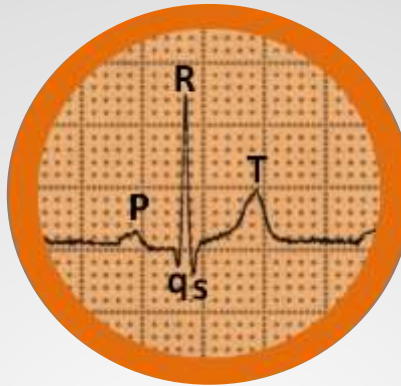
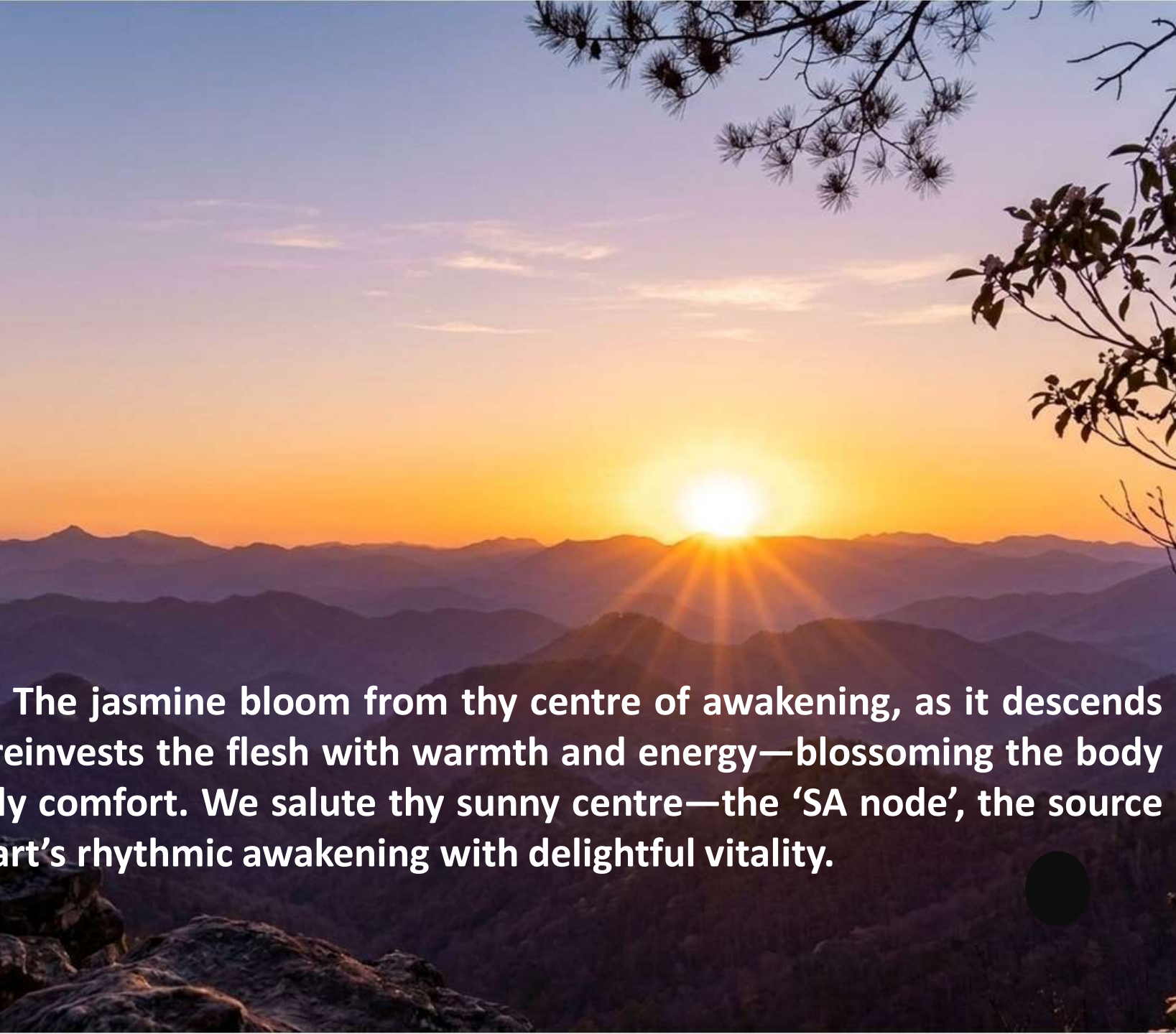




A Methodical Approach to ECG Interpretation

DR. D.P Khaitan

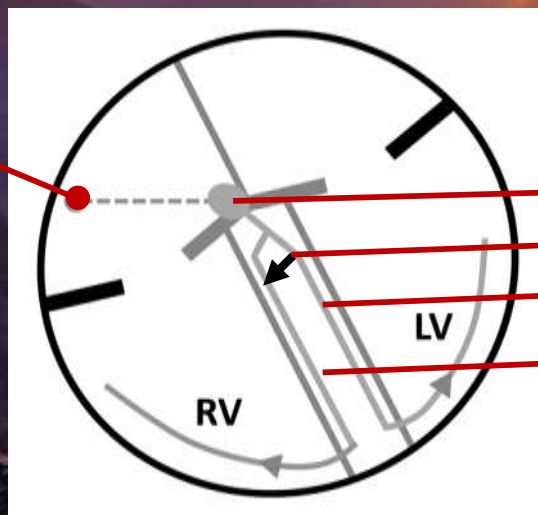
**M.D (Medicine) F.C.G.P(IND) F.I.A.M.S (Medicine) FICP FICCMD
Senior Consultant in Medicine FIACM**



‘O Heart’, The jasmine bloom from thy centre of awakening, as it descends onward, reinvests the flesh with warmth and energy—blossoming the body with lovely comfort. We salute thy sunny centre—the ‘SA node’, the source of the heart’s rhythmic awakening with delightful vitality.



SA Node



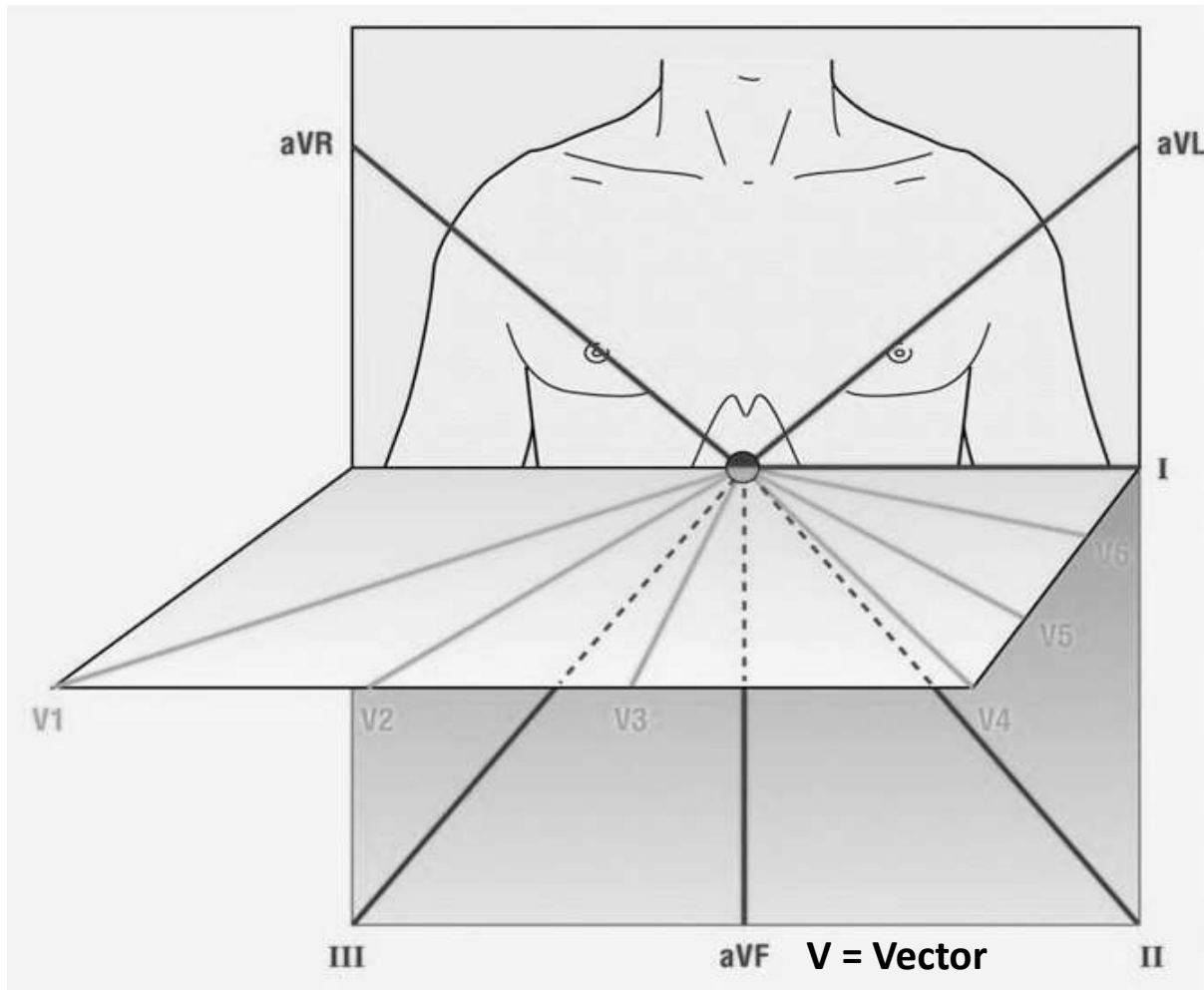
AV Node

Left septal branch

Left bundle branch

Right bundle branch

Frontal and horizontal planes of ECG recording



Central terminal
As per Kirchhoff's
law
($IR + IL + IF = 0$)

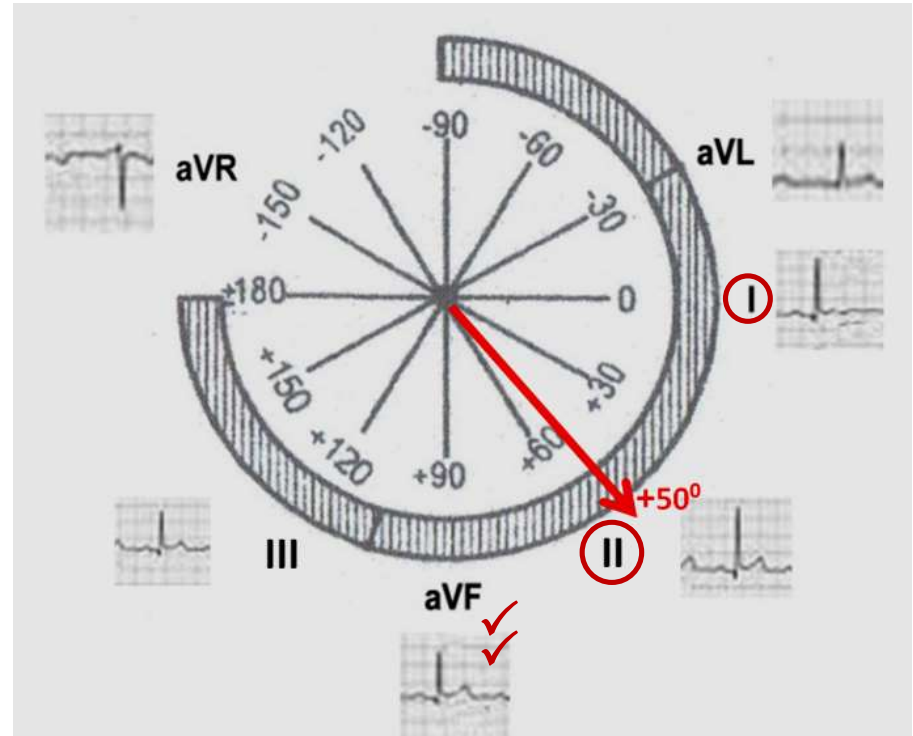
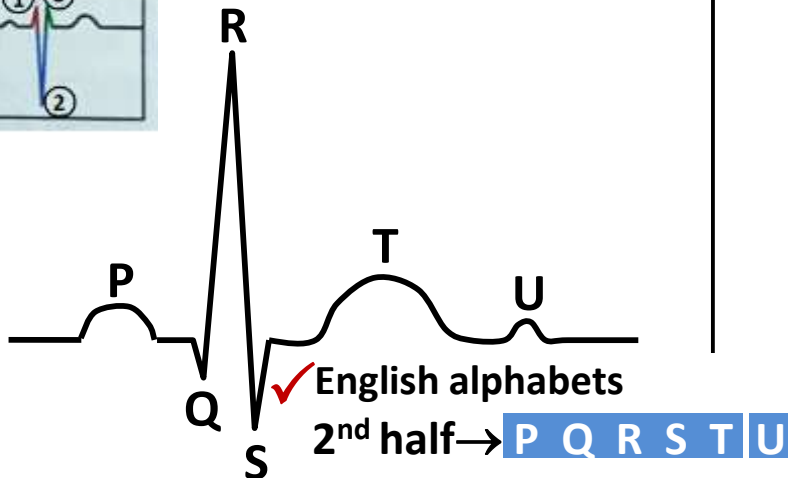
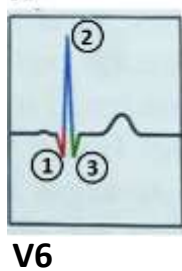
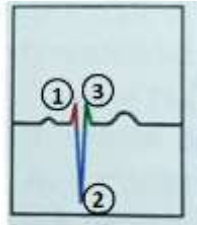
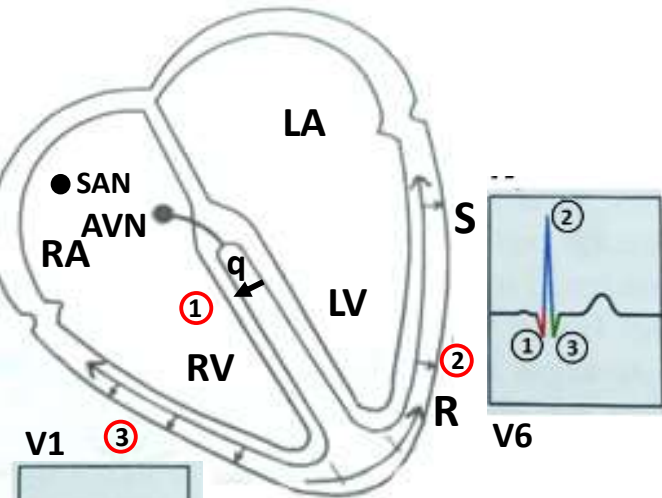
The lead over the
RT leg works as a
neutral lead just to
complete the
electrical circuit

Frontal plane Three bipolar limb leads I , II , III
PLUS unipolar limb leads aVR , aVL , aVF ('V' = Vector)

Horizontal plane six points over the chest : V1-V6
('V' stands for voltage)

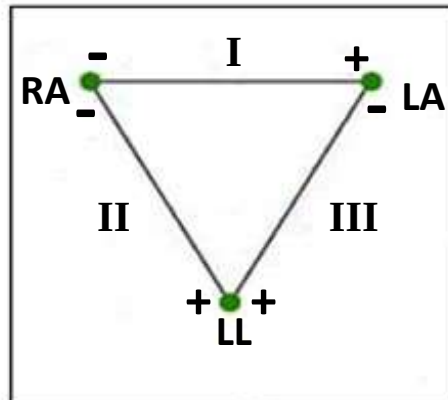
Normal ECG

- ☐ Positive wave towards the flow of current
- ✓ Negative wave away from the flow of current



Any exploring lead placed within a range of 90° in respect to cardiac vector records positive current, at 90° equiphasic deflection or no deflection and beyond 90° negative deflection.

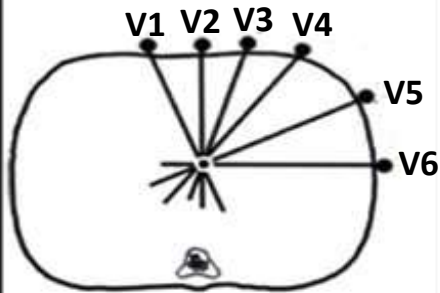
The Standard 12-lead ECG (the flow of current from -Ve to +Ve pole)



Precordial



V1 V2 V3 V4 V5 V6

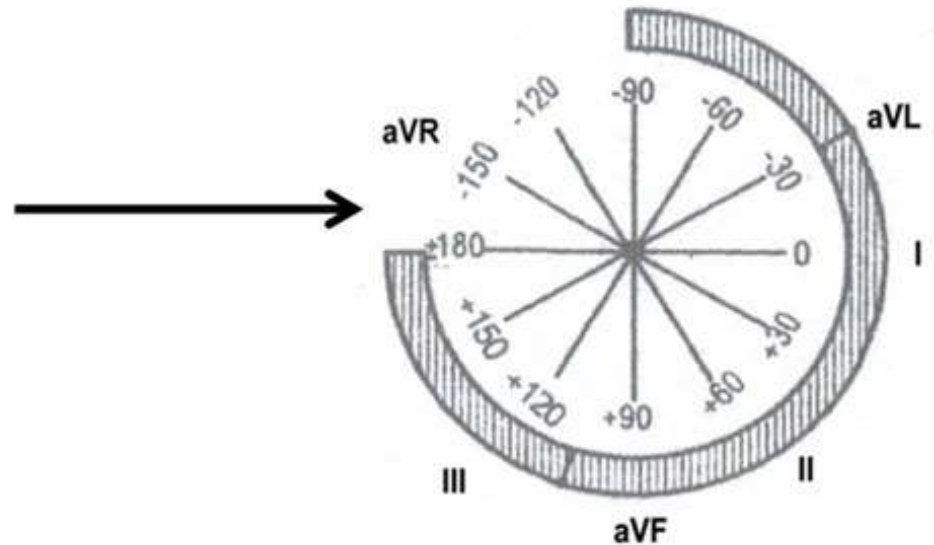
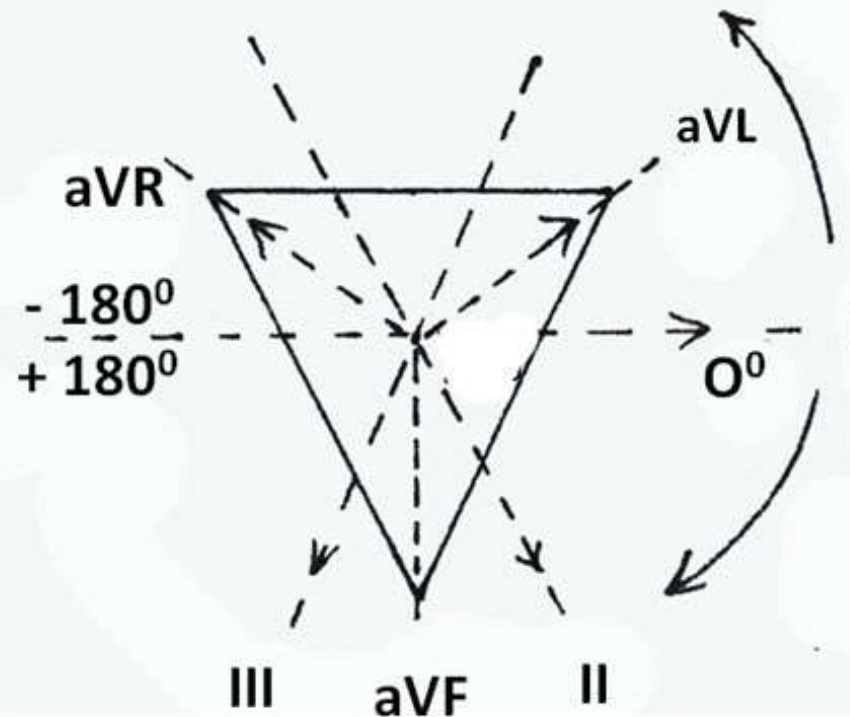


Leads		Negative Electrode	Positive Electrode
Bipolar	I	Right Arm	Left Arm
	II	Right Arm	Left Leg
	III	Left Arm	Left Leg
Unipolar	aVR	Central Terminal	Right Arm
	aVL		Left Arm
	aVF		Left Leg
V1		Central Terminal	4th Right intercostal space parasternal
V2			4 th left intercostal space parasternal
V3			Midway between V2 and V4
V4			5 th intercostal space at left midclavicular line
V5			Level with V4 at left anterior axillary line
V6			Level with V5 at left mid axillary line



A Geometrical model of Hexaxial lead system

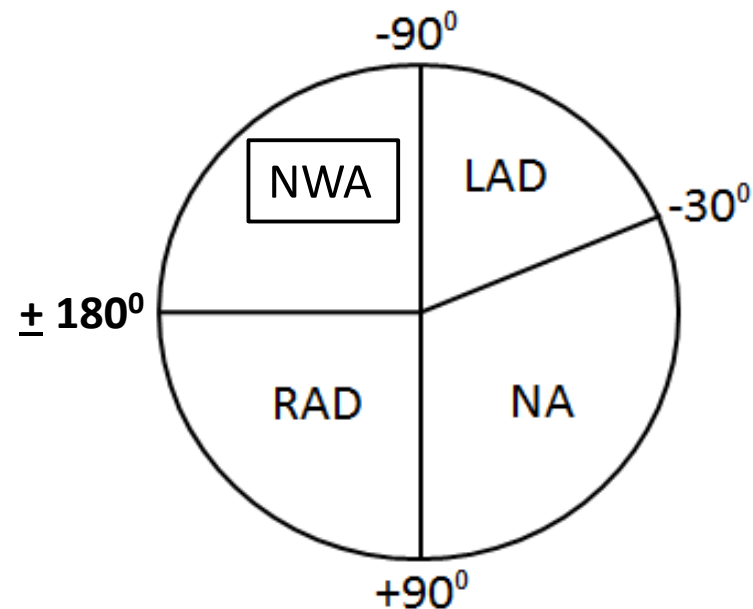
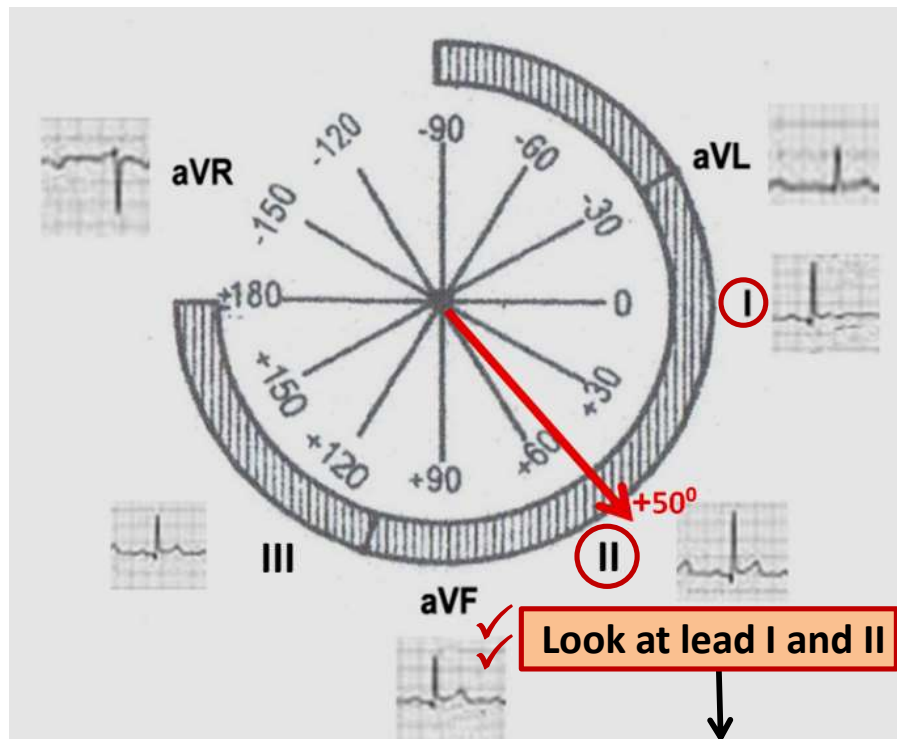
All the axes passing through the centre of the heart



Hexaxial Lead System

‘With distances greater than 15 cm from the heart, the decrement in the intensity of the electrical field is hardly noticeable. Consequently, all electrodes placed at a distance greater than 15 cm from the heart may, in an electrical sense, be considered to be equidistant from the heart.’ (Reference -LeoSchamroth – AN INTRODUCTION TO ELECTROCARDIOGRAPHY - EIGHTH ADAPTED EDITION – Basic Principles P – 6).

Electrical Axis (Frontal plane) : Rule of 90°

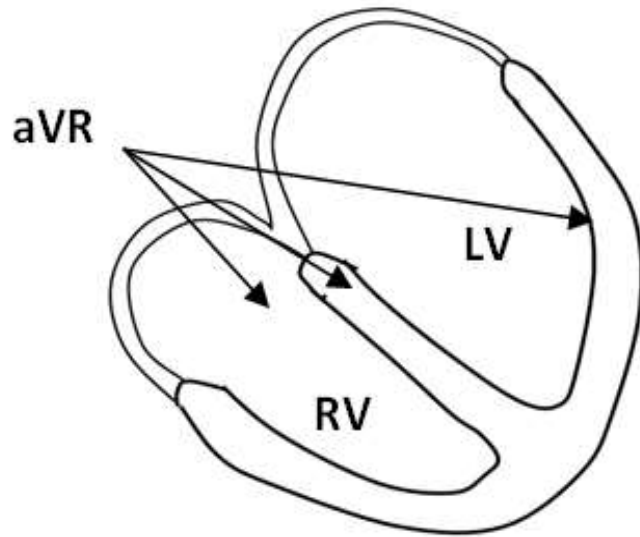


QRS Positive in leads I and II	Normal Axis	-30° to +90°
QRS complex is positive in lead I but negative in lead II	Left Axis Deviation	- 30° to -90°
QRS Negative in lead I but positive in lead II	Right Axis Deviation	+90° to +180°

- A predominantly positive QRS complex in aVR associated with a predominantly or wholly negative deflection in lead I and aVF- North -west Axis - 90° to -180°



Eyes of lead aVR looks at

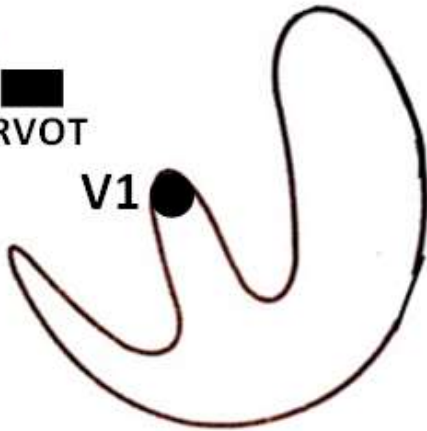


This aVR lead gives a useful information viewing the right upper side of the heart such as outflow tract of the right ventricle and the basal part of the septum. This lead also gives reciprocal information from the left lateral side of the heart as well.

aVR

■
RVOT

V1

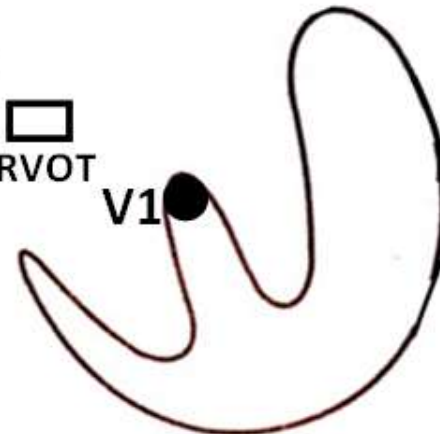


**ST $\uparrow$ in aVR > V1 = severe 3VD , LMCA
at times proximal LAD occlusion**

aVR

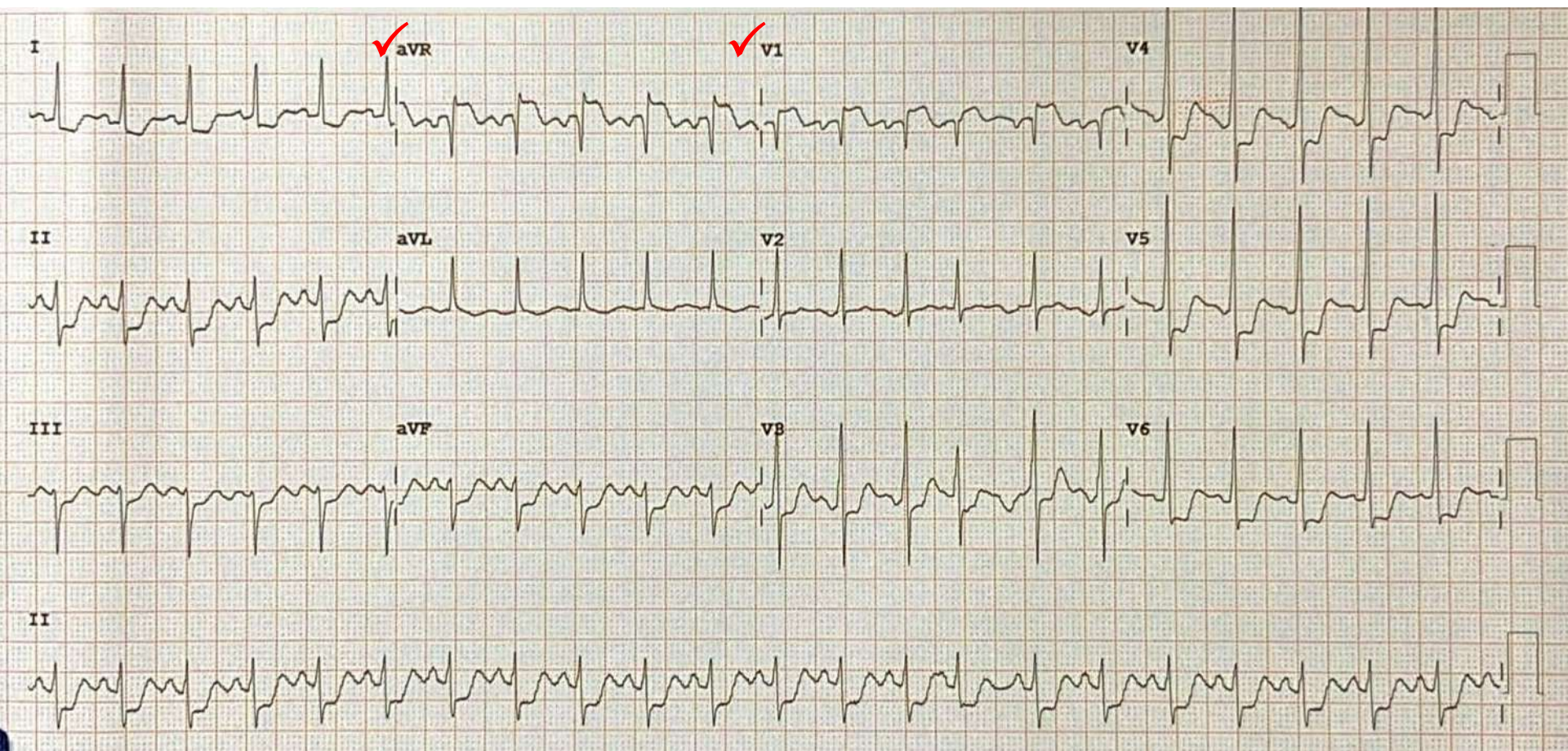
□
RVOT

V1



**ST $\uparrow$ ratio aVR/V1 < 1 ,
the culprit artery = proximal LAD**

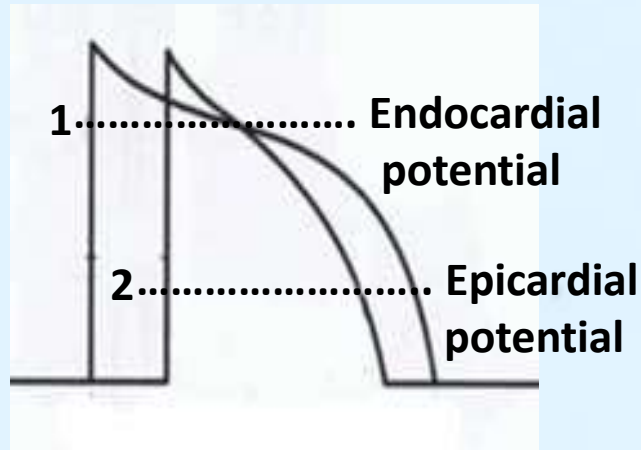
ST↑ more in aVR than V1



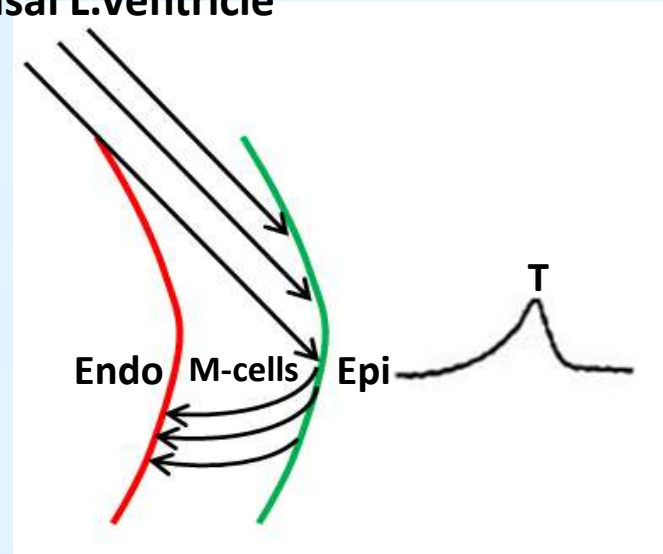
Source : Dr. Satish Kumar , Senior Consultant Physician -Cardiology, Wellmark Hospital , Bokaro Steel City (Jharkhand)
(CME INDIA on 14th Aug , 2025)

☐ **TVD : Prox LAD 95% , LCX 80%, RCA 70 %**

Positive wave T (wave of repolarization)



Posterobasal L.Ventricle



FUNDAMENTAL LAW

- ❑ Epicardial cells are normally having a shorter duration action potential than endocardial cells with a potential of earlier repolarization
- ❑ The repolarization starts from the point where the depolarization wave gets ended
(The wave of repolarization T starts from the posterobasal portion of the LV over the epicardial surface → further propagation anteriorly in a similar positive direction as that of the QRS complex → Positive T

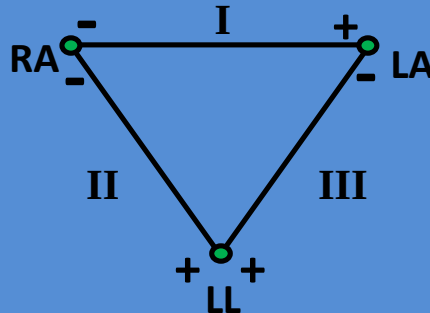
'Must Know Rules of ECG Interpretation'

Rule of 90° (with frontal plane) : Any exploring lead placed within a range of 90° in respect to cardiac vector records positive current , at 90° equiphasic deflection or no deflection and beyond 90° negative deflection.

Sequential flow through chest leads :

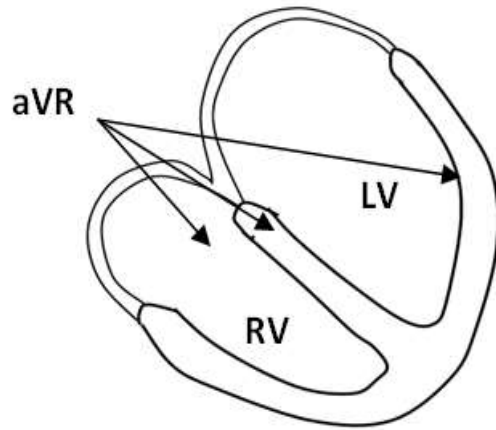
- Waves morphology as per sequential activation of the ventricles from V1 to V6
- Positive deflection towards the flow of current , equiphasic or no deflection at transitional zone and –ve deflection when away from the flow of current

**The flow of current from –Ve to +Ve pole → +Ve wave ;
towards –Ve pole → – Ve wave**



Epicardial cells are normally having a shorter duration action potential than endocardial cells with a potential of earlier repolarization

‘With distances greater than 15 cm from the heart, the decrement in the intensity of the electrical field is hardly noticeable. Consequently, all electrodes placed at a distance greater than 15 cm from the heart may, in an electrical sense, be considered to be equidistant from the heart.’ (Reference -LeoSchamroth – AN INTRODUCTION TO ELECTROCARDIOGRAPHY - EIGHTH ADAPTED EDITION – Basic Principles P – 6).



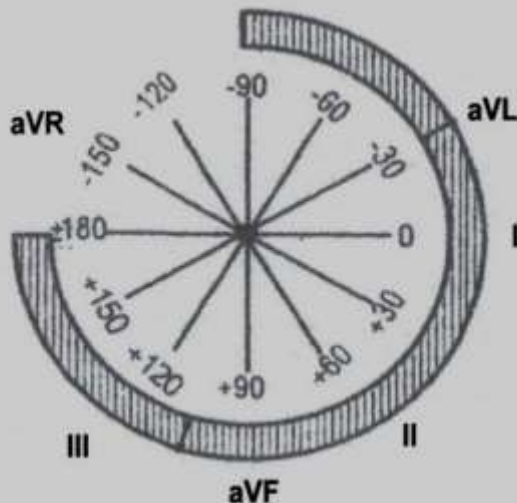
This aVR lead gives a useful information viewing the right upper side of the heart such as outflow tract of the right ventricle and the basal part of the septum. This lead also gives reciprocal information from the left lateral side of the heart as well.

Normal 12-Lead ECG

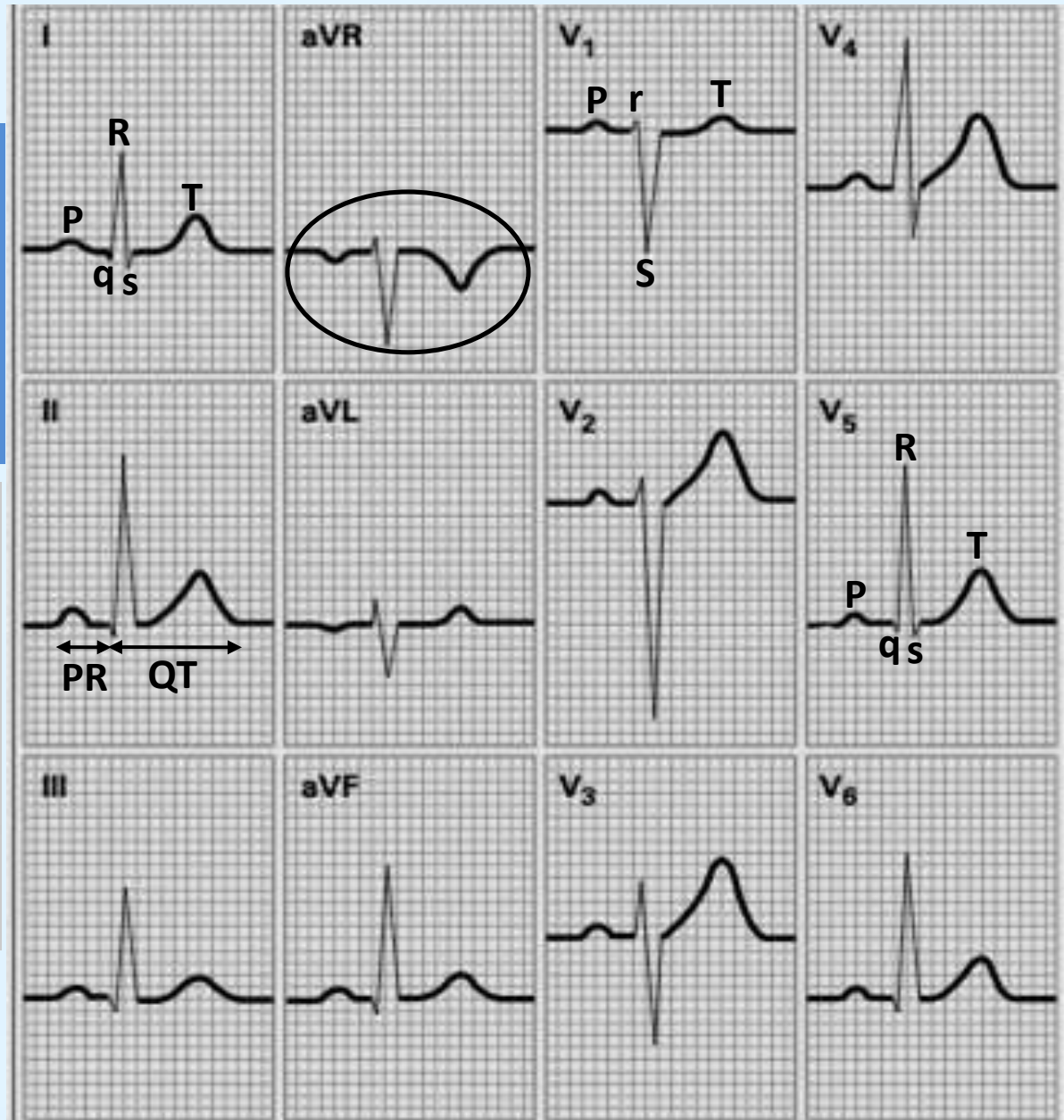
RULE OF 90°

(Electrical axis determination)

Any exploring lead placed within a range of 90° in respect to cardiac vector records positive current, at 90° equiphase deflection or no deflection and beyond 90° negative deflection.



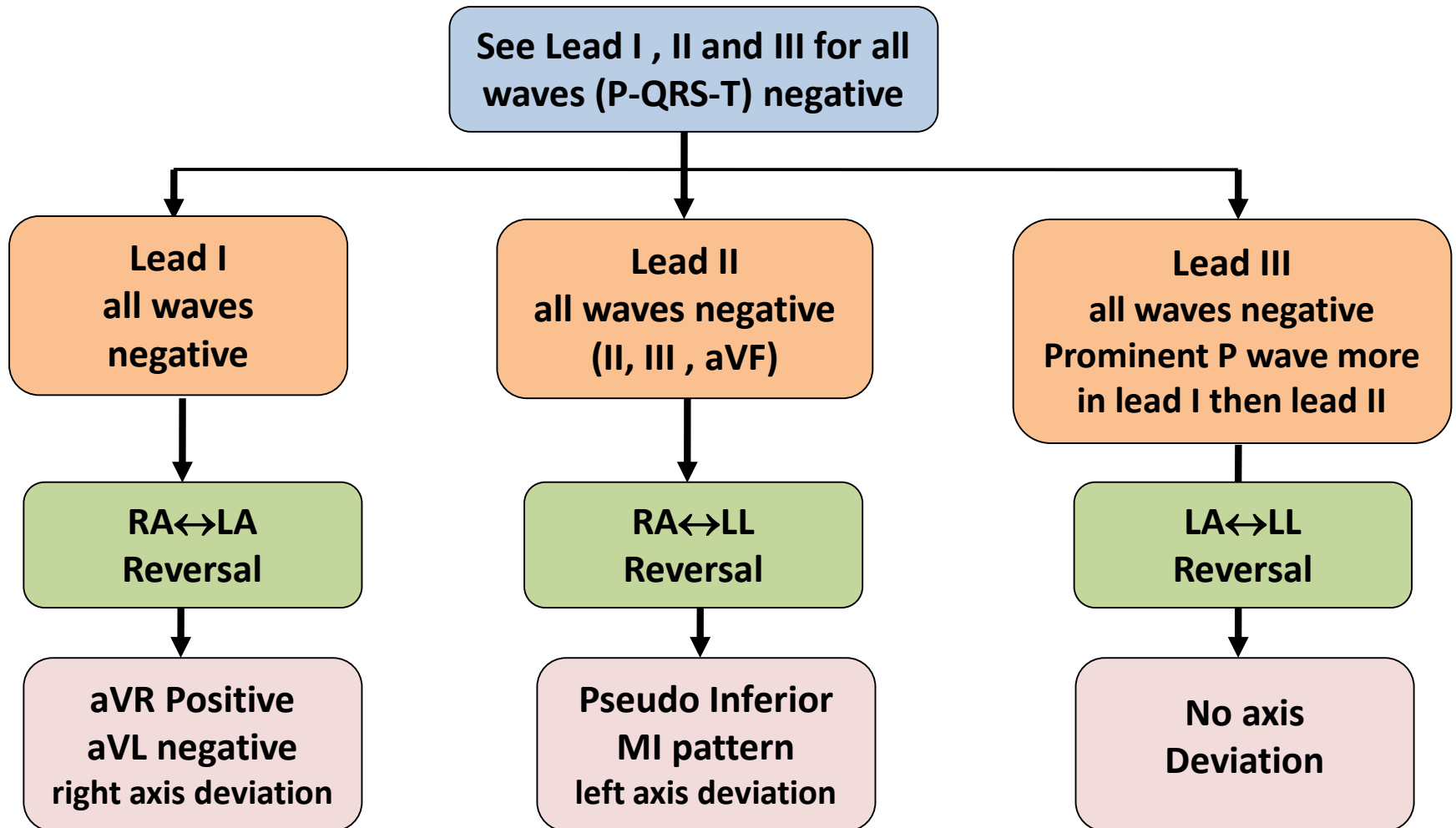
Normal QRS axis = - 30° to +90°



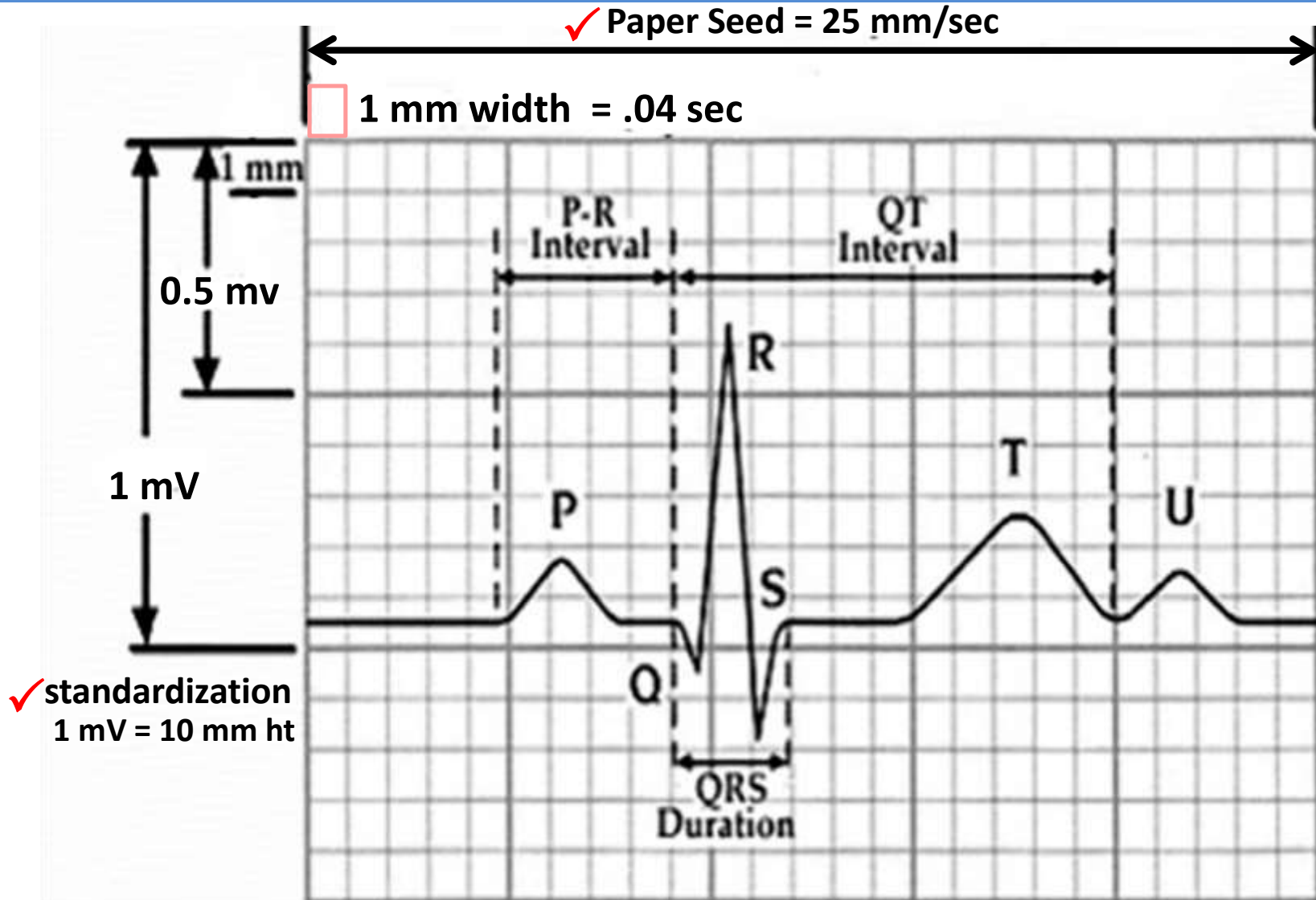
Steps interpretation of ECG

1. A Bird's eye view
2. Heart rate (A rate – V rate)
3. Rhythm
4. Electrical axis
5. P-wave
6. PR interval
7. QRS morphology
8. ST segment
9. T changes
10. QTc interval
11. U wave

Quick Diagnostic Pearl – Limb Lead Reversal



A Bird's Eye View



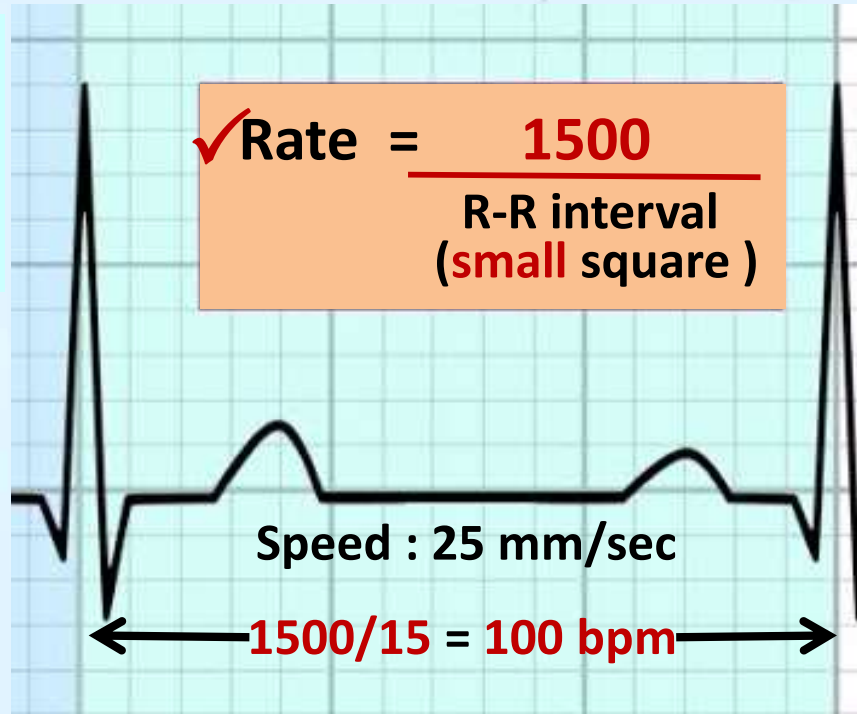
✓ NB : Any gross abnormality on ECG : Rhythm regular or irregular , Tachycardia /Bradycardia , Low voltage /Poor R-wave progression , etc.

Heart rate (A rate – V rate)

1 sec = 25 small sq
60 sec (1 min) =
25x60 = **1500** small sq

When the rhythm
is regular

A



Number of small
squares in
between two
corresponding RR

$\checkmark$ A practical approach

- < 3 big squares = Tachycardia
- > 5 big squares = Bradycardia
- Accurate rate calculation by the given formula

$\checkmark$ **B** Count QRS in 10 second rhythm strip x 6 → use this method to determine rate when rhythm is irregular (e.g., atrial fibrillation)



ECG Morphometry

- **P wave** : Normal duration < 0.12 sec (3 small squares)
Amplitude < 2.5 mm in the limb leads
 < 1.5 mm in the precordial leads
- **Q wave** : Pathological Q wave
 > 0.04 s wide
 $> 25\%$ of depth of the QRS complex
- **PR interval** : 0.12-0.20 sec
- **QRS width** : 70-100 ms (sometimes 110 ms)
- **T wave** :
Amplitude < 5 mm in limb leads , < 10 mm in precordial leads
(duration related to QT interval)

QTc interval

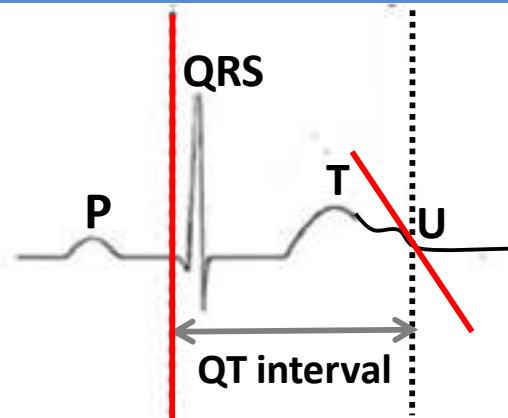
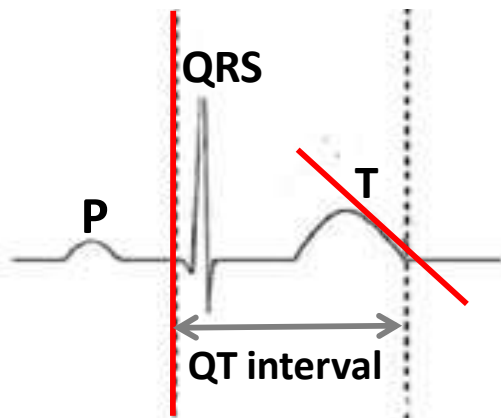
❑ QTc estimation (use scientific calculator)

<https://play.google.com/store/apps/details?id=com.scientificCalculator>



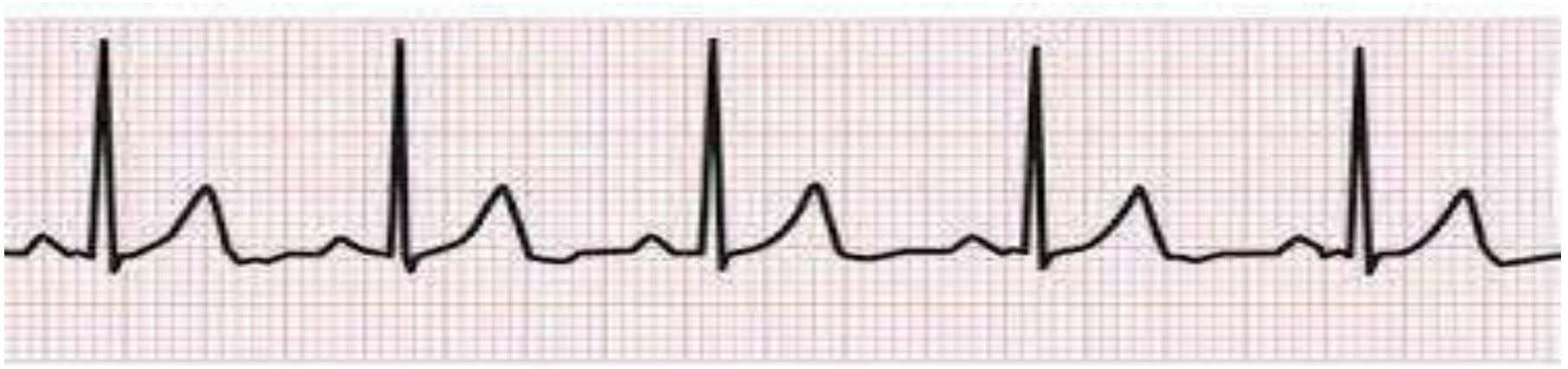
- Bazett formula : $QT / \sqrt{RR}$ (useful with HR 60-100 bpm)
- Framingham formula : $QT + 0.154 (1-RR)$ (At heart rate outside of the range 60-100 bpm)

A useful rule of thumb is that a normal QT is less than half of the corresponding RR interval



❑ Normal QTc values

- QTc prolonged if > 440 ms in male or > 460 ms in women
- QTc is abnormally short if < 350 ms
- $QTc > 500$ ms is illustrated with an increased risk of Torsades de pointes



ESSENTIALS :

❑ ECG interpretation is a knowledge based skill

3A

- **A concept of normal ECG and abnormal ECGs based on a basic book with special emphasis on illustrated ECGs explanation**
- **A regular revision**
- **A step-by-step methodical approach in collaboration with the clinical history**

Thanks

