

The Electrocardiogram (ECG)

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What is ECG?

- ECG = electro + cardio + graphy.
- A recording of the electrical activity of the heart.

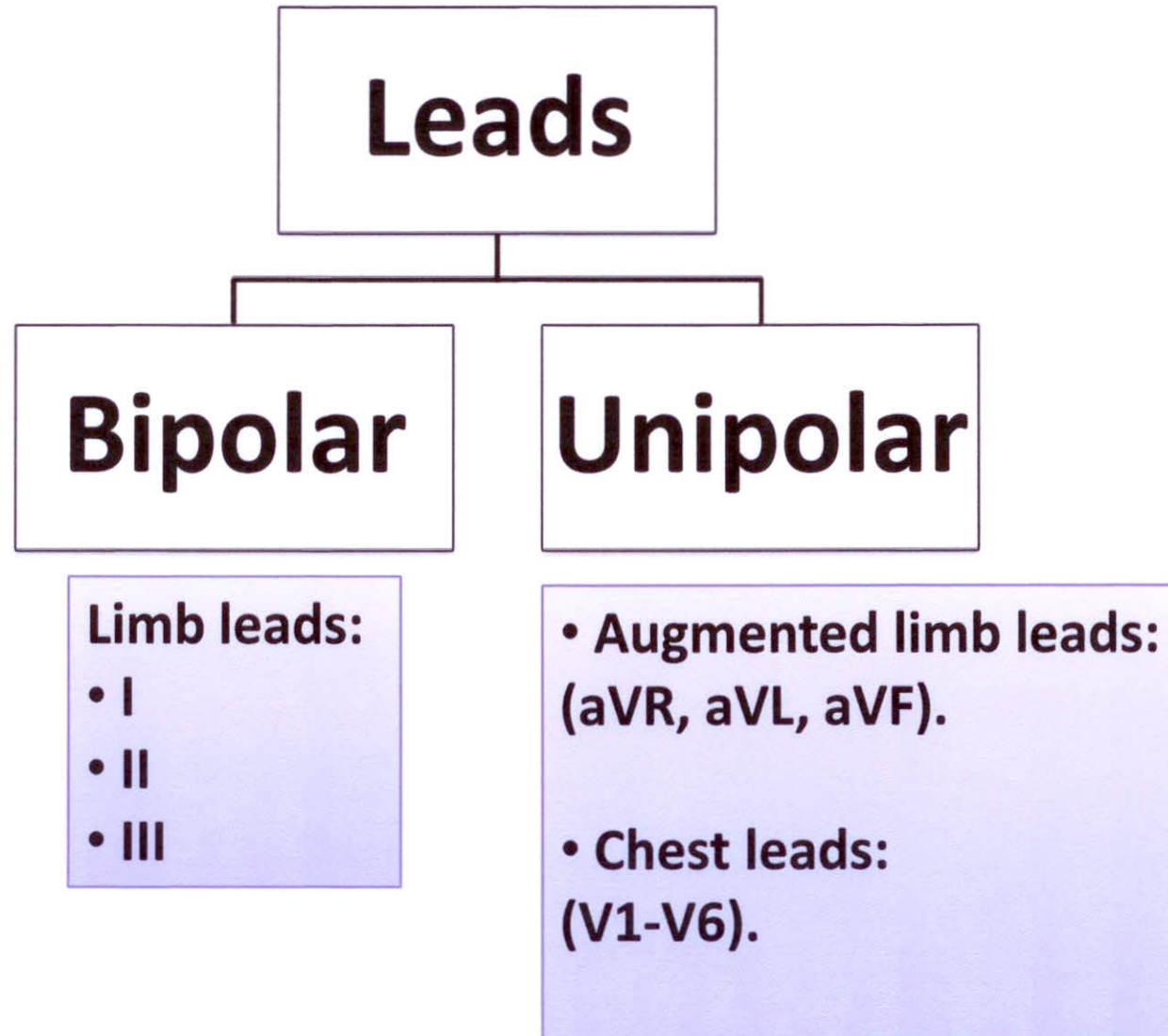
Why Is The ECG Important?

- It is a widely used & useful investigation in medicine.
- Used for:
 - Identification of cardiac rhythm disturbances.
 - Diagnosis of cardiac disorders e.g. MI.
 - Generalized disorders that affect the body e.g. electrolyte disturbances.

How is the ECG recorded?

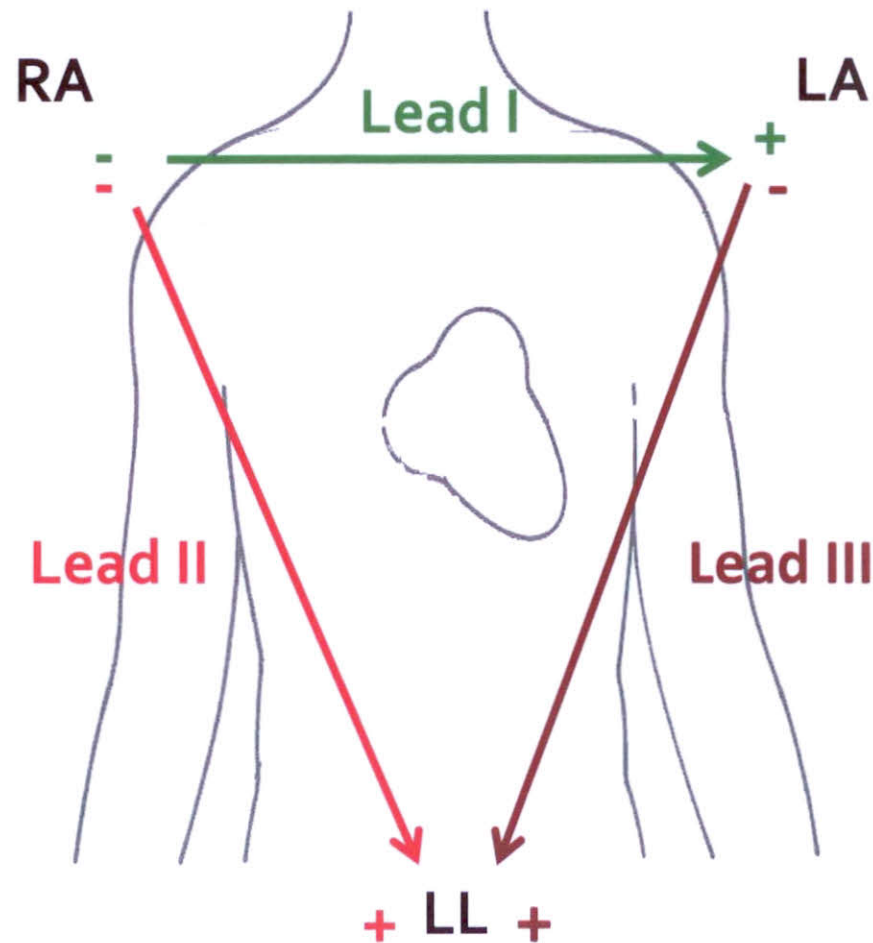
- It is recorded by electrodes placed on the surface of the body.
- The electrocardiograph (the ECG machine) measures the potential differences between the electrodes and records them.
- The arrangement of a pair of electrodes constitute a **lead**.

ECG Leads



Where are The Electrodes Placed?

- Bipolar limb leads:
 - Lead I
 - Lead II
 - Lead III
- Electrodes placed on:
 - Left arm (LA).
 - Right arm (RA).
 - Left leg/foot (LL).



Cont. Placement of electrodes

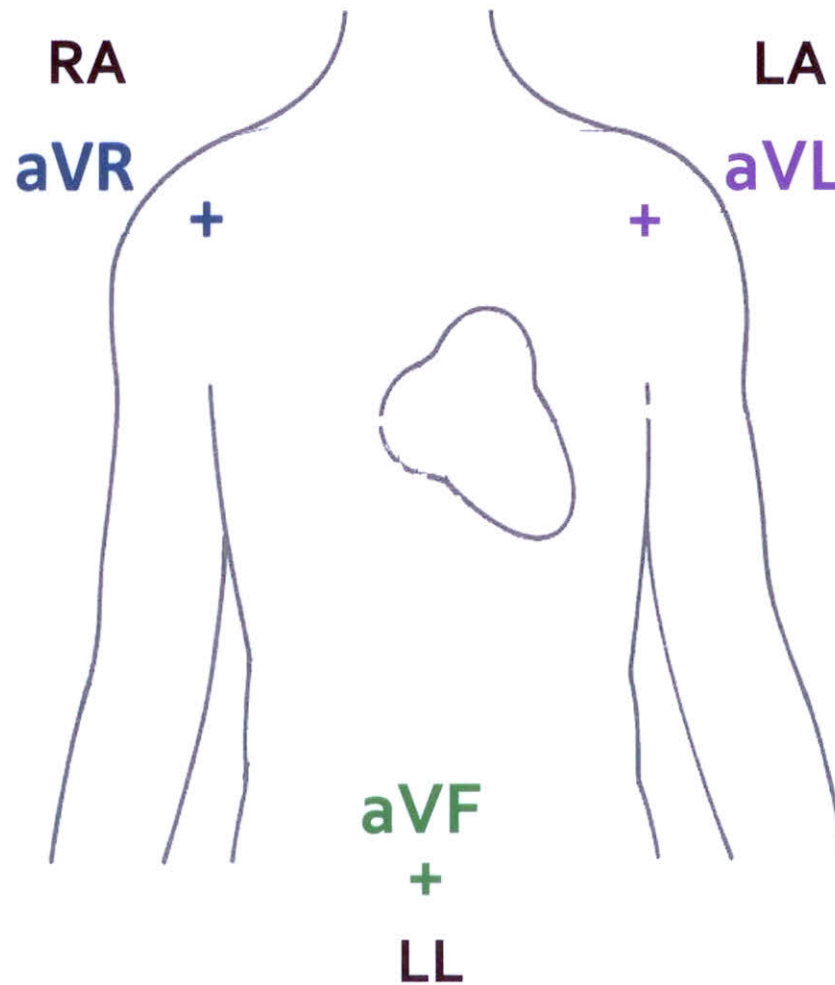
- Unipolar leads:

- 1. Augmented limb leads:

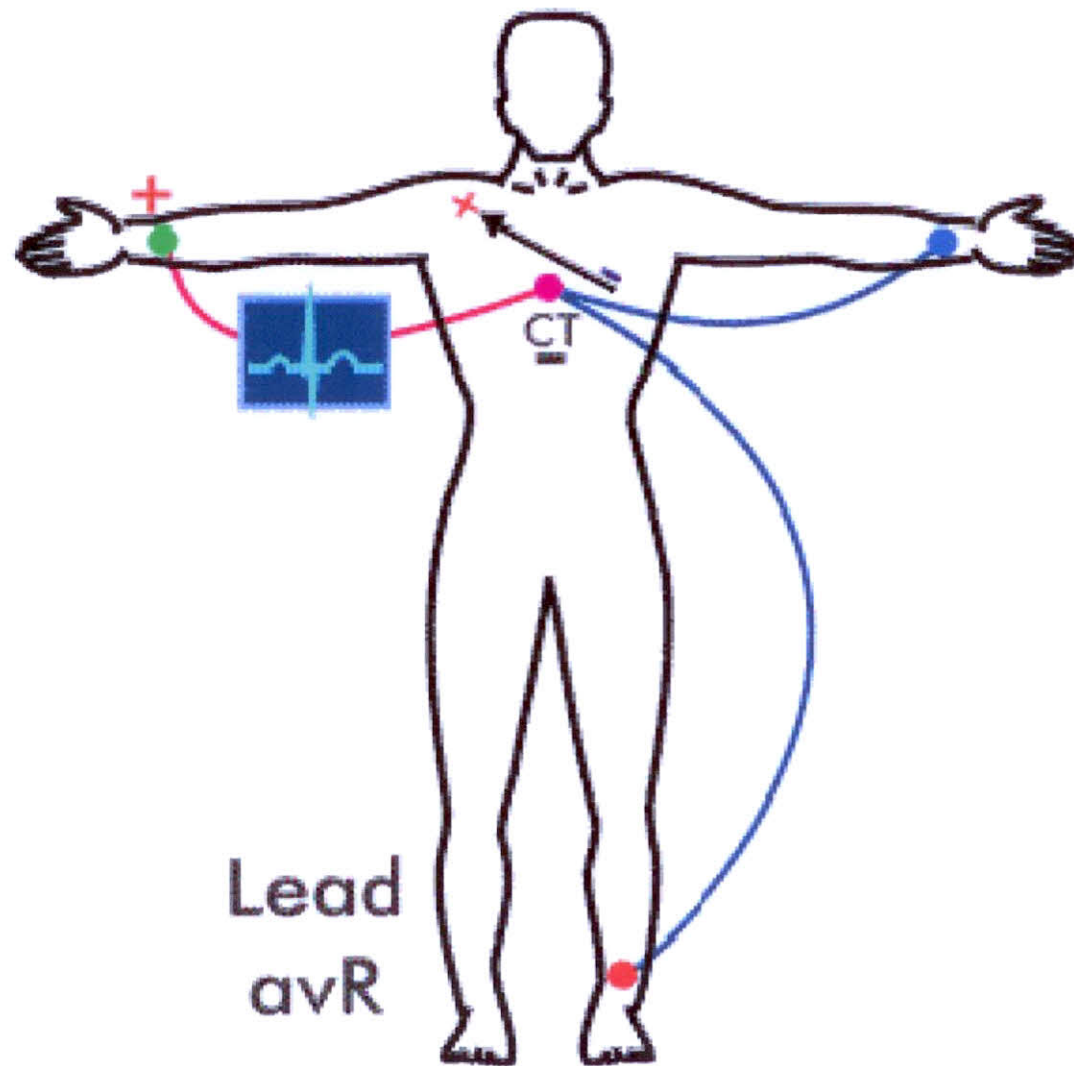
- aVR
 - aVL
 - aVF

- Electrodes placed:

- Position is the same as bipolar limb leads.



Example on an augmented limb lead

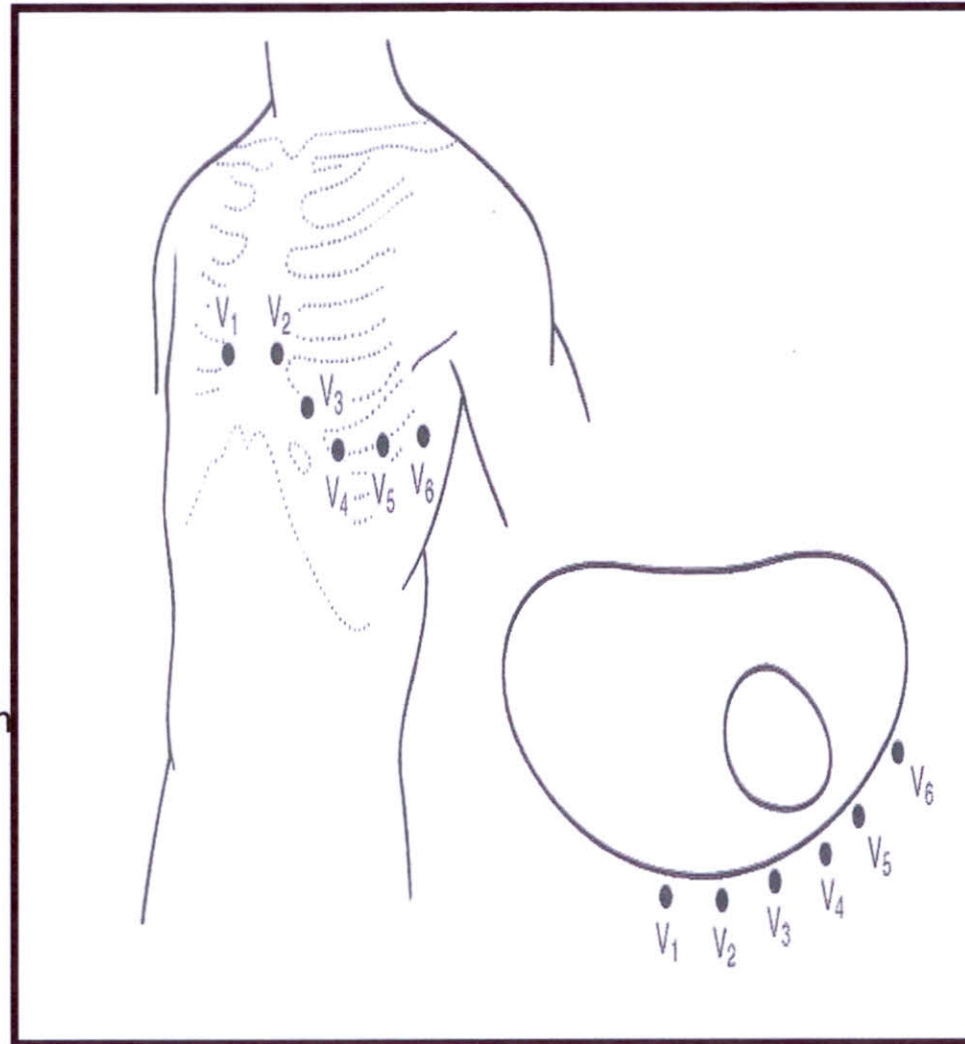


Cont. Placement of electrodes

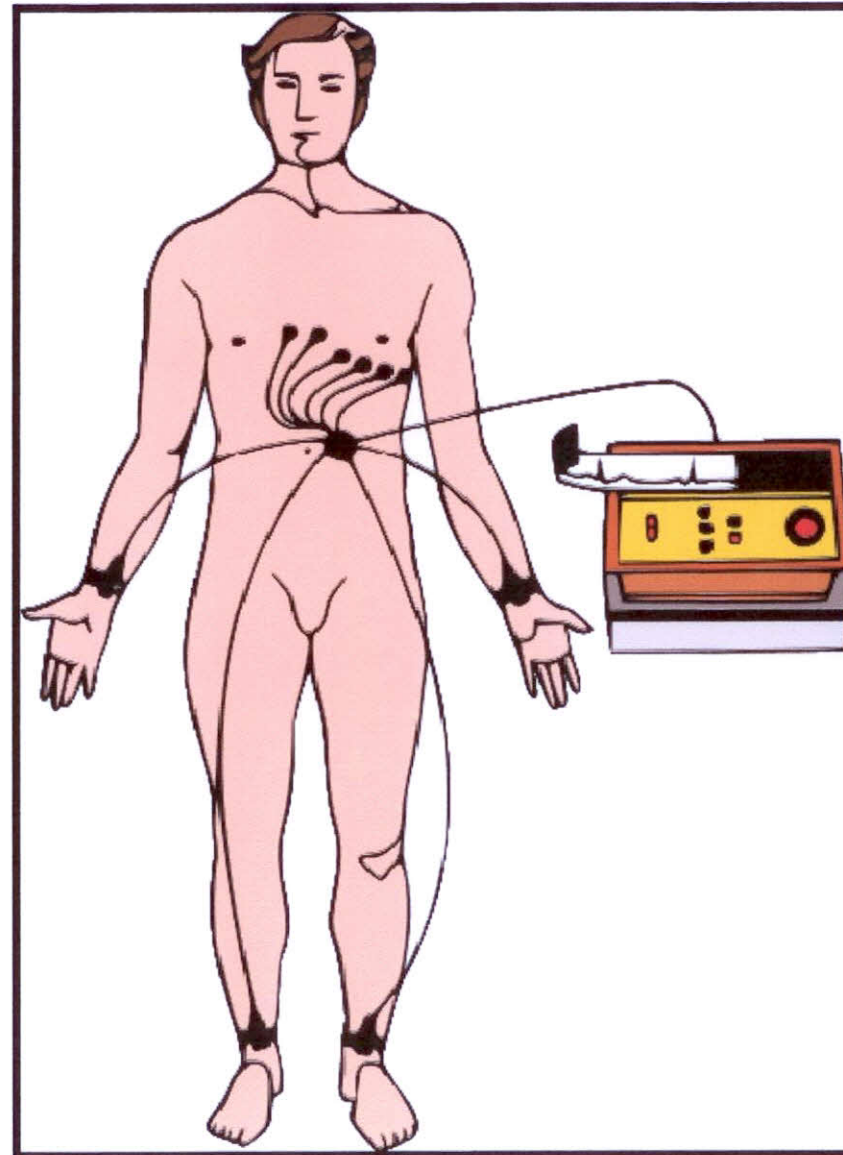
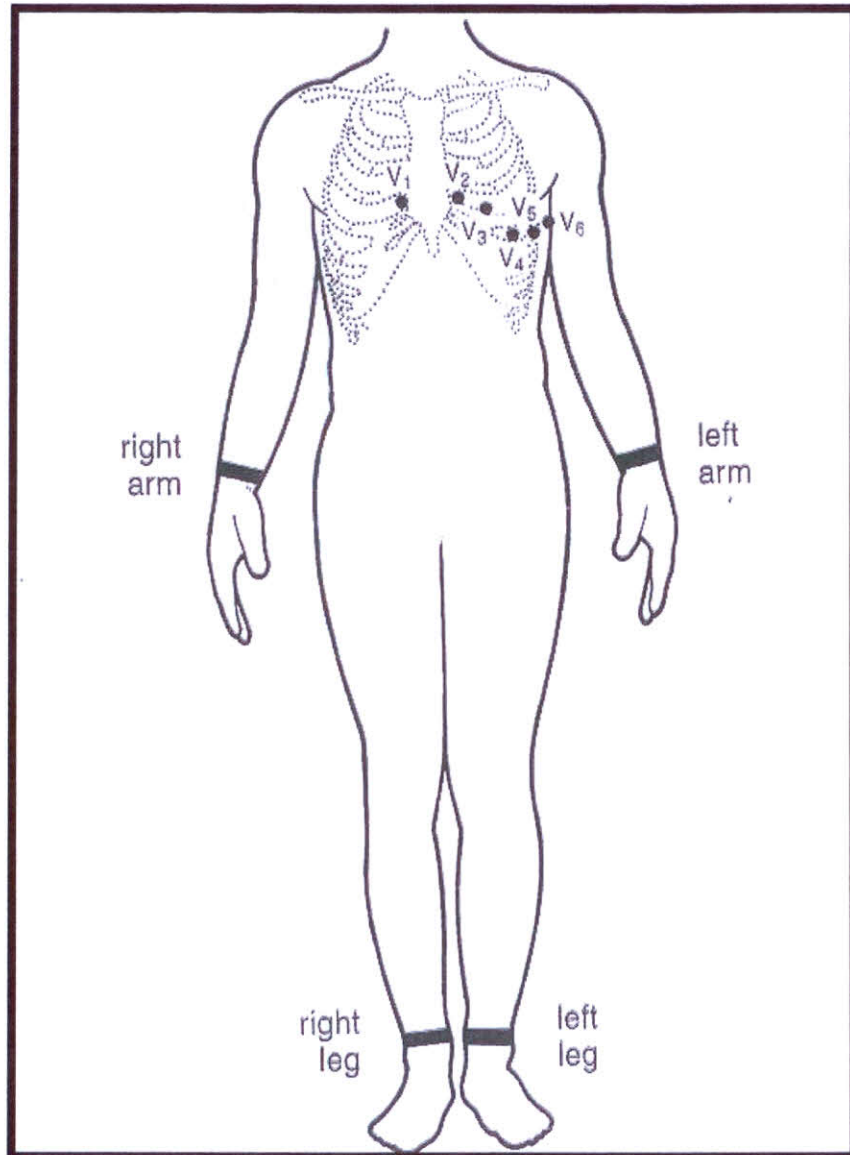
■ Unipolar leads:

2. Chest leads:

- V1: Rt sternal edge, 4th ICS.
- V2: Lt sternal edge, 4th ICS.
- V3: ½ between V2 & V4.
- V4: apex.
- V5: anterior axillary line, 5th ICS.
- V6: mid-axillary line, 5th ICS.

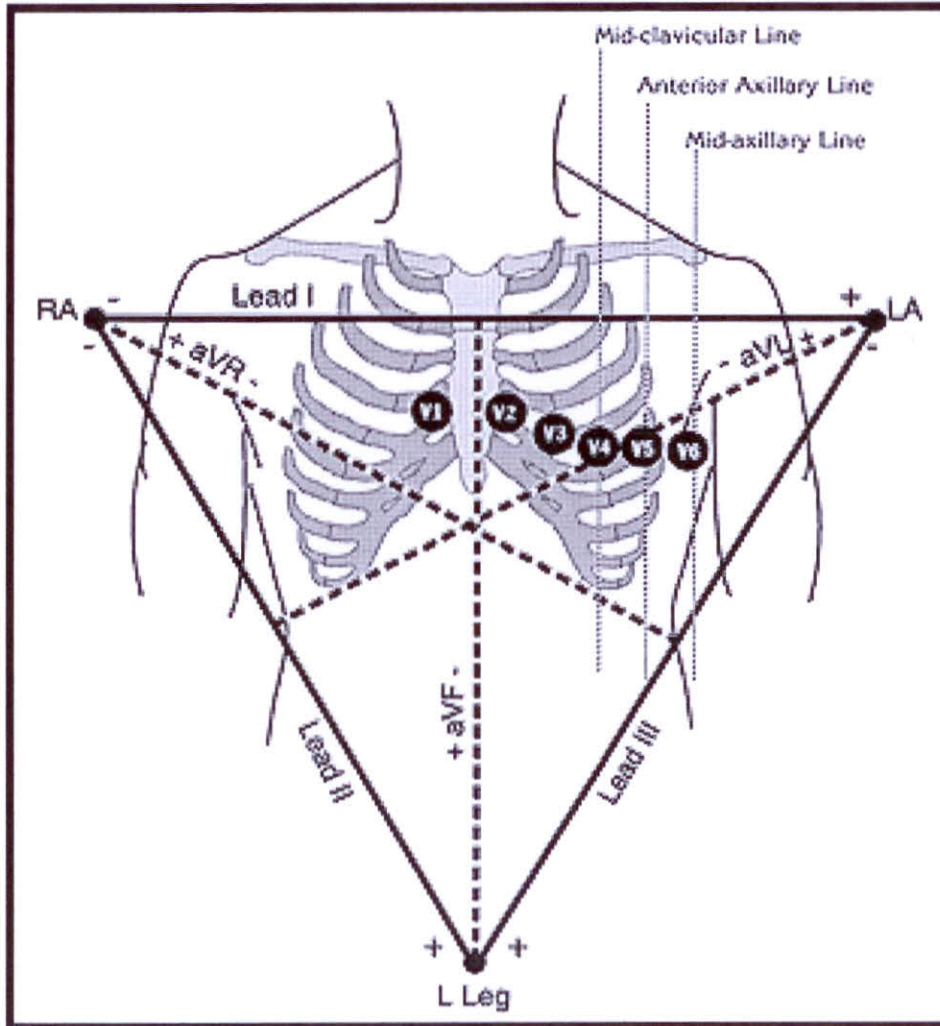


Cont. lead placement



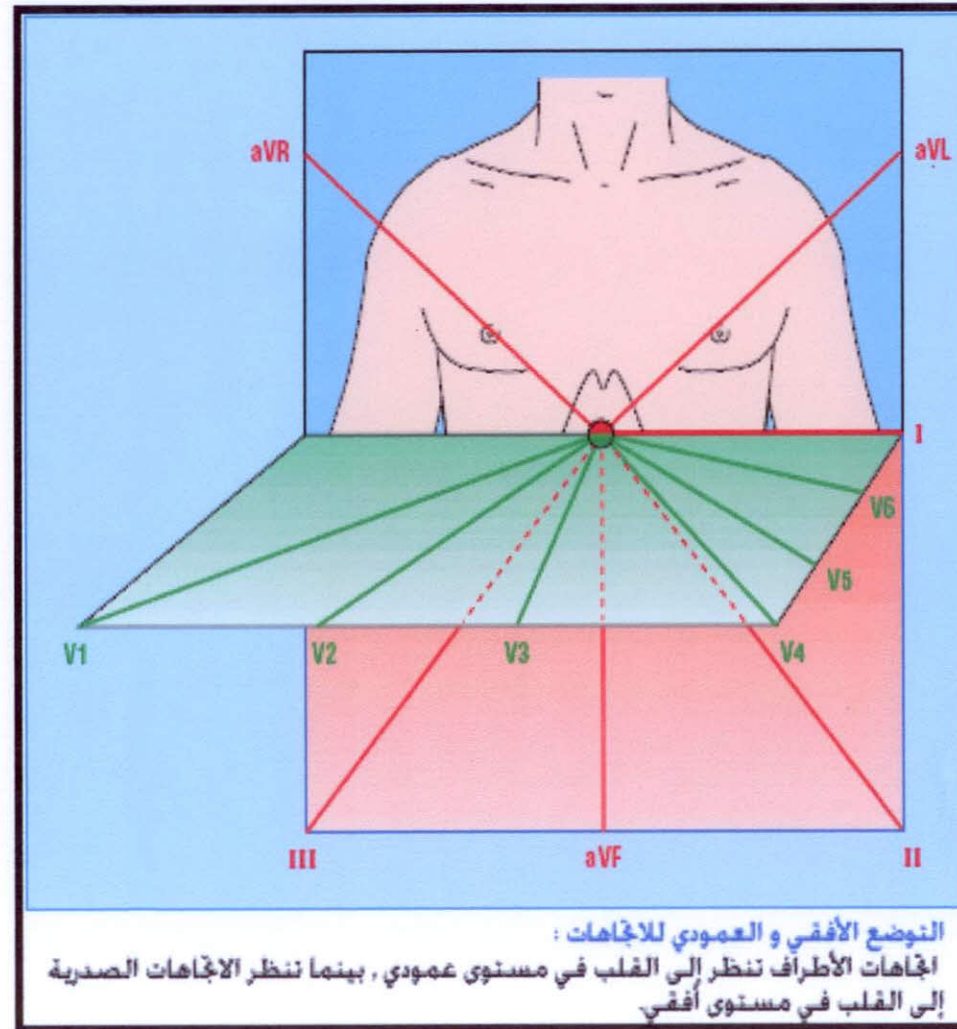
The standard 12-lead ECG

- How many electrodes?
 - 10 electrodes
- How many leads?
 - 12 leads

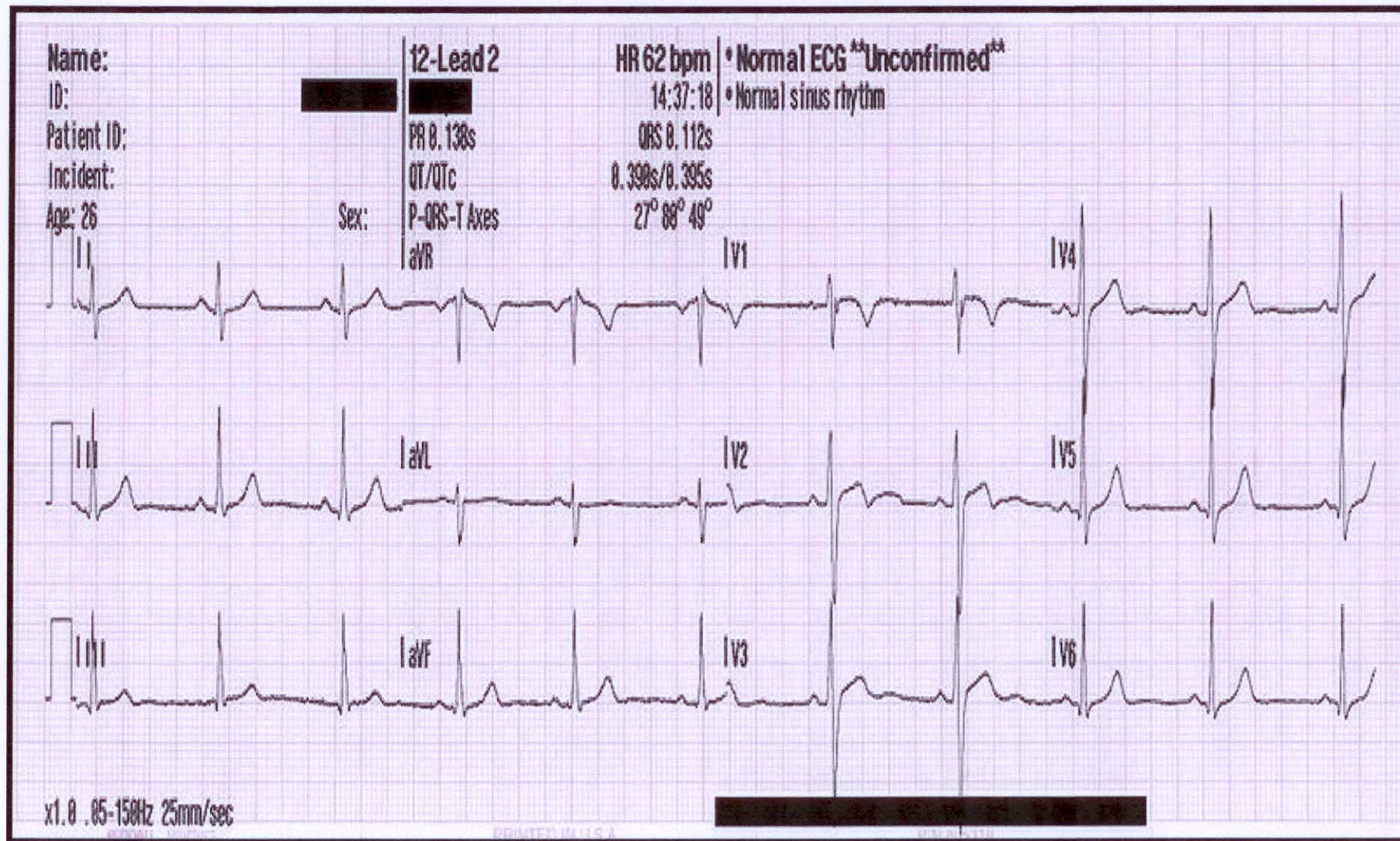


Why 12 leads?

- Lead = view
- 12 views of the heart:
 - From the frontal plane:
 - Limb leads.
 - Augmented limb leads.
 - From the horizontal plane:
 - Chest leads.

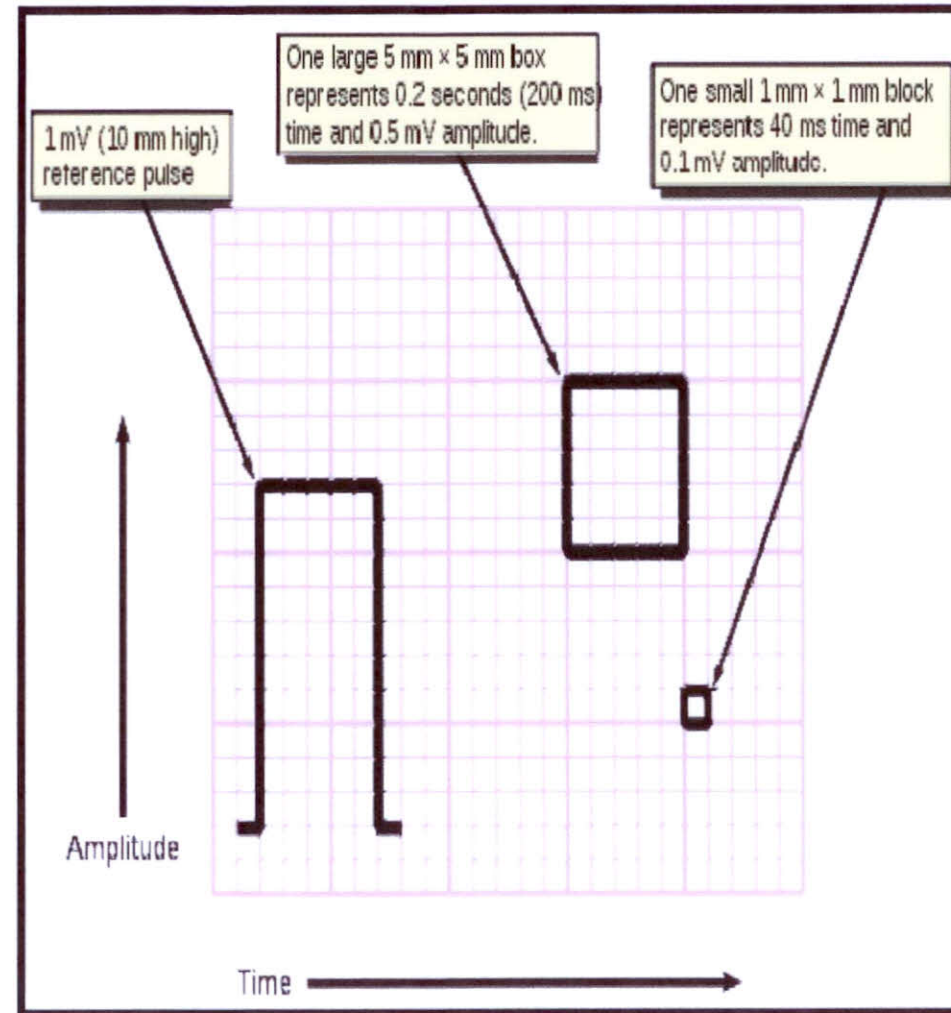


The 12-lead ECG

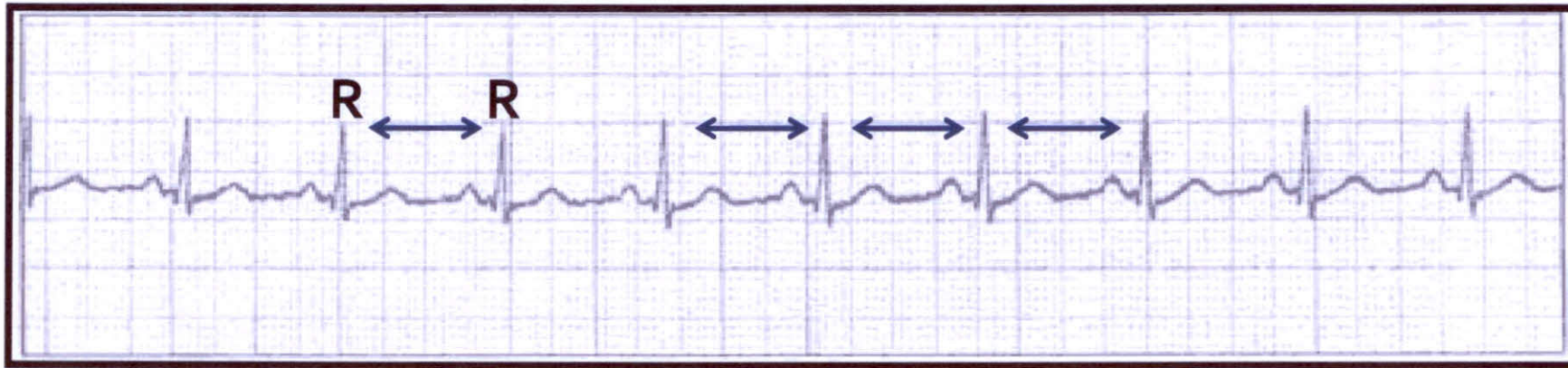


ECG Paper Calibration

- Paper speed = 25mm/s.
- $1 \text{ second} / 25 = 0.04 \text{ sec.}$
- 1 small square = 0.04 s.
- 1 large square = 5 small.
- 1 large square = 0.2 s.



Rhythm



- Rhythm:
 - Regular = equal R-R intervals.
 - Irregular = Unequal R-R intervals

Heart Rate Calculation



- Heart Rate:

- Regular rhythm: $HR = \frac{1500}{\text{R-R interval (small sq.)}}$

OR $HR = \frac{300}{\text{R-R interval (big sq.)}}$

Cont. HR calculation

- Irregular rhythm:
 - Count number of QRS complexes in 30 big sq. = no. of QRS in 6 seconds.
 - Multiply by 10.

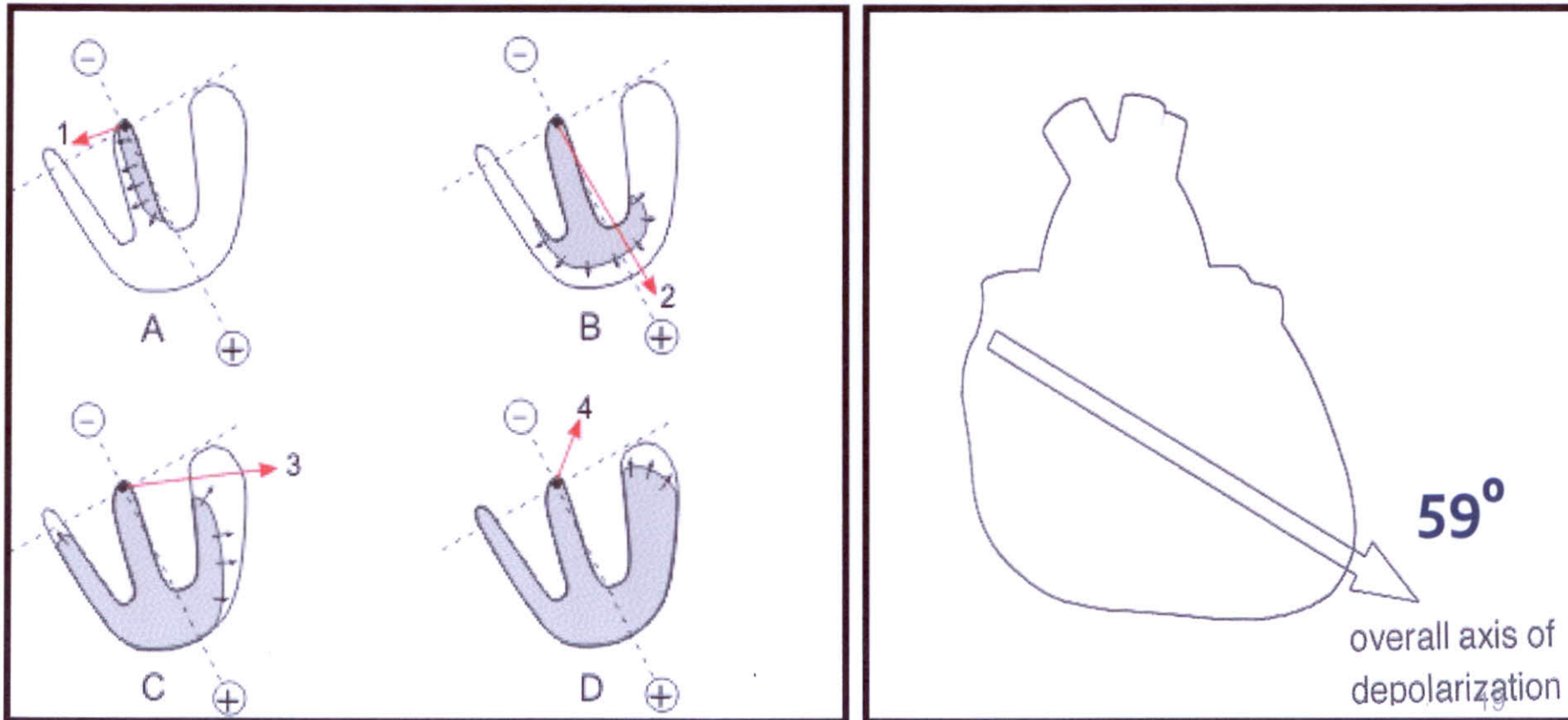
Heart Rate

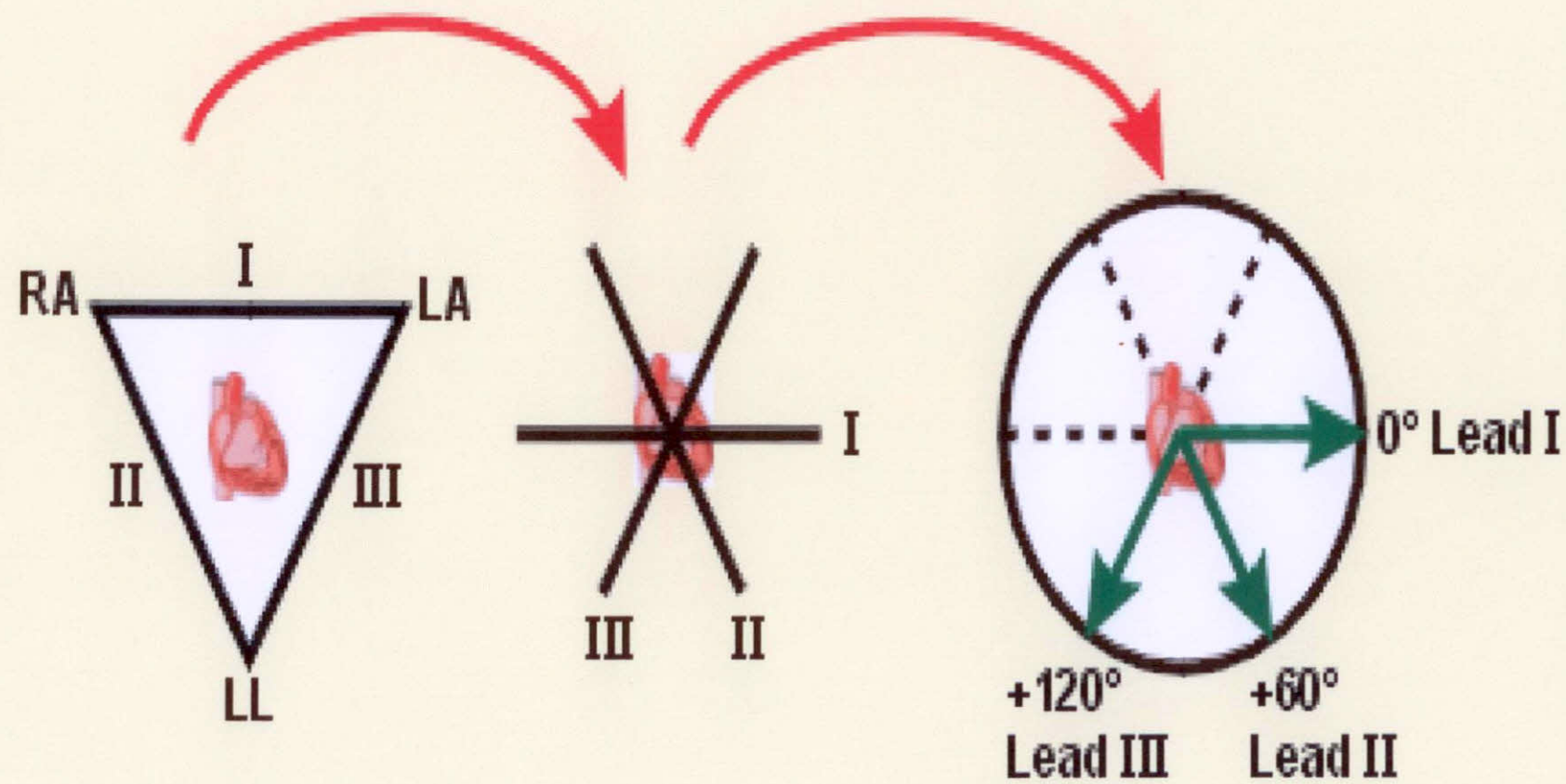
- Normal = 60-100 bpm (beats per minute).
- < 60 bpm = bradycardia.
- > 100 bpm = tachycardia.

Cardiac Axis

- What is cardiac axis?

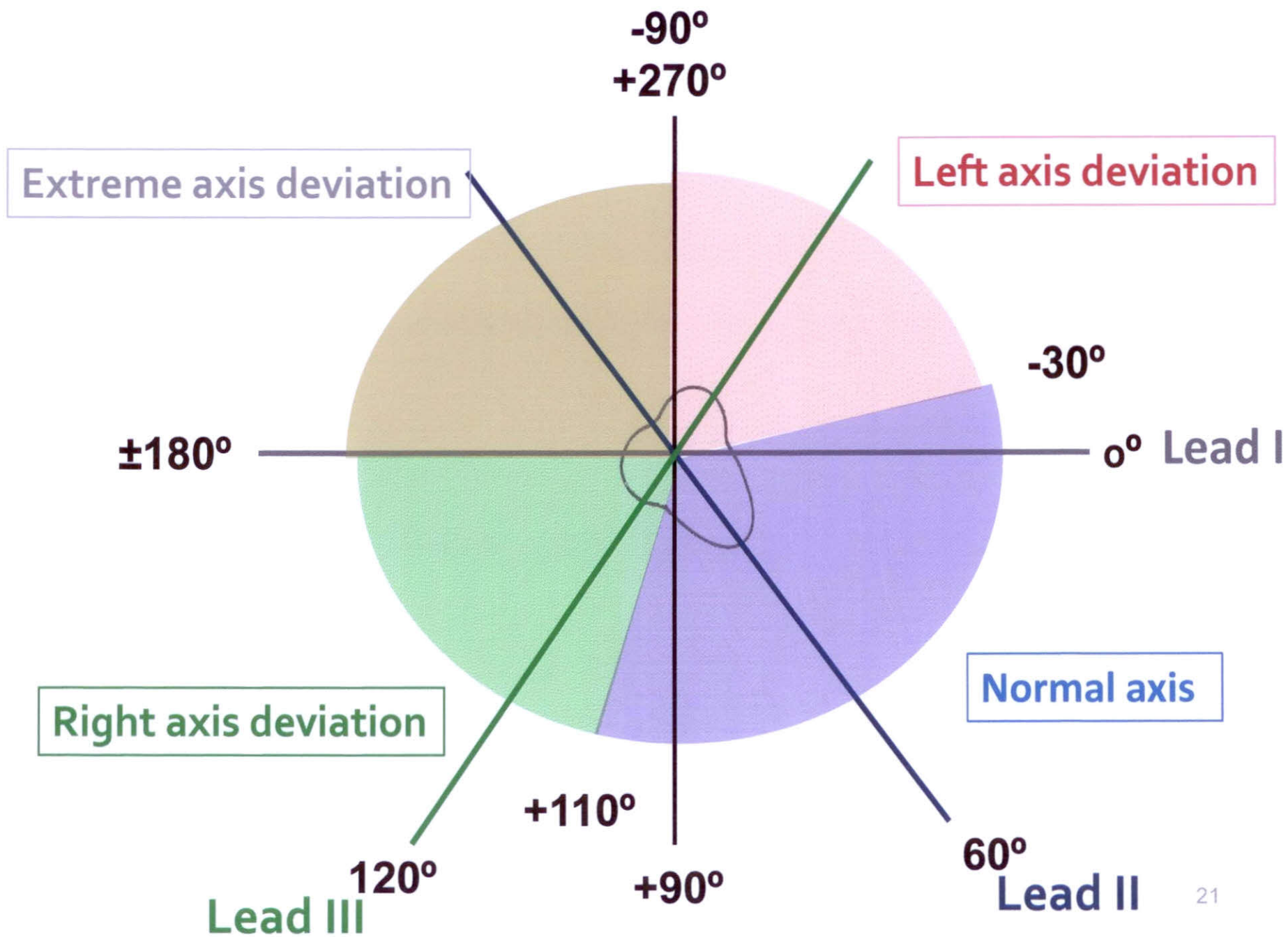
The sum (average) of all the individual vectors occurring sequentially during depolarization of the ventricles.





Einthoven's Triangle

Axial Reference System

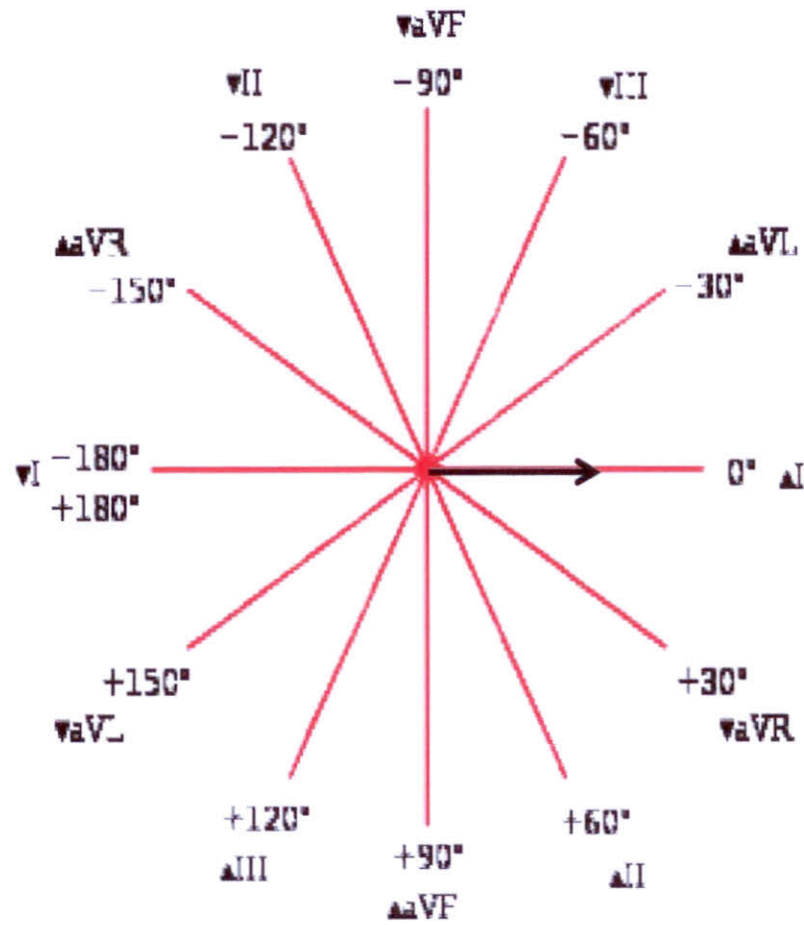


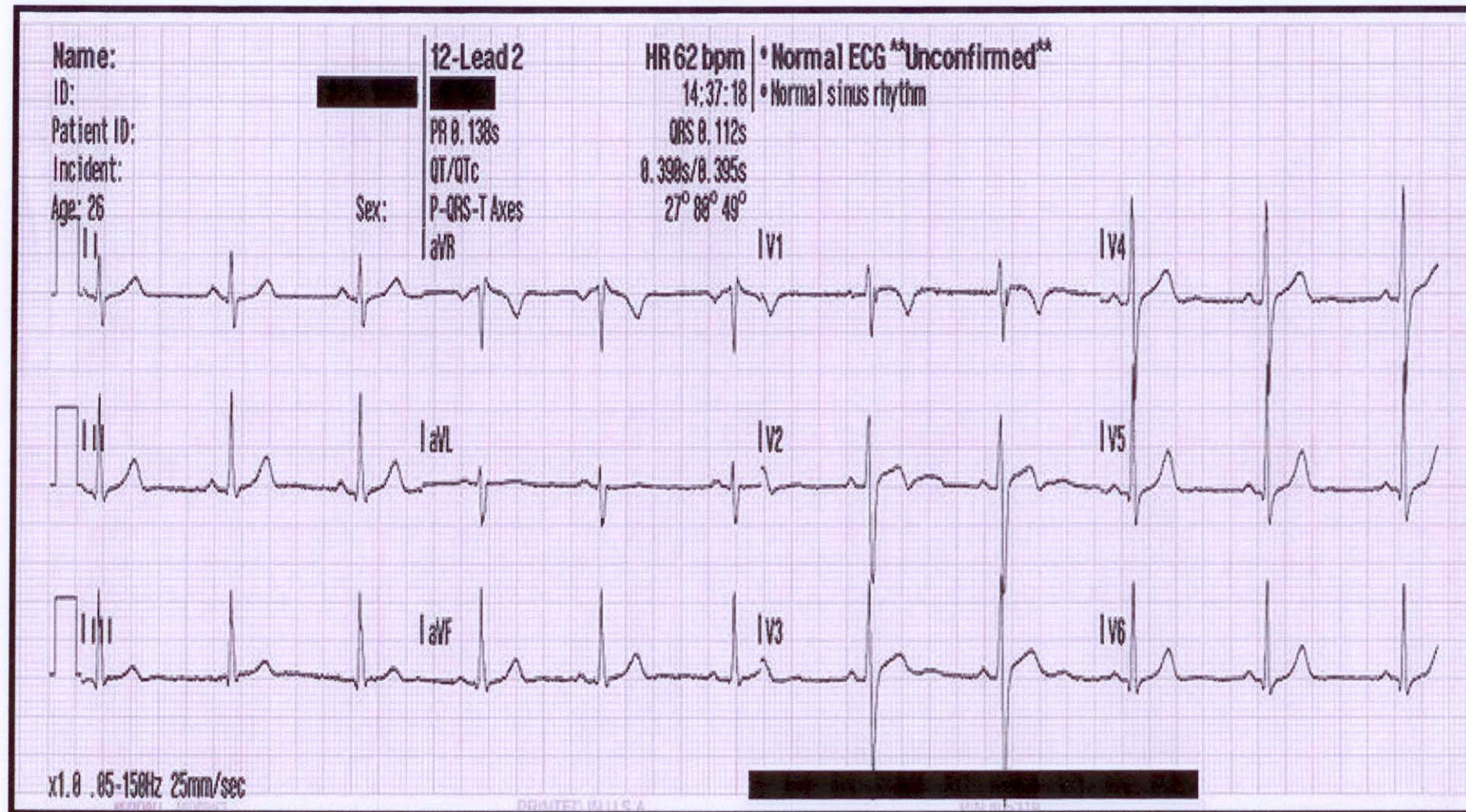
How to Calculate the Cardiac Axis?

- Use two leads:
 - Lead I
 - Lead III
- Calculate the average potential in each lead (the sum of +ve and -ve deflections).

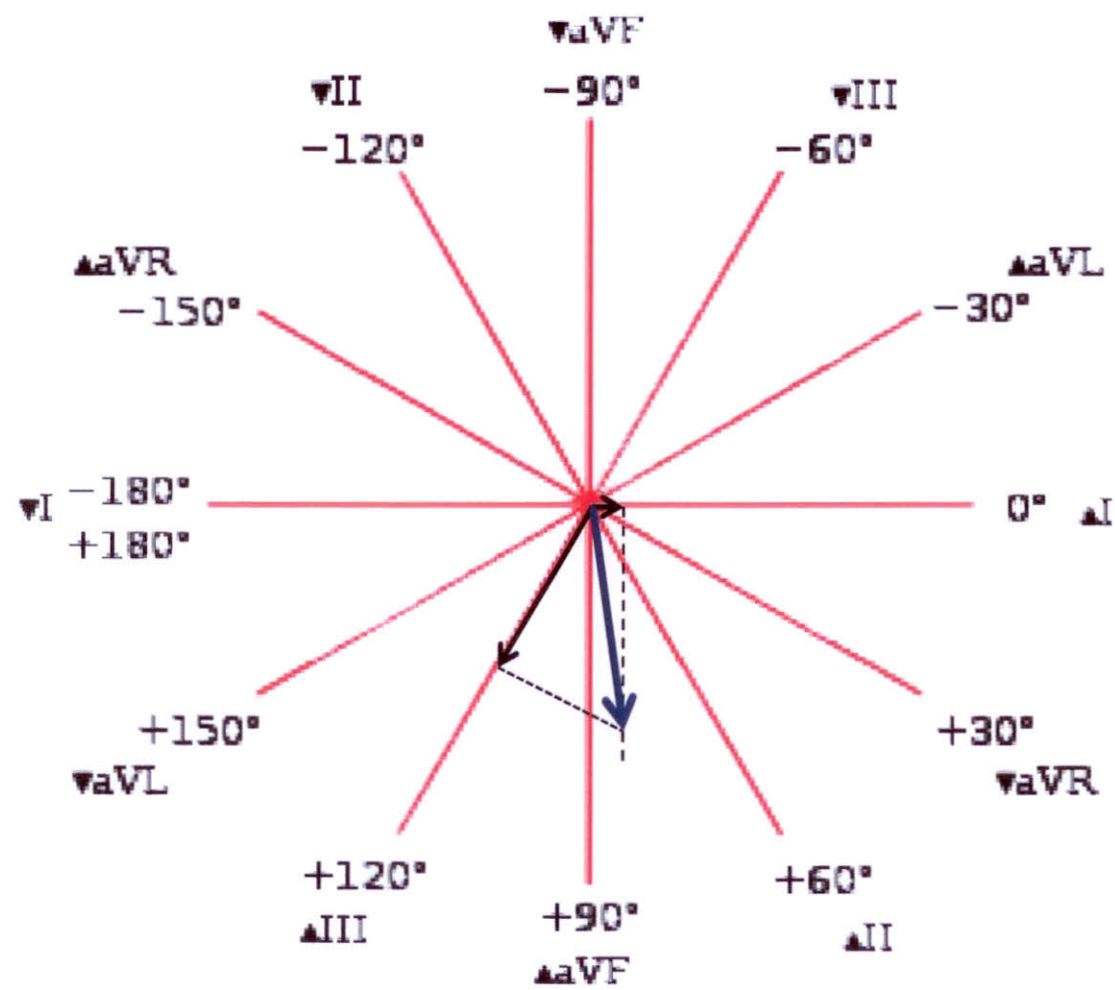


- The sum:
 - Lead I = $13 - 2 = 11$ (+ve).
 - Lead III = $5 - 5 = 0$
- Plot on the diagram

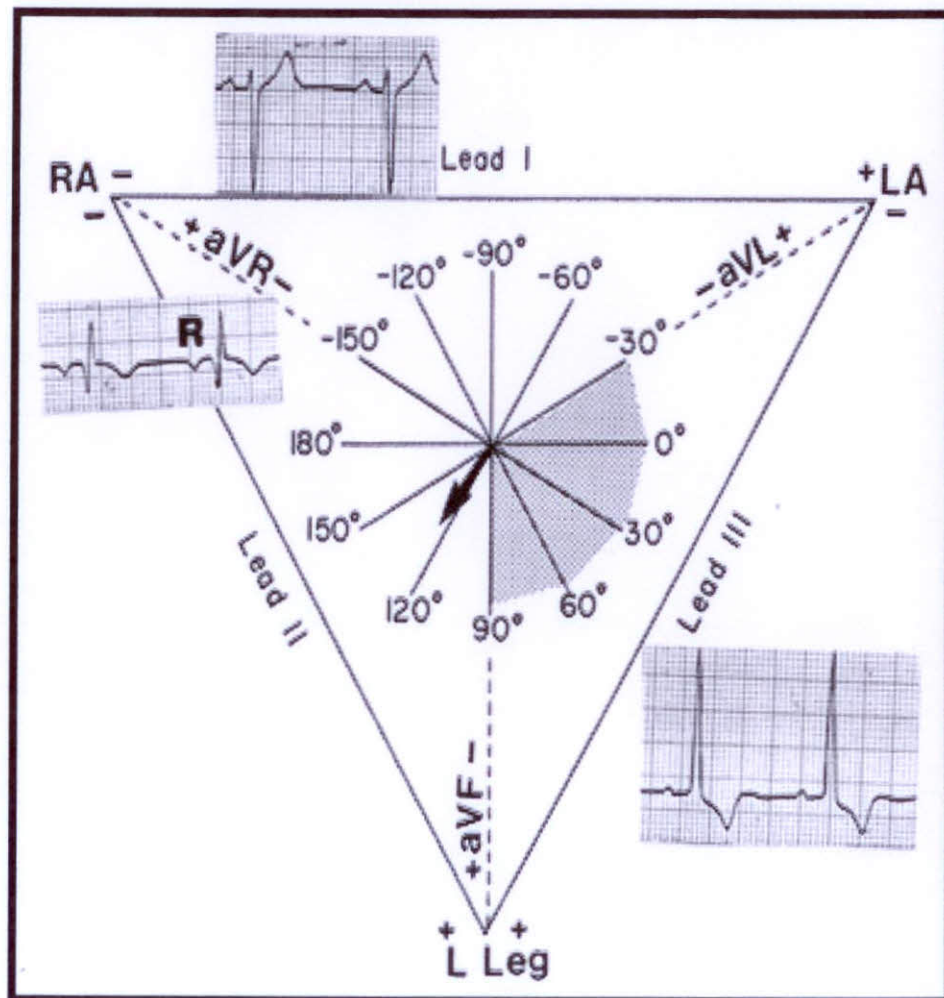




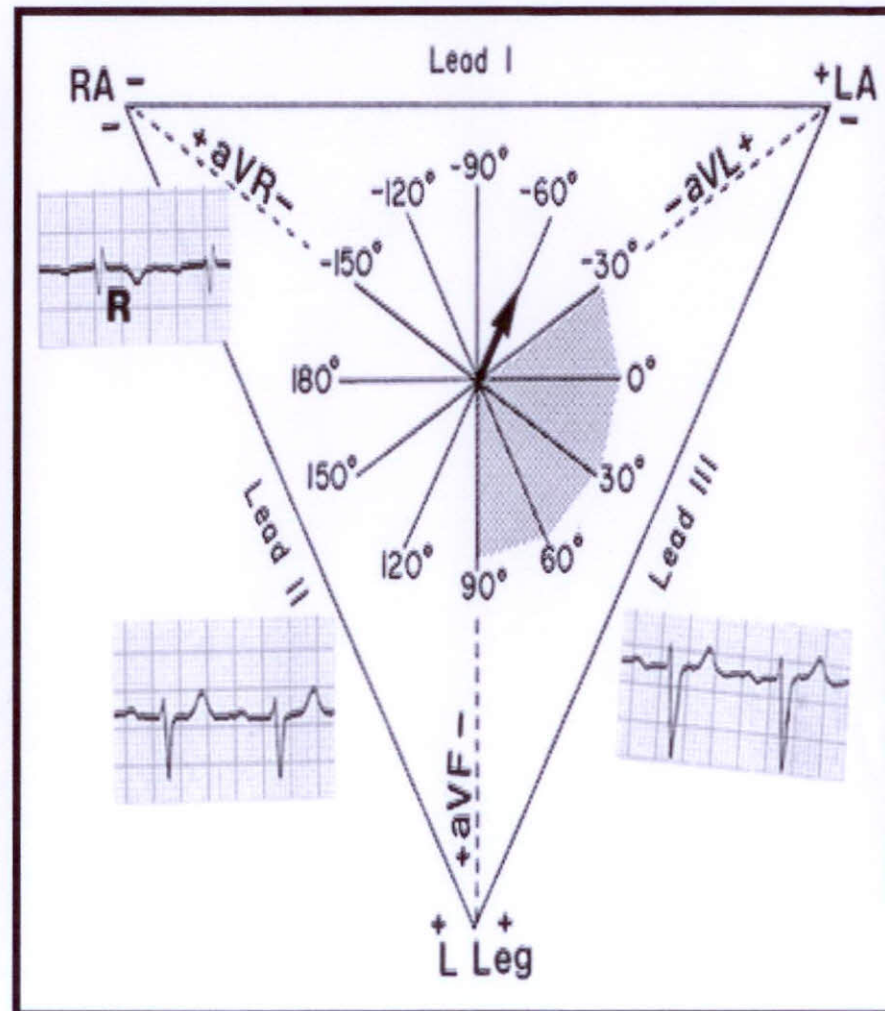
- Lead I = $5-4=1$ (+ve).
- Lead III = $12-1=11$ (+ve).



Right axis deviation



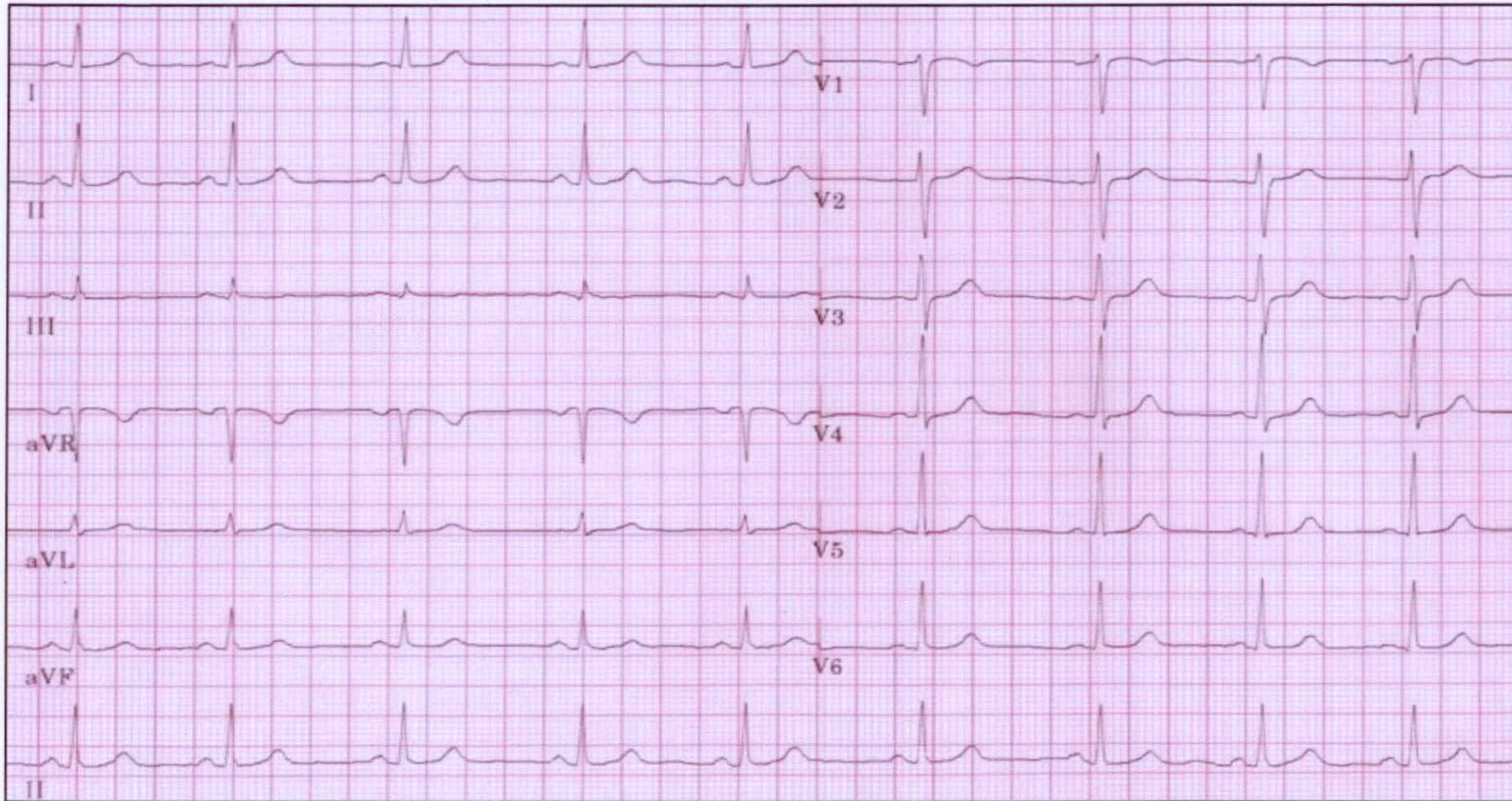
Left axis deviation



Abnormal Axis

Causes of left axis deviation	Causes of right axis deviation
Left ventricular hypertrophy	Right ventricular hypertrophy
LBBB	RBBB
	Dextrocardia

Example



- Study the above ECG: calculate HR, axis, and study waves and intervals?