Physiology Team 431

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Cardiovascular System Block
The Electrocardiogram (ECG)

Lecture Objectives

1. Identify waves of the normal ECG and the physiological cause of each
2. Define the normal intervals in the ECG trace
3. Determine the bipolar, unipolar and chest leads

The Normal Electrocardiogram (ECG)

The depolarization wave spread through the heart

↓

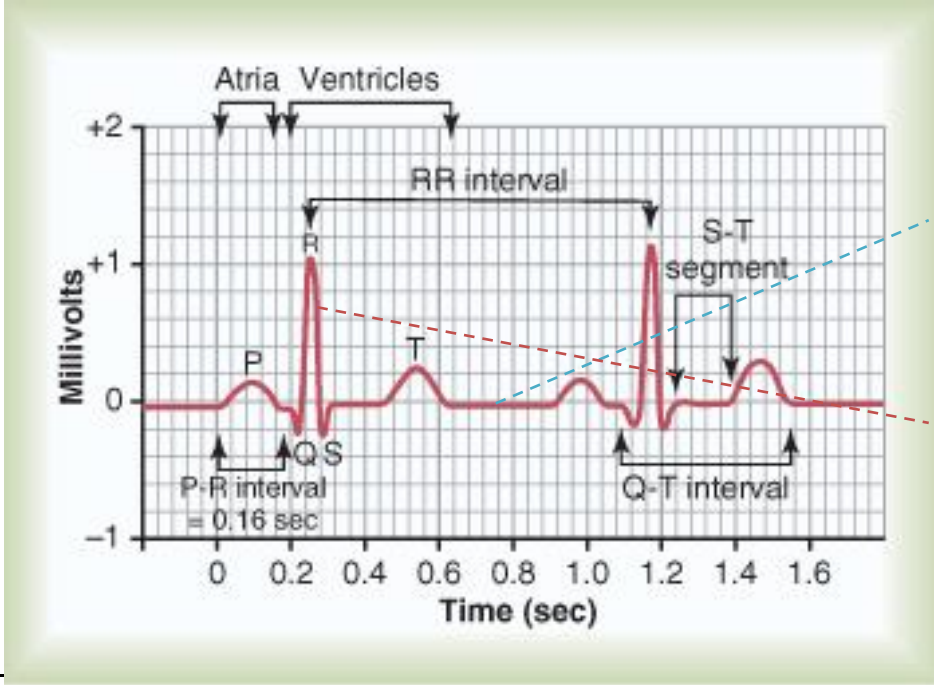
electrical currents pass into the surrounding tissue

↓

part of the current reaches the surface of the body

—The electrical potentials generated by these currents can be recorded from electrodes placed on the skin opposite the heart

—***The Electrocardiogram (ECG)*** **is a recording of the electrical activity of the heart**



Straight line means no electrical activity

In the QRS Complex: R is positive, While Q and S are Negative

—**P wave:** is caused by atrial depolarization

—**QRS complex**: is caused by depolarization of the ventricles

—**T wave:** repolarization of the ventricles

* Depolarization = Contraction "It could come both ways"

Voltage and Calibration of the ECG

The vertical calibration lines: Voltage(millivolt)

5 small lines = 1 mV

The horizontal calibration lines: Time (seconds)

1 inch(25 small lines) = 1 second

Each inch is divided by 5 dark vertical lines

The interval between the dark lines= 0.2 second

thin line=0.04 second

Further Explanation:

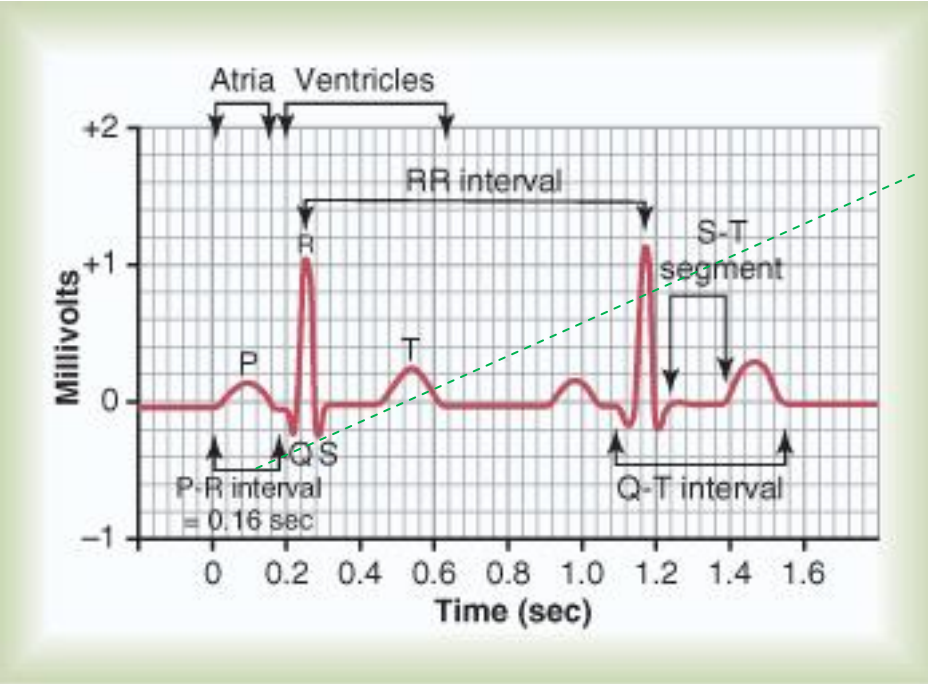
1 inch = 1 second [which is 25 small lines].

The interval between each small line is 0.04 sec.

Every inch(25 small lines) is divided into 5 groups by a dark line. Each group has an interval of 0.2 sec

P-R interval

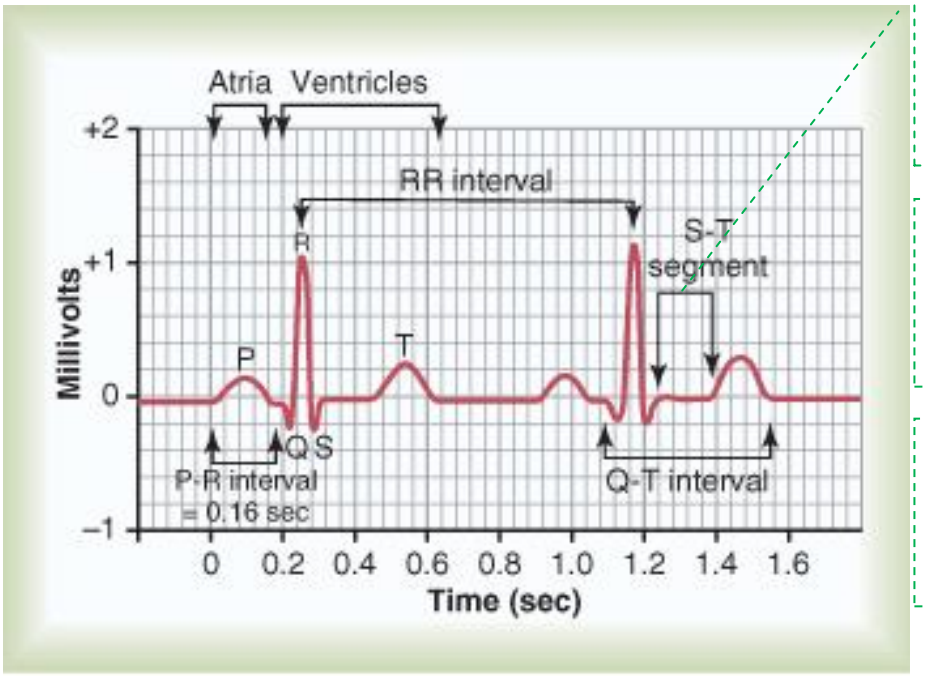
- It is the time between the beginning of the ***P wave*** and the beginning of the ***QRS complex***
- It is the interval between the beginning of electrical excitation of the atria and the beginning of excitation of the ventricles
- The P-R interval is about 0.16 second



If the P-R interval is prolonged → 1st degree of block of cardiac impulses

Q-T interval

- **Contraction of the ventricles last from the beginning of the Q wave to the end of the T wave**
- **Q-T interval is the time from the beginning of the *Q wave* to the end of the *T wave***
- **Q-T interval is about 0.35 second**



S-T segment from end of s wave to beginning of T wave

If there is prolonged Q-T interval → hypocalcaemia

If T wave is higher than normal → hyperkalemia

Any change in S-T segment → ischemic heart disease

If there is S-T segment depression → angina

If there is S-T segment elevation → myocardial infarction

Heart Rate

- **The heart rate is the repetition of the time interval between two successive heartbeats**
- **If the interval between 2 beats is 1 second , the heart rate is 60 beats per minute**

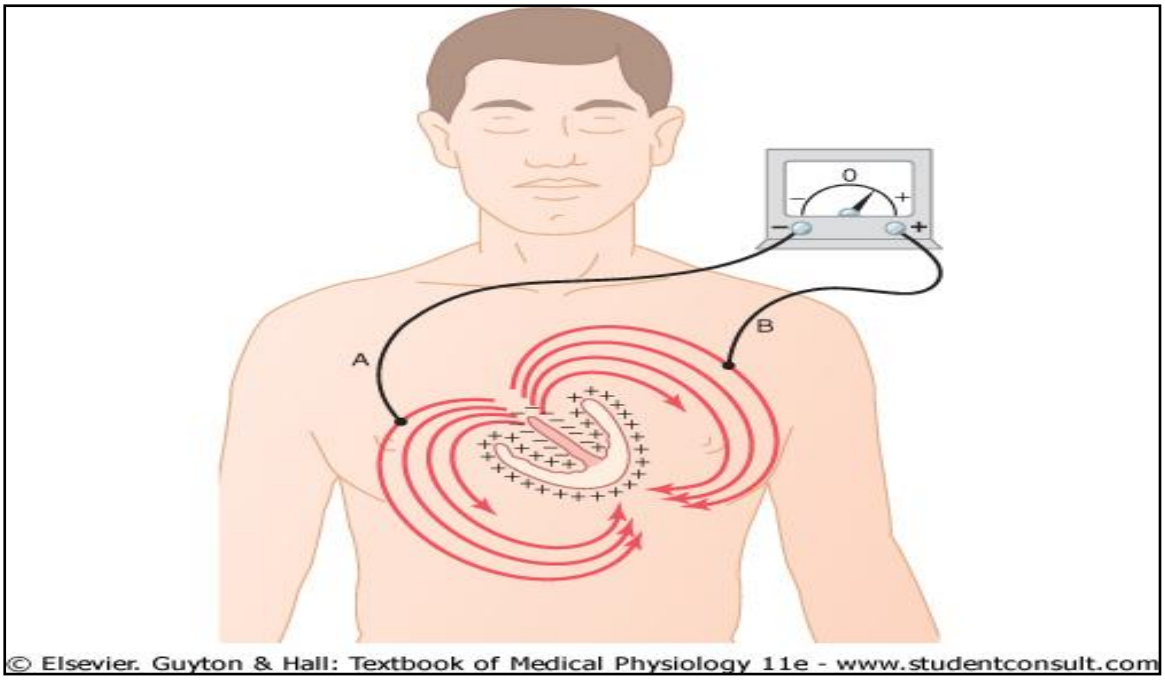
Methods for Recording Electrocardiograms

1- Computer-based and electronic display

2- Pen recorder and a moving sheet

Flow of Electrical current in the Heart

- In normal ventricles, current flows from ***negative*** to ***positive*** from the ***base*** of the heart toward the ***apex***
- Doesn't mean that it's negative in the base.
- It means that it begins to turn positive in the base of the heart leading up to the apex
- The first area that depolarizes is the ***ventricular septum***



- Current flows from the ***electronegative*** inner surface of the heart to the ***electropositive*** outer surface (from the ***base*** of the heart to the ***apex***)
- An electrode placed near the base of the heart is electronegative, and near the apex is electropositive
- An electrode is what we use to record the electrical activity.

The ECG Leads

- **Lead: two wires and their electrodes to make a complete circuit**

✓ **Types of Leads:**

- **The Bipolar Limb Leads: (I, II, III)**
- **Chest Leads: (V1, V2, V3, V4, V5, V6)**
- **Augmented Unipolar Limb Leads (aVR, aVL, aVF)**

So we have to place 12 leads on the patient, which are classified into 3 types. WHY?

So that we can look at the heart from all the different angles in order to get the most accurate recording.

The Bipolar Limb Leads

Bipolar: means that the ECG is recorded from two electrodes

—***Lead I:***

—***The right arm : –ve***

—***The left arm: +ve***

—***Lead II:***

—***The right arm: -ve***

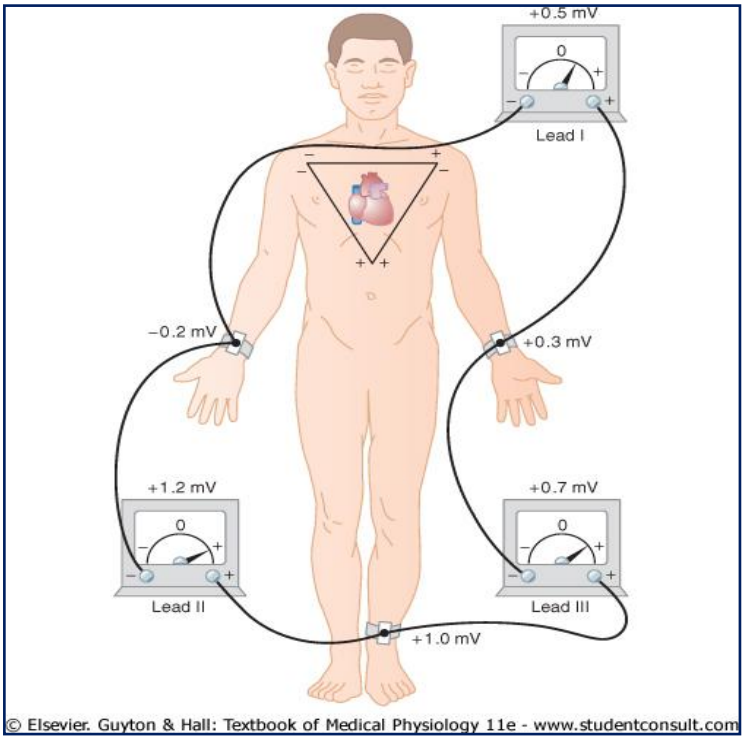
—***The left leg: +ve***

—***Lead III:***

—***The left arm: -ve***

—***The left leg: +ve***

Right leg is used for grounding

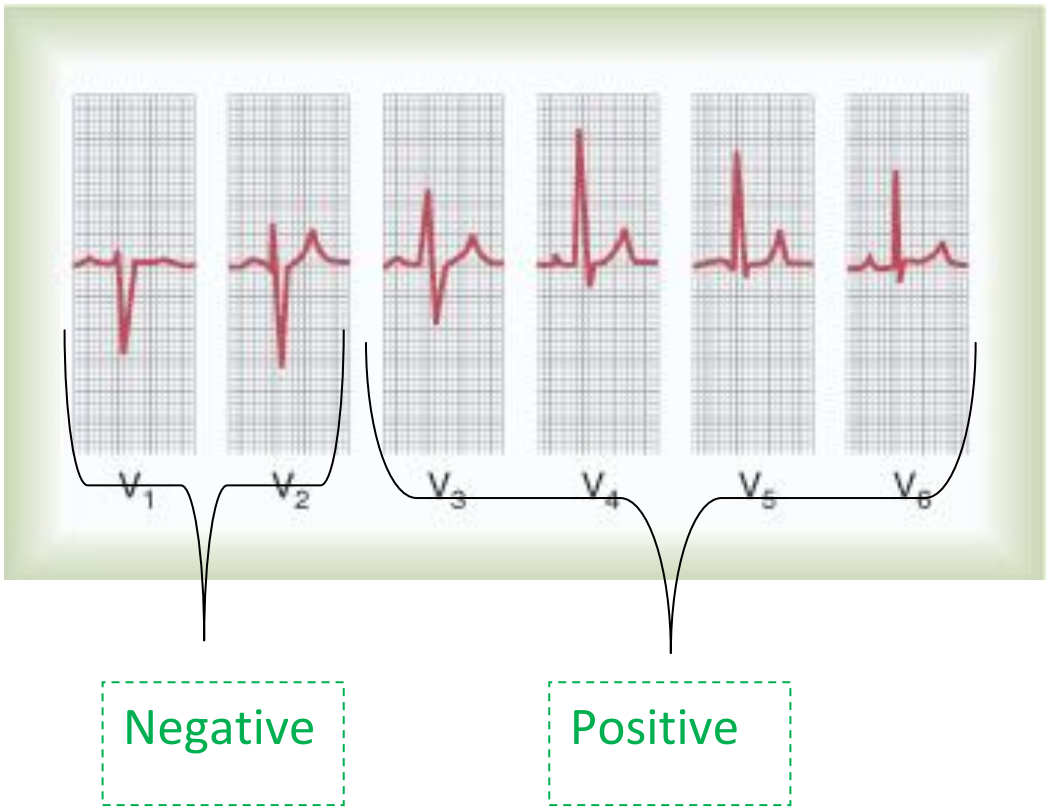


Chest Leads

- ✓ Recorded from the anterior surface of the chest (V1, V2, V3, V4, V5, V6)
- ✓ Positive electrode on the chest
- ✓ The *indifferent electrode* is the negative electrode connected to the right arm, left arm, and left leg

Not Important

- ✓ V1 and V2: QRS are mainly negative because the chest leads are nearer to the base of the heart
- ✓ V3,V4 and V6 are mainly positive because the chest electrode are nearer to the apex



Negative

Positive

Augmented Unipolar Leads

☒ The two limbs are connected to the negative terminal of the ECG, and the third limb is connected to the positive

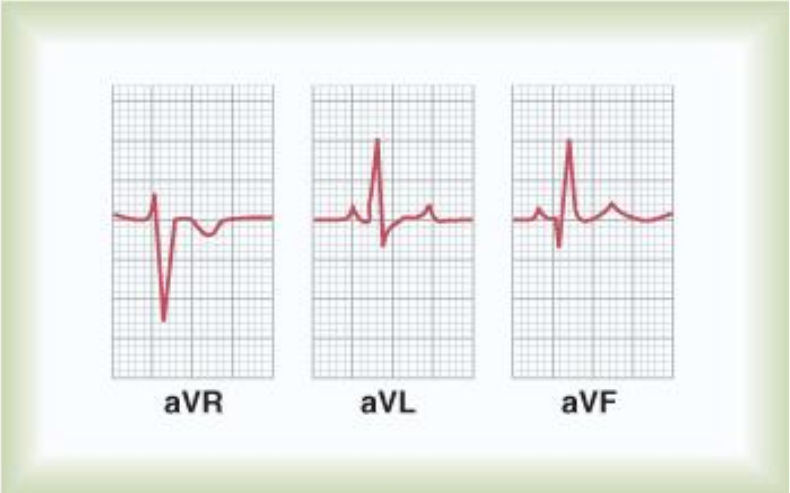
Not Important

☒When the positive terminal is on:

- The right arm (aVR)
- The left arm (aVL)
- The left leg (aVF)

☒All are similar to the standard limb leads

☒aVR lead is inverted



Practical use of the ECG

- Heart rate
- Normal intervals
- Rhythm
  - Regular
  - Single p-wave precedes every QRS complex
  - P-R interval is constant and within normal range
- Cardiac axis Axis

Einthoven's Triangle

The doctor said that Eithoven's Triangle is just for your information. So it's better if you go through it just in case

Questions:

The interval between the beginning of electrical excitation of the atria and the beginning of excitation of the ventricles is:

a) Q-T interval
b) P-R interval
c) R-R interval

In lead I :

a) The left arm –ve
b) The right arm –ve
c) The left leg +ve

In normal ventricles the first area that depolarized is :

a) The major ventricles
b) The basal ventricles
c) The ventricular septum