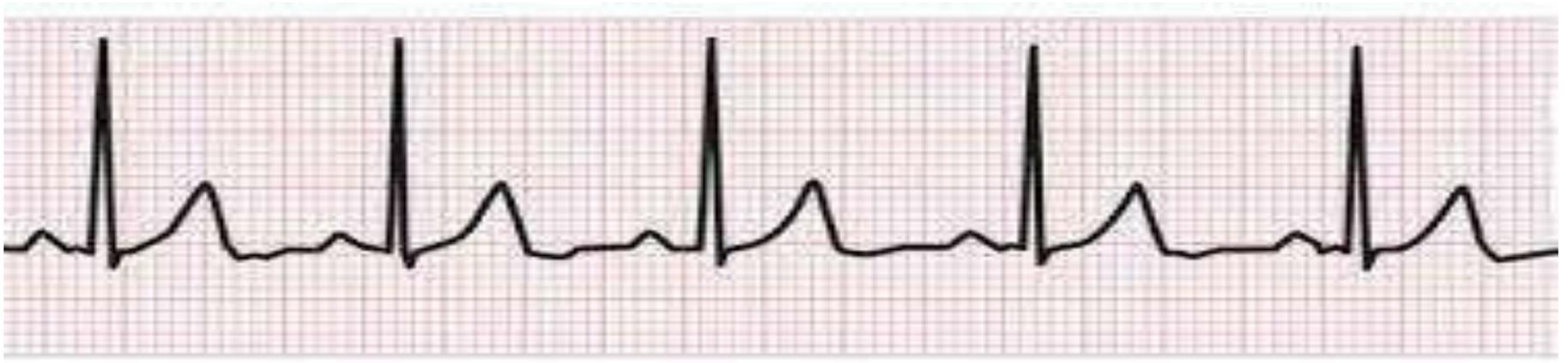


An Easy Approach to Interpret ECG

DR. D.P Khaitan

M.D (Medicine) F.C.G.P(IND) F.I.A.M.S (Medicine) FICP FICCMD



ESSENTIALS :

- ❑ **ECG interpretation is a knowledge based skill**

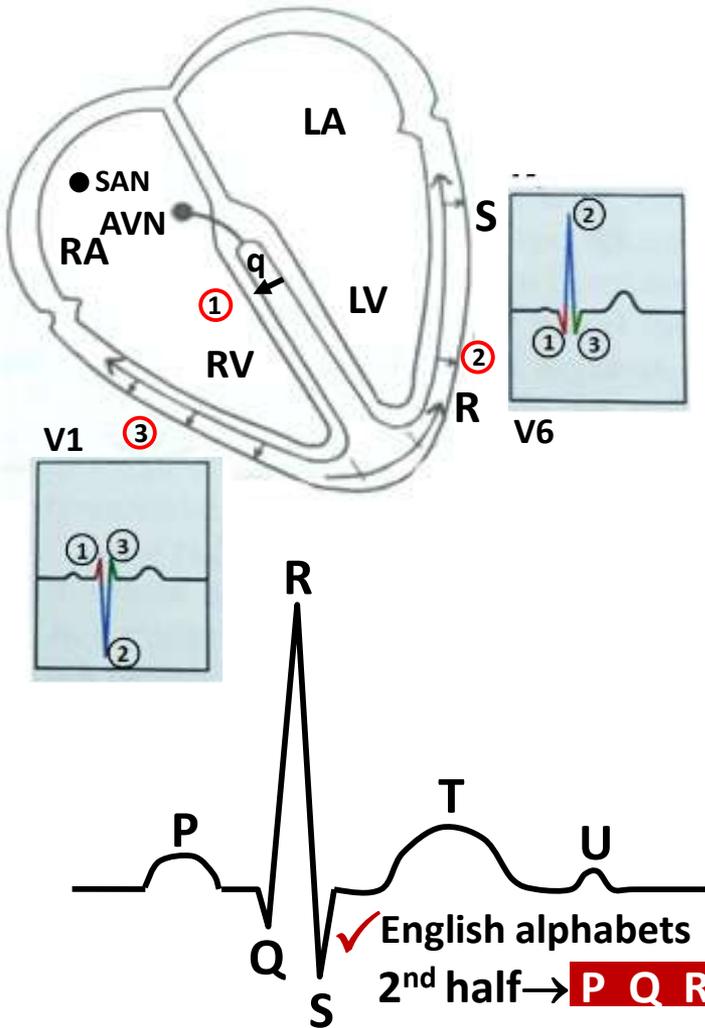
3A

- **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**

Normal ECG

✓11 Steps interpretation of ECG

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



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

Step 1 : A Bird's Eye View

✓ Paper Speed = 25 mm/sec

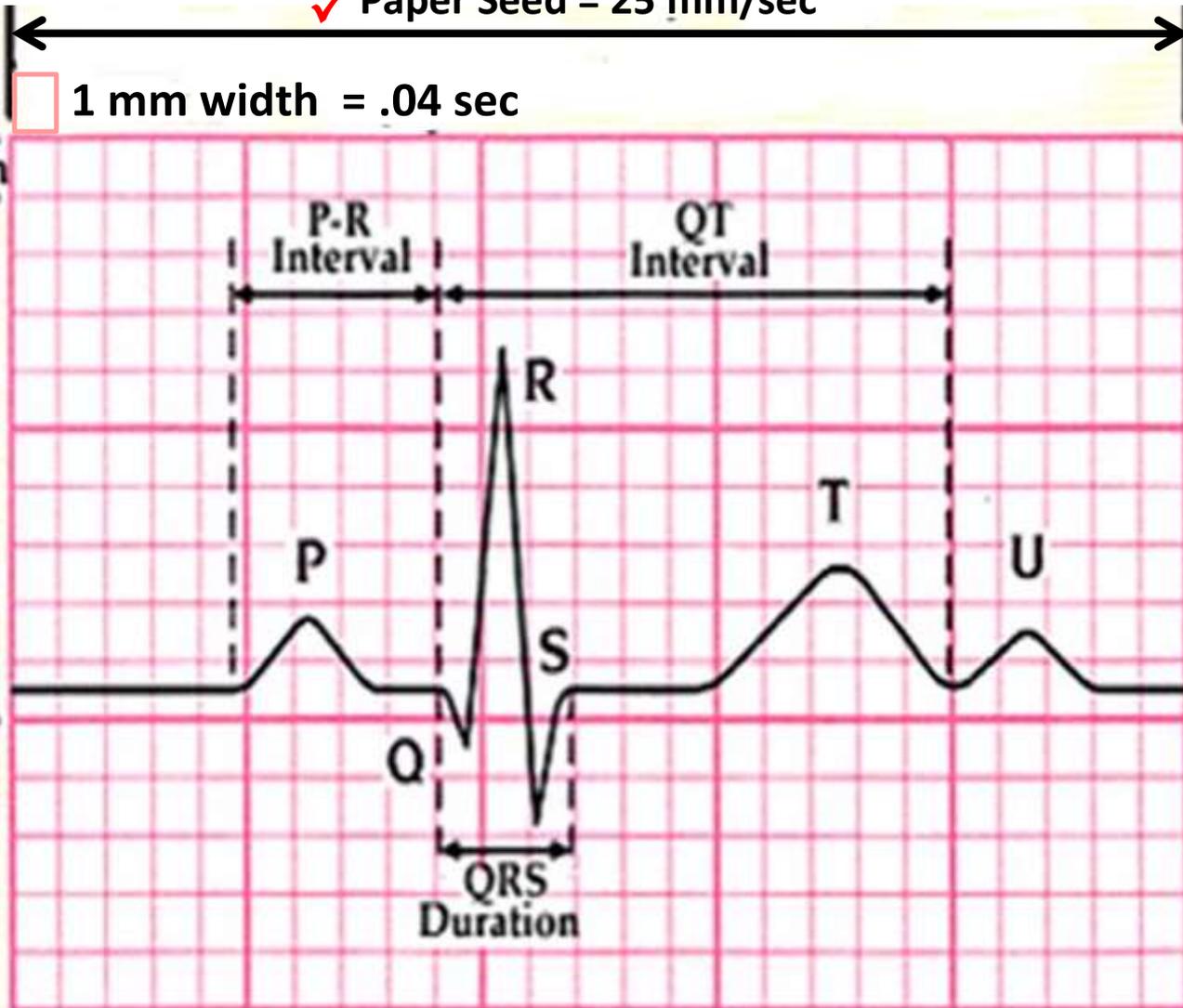
1 mm width = .04 sec

1 mm

0.5 mV

1 mV

✓ standardization
1 mV = 10 mm ht



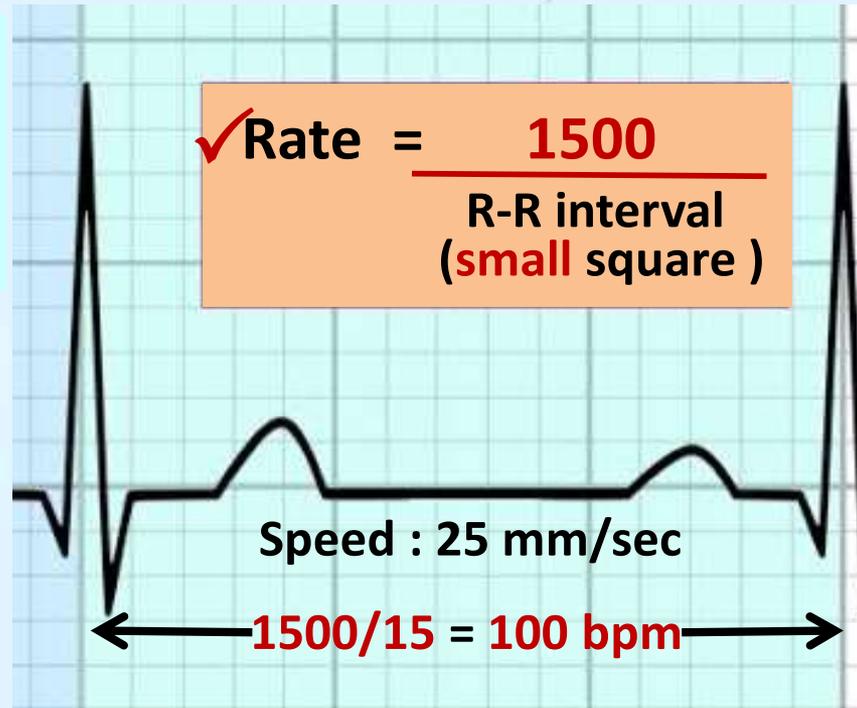
✓ NB : Any gross abnormality on ECG : Rhythm regular or irregular , Tachycardia /Bradycardia , Low voltage /Poor R-wave progression , etc.

Step 2 : 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

✓ A practical approach

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

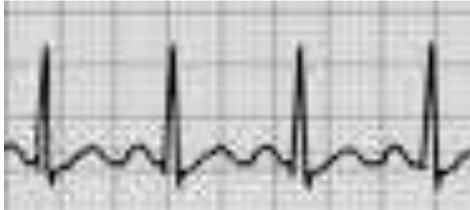
✓ **B** Count QRS in 10 second rhythm strip x 6 → use this method to determine rate when rhythm is irregular (e.g., atrial fibrillation)



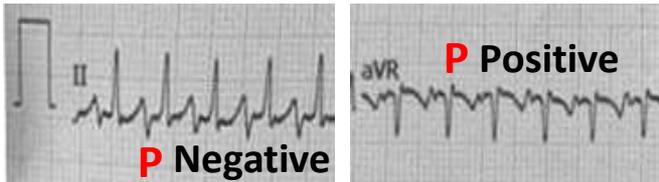
Step 3 : Rhythm

Tachy-rhythm

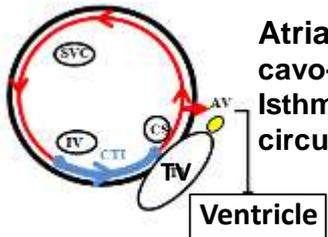
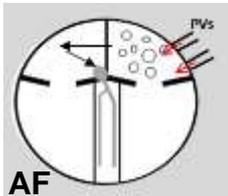
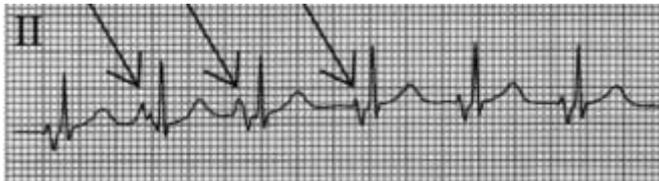
Sinus Tachycardia



Atrial Tachycardia



MAT

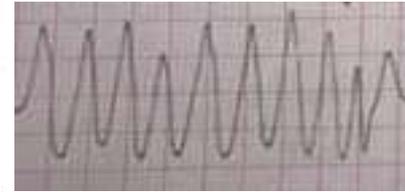
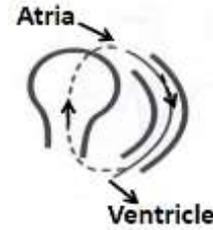


Atrial flutter : cavo-tricuspid isthmus circuit

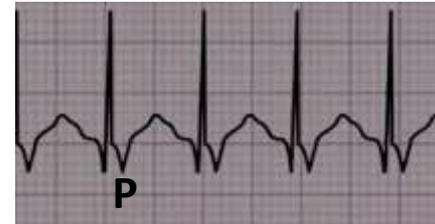
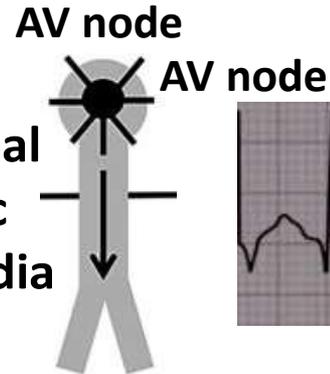


Bix Rule

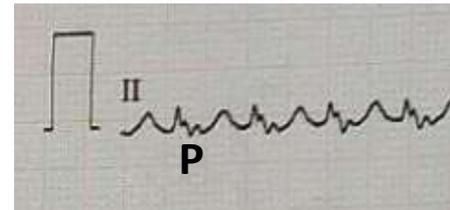
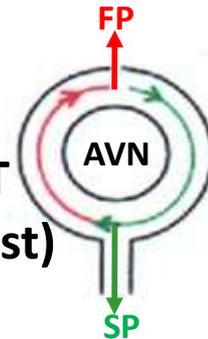
Pre-excitation AF



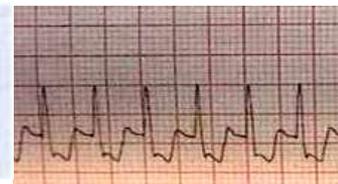
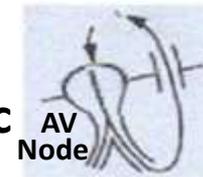
Junctional Ectopic tachycardia



AVNRT (Slow-Fast)

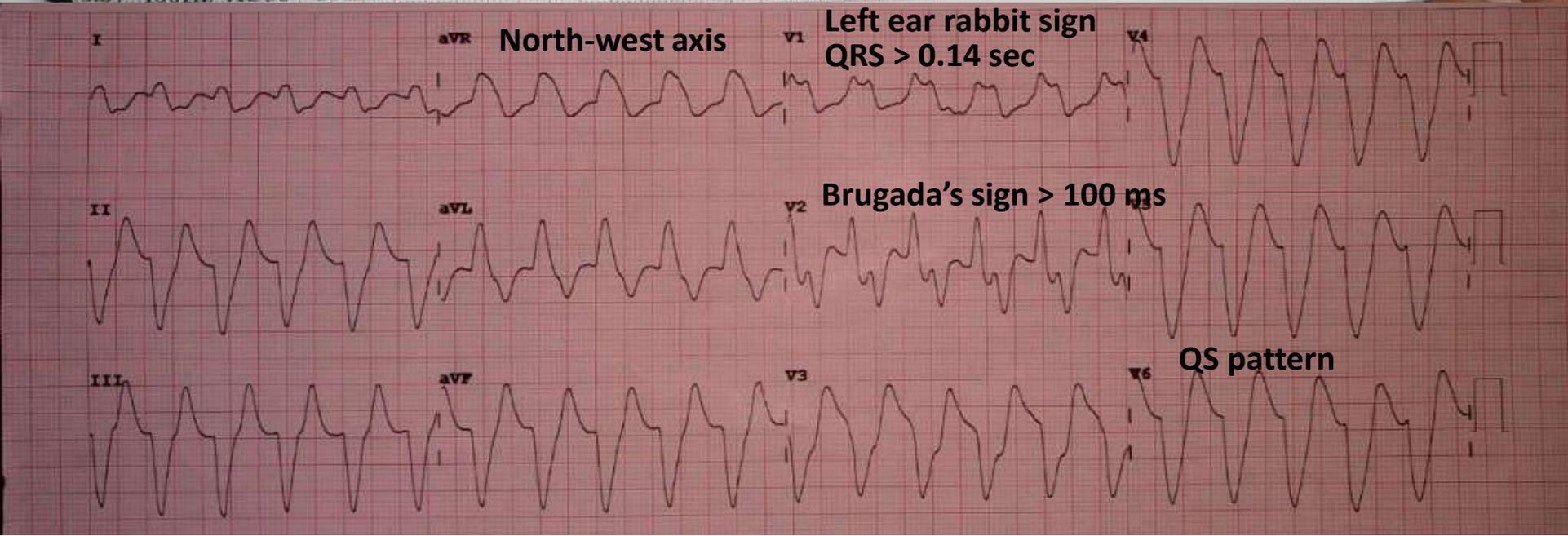
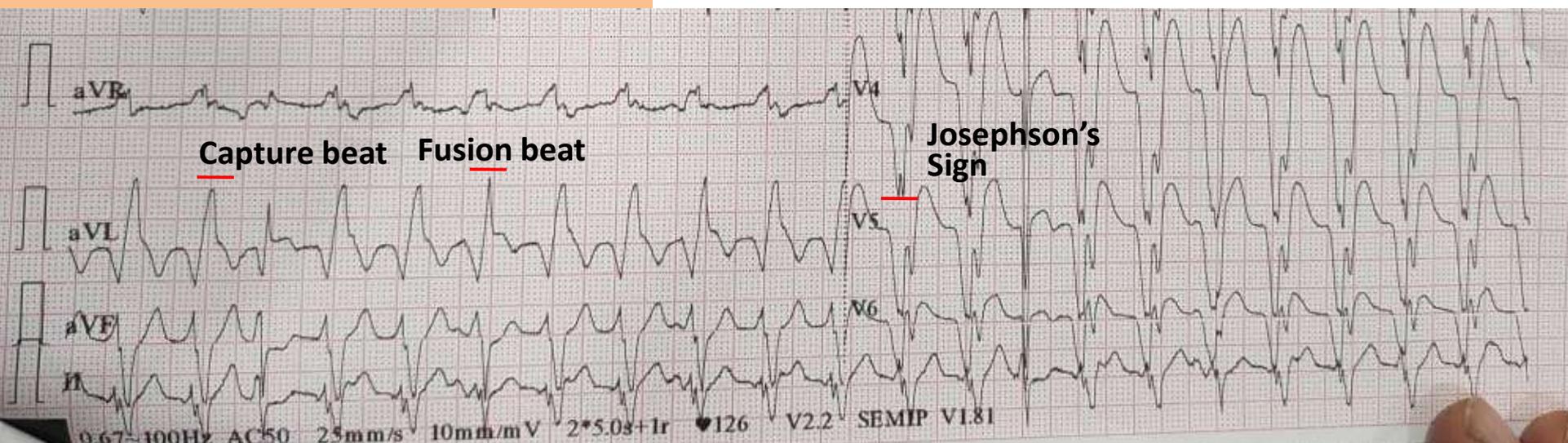


AV orthodromic



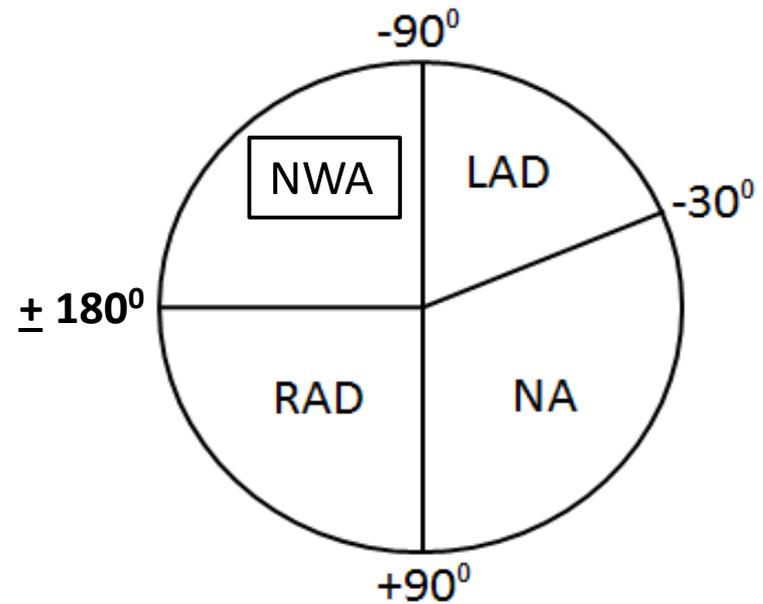
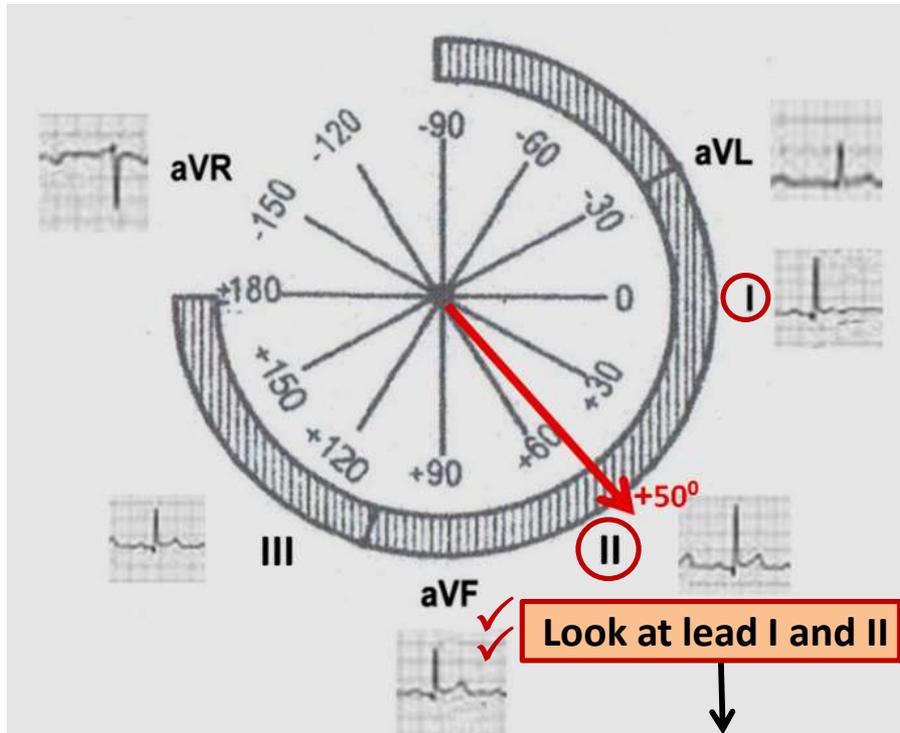
Ventricular tachycardia - VT

AV dissociation with faster ventricular rate (ventricular origin)



NB : +Ve or -Ve concordance throughout the chest lead , i.e. with leads V1-6 so entirely positive (R) or entirely negative (QRS complexes) , with no RS complexes seen

Step 4 : Electrical Axis (Frontal plane)

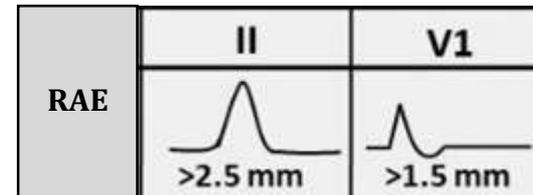


QRS Positive in leads I and II	Normal Axis	-30° to $+90^{\circ}$
QRS complex is positive in lead I but negative in lead II	Left Axis Deviation	-30° to -90°
QRS Negative in lead I but positive in lead II	Right Axis Deviation	$+90^{\circ}$ to $+180^{\circ}$

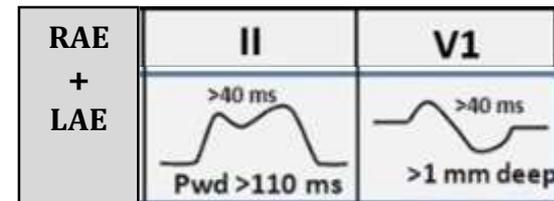
Step 5 : P-wave

- P wave pattern usually best seen in lead II
- Inverted P-waves in inferior leads (II, III & aVF) suggest retrograde activation of the atria :
 - AV nodal rhythm
 - Low left atrial site
 - AVNRT or AVRT
- Inverted P wave wave in standard lead I :
 - Incorrect electrode placement (in between right arm and left arm)
 - Mirror image dextrocardia

RAE



LAE



Step 6 : PR interval (0.12 to 0.20 Sec)

- PR > : constant or gradual prolongation till QRS drop

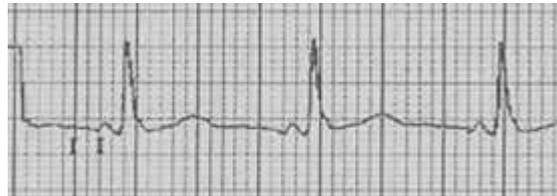


First degree AV block



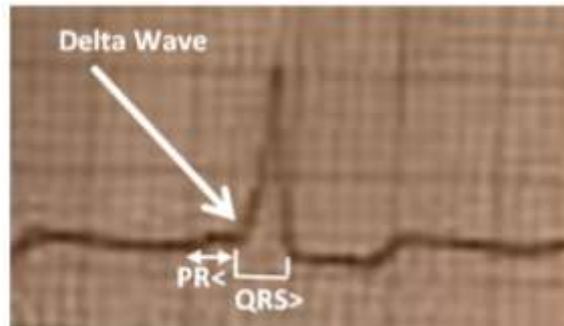
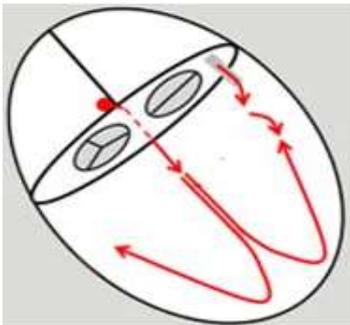
Second degree – Mobitz type I

- Shortened PR interval , LGL syndrome or WPW pattern



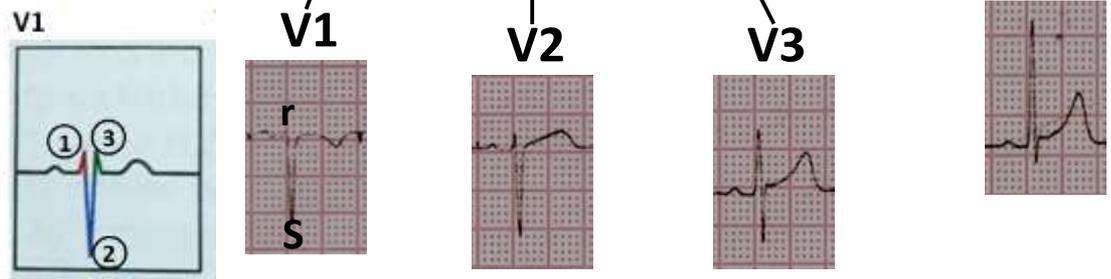
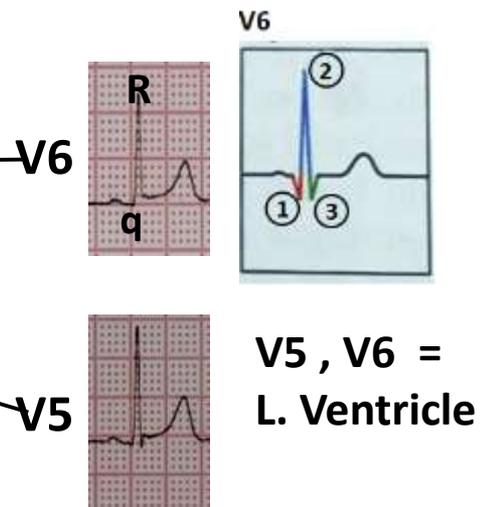
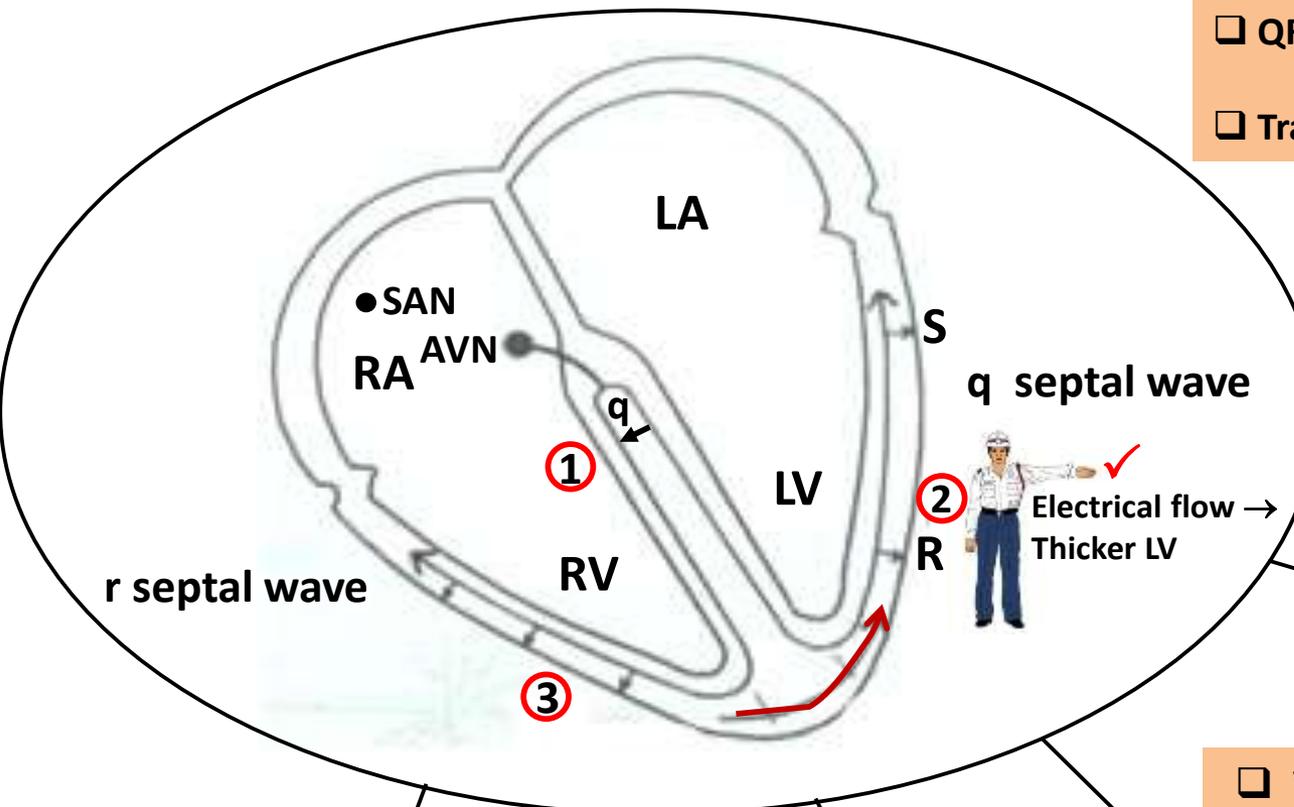
LGL syndrome

- WPW pattern



Step 7 : QRS (on horizontal plane) morphology

- QRS voltage < 5 mm in limb leads
<10 mm in chest leads
- Transition zone & R-wave progression

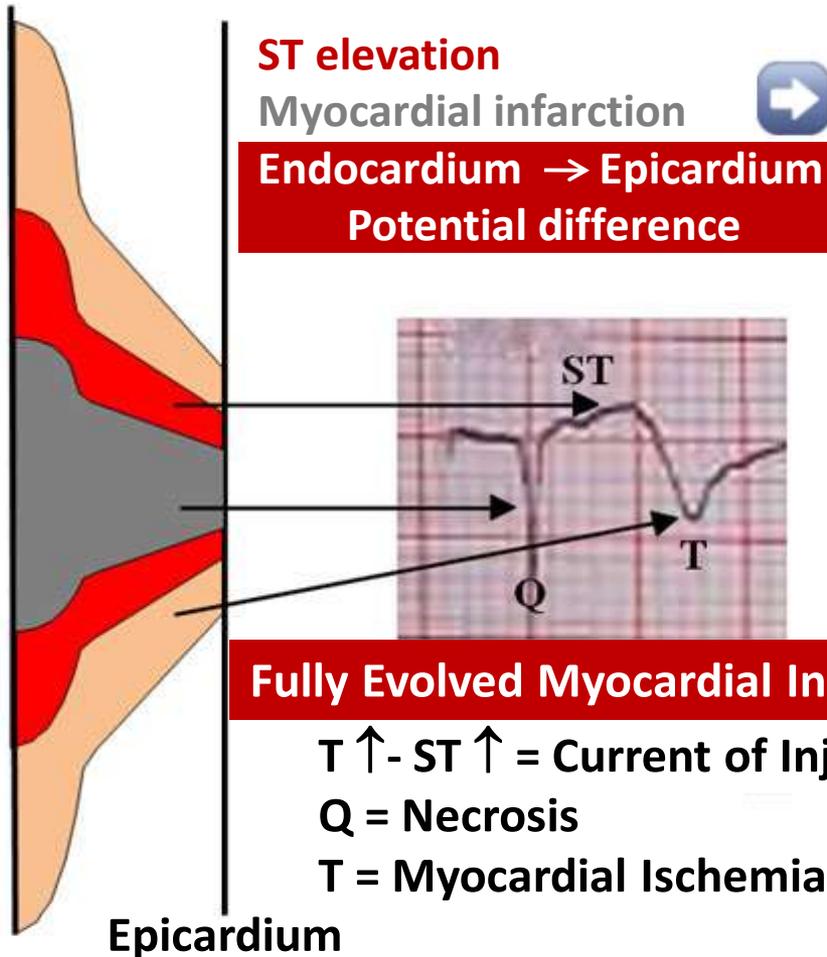


V1 -V2 = R. Ventricle

Transitional zone

- Ventricular dominance : RVH/LVH
- In bundle branch block :
no simultaneous ventricular activation but one after the other (Biphasic R)
 - RBBB with RV pattern dominance
 - LBBB with LV pattern dominance
- Pathological Q wave : dead / inert myocardium

Diagnostic Approach to STEMI



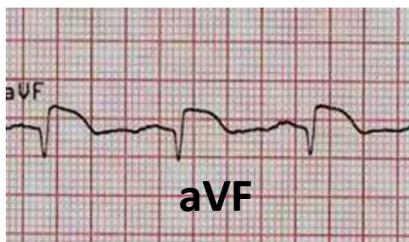
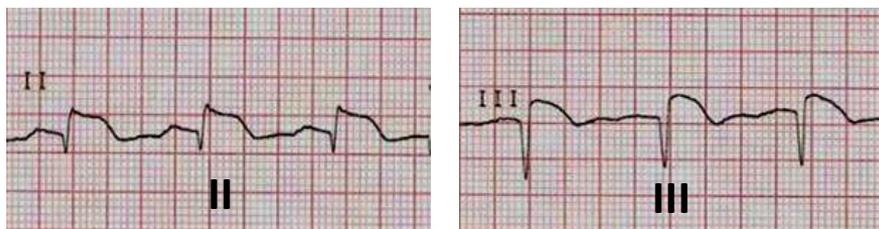
Hyperacute T	mts-few hrs ✓	few hrs-few days ✓	few days – few weeks

New ST-segment elevation at J-point in at least two anatomical continuous leads of ≥ 2 mm in a male or ≥ 1.5 mm in a female over leads V2-V3 and/or at least 1 mm in other continuous leads or limb leads

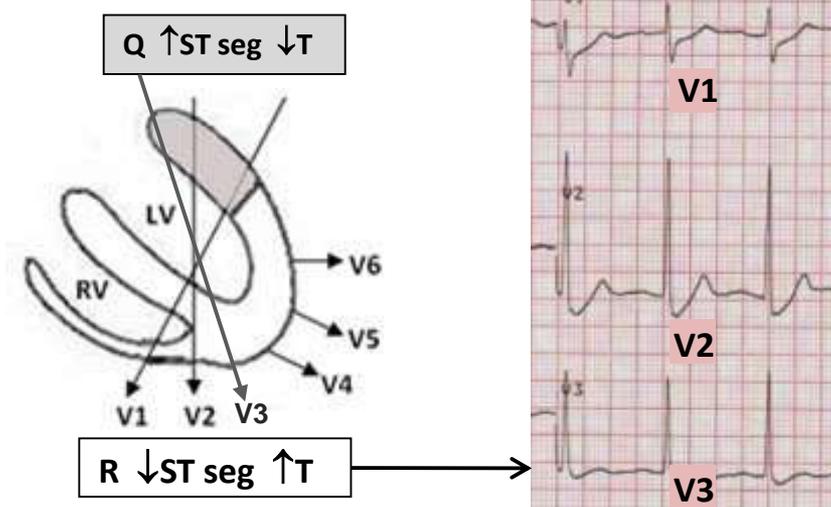
(other \uparrow ST causes excluded)

A wide Q wave (>0.04 sec) that exceeds 25% of the R wave in the leads with necrosis.

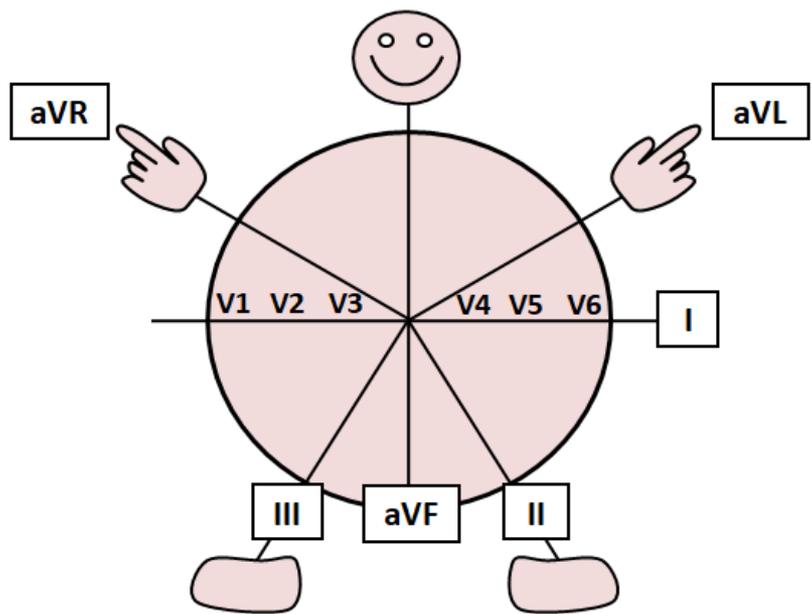
STEMI pattern on ECG



Inferior STEMI



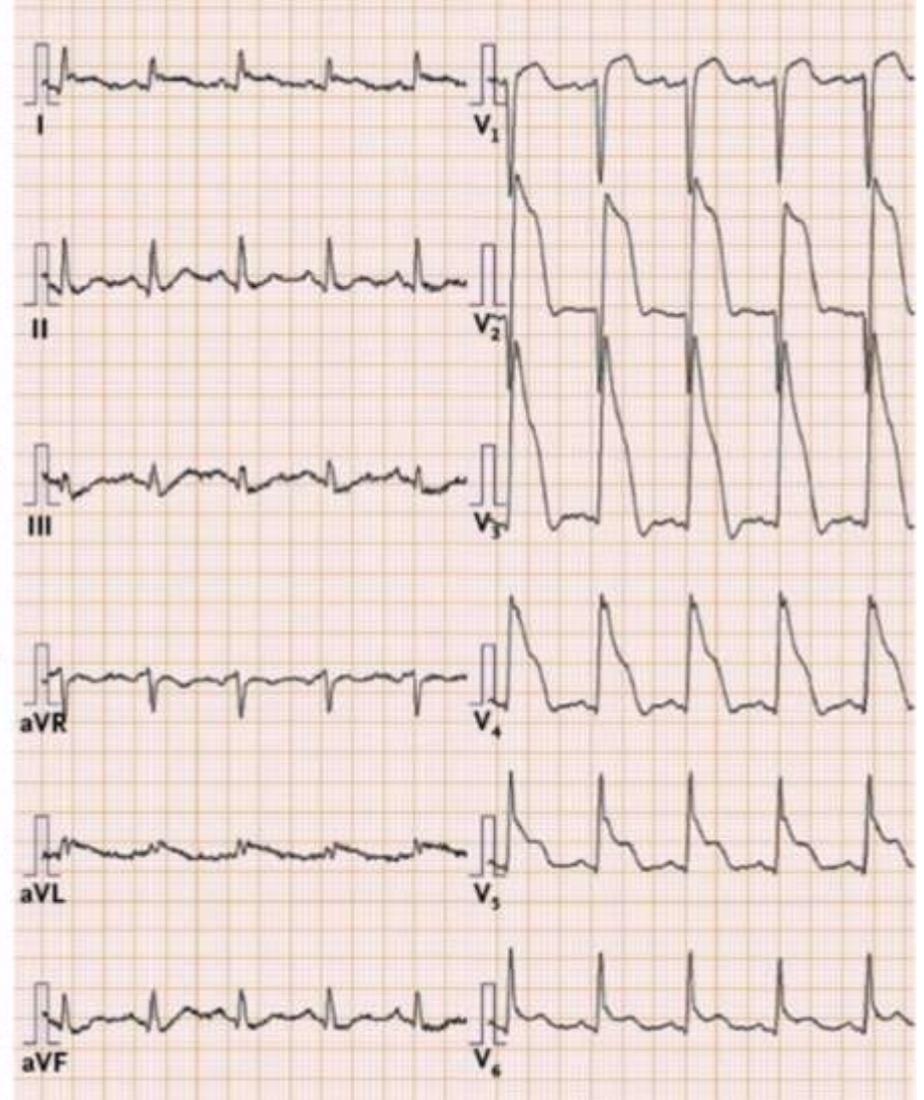
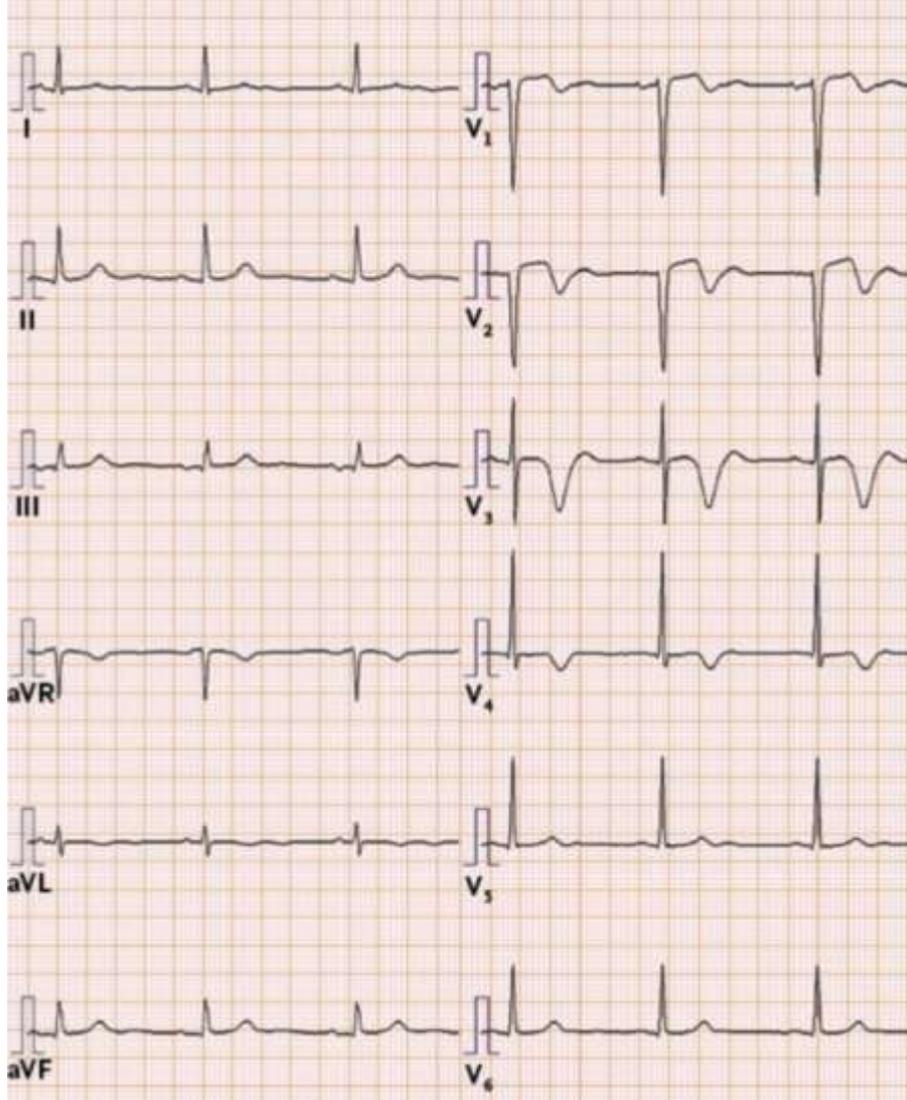
Posterior wall MI



➔ **Reciprocal change** is defined as ST-segment depression ≥ 1 mm in at least 2 leads in a single anatomic segment, occurring onto the contralateral side, as a mirror-image effect of ST-segment elevation associated with STEMI.

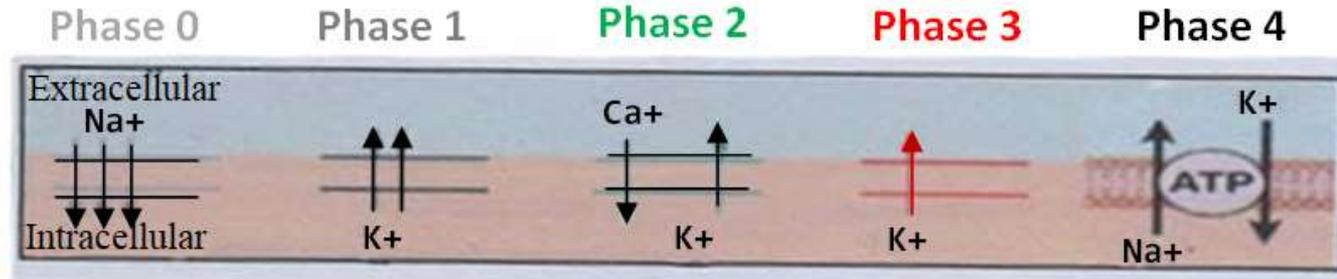
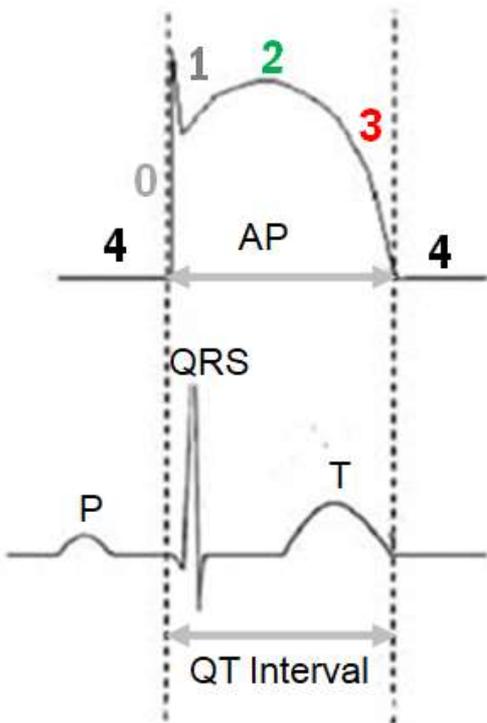
This supports the diagnosis of STEMI with specificity and positive predictive value of 93%.

Wellens' syndrome → anterior STEMI



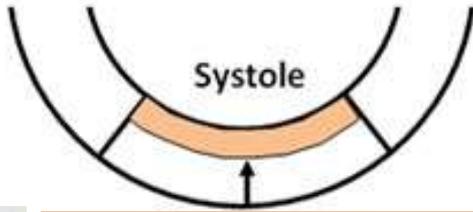
A Wellens' Syndrome → **B Anterior STEMI with "Shark Fin" sign formed by fusion of QRS , ST-seg and T wave**

Step 8 : ST segment - Phase 2



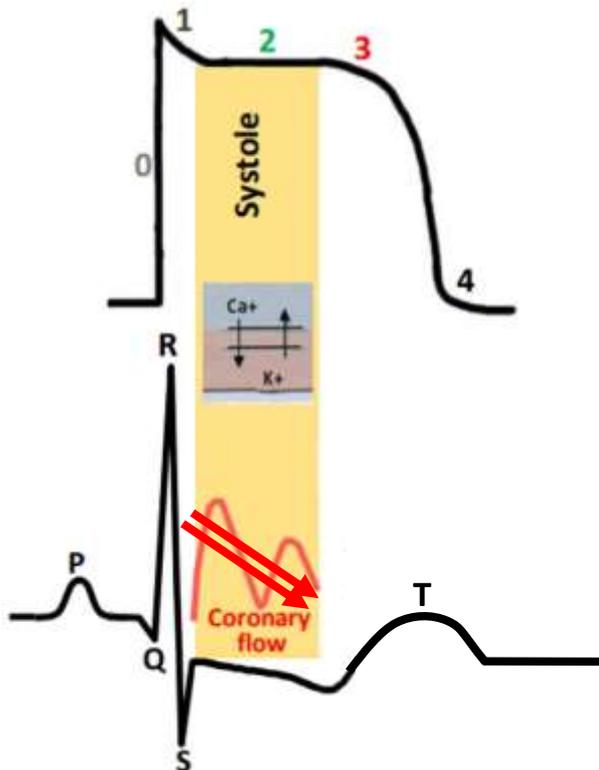
- ❑ Coronary artery disease is suggested by horizontal plane or down sloping ST segment
- ❑ The strain pattern – depressed convex – upward ST segment with inverted T-wave
- ❑ Digitalis effect : a mirror image correction mark shape of the ST segment
- ❑ Hyperacute phase of myocardial infarction and Prinzmetal's angina is reflected by slope elevation of the ST segment associated with the tall and widened T-wave

ST↓ in myocardial ischemia



Subendocardial Injury

- The flow of current is away from the exploring electrode (Potential difference)
- ST segment depression



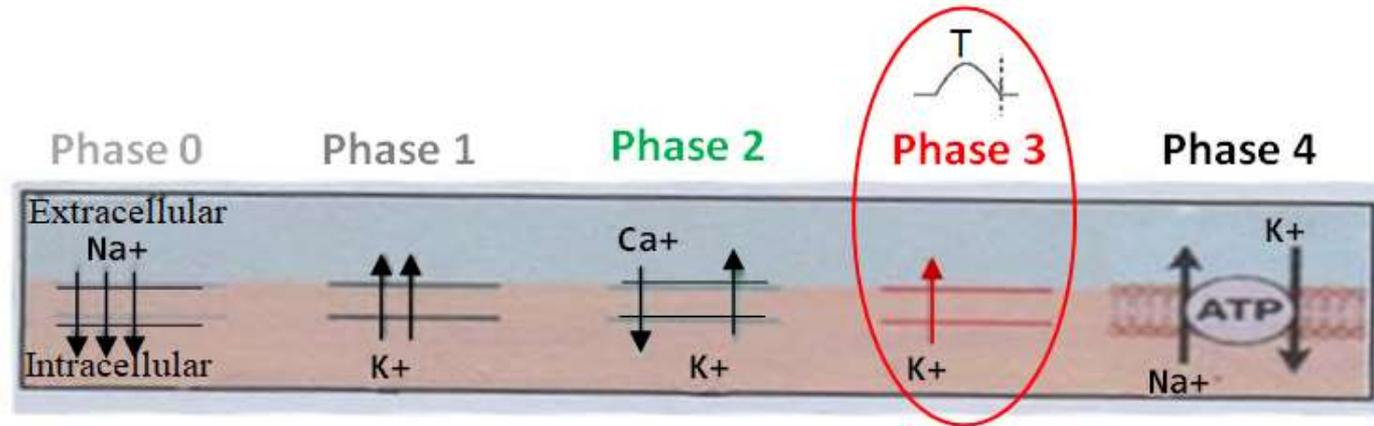
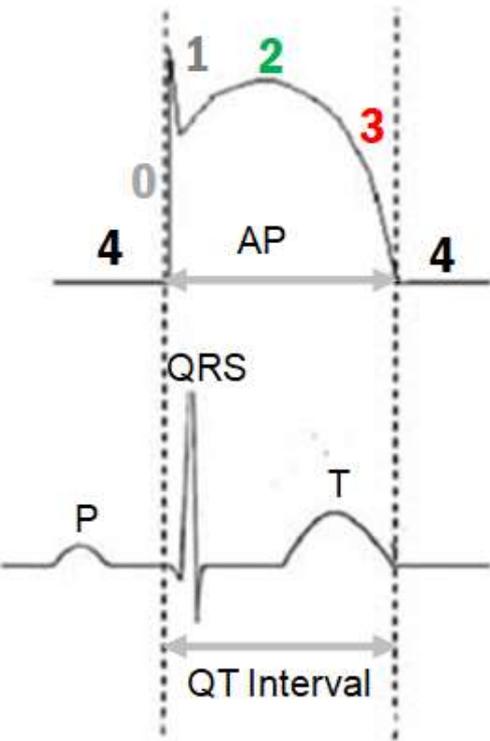
Downsloping ST segment depression



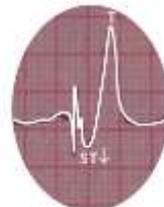
Horizontal or downsloping ST segment depression

- ≥ 0.5 mm ≥ 2 in two contiguous leads myocardial ischemia
- ST depression ≥ 1 mm a worse prognosis.
- ST depression ≥ 2 mm in ≥ 3 leads possibility of Non-ST elevation myocardial infarction (NSTEMI) \pm T inversions or flat T

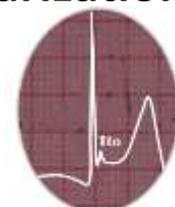
Step 9 : T-wave – Phase 3



- Low or inverted T waves in most leads may be associated with coronary heart disease
- Low or inverted T waves associated with generalized low voltage of the QRS complex suggest pericardial effusion or myxoedema.
- Tall, peaked T waves in the precordial leads may be due to :
 - ST elevation MI (broad based hyperacute T-wave)
 - de Winter T-wave • Early repolarization syndrome



de Winter T-wave



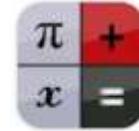
ERS T-wave

- Hyperkalaemia (narrow based Tall T-wave)

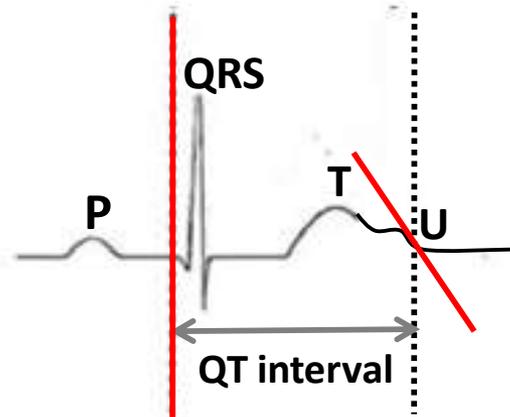
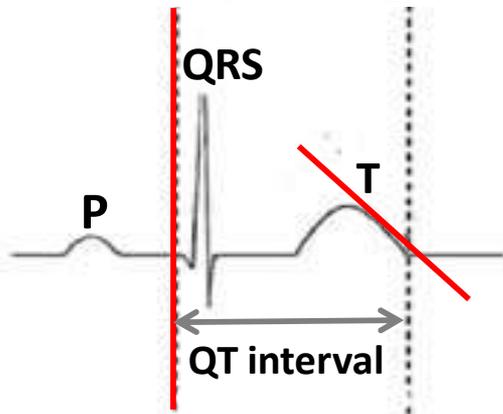
Step 10 : QTc interval

□ 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 the Corresponding RR interval



□ Normal QTc values

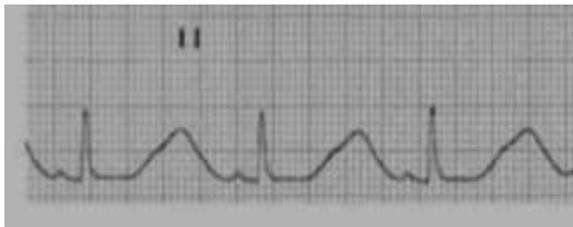
- QTc prolonged if > 440 ms in male or > 460 ms in women
- QTc is abnormally short if < 350 ms
- $QTc > 500$ ms is illustrated with an increased risk of Torsades de pointes

QTc (continued)

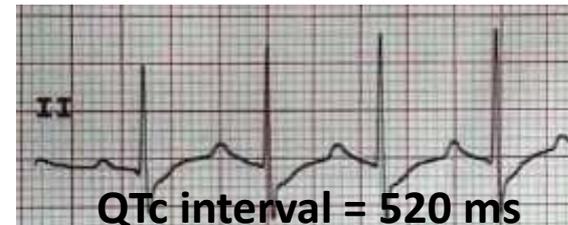
- ❑ Prolonged QTc in hypokalemia , hypocalcaemia , myocardial disease , congenital long QT syndrome

Shortened QT interval : In Hyperkalemia , Hypercalcaemia , Vagotonia , Digoxin toxicity , congenital short QT syndrome

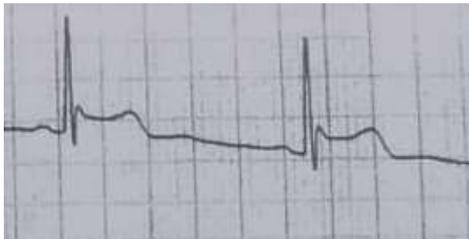
- ❑ Illustration by ECGs



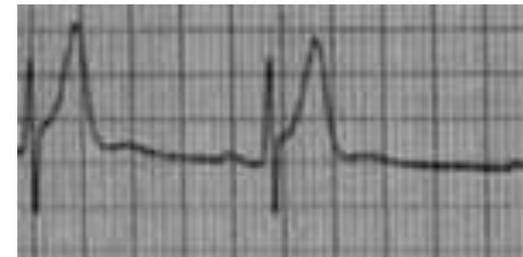
Prolonged QT by rule of thumb



Hypokalemia (A young male with Quadriplegia and respiratory arrest)



Hypercalcaemia : with 340 ms with virtual absence of ST segment and a widening of T-wave

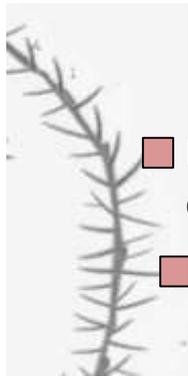


Congenital short QT syndrome

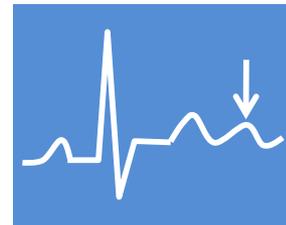
- QT and QTc intervals respectively : 0.32 and 0.32 ms both are equal and unchanged.
- Tall / peaked T , best seen over precordial leads V1-V4.

Step 11 : U wave

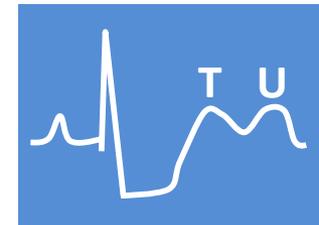
- ❑ A predominant U wave in the midprecordial leads – V3 to V5 – commonly due to hypokalemia
- ❑ An inverted U wave in standard leads leads I and II and leads and V6 is usually due to one of the following :
 - Coronary heart disease
 - Hypertensive heart disease



- Normally Synchronized repolarization of cardiac myocytes and Purkinje fibres
- In hypokalemia dichotomized repolarization : delayed and prolonged repolarization through purkinje fibres → T-U complex fusion of T with U → QT prolongation



Prominent
U wave



- ST depression
- Fusion of T with U

Concluding remark

Again to remind

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

