ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
Approved by AICTE and affiliated to Anna University Chennai (An ISO Certified Institution)
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DEPARTMENT OF BIOMEDICAL ENGINEERING

BM3491 Biomedical Instrumentation

UNIT-II BIOSIGNAL CHARACTERISTICS

2.2 Einthoven's triangle, standard 12 lead system.

ECG Electrodes:

1. Electrocardiography (or) Electrokardiography deals with the recording and study of electrical activity of the heart muscles.
2. The potentials originated in the individual fibers of heart muscles are added to produce the ECG waveform.
3. The ECG waveform reflects the rhythmic electrical depolarization and repolarization of the heart muscles associated with the contractions and relaxation of the atrium and ventricles.
4. The electrocardiogram gives details of the state of the heart and any disturbance in the heart rhythmic (arrhythmia) can be diagnosed. The typical ECG wave consists of P wave, QRS complex and T wave.
5. The electrical potentials of the heart are measured by placing suitable electrodes. Either surface electrodes with proper electrode paste or needle electrode can be used. ECG Lead system: There are four different ECG lead systems used universally,
    i. Bipolar limb lead (or) standard lead system
    ii. Augmented limb lead system
    iii. Chest lead (or) Pre-cordial system
    iv. Frank lead system (or) corrected orthogonal lead system

bipolar limb leads:

In bi polar limb leads system ECG is recorded with two electrodes at a time. The final trace is due to difference in potential of 2 electrodes kept at 2 different locations on the body. This is also called the standard lead system. For this system, the potentials are tapped from 4 locations of the body namely,

i. Right arm – white colour electrodes
ii. Left arm – Black colourelectrodes
iii. Right leg – Green colourelectrodes
iv. Left leg – Red colourelectrodes

The right leg electrode is used as reference electrode. The three different leads of the system are,

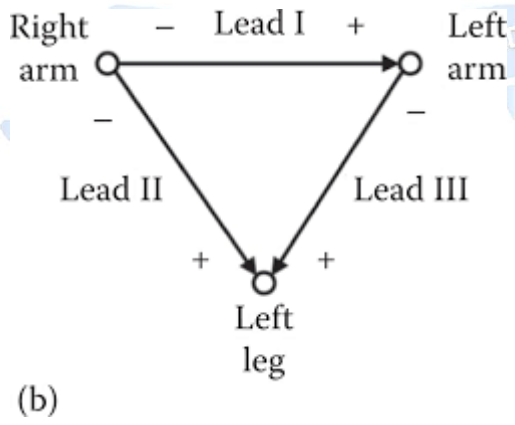
Lead I - V1 (Voltage drop from left arm (LA) to right arm (RA)

Lead II - V2 (Voltage drop from left leg (LL) to right arm (RA)

Lead III - V3 (Voltage drop from left leg (LL) to left arm (LA)

The closed path between RA to LA to LL and back to RA is called the **Einthoven triangle.**

The bipolar limb leads are those designated lead I, lead II, and lead III and form what is called the ***Einthoven triangle***.



Einthoven Triangle

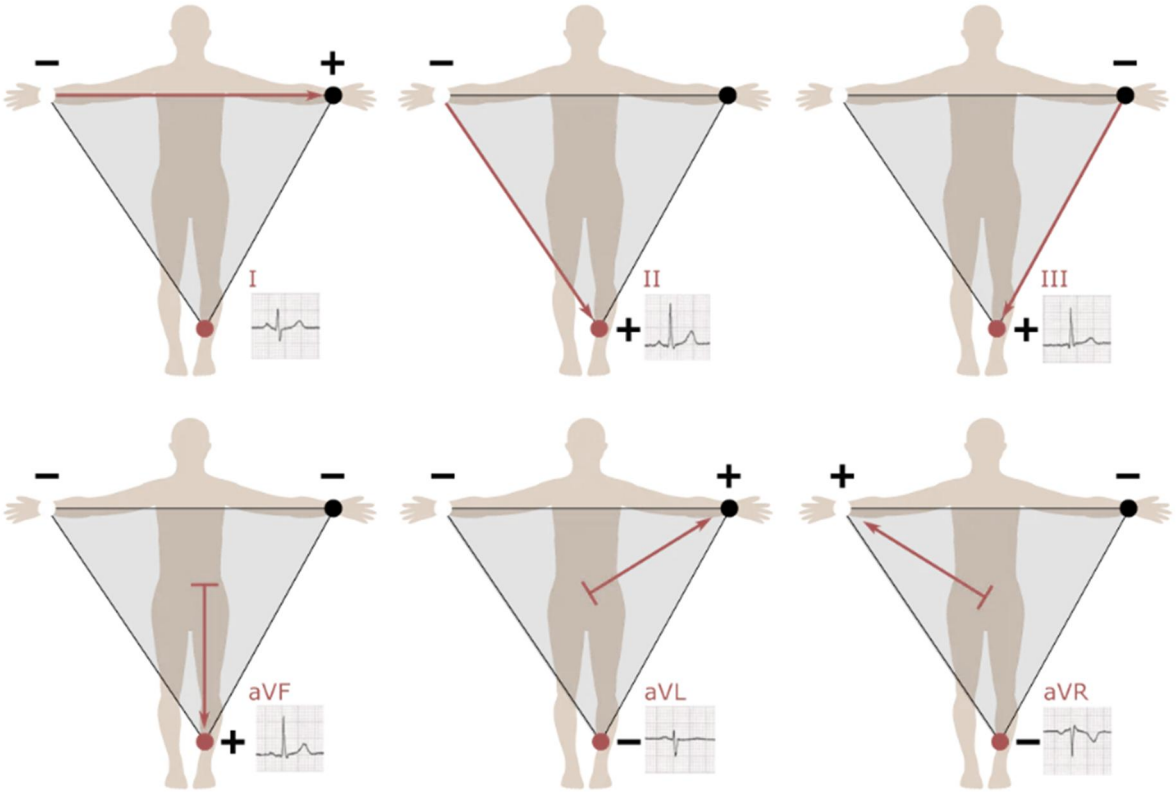
R wave amplitude of lead II is equal to sum of R wave amplitude of leads I and leads III.

For example, if V1 = 0.5 mV, V2 = 0.7 mV, then,

V3 = 0.2 mV. (i.e) V2 = V1 + V3.

2. Augmented Unipolar Limb leads:

This type of lead system is introduced by Wilson. ECG trace is due to potential between single measuring electrode and central reference electrode. The central reference



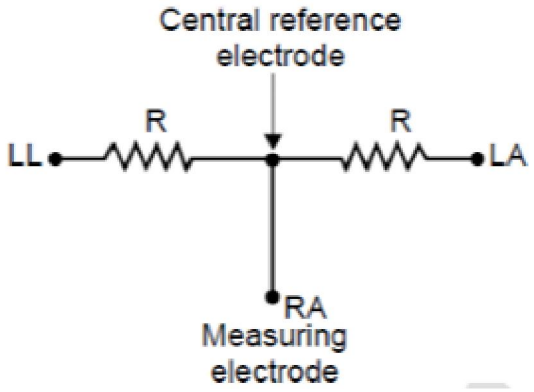
electrode is built up by tying two electrodes with two equal and large resistors in between them. A pair of limb electrodes is tied up with 2 large resistors to make the central reference electrode and the third limb electrode is the measuring electrode.

Leads I, II, and III require a negative and positive electrode (bipolarity) for monitoring. On the other hand, the augmented leads-aVR, aVL, and aVF-are unipolar and requires only a positive electrode for monitoring.

aVR – augmented voltage RA

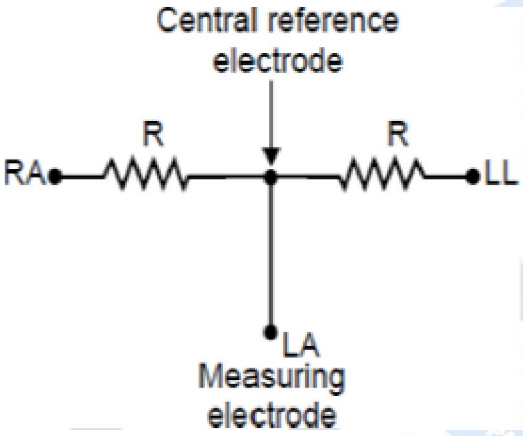
aVL – augmented voltage LA

aVF – augmented voltage foot



By Kirchoff's law, aVR = -V1 – V3/ 2

aVL = V1 – V3/ 2



aVF = V2 – V2/ 2

3. **<u>Unipolar chest lead</u>**:

i. In Unipolar chest leads system, in addition to electrodes present in augmented Unipolar limb leads there are two more electrodes placed in the chest, close to heart.

ii. By connecting 3 large equal resistors between LA, RA and LL reference electrode centre point obtained, this is the central electrode.

iii. This system includes an integration of **3 unipolar leads, 3 bipolar leads and 6 chest leads.**

iv. Location of chest leads (V1 till V6)

V1 – 4th intercoastal space at right sternal margin

V2 – 4th intercoastal space at left sternal margin

V3 – Midpoint of V2 and V4

V4 – 5th intercoastal space at mid-clavicular line

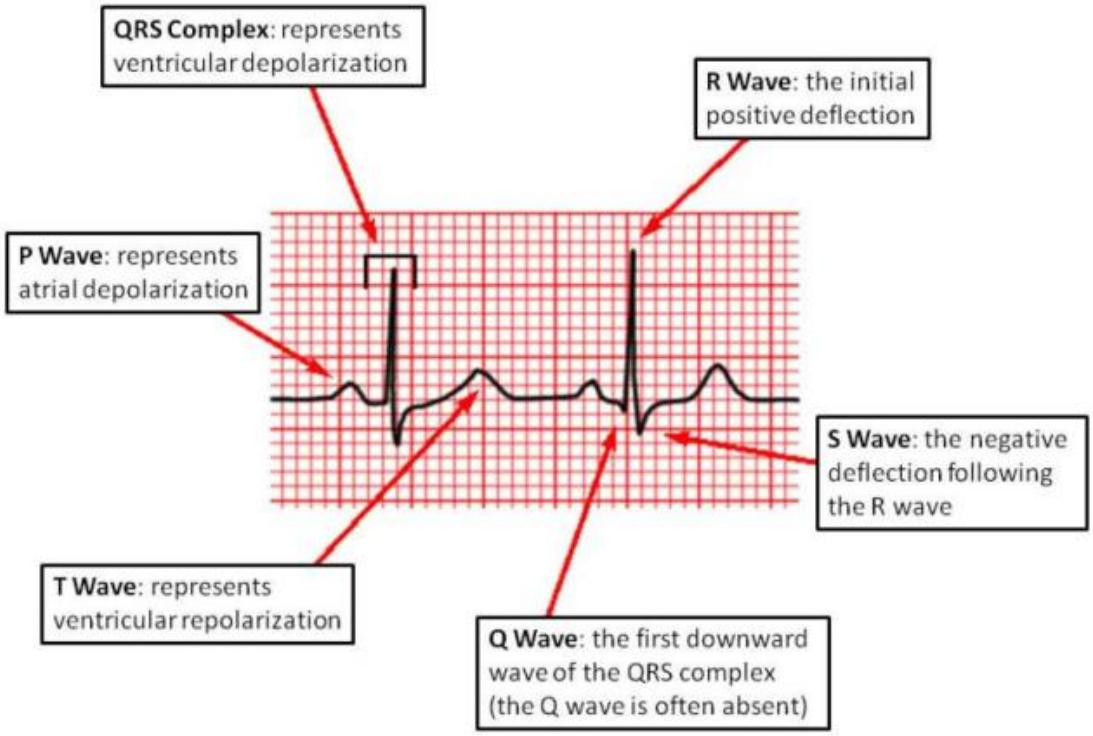
V5 – Same level as V4 - anterior auxiliary line

V6 – Same level as V4 - Mid auxiliary line

4**. Frank lead system**:

Same as chest lead system. Heart's dipole field is resolved into three mutually perpendicular components and hence state of heart is studied three dimensionally.

ECG wave and complexes: Every ECG wave is represented as PQRST complexes wherein P represents the atrial depolarization, QRS represents the ventricular depolarization and T represents the ventricular repolarization.



Skin Preparation:

Skin is a poor conductor of electricity and therefore skin resistance plays a critical role in acquisition of ECG trace quality.

To reduce resistance at the skin and ECG electrode contact following steps are to be taken

1) If needed excessive hair on the skin must be removed with water, soap and non-alcohol wipes.

2) The skin must be dry and free from dead cells and oil.

3) Dry the Skin vigorously to increase the Capillary blood flow of the tissue.

4) Electrodes must be full contact with the skin.

5) Choose proper position of electrodes based on manufacturer's recommendation.

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