فسلجة

Lec.5 Cardiac Cycle د.شاكر

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Everything that happen inside the heart, occur during the cardiac cycle. And as we said the heart is a pump and this pump must be filled and emptied so these events are called the cardiac cycle. The most important thing about it is that it's closed continues circulation

And we also said that the valves are open when the atrial pressure is more than ventricular pressure (mitral and tricusps), and when the ventricular pressure is more than the blood vessel's pressure (aortic and pulmonary).

STAGE 1: Atrium is relaxed and ventricle is relaxed and the blood is still coming from the veins (pulmonary veins), so when the blood enters the atrium; this means increase the pressure inside the atrium (and pressure atrium > pressure ventricle). So the mitral and tricusp valves are opened, while the aortic and pulmonary valves are closed. This **passive filling** stage is atrium receives blood from the veins, the valves between atrium and ventricle open and the blood moves toward the ventricle. This stage won't last a long time, because depolarization will be initiated from SA nodes to the atrium, and as a result of the atrium's

contraction, the pressure will increase and it will push additional blood to the ventricle.

STAGE 2: The ventricle after that won't stay relaxed , because depolarization will come from (AV nodes → bundle of hiss → Purkinji fibers → ventricular muscles) this will cause contraction of ventricular muscles and increase the pressure inside the ventricle , so the mitral and tricusps valves are close and (aortic , pulmonary) valves are also closed because the pressure inside the ventricle is still not more than the aortic or pulmonary pressure. This stage is called **isovolumetric contraction**. So the features of "Isovolumetric contraction stage" are:

1- Volume is the same in the ventricles

2-Ventricular muscles are contracted

3-Pressure is increasing

4-The four valves are closed

And once again, this stage won't last.

STAGE 3: the pressure will be increased and when the pressure in the ventricle is more than the pressure in the blood vessels' pressure. The aortic and pulmonary valves will be opened (the Semilunar valves will be opened). Once they're opened, the blood is trapped in the ventricle and the pressure is high, this will cause a rapid ejection through the pulmonary and Aortic valves , the mitral and tricusps valves are closed (Pressure in ventricle > pressure in Atrium) , and even when the pressure in the ventricle is so high the mitral and triceps valve won't open due to

the presence of papillary muscles that are contracted during the muscle contraction and pull the chorda tendinae and it won't allow the valve to open . This stage is **Ventricular contraction and ejection of blood.** The amount of blood ejected equals 70 ml per each contraction toward the aorta and 70 ml per contraction toward the pulmonary artery this is called **"Stroke Volume".** During the ejection, the atrium will be filled with blood by the pulmonary veins. And once again this ejection won't continue because depolarization will end and replorazation will start.

Stroke volume: is the volume of blood ejected from the ventricle for each ventricular contraction, it equals 70 ml per contraction.

STAGE 4: When the ventricle is relaxed , the pressure in it will be decreased and quickly the aortic and pulmonary valves will be closed (pressure in vessels > pressure in ventricle) , but even though ; the pressure inside the ventricle still more than the pressure in the atrium so all valves are closed (mitral , tricusps , aortic , pulmonary) . The heart muscle is in stage of relaxation (the pressure is decreasing but the volume inside the ventricle isn't changed and the ventricular muscles are relaxed) this stage is called **Isovolumetric relaxation.** The features of isovolumetric relaxation are:

1-Four valves are closed

2- Pressure in the ventricle is decreased

3-The Volume is the same in the ventricle

4-The blood continues to fill the atrium.

Filling the atrium will produce pressure in the atrium, and when the pressure inside the atrium will become more than the pressure in the ventricle, the mitral and tricusps valves will be open and the blood will move rapidly (Quickly) from the atrium toward the ventricle this is called **rapid ventricle filling**. It will fill 70 % of the ventricle. This stage's features are:

1- Atrium is relaxed

2- Ventricle is relaxed

3-Aortic and pulmonary valves are closed

4-Rapid ventricle filling from the atrium to the ventricle.

In the next stage the blood will come from the veins to atrium to the ventricle is called passive ventricular filling.

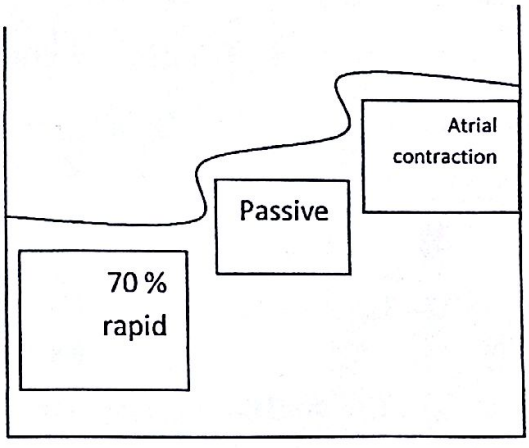
~~Now both are relaxed but it can't continue because the atrium will be~~ contracted soon and it will push more blood toward the ventricle.

So now we have 3 types of filling:

1-Rapid filling

2-Passive filling

3-filling due to the atrium contraction



The end volume: is the volume of the blood which fills the ventricle by 3 stages, its called end diastolic volume (EDV) which equals 120 or 130 ml.

The amount of blood present after the end of diastole equals 120 to 130 ml in right ventricle and 120 to 130 ml in left ventricle.

This blood that present in the ventricle gives a very small pressure (in the end diastolic volume) which equals (0-5 mmHg) the reason why it's small , in the heart muscle we have the ability to stretch and more volume and more stretch fibers with less pressure (Volume increase , stretch increase , pressure is low). This is called end diastolic pressure EDP

The more we fill the ventricle, the more stretching will happen, no increase in the end diastolic pressure if the muscle was stiff, we can't fill the ventricle with more blood so we need it to be stretchable so that more blood with less pressure).

When we fill the ventricle with blood and eject it, the blood won't be completely ejected (not all the blood will be ejected).

Stroke volume = 70 ml per contraction

EDV = 130 ml per contraction

ESV (End systolic volume) = EDV – Stroke volume → 130 – 70 = 60 ml inside the ventricle after the end of contraction.

The reason of these processes is to preserve circulation continuously in the heart

Stroke volume = EDV – ESV

The SA nodes make the heart contract 70-80 times per minute.

So in each minute let's say = 80 beat

Stroke volume = 70 ml per contraction

70 x 80 = 5600 ml called the cardiac output

Cardiac output: Volume of blood ejected from each ventricle in one minute which equals 5 liters (5600 ml)

The cardiac output must be equal in both left and right ventricles, even if there were a slide difference later on after 2 or 3 contractions it would become equal.

Cardiac output = Stroke Volume x number of beats per minute

Stroke volume is determined by filling, while SA nodes determine the heart rate.

NOTES:

1- the stages of the cardiac cycle are : (#1 passive and atrial contraction - #2 isovolumetric contraction - #3 Ventricular contraction and ejection of blood - #4 Isovolumetric relaxation and then rapid ventricular filling).

2-The cardiac cycle is closed continues circulation.

3- The contraction must be preceded by depolarization while the relaxation must be preceded by repolarization.

4-In isovolumetric contraction the volume is the same in the ventricles, the ventricular muscles are contracted, pressure is increased and all valves are closed.

5-Stroke is an old-used word for systemic, contraction or beat.

6-The amount of blood ejected from the ventricle equals 70 ml (stroke volume) and the amount of the blood enters the ventricle equals 130 or 120 ml (EDV) and the remain in the ventricle (won't be ejected) equals 60 ml (called end systolic volume ESV).

7-In isovolumetric relaxation the four valves are closed, the pressure is decreased in the ventricle, the volume is the same in the ventricles and the blood is continuously filling the atrium.

8-When the pressure in the atrium become more than the ventricle, the atrioventicular valves (mitral or tricusps) will be opened and the blood will rapidly move to the ventricle (#rapid ventricular filling = 70 % of the ventricle).

9-Passive means without energy, in this case without contraction.

10-We have 3 types of filling: rapid, passive and atrial contraction.

11-ESV = EDV-Stroke volume ➔ ESV = 130-70 = 60 ml

12-The heart muscles have the ability to stretch (more volume, more stretching with less pressure).

13-The heart is filled with 130 ml, it pushes 70 ml and remain 60 ml (EDV, Stroke, ESV Respectively)

14-Cardiac output is the volume of the blood ejected from each ventricle in one minutes equals 5 liters

15-Cardiac output must be equal in right and left ventricles.

16-Stroke volume is determined by filling, while SA nodes determine heart rate.

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