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Physiology sheet

Doctor 2021 -mercy- I medicine I MU

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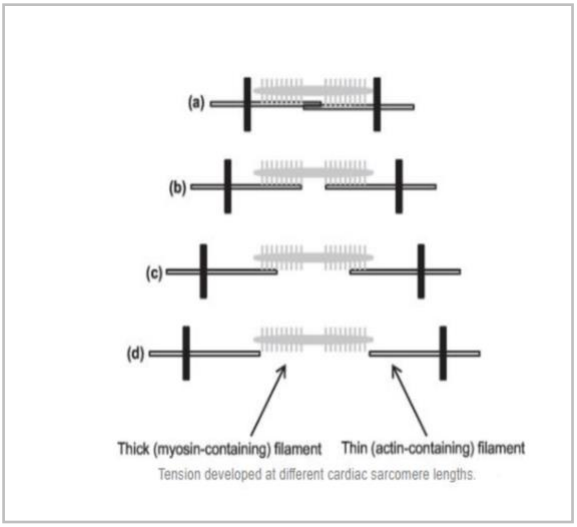
Frank- starling mechanism

This figure describes how the contractions occur

Between the actin and myosin filaments:



A - **The beginning of the process of pumping blood is called early diastole .**

the actin filaments overlap with each other due to the lack of muscle lengthening,

but there is contact between the myosin heads and the actin filaments.

B- **It is called the middle diastolic . the volume of blood increases, which leads to the pumping of a lot and a lot of blood into the ventricle and the atrium. There is a gradual increase in the volume of blood inside the heart and there is an increase in the length of the muscle (all are stretched and actin filaments moving away) , but there is still an overlap between the actin filaments and the myosin head.**

- **Stretch: increase in length**

C- **Continue to pump blood into the heart.**

actin filaments and the myosin heads still binding , and the process of increasing the length (stretching) continues, which leads to an increase in the distance between actin filaments

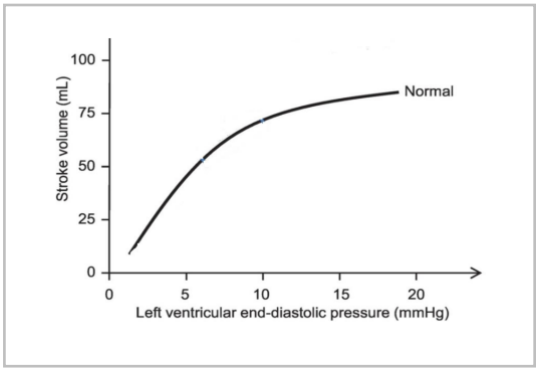
D- **The maximum volume of blood inside the heart so that the heart does not receive any type of blood,**

Too much stretching, so there is no connection between actin and myosin due to increased distance.

- **Tension : Force inside the cell.**

This figure shows the relationship of pressure

to volume :



the greater the volume :

- ➔ **the greater the contraction force**
- ➔ **the greater the tensile force**
- ➔ **the greater the cardiac output**

cardiac output is an increase in blood volume, either on the right or left side

stroke volume means amount of blood outside a heart chamber (venous blood return)

The amount of blood on the right side must be equal to the amount of blood on the left side

Frank – Starling Principle

• The Frank–Starling law of the heart (also known as Starling's law and the Frank–Starling mechanism) represents the relationship between stroke volume and end diastolic pressure

• This principle illustrates the relationship between cardiac output and left ventricular end diastolic volume

• The law states that the stroke volume of the heart increases in response to an increase in the volume of blood in the ventricles, before contraction (the end diastolic volume), when all other factors remain constant.

• As a larger volume of blood flows into the ventricle, the blood stretches the cardiac muscle fibers, leading to an increase in the force of contraction.

• The Frank-Strling mechanism allows the cardiac output to be synchronized with the venous return, arterial blood supply

• The physiological importance of the mechanism lies mainly in maintaining left and right ventricular output equality

• If this mechanism did not exist and the right and left cardiac outputs were not equivalent, blood would accumulate in the pulmonary circulation (were the right ventricle producing more output than the left) or the systemic circulation (were the le*ft ventricle producing more output than the rig*ht).

Some pathological diseases of the heart:

- hepertrophy of the heart muscles means Increasing the thickness of the muscles inside the ventricle leads to an increase in pressure, so the relationship between pressure and blood volume does not become as in the previous figure (no matter how much you reduce the volume, the pressure remains the same)

-cardiomyopathy refers to conditions that affect your heart muscle. If you have cardiomyopathy, your heart can't efficiently pump blood to the rest of your body.

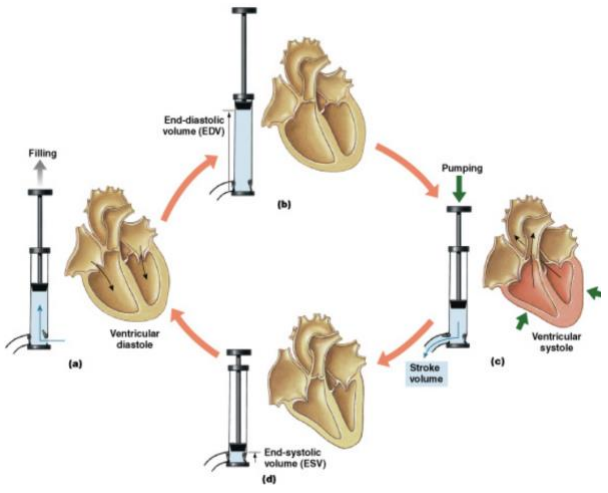
- cardiomyopathy dilation The heart muscle is in a kind of relaxation so that it can recieve larger amount of blood volume and because of deficiency elacitecy? we have no effect on pressure no matter how much blood volume.

Frank – Starling Principle

- **End diastolic volume: The amount of blood that remains in the ventricle just before ventricular early systole is the EDV**
- **End systolic volume: The amount of blood that remains in the ventricle at the end of ventricular systole is the ESV**

SV = EDV - ESV

Stroke Volume(SV)



On the left in the form of a carton:

start pumping an amount of blood,

then fill it in the right or left atrium and

pump blood into the right or left ventricle

and continue pumping blood until it reach

the maximum limit, then the contraction

process begin or the so-called systole.

Now the ventricle is creating a gradual flow

in order to pump all the blood starting from the early systole, then the middle systole, then the end systole until it becomes pumping of all blood to the pulmonary artery

It expresses the relationship of right CARDIC OUTPOT or left CARDIC OUTPOT, when the blood volume in the ventricle reaches the upper limit, the pressure becomes opposite to the pulmonary valve, so it becomes a gradual pumping of blood

- **The relaxation process is associated with contraction so that the more EDV increases, the SA increases, the force of contraction increases, and there is a balance between the two sides in terms of blood volume**
- **EDV The amount of blood before the ventricle begins to contract a little bit from the amount of blood.**

- **ESV is the amount of blood left after the ventricle has pumped blood**

- **The higher the EDV, the greater the SV, and the greater the CARDIC OUTPOT**
- **It decreases with increasing ESV because the relationship between them is inverse.**
- **ESV indicates retention of blood inside ventricles, so high value of ESV compared to the original value of EDV is related to cardiac diseases.**

The cardiac cycle begins with an early diastole, then a middle diastole, and then an end diastole .

one complete set of the cardiac cycle called heart beat…

- **Contraction: systole**
- **Relaxation: diastole**

When the whole blood is pumped from the right atrium to the right ventricle, from the right ventricle through the pulmonary artery to the lungs, from the lungs through pulmonary veins to the left atrium, from the left atrium to the left ventricle, and from the left ventricle to the aorta, this is how the Cardiac cycle is completed (its happen in both -right and left side- at the same time)

But the occurrence of part of these stages, is called heart beat

Conduction system or Electrophysiology system

SA node

Crescent shape structure ;Superior component of the right atrium just beneath the large vessel here called superior vena cava.

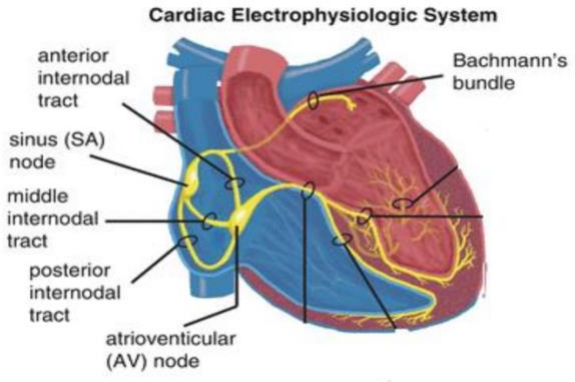
Sets the pace at around 60 to about 80 beats per minute (normal heartbeat) on its own without any extrinsic innervation and this is called sinus rhythm

-SA: sinoatrial node

- SA is the starting point of the action potential generation

- SA leads to the transmission of the signal from one cell to another to generate the heart rate

- The normal heart rate -> if it increases, tachycardia, while decreased heart rate is known as bradycardia.



Bachman's bundle

The electrical potential conducted from the right atrium by SA node to the left atrium through Bachman's bundle

Internodal pathway

This will supply all the other parts of the right atrium but eventually all this internodal pathways converge on this second important structure to the AV node

Internodal pathway involves contraction of right atrium

AV node

Runs from the actual right atrium to the interventricular septum so it is acting as a connection, the gateway between the atria and the ventricles because what happened is some potentials of Bachman's bundle can make their way over here to the AV node also

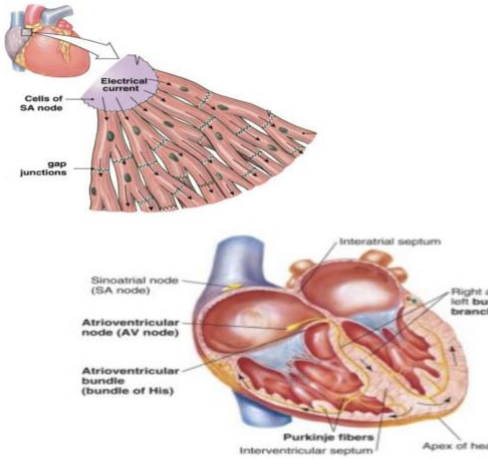
So, all the action potentials that are coming from the SA node that are being spread out to the internodal pathway or the Bachman's bundle are converging to the AV node

When reaching the purkinje fibers, the contraction becomes rapid in all the heart muscles located in the apex area.

- During the formation of the action potential, the signal is transmitted from one cell to the cell next to it. Failure to do so leads to a problem with blood pumping

Conduction pathway

- **Once the AV node receives the signals it is going to take**
- **From AV node it is going to move to bundle of His**
- **Bundle of his to two bundle of branches (right bundle branch and left bundle branch)**
- **From there to purkinje fibers**



-) once action potential is propagated along cardiac cells.

-) myofilaments , actin and myosin, stretch.

-) causing an increase in distance between adjacent cardiac cells (fibers).

-) This interrupts the conduction process of action potential.

-) intercalated discs are found to guarantee a constant short distance between cardiac cells.

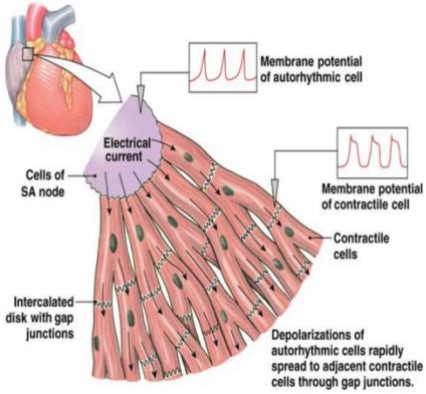
The shorter the distance between the cells, the better and faster the transmission of the action potential, and vice versa

Intercalated disks

Desmosomes is basically acting like adhesion molecules from cell to cell and keeping the cells very tightly connecting and that's really really important

• This led us to concept whenever we have two cells communicating to each other and I have a combination of desmosomes and gap junctions they called together intercalated disks

• Intercalated disks are basically a bunch of gap junctions and desmosomes connecting the actual cardiac cells together



- **intercalated disk reduces the space between cells when stretching occurs and contains a gap junction to prevent interrupts the conduction process of action potential, which is a gate separating neighboring cells, which consists of small units of proteins called connexins.**

- **The heart exhibits was called automaticity (the heart has its intrinsic ability on its own to spontaneously depolarize itself, and then trigger action potentials to send it out to all other parts of the heart.**

- *(a reminder found in the previous lecture)*

لا عليك يا صاحبي ، لا عليك

هذه التي أتعبتك هي في نهاية المطاف دنيا! هكذا سماها خالقها كي لا نغتر بها .. فاستجمع قواك إن لك أن تمشيه وعلى كاهلك أمانة عليك أن دورا ، وقد كان شعارك دوما: لا أبرح حتى أبلغ! فلا تبرح