**SNS COLLEGE OF ALLIED HEALTH SCIENCES**

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

## DEPARTMENT OF CARDIAC TECHNOLOGY- I YEAR

## PAPER III- BASIC ELECTROCARDIOGRAPHY

# UNIT I : BASICS PRINCIPLES OF ECG

# ELECTROCARDIOGRAM

1. Introduction
2. History
3. Technical Aspects
4. Normal Electrocardiogram
5. Physiological Basis
6. Systematic Interpretation
7. Clinical Applications

# Introduction

- Definition:

Electrocardiogram is the graphic record of electrical activities of the heart obtained by placing electrodes on the surface of the body that records the voltage differences generated by the heart.

- Electrocardiography
- Electrocardiograph
- Electrocardiogram

# History

- Word Electrocardiogram is derived from Greek meaning:

  Electro- related to electrical activity

  Cardio(kardio)- heart

  Graph- to write

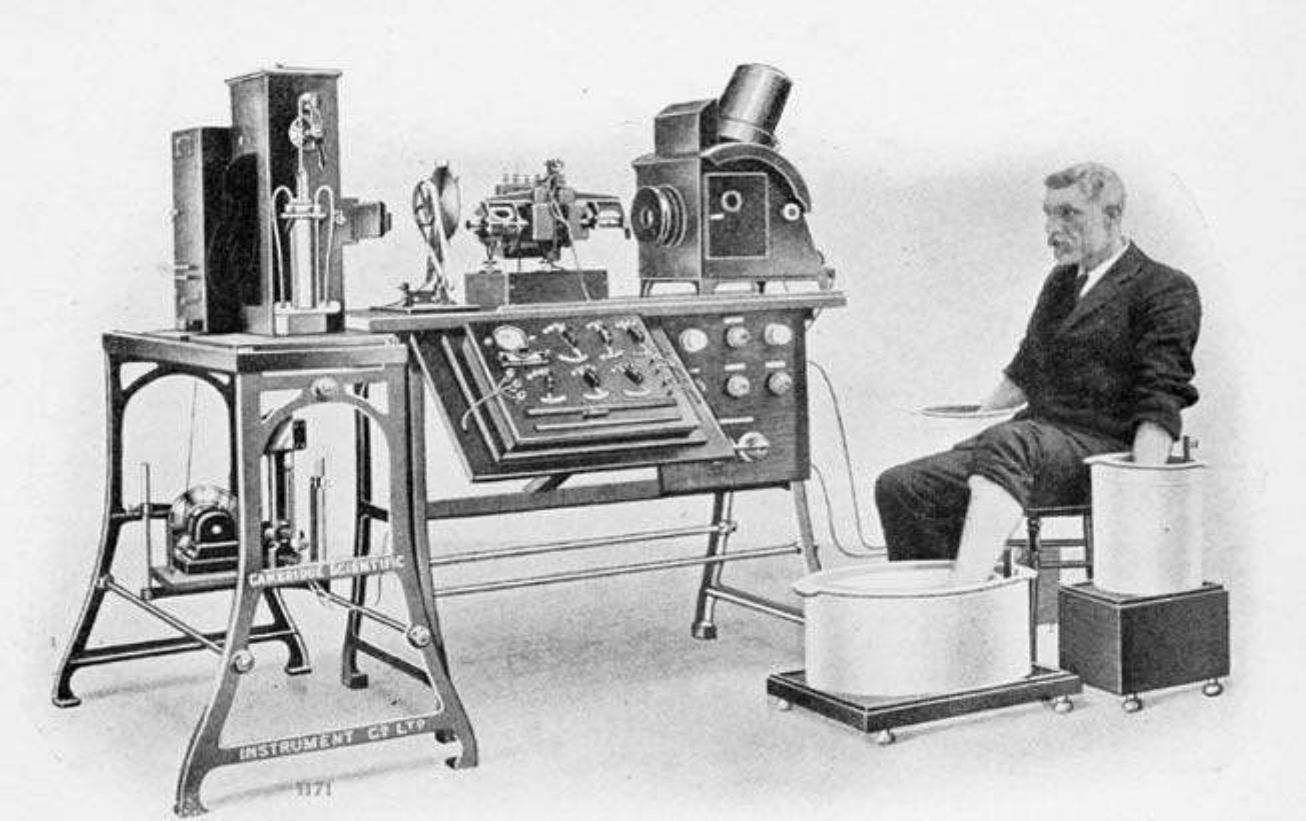
# **Augustus Desiré Waller** (1856 –1922)

- First to record electrical potential associated with beating heart from the human body surface (1887-1888).

# Willem Einthoven (1860-1927)

- Invented string galvanometer in 1901.
- In 1924, he was awarded Nobel prize for inventing the first practical system of electrocardiography.

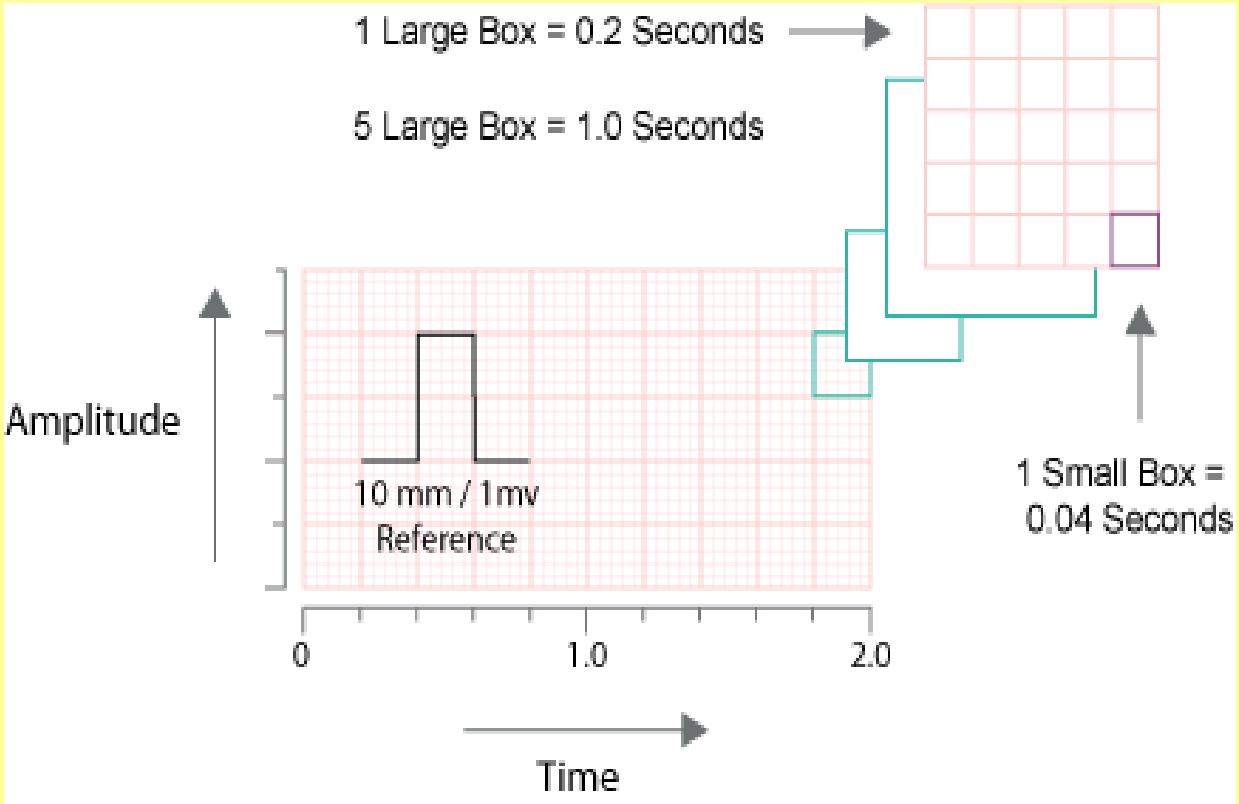
# An early ECG device




PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

# Technical Aspects

# ECG paper


1 Large Box = 0.2 Seconds
5 Large Box = 1.0 Seconds
Amplitude
10 mm / 1mv
Reference
1 Small Box =
0.04 Seconds
0
1.0
2.0
Time

# ECG leads

- Direct leads
- Indirect leads
  - Limb leads
  - Chest leads
  - Esophageal leads

# ECG leads

- Limb leads: Bipolar & Unipolar Leads
  - ❖Lie in frontal plane

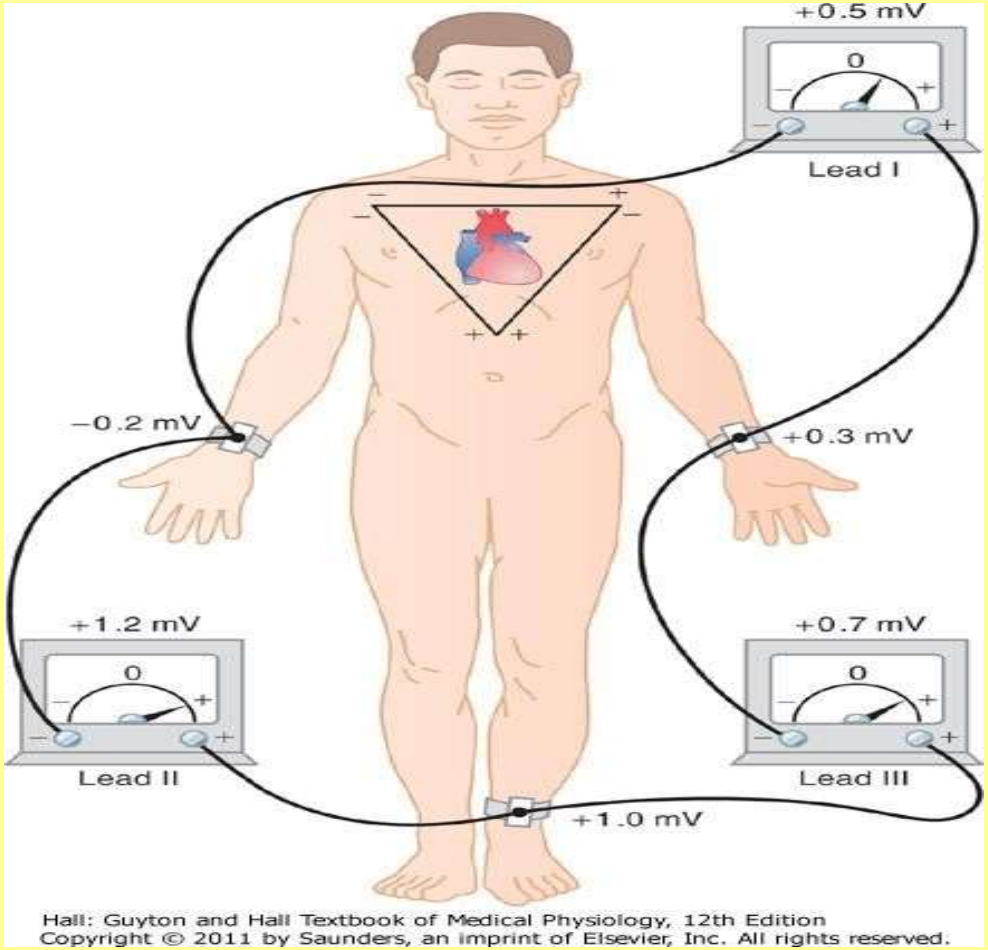
Bipolar leads

Lead I- between right arm(-ve) and left arm(+ve)

Lead II- between right arm(-ve) and left leg(+ve)

Lead III- between left arm(-ve) and left leg (+ve)

# Einthoven Triangle



# Einthoven's Law

- If the electrical potentials of any two of the three bipolar limb electrocardiographic leads are known at any given instant, the third one can be determined mathematically by summing the first two.
- The positive and negative signs of the different leads must be observed when making this summation.

- According to Kirchoff's law:

  L I+L II+L III=0

- Einthoven deliberately reversed lead II to get positive QRS deflections in all three leads.
- With Einthoven's system Kirchoff's law becomes

  L I-L II+L III=0 (or)

  L I+L III=L II

# Unipolar Leads

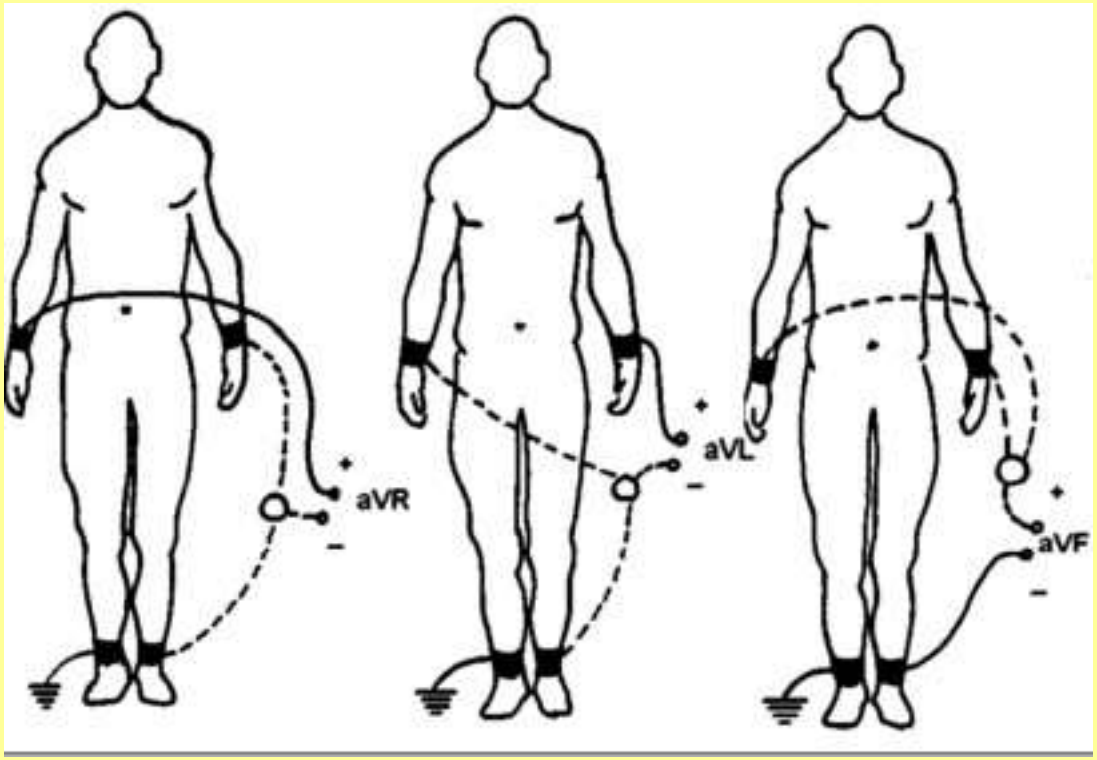
- Unipolar limb leads (Wilson leads)
  - VR,VL,VF
- Augmented limb leads
- Unipolar chest leads

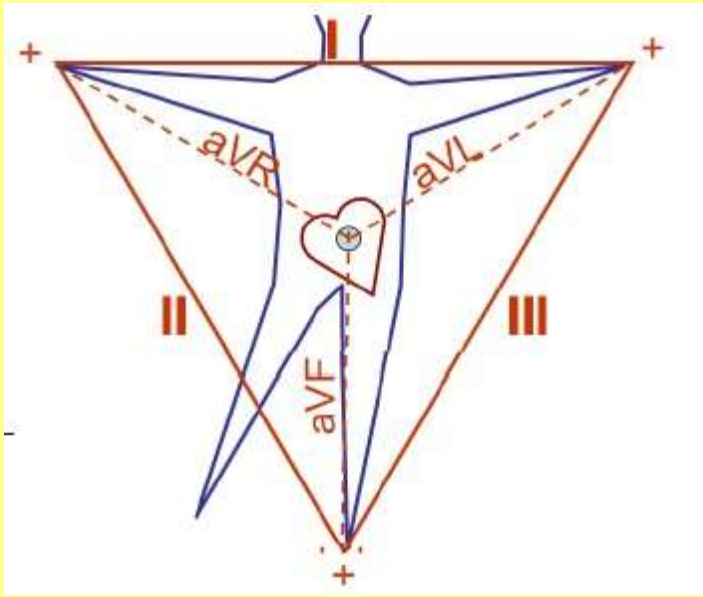
# Augmented Limb Leads

- aVR, aVL and aVF

| Active electrode | Indifferent electrode | Lead |
|---|---|---|
| RA | LA & LF | aVR |
| LA | RA & LF | aVL |
| LF | RA & LA | aVF |

# Augmented Limb Leads



# Unipolar Chest Leads (Precordial leads)

- Lie in transverse plane or horizontal plane

❑Usually six standard chest leads are recorded:

**V1**: 4th intercostal space to the right of the sternum

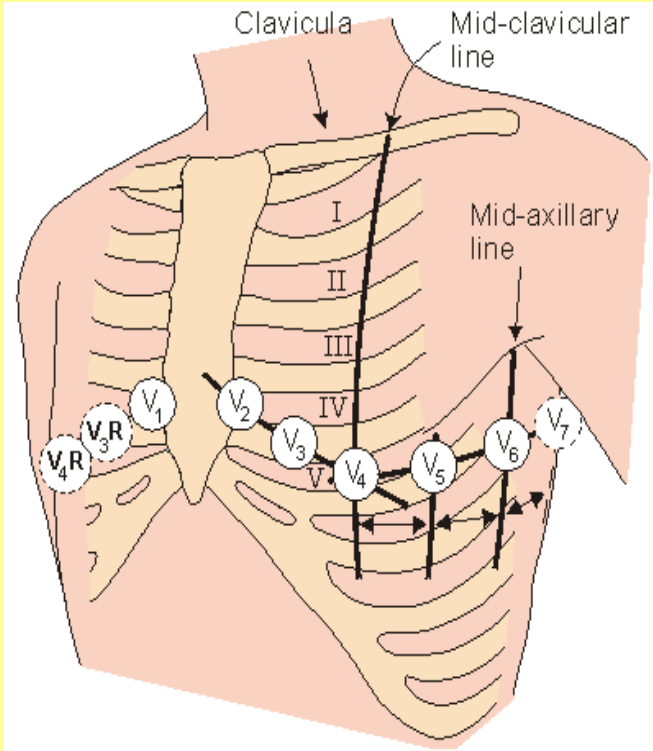
**V2**: 4th intercostal space to the left of the sternum

**V3**: halfway between V2 and V4

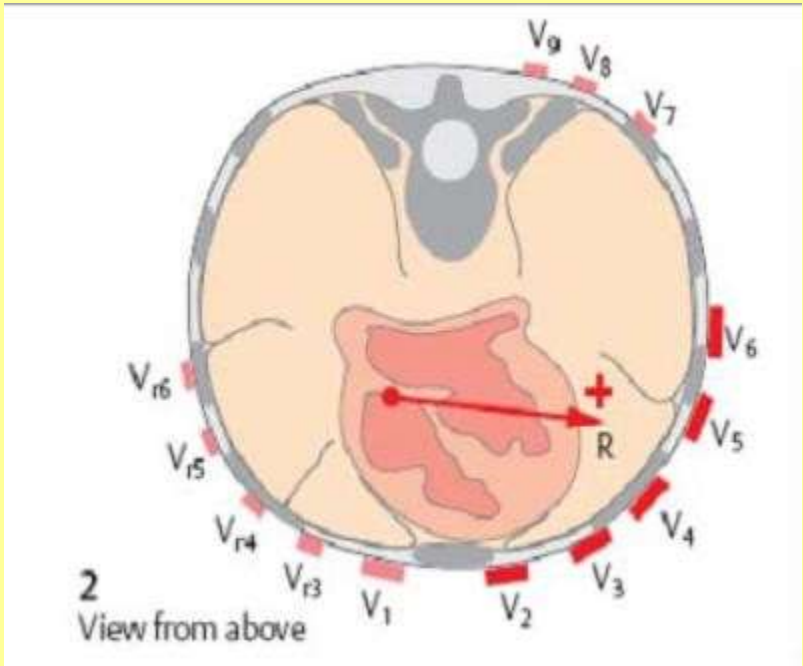
**V4**: 5th intercostal space at the midclavicular line

**V5**: halfway between V4 and V6

**V6**: 5th intercostal space at the midaxillary line



# Special Leads



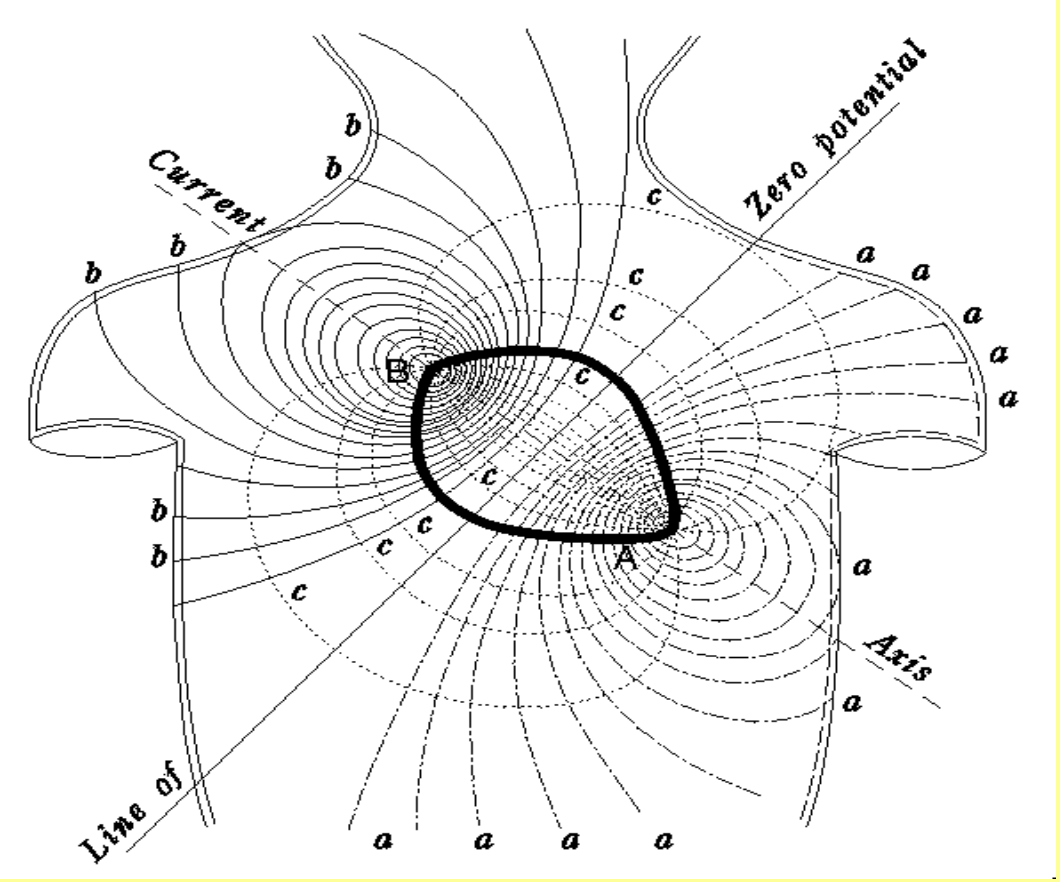

- V7- left 5th intercostal space on the posterior axillary line.
- V8- left 5th intercostal space on the posterior scapular line
- V9- left 5th intercostal space on the back at the left border of spine
- Right sided ECG: V2 and V1 remain in the same place.
- V3R to V6R placed on the same place as V3 to V6 but on the right side of chest.
- Intracardiac leads (Endocardiac leads)

# Esophageal leads

- E15-25 : Record the activity of right atrium
- E25-35 : Record the activity from AV groove region
- E40-50 : Record the activity from posterior surface of left ventricle

# Physiological Basis

# Electric field of the heart on the surface of the thorax, recorded by Augustus Waller (1887).




The curves (a) and (b) represent the recorded positive and negative isopotential lines, respectively.

These indicate that the heart is a dipolar source having the positive and negative poles at (A) and (B), respectively.

The curves (c) represent the assumed current flow lines..

# Systematic interpretation

## *Heart Rate*

- If the heart rate is regular
  - Rate = 300/No. of large squares in RR interval
  - Rate = 1500/No. of small squares in RR interval

## *Cardiac rhythm*

- Normal rhythm is regular

# Waves and Intervals

- P wave
  - Does not exceed 0.10s in duration or 2.5mm in height
  - Abnormal in atrial enlargement (tall peaked P wave) and intra-atrial conduction abnormalities

# Waves and Intervals

- PR Interval

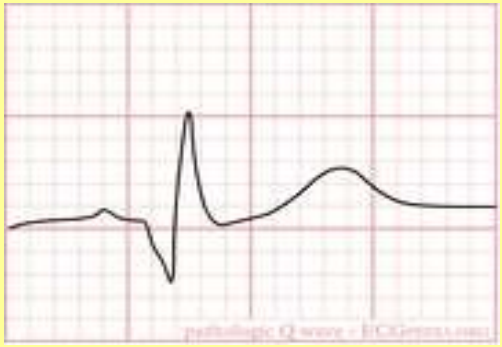
  Normal PR interval is 0.12 to 0.20secs

# QRS Complex

- Amplitude
  - In limb leads should be 5mm or more
  - In chest leads should be 10mm or more
- Low amplitude
  - ✓ Marked emphysema
  - ✓ Pericardial effusion
  - ✓ Cardiomyopathy
- High amplitude
  - ✓ Ventricular hypertrophy

# Q wave

- Small in L I, aVL, V5, V6
- Deep in lead III
- Pathological Q waves
  - ✓Acute or old MI
  - ✓Unstable angina
  - ✓Dilated cardiomyopathy
  - ✓Hypertrophic cardiomyopathy



# ST Segment

- Normal ST segment is isoelectric
- ST elevation is upto 1mm in limb leads & V5 & V6 and 2mm in V1- V4 is normal
- ST depression < 0.5mm is not abnormal
- ST elevation
  - ✓Acute MI
  - ✓Acute pericarditis
- ST depression
  - ✓Myocardial ischemia

# T Wave

- Upright in L I, II, V4- V6; inverted in aVR
- Upright, inverted or biphasic in L III, aVL, aVF, V1- V3
- Tall T Wave
  - ✓ Hyperkalemia
  - ✓ Acute MI
- Inverted T Wave

| *Physiological* | *Pathological* |
| --- | --- |
| ✓ Young Children | Ventricular Hypertrophy |
| ✓ Deep Inspiration(sometimes) | Bundle Branch Block |
| ✓ After Heavy Meals | Digitalis Effect |
| | Myocardial Ischemia |

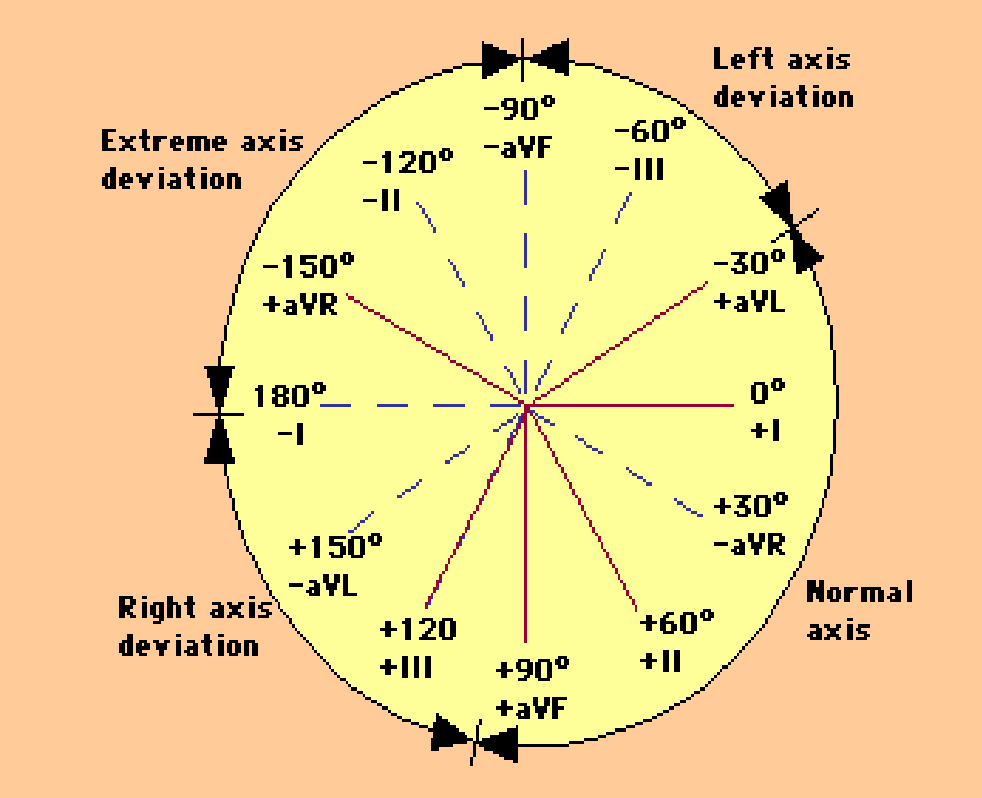
# Mean QRS Axis

- Is the magnitude and direction of mean cardiac dipole (vector)
- Normal mean cardiac vector ranges between $-30^0$ to $+110^0$
- Less than $-30^0$ indicates left axis deviation and more than $+110^0$ indicates right axis deviation

Factors affecting mean cardiac vector

- ✓ Position of heart
- ✓ Properties of conducting system
- ✓ Electrical properties of ventricular myocardium
- ✓ Muscle mass of each ventricle

# Mean QRS Axis



# Abnormal Axis Deviations

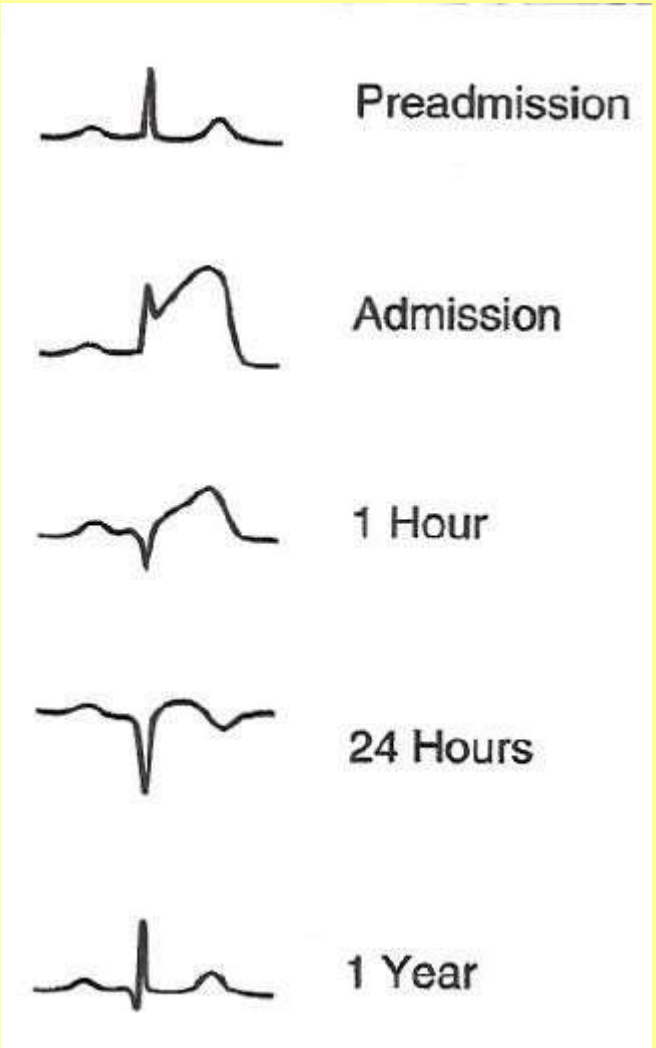
- Right axis deviation
  - ✓ Right ventricular hypertrophy
  - ✓ Left posterior hemiblock
  - ✓ WPW syndrome
  - ✓ Dextrocardia
- Left axis deviation
  - ✓ Left ventricular hypertrophy
  - ✓ Left anterior hemiblock
  - ✓ WPW syndrome
  - ✓ Inferior MI
  - ✓ Obstructive airway disease

# Clinical applications

- ECG is useful in diagnosis, assessment of prognosis and management of the following conditions
  - ✓ Cardiac arrhythmias
  - ✓ Abnormalities of myocardium
  - ✓ Anatomical orientation of the heart
  - ✓ Electrolyte imbalance
  - ✓ Assessment of toxic effects of drugs acting on the heart
  - ✓ Conduction defects
  - ✓ Chamber hypertrophy
  - ✓ Myocarditis and cardiomyopathies
  - ✓ Cardiac involvement secondary to other diseases

# Hallmark of Infarction

- ST elevation
- T wave inversion
- Q wave formation

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# THANK YOU