Electrocardiogram

① The electrical activity (action potential) of the heart can be transmitted to the surface of body through body fluids as the body fluids are good conductors.

② The sum of the action potential of the heart can be recorded by placing electrodes on the surface of the body with the help of a machine called Electrocardiograph. The record is called Electrocardiogram (ECG).

③ ECG record helps to determine the following

(a) Abnormal Conducting Pathway

(b) If the heart is enlarged

(c) Heart Damage

(d) Cause of Chest pain

(4) Recording of ECG

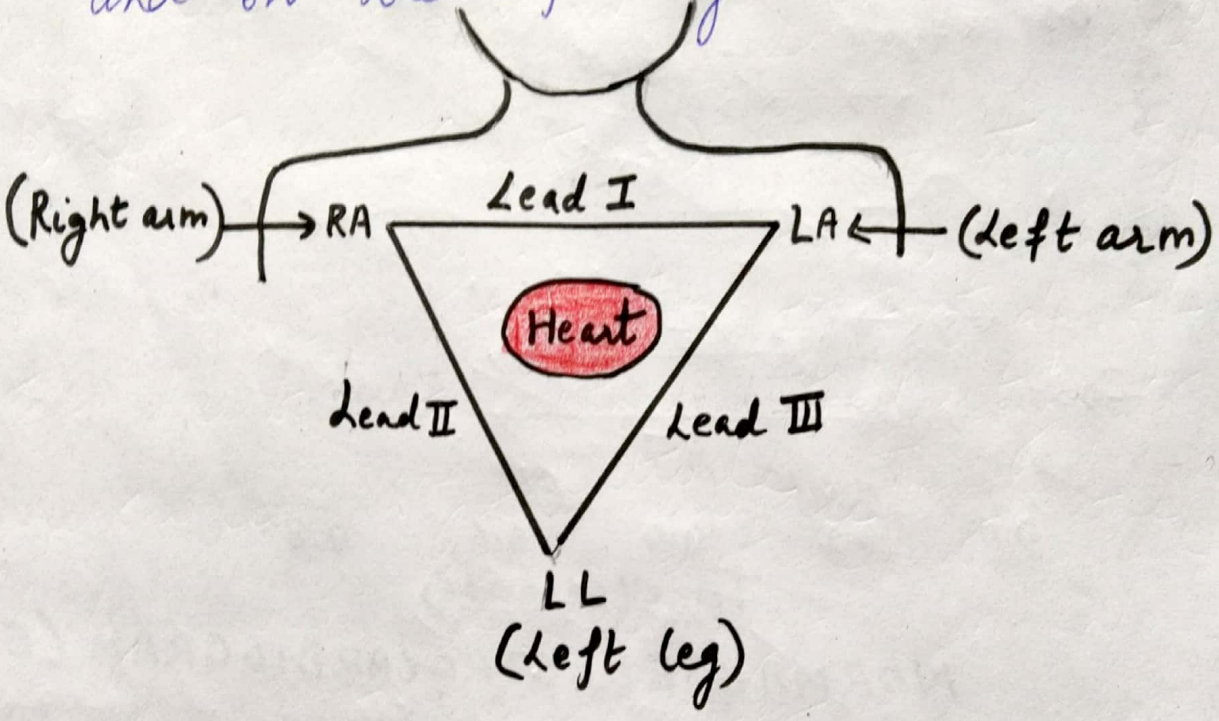
(a) To record ECG electrodes are placed on the arms and legs (limb leads) and at six position on the chest (chest leads)

(b) ECG leads (electrodes) are of two types

(i) Unipolar Leads (electrodes) in which one electrode is kept at zero potential and the other is the active or exploring electrode. The recording with such an electrode is called Unipolar recording.

(ii) Bipolar leads (electrodes) in which there are two active or exploring electrodes. The two active electrodes are placed on any two limbs and the potential difference is measured which is the algebric sum of the potentials of the two active electrodes. The recording using two active electrodes is called bipolar recording. These were the earliest leads used (William Einthoven, 1860-1927)

A triangle with the heart at the center (Einthoven's triangle) can be approximated by placing electrodes on both arms and on the left leg.



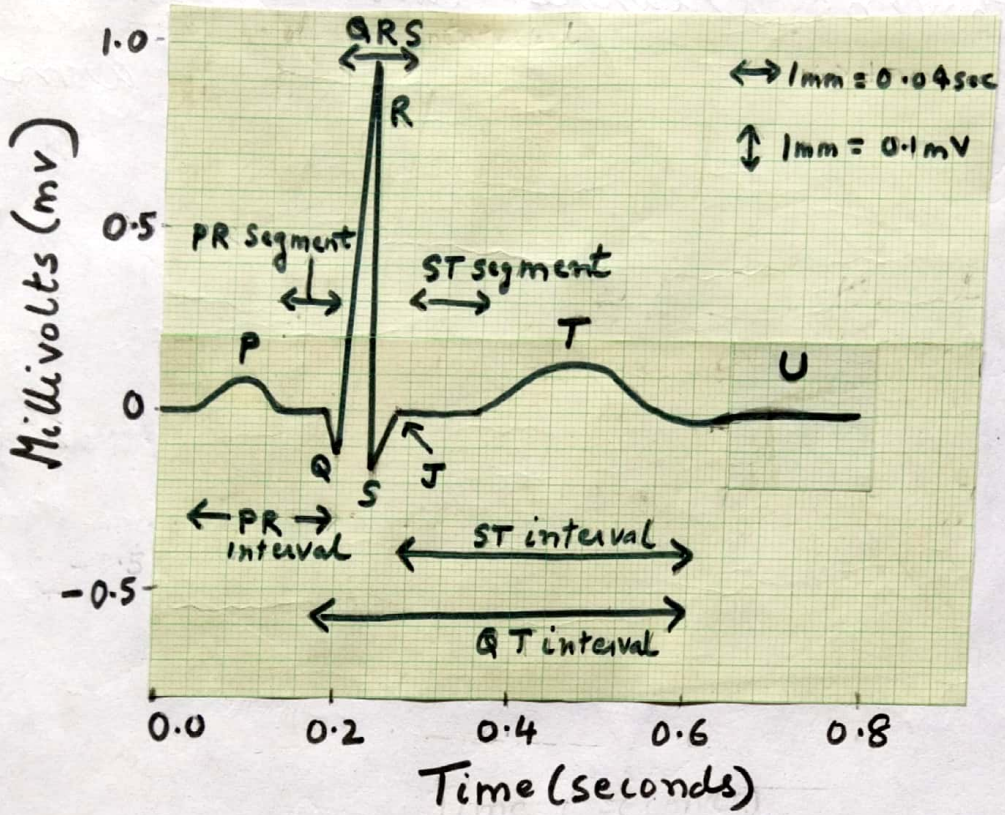
EINTHOVEN TRIANGLE

Einthoven Law : It states that the sum of the potentials recorded in leads I and III will equal the potential in lead II

[I + III = II]

(c) The 12-lead ECG gives information about the chamber size, orientation of the heart. It also evaluates arrhythmias, conduction abnormalities, progress of myocardial ischemia and infarction.

(5) ECG Components.



NORMAL ELECTROCARDIOGRAM (ECG)

(a) A normal ECG contains waves, segments, intervals and one complex.

(i) Wave :- It is a positive or a negative deflection from baseline indicating a specific electrical activity. ECG waves are 'P' wave, 'Q' wave, 'R' wave, 'S' wave 'T' wave and 'U' wave.

(ii) Segment :- Length between two specific points on an ECG which are at a baseline (neither positive or negative)

Segments in an ECG are "PR segment", "ST segment" etc.

(iii) Interval :- It is the time between two specific events in an ECG. The ECG intervals are shown below

	INTERVAL	NORMAL AVERAGE DURATION (seconds)
1.	PR interval	0·18
2.	QRS interval	0·08
3.	QT interval	0·40
4.	ST interval	0·32

(iv) Complex – Multiple waves grouped together is called a complex. In the ECG there is one main complex called the "QRS complex".

(v) Point – In an ECG there is a single point called "J" point. It is the point where the QRS complex ends and the ST segment begins.

(b) A typical ECG record shows the following:

(i) "P wave" :- Also called atrial complex. It represents atrial depolarization, which spreads from SA node to both the atria. Duration is 0.11 s; Amplitude usually less than 2.5 mm.

(ii) PR segment :- It extends from the end of P wave to the start of QRS complex. Normally it is isoelectric.

(iii) PR or PQ interval if Q wave is present. It is the interval between start of P wave upto the start of QRS complex. It represents the atrioventricular (AV) Conduction time. Normal duration is 0.12 to 0.2 seconds

(iv) "QRS complex" :- It starts as a downward deflection, then continues as a long upright triangular wave and finally ends as a downward wave. The QRS complex represents ventricular depolarization. Its duration is ≤ 0.08 seconds and its amplitude is 1.5 - 2.0 mV.

(v) J point :- It occurs at the end of the QRS complex. At this particular point the entire Ventricular muscle is depolarized.

(VI) "T wave" :- It is a dome shaped upward deflection which represents Ventricular repolarization. Its duration is 0.10 to 0.25 seconds and its amplitude is less than 5mm usually.

(vii) ST segment :- It starts at the end of "S" wave and ends at the beginning of the "T" wave. It represents the time when the ventricular contractile fibres are depolarized. Normally it is isoelectric.

(viii) ST interval :- It is measured from the end of "S" wave till the end of "T" wave. It represents ventricular repolarization and its duration is 0.32 seconds.

(ix) QT interval :- It is measured from beginning of "Q" wave to the end of "T" wave. Its duration is 0.40 - 0.43 seconds. It represents ventricular depolarization and repolarization.

(x) "U" wave :- It is seen in some individuals after "T" wave and possibly due to slow repolarization of the intraventricular contracting system. It represents the last phase of ventricular repolarization.

⑥ Clinical application of ECG

ⓐ Basis of ECG interpretation is formed upon recognizing the abnormalities in the size, shape, pattern and timing of the waveforms

ⓑ ECG is a diagnostic tool routinely used to assess the electrical and muscular functions of the heart

ⓒ Clinicians can identify many cardiac diseases by examining the changes from normal on the ECG.

(i) First degree heart block :- All the atrial impulses reach the ventricles but the PR interval is abnormally long (>0.20 seconds).

(ii) Second degree heart block :- Not all the atrial impulses are conducted to the ventricles. For example, a ventricular beat follows every second or third atrial beat. (2:1 block or 3:1 block, etc)

(iii) Third degree or complete block :- Here the conduction from the

atria to the ventricles is completely interrupted. The ventricles beat at low rate (idioventricular rhythm) independently of the atrial beat.

(iv) Myocardial infarction :- ST segment elevation with inverted T wave. Q wave may be prominent in some.

(v) Hypokalemia :- Prolongation of the PR interval, ST segment is depressed, T wave is inverted and prominent U wave.

References

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