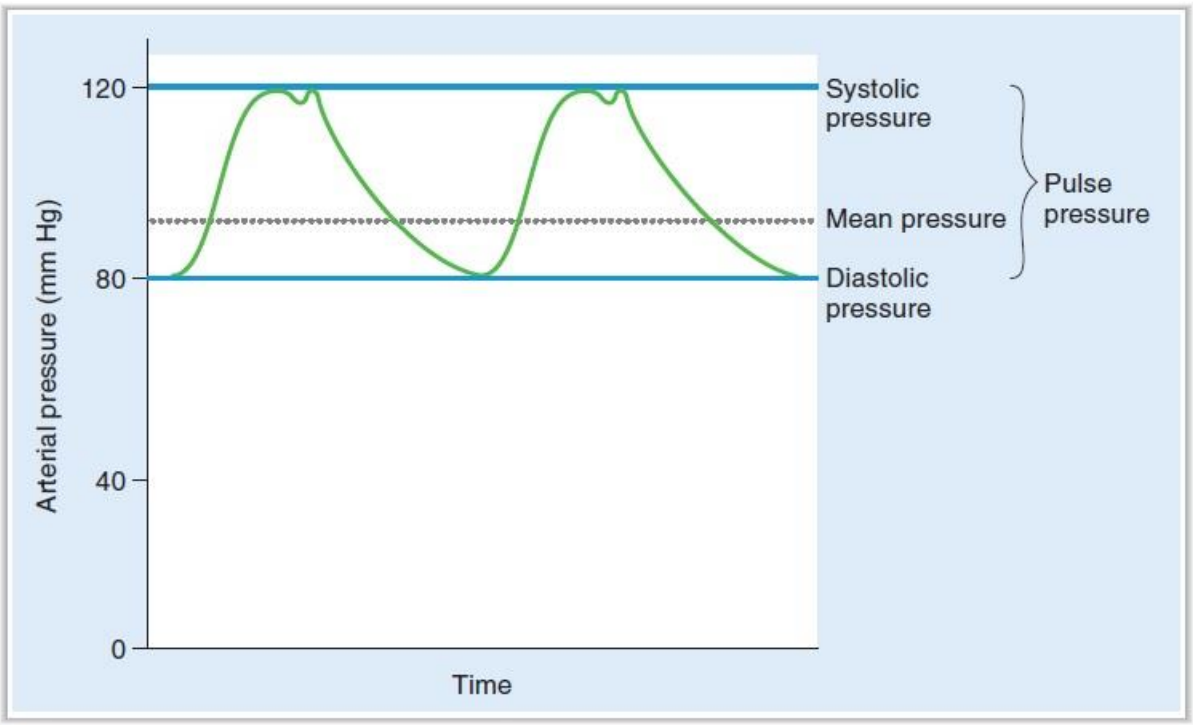


FIGURE 3-2 Arterial pressure during the cardiac cycle.

VENOUS RESISTANCE AND PERIPHERAL VENOUS PRESSURE

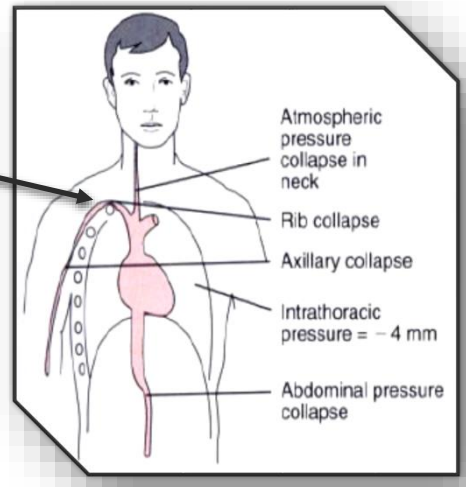
Regarding the highest pressure we said it is in the arterioles and the reason behind that is their thick muscle fibers, also the veins have some muscle fibers but they are thin. But do they have a resistance or not??

They do have resistance sometimes you can say it is not significant however the resistance in the veins is due to their location like in the

abdomen they are surrounded by the stomach and the intestine … these organs will apply force on the veins causing a source of constriction.

So there is a resistance in the veins because of 3 things:

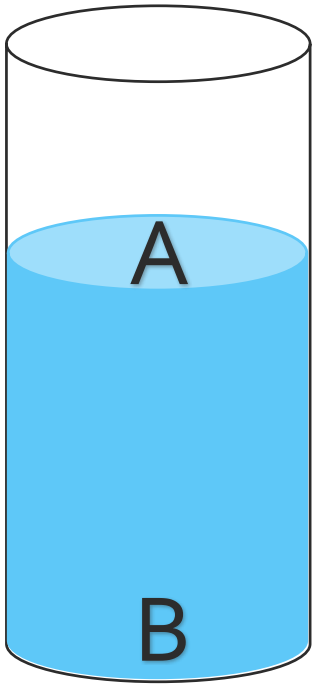
1- Applied force by the surrounding tissue
2- Bending in the vein
3- Muscles surrounding the veins



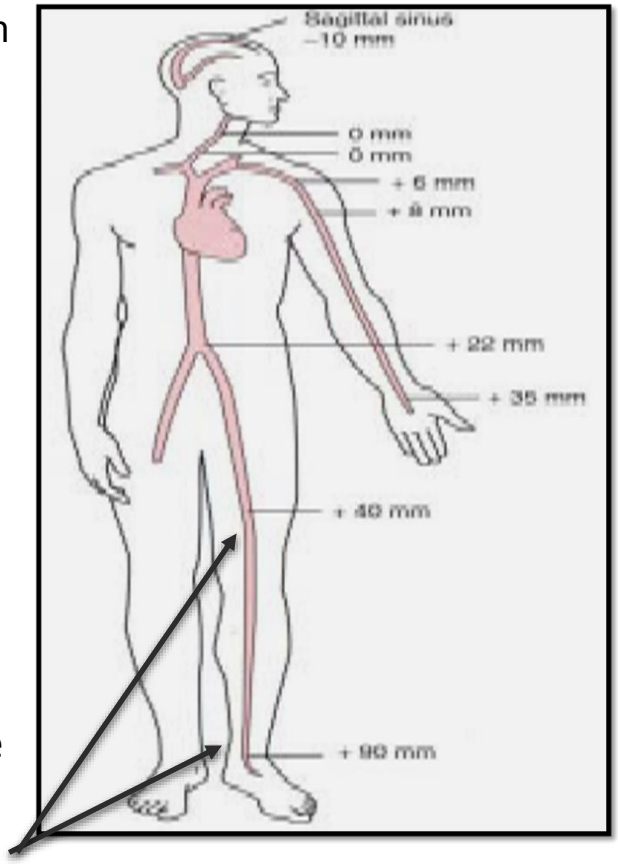
HYDROSTATIC PRESSURE AND VENOUS PRESSURE

Suppose that this is a vessel filled with fluid, the pressure at the point (A) "which is the top" is the atmospheric pressure (760mmHg) or we can say it is zero, At point (B) the pressure is +ve which mean its higher than the atmospheric pressure (zero + the weight of the fluid)

So the pressure depends on the length, as you go from point (A) to point (B) the pressure will increase



The same principle is applied to the human body in which the zero pressure is in the right atrium, **<u>regarding the veins</u>**, as you go down while you are standing the pressure will be (zero +) so the more you go down the higher the pressure is increased, **remember 2 things it depends on the length and we are talking about the veins.**



In a standing position the pressure in the atrium is zero while in the lower limb it's around the 100 due to the weight "gravity effect" depending on the **<u>length</u>** like in the femoral vein the pressure will be less than what is lower to it "like the popliteal". (Look at the picture)

In ***<u>veins</u>*** as you go closer to the heart the closer the value to zero if you go down it will be higher.

For arteries the pressure in the heart or the aorta it is 100, if you measure it in the lower limb it will be higher maybe 200.

Now that was the case when we go down but if we go up it should be negative (**<u>for the veins</u>**), which means it should collapse but that does not happen because of the skull that will prevent the veins from collapsing otherwise there will be no life.

In the sagittal sinus the pressure is negative but in the jugular vein it is supposed to be negative but it's not, by the time the atmospheric pressure tries to collapse veins the blood comes from up and open them, in the jugular vein the pressure is around zero.

In arteries the pressure in heart is already 100 if you go up it will decrease but will not reach negative.

How the blood flow will continue? The gravity "accelerating factor" will insure the blood flow to continue. (Because the blood normally flows from higher to lower pressure but here in the inferior arteries the pressure is higher than the pressure in the arteries superior to it, even in the sagittal "superior veins" it has lower pressure than the heart and it has to flow back to the heart, so the gravity will help in both cases "which is the flow from low to high pressure").

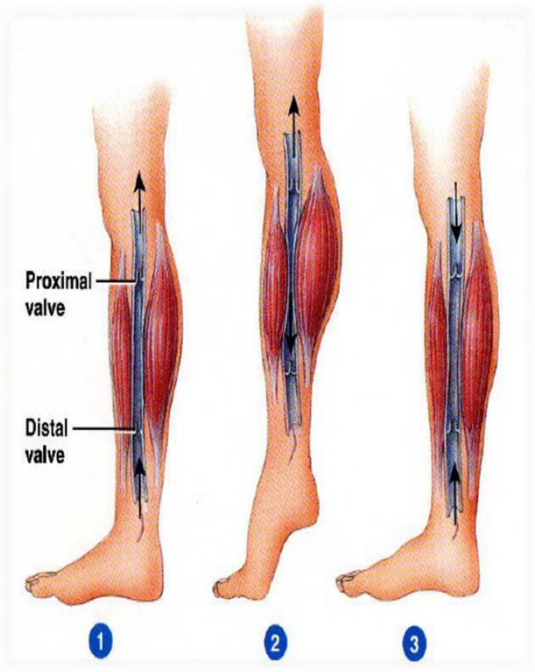
During sleeping there isn't hydrostatic pressure, if you measure the pressure within the brachial artery or the femoral artery it is supposed to be the same. In the jugular vein the pressure will be more than zero so the blood flow will be there

In a supine position the gravity effect will be abolished (the gravity is present but equal in deferent parts of the body so its effect is abolished) unlike when we are standing or setting where it is always present.

VENOUS VALVES AND VENOUS PUMP: THEIR EFFECT ON VENOUS PRESSURE

The doctor here just mentioned the 3rd point in the slide:

- Importance of valves.
- Arrangement of valves.
- **Effect of movement of the legs**.



• VOLUME- PRESSURE CURVE OF THE ARTERIAL AND VENOUS CIRCULATION

There is no one can walk with a blood pressure 80 it's only seen in hospitals, a drop in the blood pressure can be compensated by either:

1- Vasoconstriction (increase the resistance)
2- Tachycardia (increase the blood flow)
3- Increase the flow (by the volume)

The veins are the blood reservoir it contains about 65% of the blood.

If hemorrhage develops there will be a blood loss so the blood pressure will drop, first thing there will be an increase in the heart rate and vasoconstriction (both by sympathetic stimulation) 2nd event is constriction of the veins for shifting blood from the veins to the arteries that's why we call them blood reservoir including :

Spleen, liver, subcutaneous tissue, veins of the abdomen and in severe cases the heart and the kidneys and the lungs.

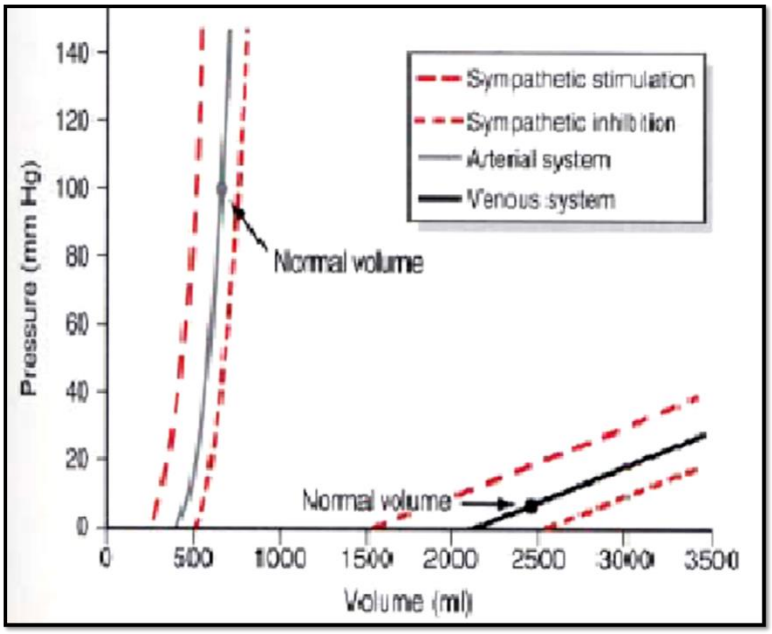
Because the increasing the blood volume in the arteries will increase the pressure, if bleeding was from the arteries usually we can't save the patient, so most of the bleeding in the venous side.

NOTE:

Little change in the volume in the arteries will be significantly reflected in a change in the pressure within that artery look at the diagram.

Little change in the pressure within the veins will be reflected significantly in the volume within the veins.

- In the diagram the black line on the left concerns the arteries and the one on the right for the veins, red lines sympathetic stimulation and inhibition.

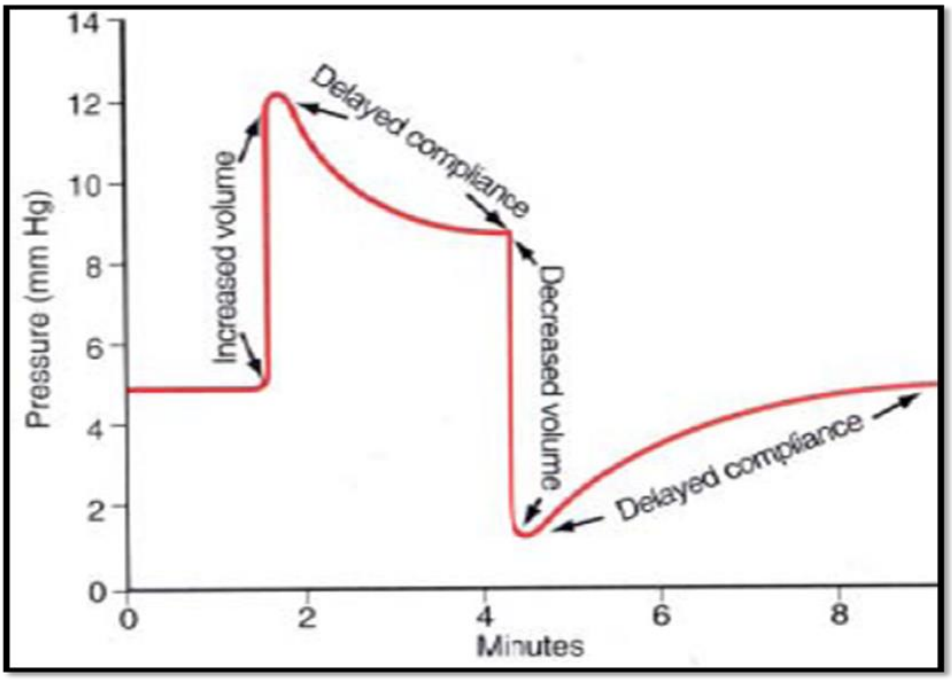


The normal blood volume in the arterial side is 750ml less than one liter, the pressure can be zero but the volume is 500ml, significant change in the pressure with minimal change in the volume. (Pressure reservoir)

While the veins 4 or 5 mmHg is the pressure and the volume is 2.5 liters, minimal change in the pressure with significant change in the volume. (Blood reservoir)

DELAYED COMPLIANCE (STRESS- RELAXATION) OF VESSELS

If you have a blood vessel and suddenly increase the blood volume, 1st thing the muscle will stretch and the flow increase as well as the pressure, later there will be a sort of adaptation (delayed compliance) after that a sudden decrease in the adaptation and the pressure and volume finally delayed compliance with a slight increase the pressure.



Done by: Salem Khater

I've tried as much as I can to include the doctor answers for my colleague's questions forgive if I have missed anything. And you need to check the slides the doctor didn't use them as they are sequenced and didn't explain some of them so it was hard to include them here.

Edited by: Layth Al-Zu'bi