Cardiovascular system
Physiology-6-

In this lecture, we will continue talking about ECG concept and mechanism of working:
Let's recall some information from the 5th lecture:
- We learnt different waves and differentiated between an interval and a segment.
-we learnt that a normal P-R is less than 0.2 sec.(if it's more then 0.2 we have heart or AV block) /QRS is less than 0.12 sec/QT is variable 0.35.
-we talked about calibration.
-we learnt to differentiate between depolarization and repolarization waves.

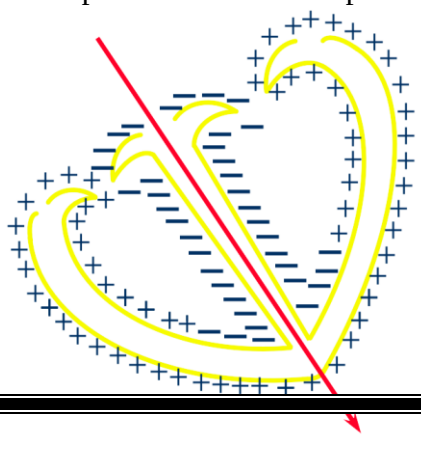
Let's start our lecture:

-Isoelectric line is the line that is formed due to complete repolarization or depolarization of the cardiac muscles.
P: is atrial depolarization. -
QRS: is ventricular depolarization.-
QT or RT (in case Q wave is absent): ventricular contraction. -
Notice that the atrial repolarization is not shown. (But at AV block we can see it).
This causes a prolongation of the PR interval.- it appears as a downward reflection.
-We calculate the R-R interval if we want to measure the heart rate.
-we call it interval because it includes a wave. If it didn't include a wave, it's a segment.
Cardiac cycle needs 0.8 sec.
Q doesn't usually show up; if it does, it is minimal or an abnormal condition.

- RECORDING process:

- When we are recording the PQRST and the current is going towards the positive electrode, then the recording is positive. If it's going away from the positive electrode, then the recording is negative.
That explains why we put the positive electrode on the left arm and the negative one on the right arm, so we can have positive recordings. If we switched them we`ll have a negative reading.

- The depolarization starts in the interventricular septum → then it goes to the left and right ventricles.
- When depolarization starts, there is usually a vector that's going from the negative charges to the positive charges.
- At the first instant of depolarization, there will be many vectors going in all directions so we calculate the resultant of vectors. It's like the summation of all vectors in one vector. This resultant will be analyzed in the planes of ECG (xyz axis.)
- The vector goes from the depolarized to the still polarized, so the last part that gets depolarized is the *posterior aspect of the left ventricle.*



NOTE:

1. The ventricle depolarization starts at the interventricular septum at the endocardial surface of the heart. The average current flows positively from the base of the heart to the apex. At the very end of depolarization, the current reverses.

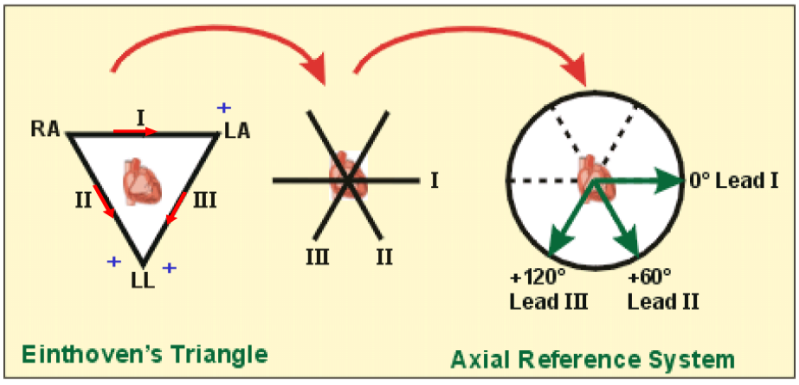
2. The electrical signal is followed by a mechanical action.

3. PR represent the time between the beginning of atrial contraction and the beginning of ventricular contraction OR the beginning of the P wave and the beginning of the QRS wave.

4. If the cardiac cycle is shorter the heart rate is faster, and vice versa.

- Bipolar Limb leads :

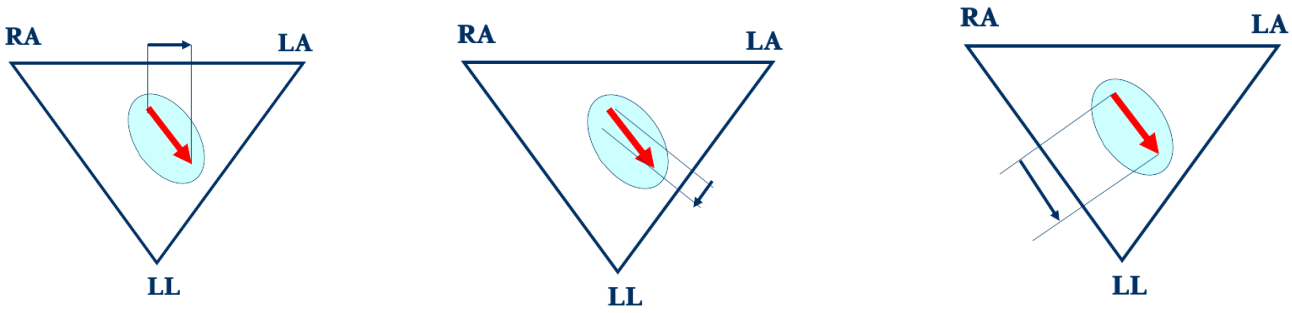
In bipolar limb leads we are recording from two electrodes from the body:
-lead I: 2 electrodes one on the right arm (-ve) and the other on the left arm (+ve).
-lead II: right arm (-ve) and left foot (+ve).
-lead III: left foot (+ve) and left arm (-ve).
A fourth electrode is connected to the right foot for earthing.
*why we put them in this manner? To have positive recordings in all three leads.
- If we calculate the QRS results, we will find that:
QRS LI+ QRS LIII= QRS LII → (Einthoven`s law)
Look at the no. in slide 18.
"jump to slide 23"
- we can see the triangle of Einthoven`s:



RA: right arm
LA: left arm
LL: left foot

. (The 3 have the same value = 60) متساوي الأضلاع والزوايا) -This triangle is an equilateral triangle(
-as we can see all currents are moving from RA to LL and from LA to LL. (negative to positive)
If the current moves in a circular manner, the resultant vector would be 0.
- It should be from LL to RA but if it was like this we`ll going to have 0 current flow according to Kirchof`s 2nd law (LI+LII+LIII=0).
- Einthoven switched the electrodes (from RA to LL) so we can have a value for the flow (from RA to LL). So the calculations became (LI+LIII-LII=0) → (LI+LIII=LII).

-If we slowed down the RA LA arrow to the level of the other arrows at the triangle we are going to have the drawing on the right, the arrows will preserve the angle between them (60 degree).(arrow translocation)
- In the slides (19,20,21) the dr is analyzing each arrow from the arrows(vectors) above :



*** The mechanism of this analyzing** is making a column from the head and the tail of the arrow to get the value of the leads.
The value of the mean vector in the direction of leads: 1, 2, and 3
* Then we gather these three limb leads and make them have the same center (as in the drawing on the middle besides the triangle, the one that have a heart on the center).
We just translocated the vectors, so they can meet at the center. The center here represents the heart and it lies in the center of the triangle.
*Then we draw a circle that will touch the heads of the arrows.
So the center of the triangle is the center of the circle and is the center of the heart)
* The angle of the circle is 360 degree, if we start from the arrow of the lead I and we give it a 0 value, then the arrow of the lead II will have the +60 degree value and the arrow of lead III will have the angle of +120. Then we reverse the sign (-60, -120, etc..)
*** mean vector of QRS** of the heart is +59 but because in medicine we don't have black and white , we always have gray areas the value can range between (-30-+110).
- As long as the pts are in these range they`re normal.
-But clinicians hate to deal with angles so they state a normal range which is (0-+90)
Eventually the normal mean vector of QRS is (0-+90).
*** That was the case in triangle
But we deal with hexagonal shape too, as you can see there are also 3 interrupted lines, we call them unipolar leads.

- UNIPOLAR leads :

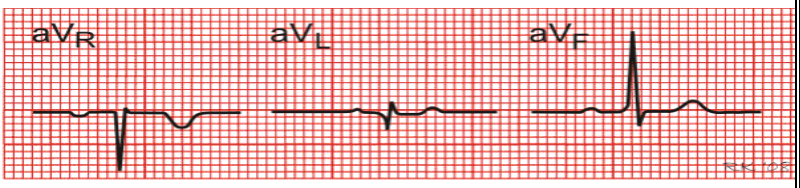
-We mean by this that the current is coming from the **heart(1st electrode** which is neither a +ve nor a –ve , its value is **zero** , that's why we **don't** consider it as a 1st electrode)**) to the left arm/foot/right arm** (2nd electrode) , and that's why it's called unipolar. So the electrode value in the left arm is positive because the current is going to it (The current always goes to the positive).
-Each limb has 5000 ohms resistance value on the negative electrode. We connect them together in the middle, and due to the high resistance, the current equals to zero.
- **""but according to Guyton ""**We have an electrode on the right arm that's called "indifferent electrode" it's connected through equal electrical resistances, its value its negative. (Refer to page 126).

- There is another scientist who tried to remove one other electrode and kept the others. For ex. He removed the LA and kept the RA and LL and measured the value from the LA, and he found that the value is amplifying.
- When he removed the electrode from the RA and measured from it , he had the same result (the value is higher)
- And the same goes to the LL.
- To get the amplification, you remove the resistance from the limb you're recording from.

So we added the letter "a" that stands for Augmented to the abbreviation so now, the abbreviations are: (refer to slides 26, 27, 28)

aVR: right arm
aVL: left arm
aVF: left foot

-**Notice** the Amplifications In the waves.



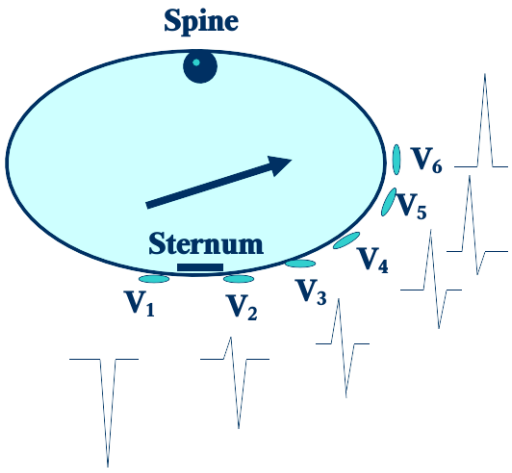
-in the aVR the wave is inverted because the mean vector is moving away from the RA current (away from the +ve), (to the left and anterior) its normal not pathological record.

- We put 6 leads on the chest :

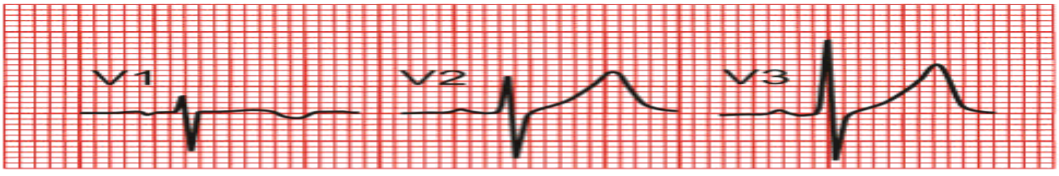
*These leads in the hospital are colored and labeled. You just need to put them in the right places.

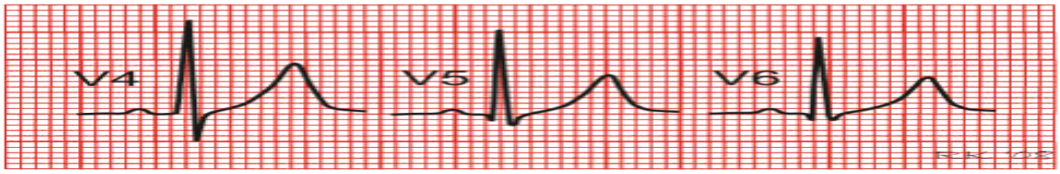
-V1→on the right 4th intercostals space
-V2→on the left 4th intercostals space
-V3→midway between V2 and V4
-V4→5th intercostal space (midcalvicular)
-V5→5th intercostal on the anterior axillary line
-V6→midaxillary and 5th intercostals space

*we can see that the recording started as negative recordings because the current vector here is against the direction of the current on the RA.



-Unipolar leads: (Slide 32, 33 is the same too)





This is a complete ECG: (slide 34) -

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