

# *Physics of Medical Devices*

## *Eighth Lecture*

### *ECG: Electrocardiography*

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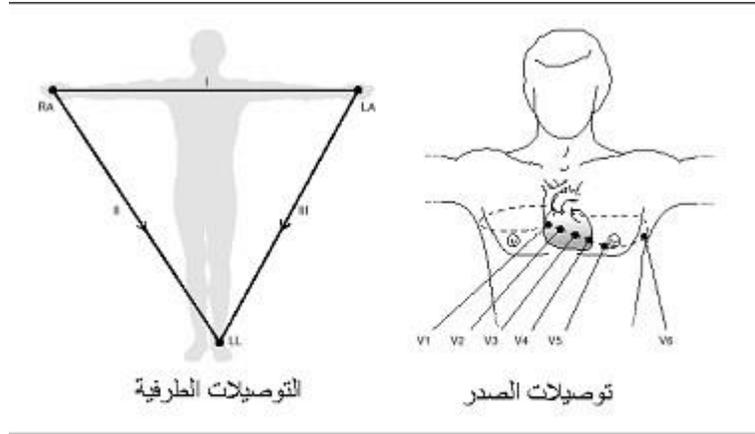
## **ECG: Electrocardiography**

The electrocardiograph is one of the basic medical devices that are available in clinics and hospitals. On this device, doctors rely on the initial diagnosis of heart work .

(ECG) Electrocardiography which is captured from the surface of the body using electrodes And display it on the display screen or print it on paper designated for that .For the standard recording of the heart signal, we need five electrodes installed in different places of the patient's body, and to avoid error in connecting the electrodes, it was agreed on the colors that distinguish the wires that connect with each of the electrodes, which are:

- 1- The right arm - Right Arm (RA) is white**
- 2- The left arm – left Arm (LA) is black**
- 3- The right foot – Right Leg (RL) is green**
- 4- The right foot Left Leg (LL) -is green**
- 5- The chest Chest ( C) is brown**

Connect these terminals to the input of a difference amplifier through the connection picker (Lead Selector) . The right foot( RL) is used as a joint pole and the connection picker works Connect the appropriate polarities to the two inputs of the differential operation amplifier .



شكل ١.١ توصيلات الأقطاب

The ECG signals that we get through two different pairs of electrodes have different waveforms and heights, depending on the chosen delivery method (Lead).

**Electrode connections are divided into three types:**

**1- Biopolar Limb Lead :**

Symbolizes it Lead III, Lead II, Lead I. This type represents the most famous placement of poles on the body and is called a triangle Einthoven Triangle.

**First contact (Lead I):** The left arm (LA) is connected to the non-reflective (positive) side of the amplifier input, and the right arm (RA) is connected to the negative reflective side.

**Second contact (Lead II) :** The left foot (LL) is connected to the non-reflecting side of the amplifier input, while the right arm (RA) is connected to the reflective side and it is connected LA with RA.

**Third contact (Lead III) :** The left foot ( LL) is connected to the non-reflective side of the amplifier input, and the left arm ( LA) is connected to the reflective side. And it is connected *RL* with *RA*.

## **2- Unipolar Limb Lead :**

### **AVR Connection (Lead AVR):**

The right arm RA connects to the non-reflective entrance while the left arm LA and left foot LL are combined and connected to the reflective entrance.

### **AVL Connection (Lead AVL):**

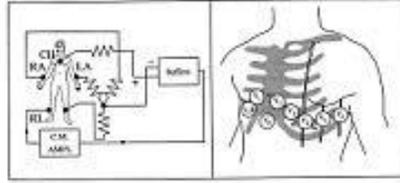
The left arm LA is connected to the non-reflecting entrance, while the right arm RA and the left foot LL are combined and connected to the reflective entrance.

### **AVF Connection (Lead AVF):**

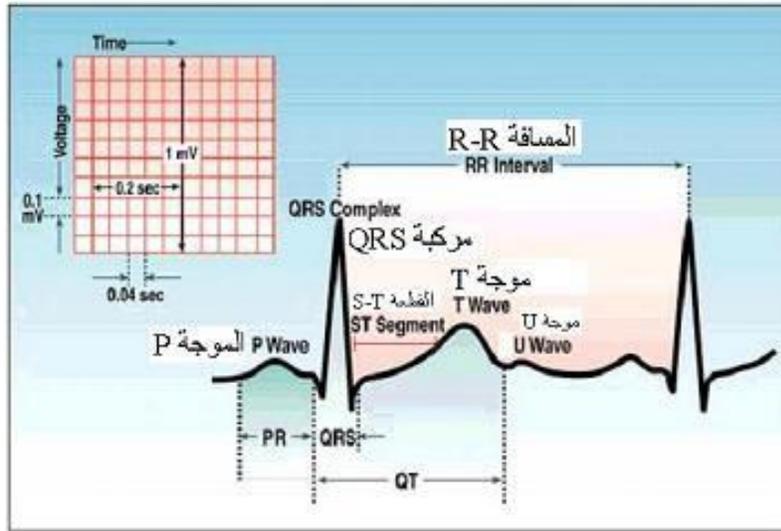
The left foot LL is connected to the non-reflecting entrance while the right arm RA and the left arm LA are combined and connected to the reflective entrance.

## **3- Unipolar Chest Lead :**

This is the third type of electrode connections, which is denoted by the symbol (V1-V6) Leads V, It consists of six locations spread over the rib cage, one of which connects to the non-reflective entrance of the amplifier, while the three terminal poles ( RA, LA, LL ) are collected by means of a network of Wilson's resistors, and the total connects to the reflective entrance of the amplifier.



شكل (١.٢) التوصيلات الصدرية أحادية القطب Unipolar Limb Lead



شكل ١.٣ إشارة مثالية لتخطيط القلب ECG

### Heart rate calculation

1- **HR = 1500** divided by the number of large squares sandwiched between two successive R waves.

2- **HR = 60** divided by the time between two successive R waves.