

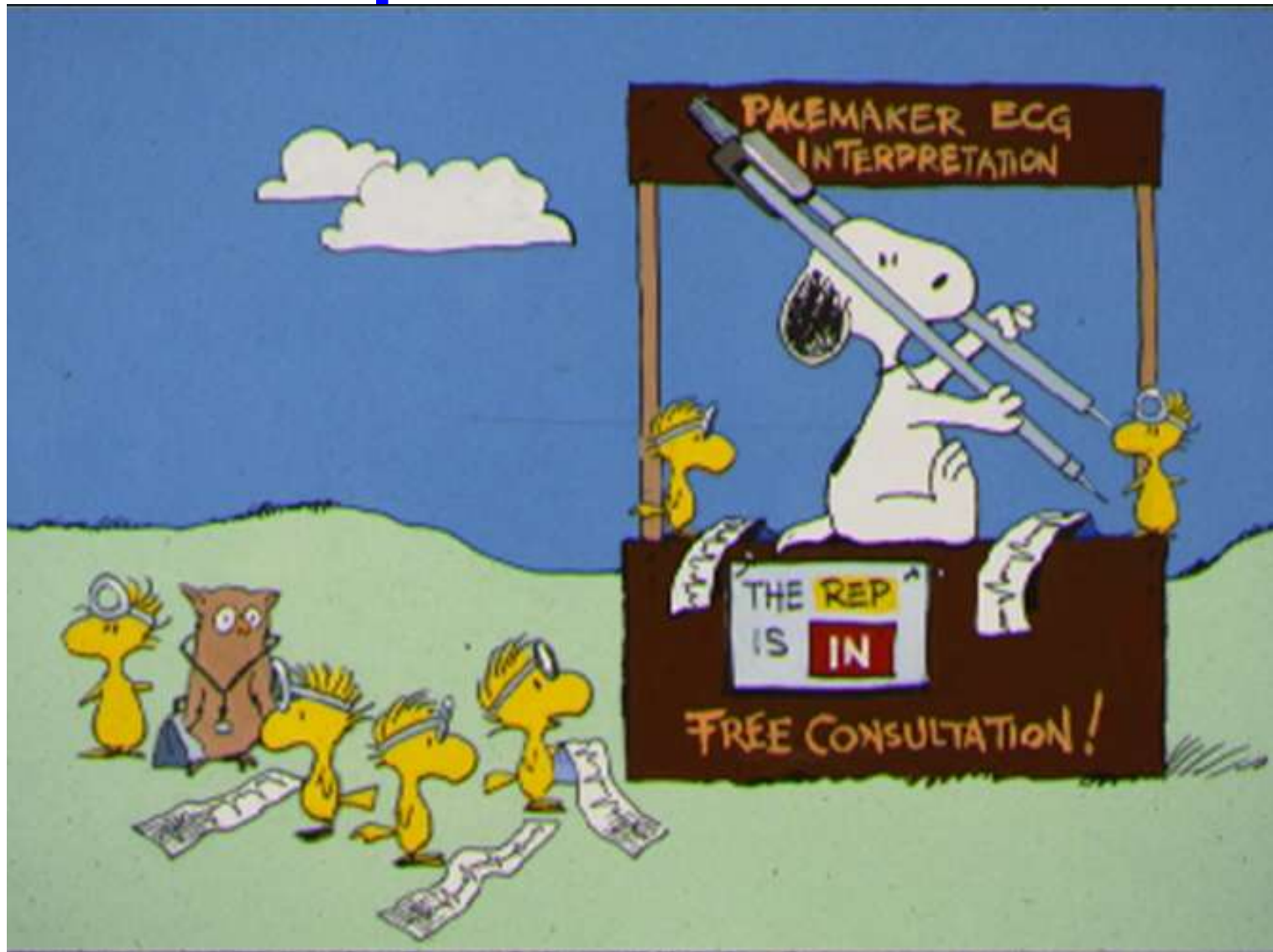
WAPNA 26<sup>th</sup> March 2011

# Update on ECG's and Atrial Fibrillation

Vince Paul  
Royal Perth Hospital  
Heart Care WA

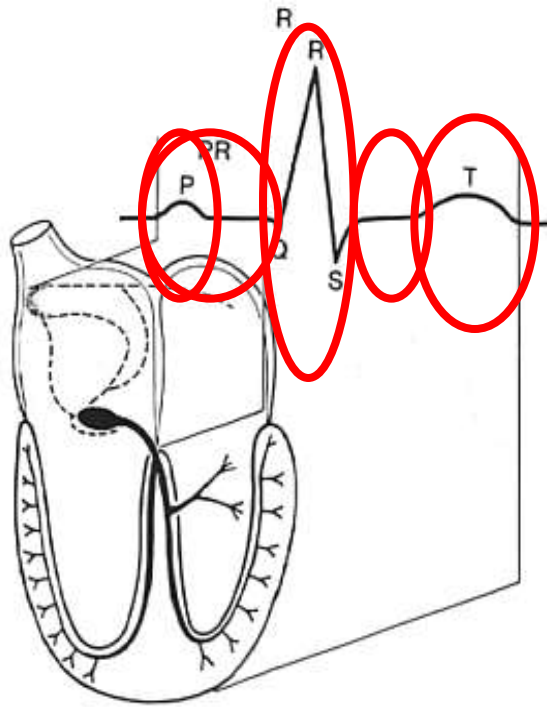
<http://www.mountcardiology.com.au/facts.php>

# Update on ECG's



<http://www.mountcardiology.com.au/facts.php>

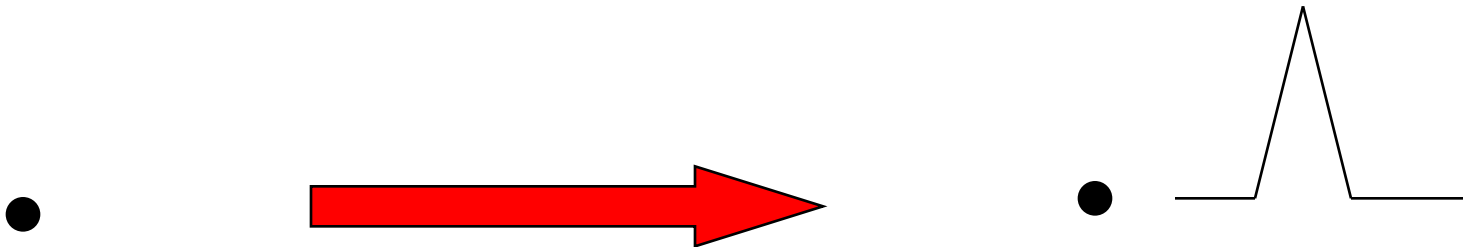
# Components of a Normal ECG



- P wave- atrial depolarisation
- PR interval
- QRS complex- ventricular depolarisation
- ST segment
- T wave Ventricular repolarisation

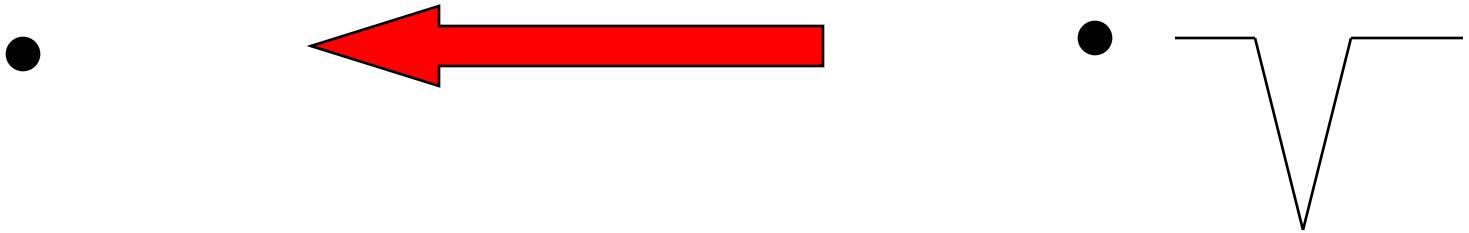
# ECG- What creates deflections

- Activation of the myocardium is associated with transfer of ions in and out of cells resulting in change in electrical potential
- A lead looks at the potential difference between two points.
- If an electrical wavefront is directly from one point to another this will be seen as a potential difference or deflection. A wave moving towards a lead is seen as a positive deflection



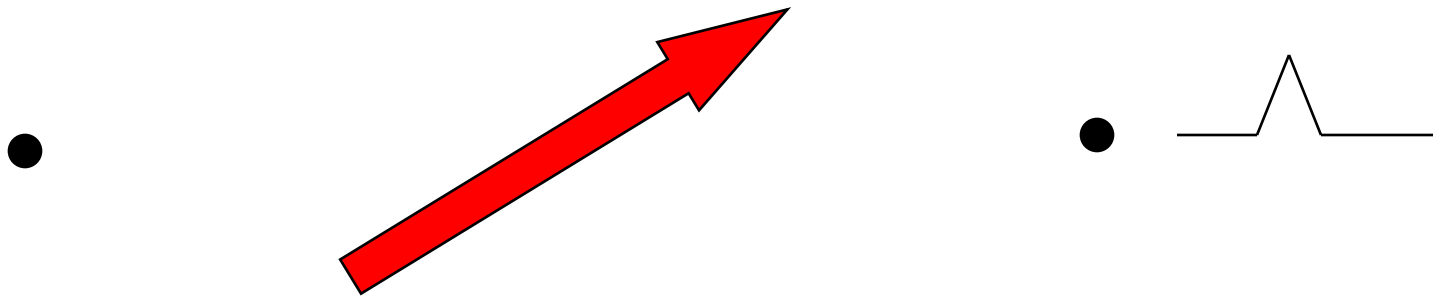
# ECG- What creates deflections

- A wavefront travelling in the opposite direction will give a deflection of opposite polarity
- Amplitude depends on magnitude of electrical change and proximity of electrode to heart



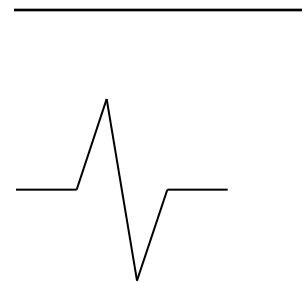
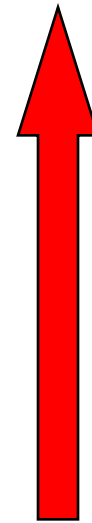
# ECG- What creates deflections

- Amplitude also effected by orientation
- If the same wavefront is at angle ( $<90$  degrees) to the leads it will still be seen as a deflection but of lesser amplitude.



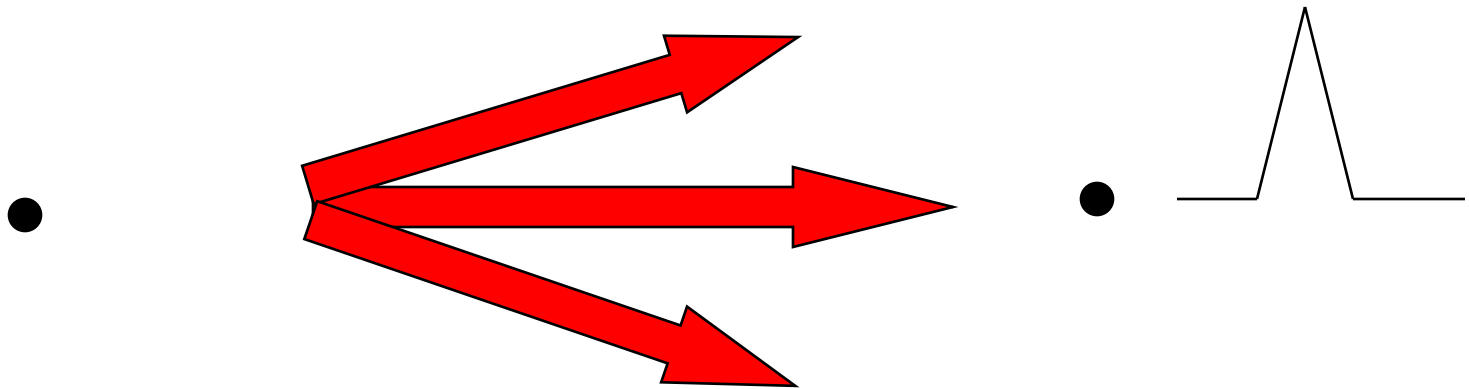
# ECG- What creates deflections

- The same wave front passing perpendicular to the lead orientation will have no net effect on the lead and will not be seen (isoelectric throughout)



# ECG- What creates deflections

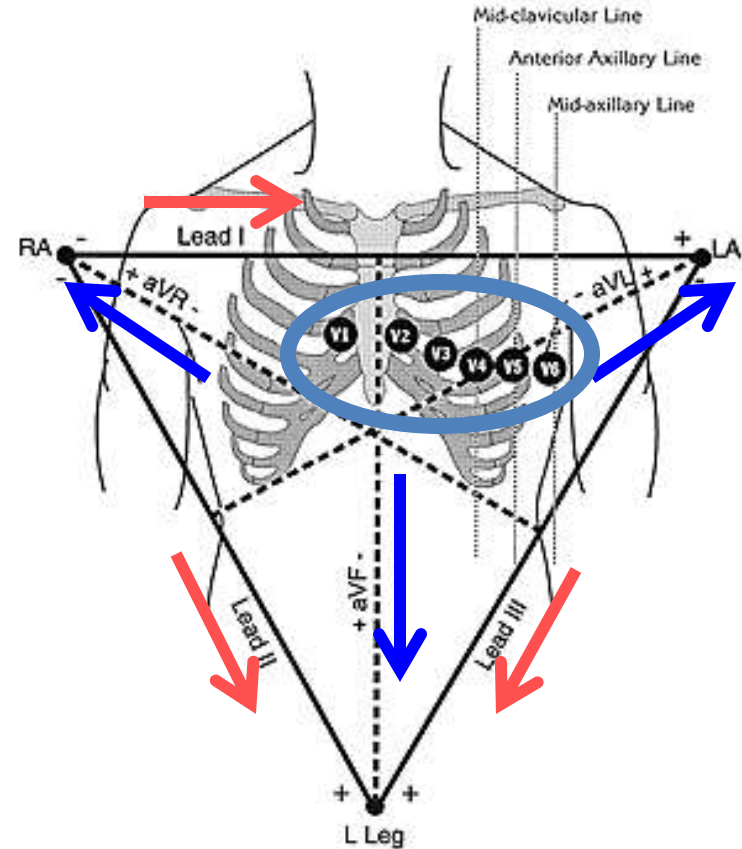
- The heart is three dimensional structure.
- Electrical activation is often happening at more than one point and in more than one direction at a time.
- ECG is summation of activation.



# The 12-Leads

The 12-leads include:

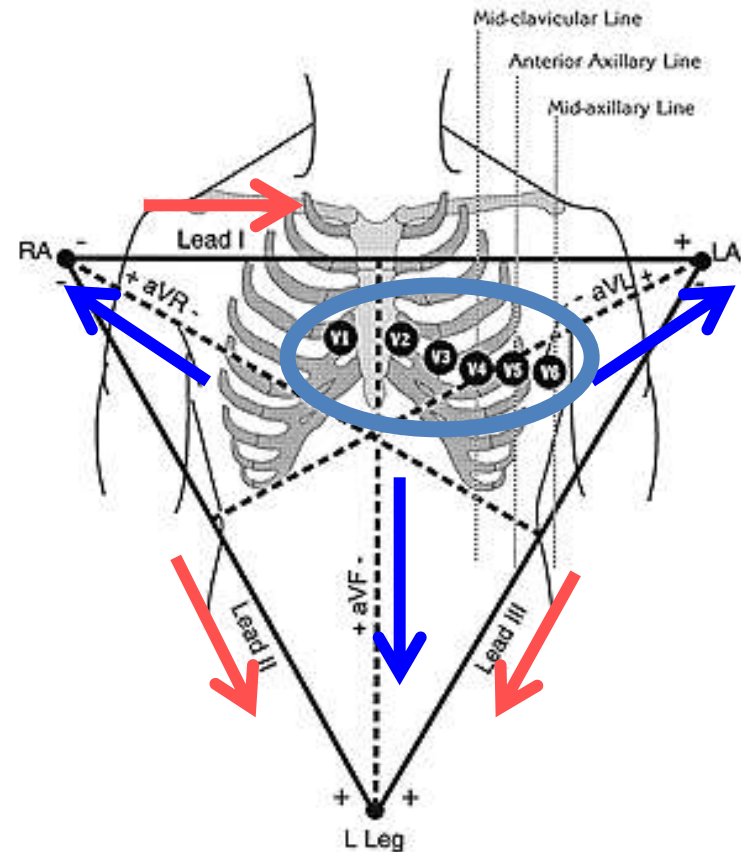
- 3 Limb leads  
(I, II, III)
- 3 Augmented leads  
(aVR, aVL, aVF)
- 6 Precordial leads  
(V<sub>1</sub>- V<sub>6</sub>)



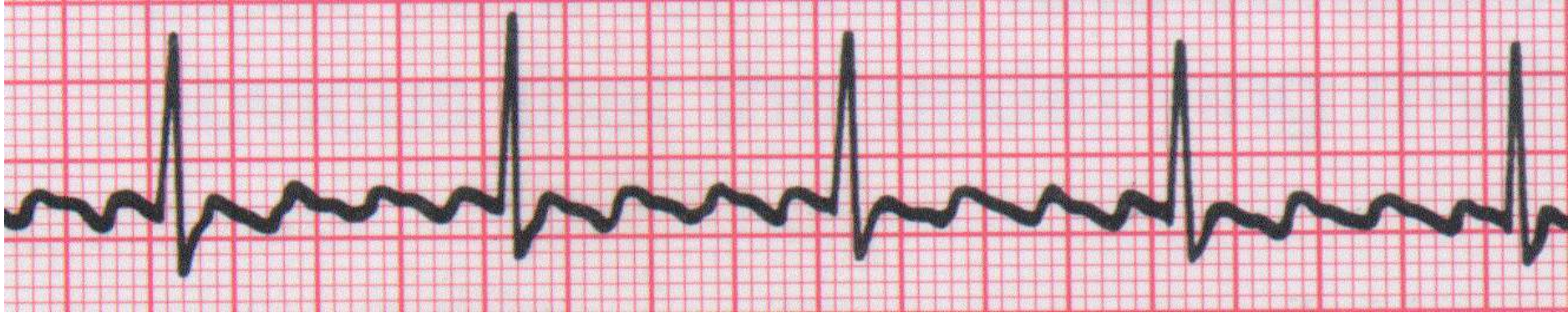
The leads document the electrical activity of the heart that is orientated towards lead

# The P Wave

- P shows activation of the left and right atrium starting from sinus node and spreading downwards and to the left.
- Normally the P wave is:
  - Upright: I, II, avF, V4, V5, V6
  - Inverted: aVR
  - Variable: III, avL, V1, V2, V3

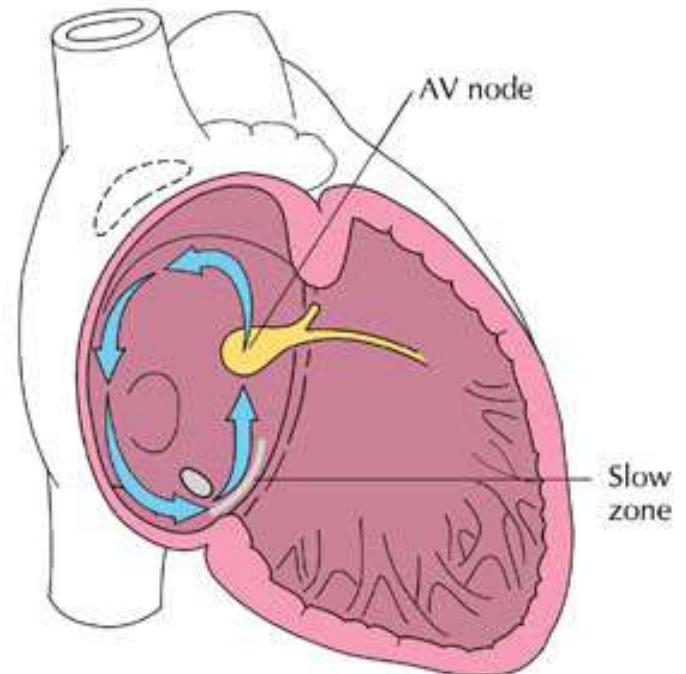


# Common P wave abnormalities



## Atrial flutter

Saw toothed flutter waves ,  
Prominent and negative in  
II, III and AVF



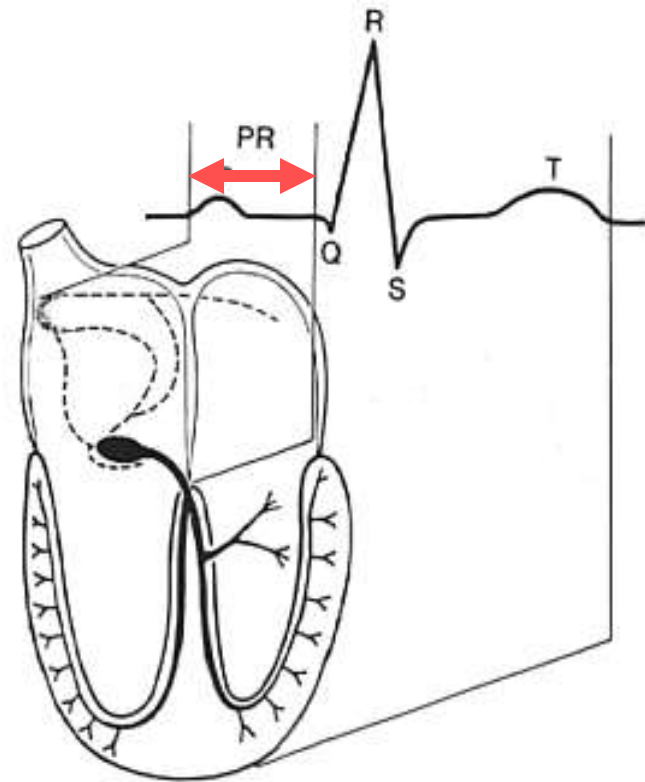
# Common P wave abnormalities



Atrial Fibrillation

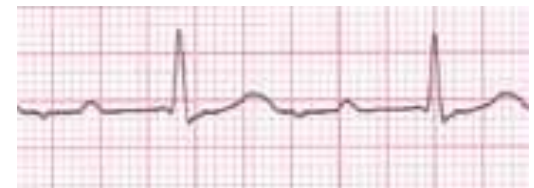
# The PR Interval

- Atrial depolarization
- **Conduction through AV node**
- Conduction through His/purkinje system



# PR Interval

| $< 0.12 \text{ s}$  | 0.12-0.20 s | $> 0.20 \text{ s}$                    |
|---|-------------|---------------------------------------|
| High catecholamine states<br>Pre-excitation (WPW)<br>Ectopic atrial focus | Normal      | AV nodal block<br>Vagal tone<br>Drugs |



# 1st Degree AV Block



- The P wave is of normal morphology and rate
- Each P wave is followed by a QRS
- The PR interval is increased  $>0.20$  sec and is constant
- Conduction delay may occur in:
  - The atrial tissue
  - **The AV node**
    - Vagal stimulation, Drugs, Conduction disturbance
  - The Bundle of His.
- No investigation or treatment required unless symptoms suggest higher grade block

# 2nd Degree AV Block, Mobitz Type I, Wenkebach



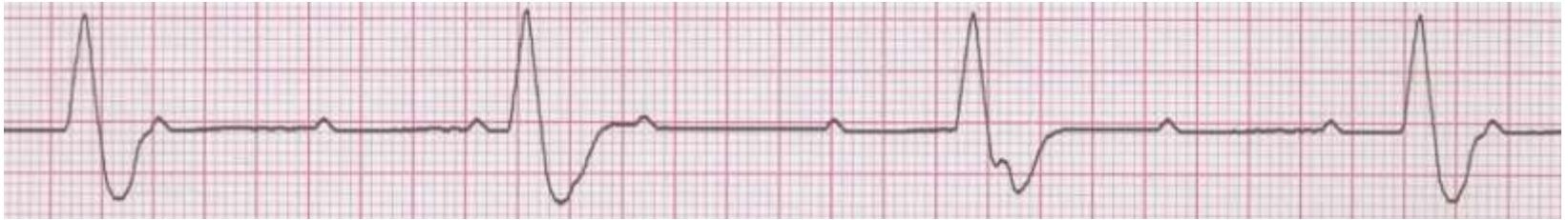
- The P wave morphology and rate are normal
- PR interval progressively lengthens until a P wave is not followed by a QRS.
- The PR interval following the blocked beat is the shortest and may be normal
- This phenomena can be seen in normal individuals if:
  - Atrial rate is inappropriate elevated
  - High vagal tone
- Usually occurs within AV nodal tissue
- Decremental tissue properties
- No treatment usually required

# 2nd Degree AV Block, Mobitz Type II



- P wave morphology is normal, rate is appropriate and regular
- Not every P wave is followed by a QRS but there is a fixed ratio
- The PR interval when present is constant
- Conduction block occurs most often in the His/Purkinje system
- Occasionally seen in young individuals at night
- Usually pathological

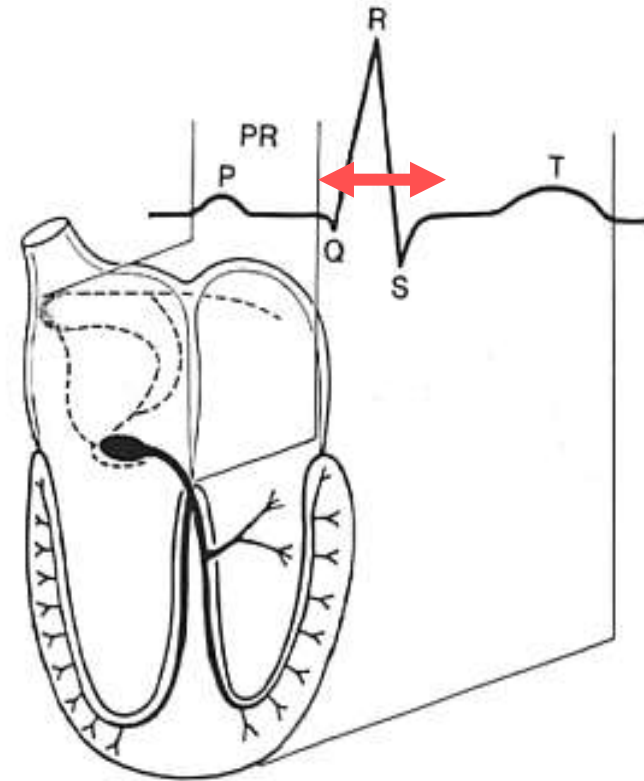
# 3rd degree or complete AV Block



- The P waves are regular and of normal rate (95bpm)
- The QRS rate is slower than the P wave rate and regular
- The P waves are completely blocked in the AV junction; QRS complexes originate independently from below the junction; so no relationship between P waves and QRS complexes.
- The ventricular rhythm is called an escape rhythm and may be broad or relatively narrow complex
- The slower and the broader the QRS complex the less reliable.
- Pacemaker generally indicated

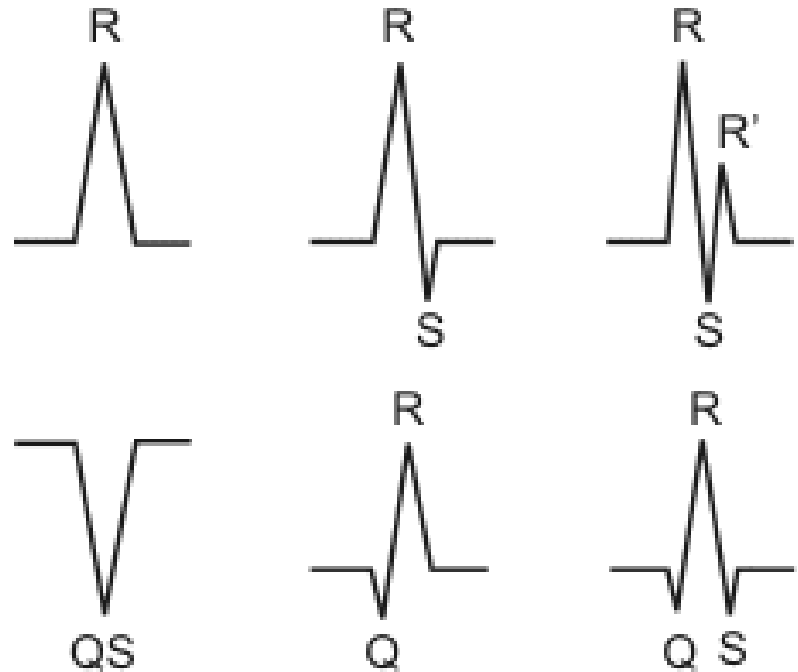
# The QRS complex

- Activation of the myocardium is via the His Purkinje system.
- The ventricles are usually activated from the endocardial surface
- The QRS is caused by the sequence of myocardial activation
- The QRS voltage is dependent on
  - Muscle mass
  - Orientation to electrode
  - Distance of electrode from myocardium

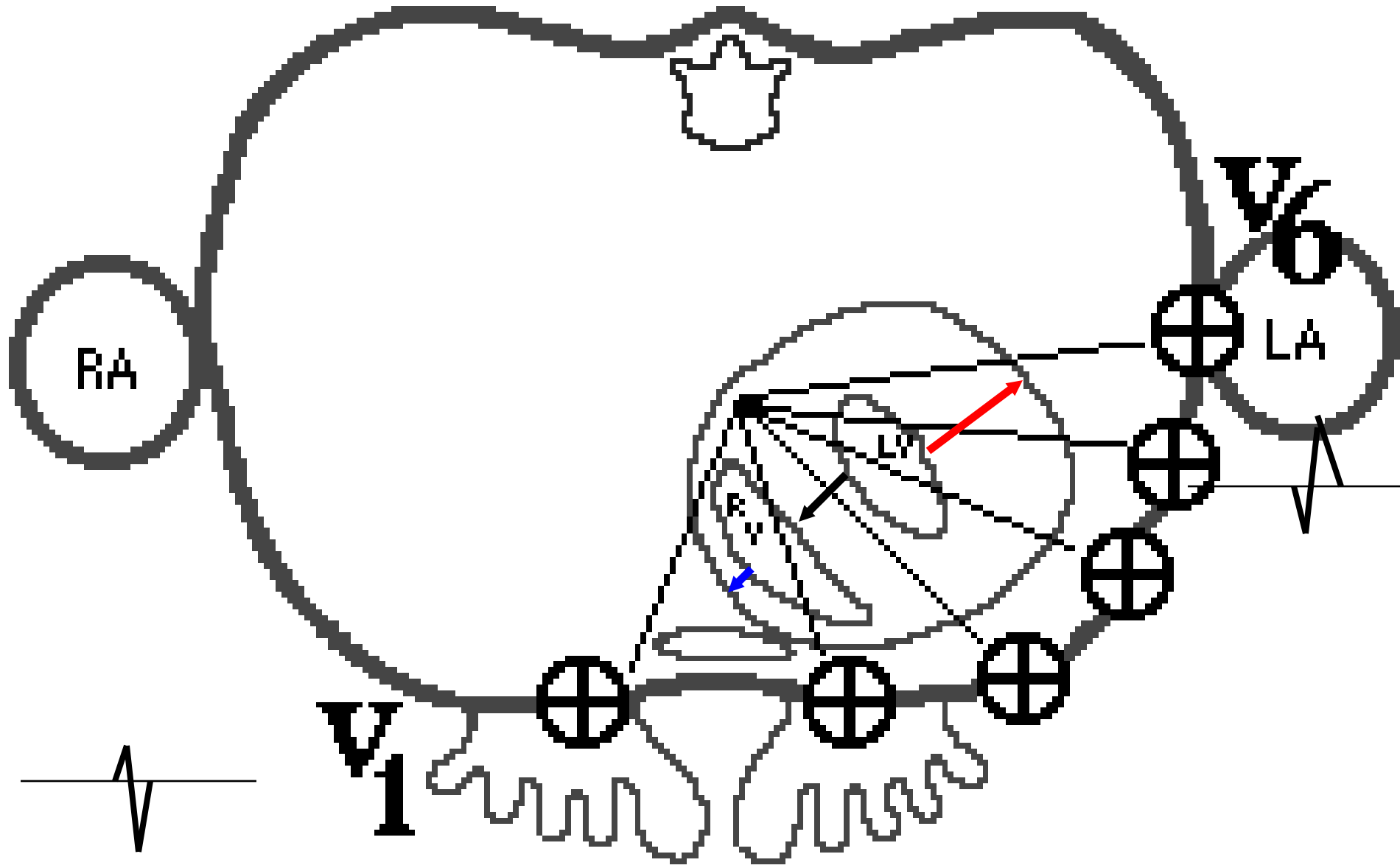


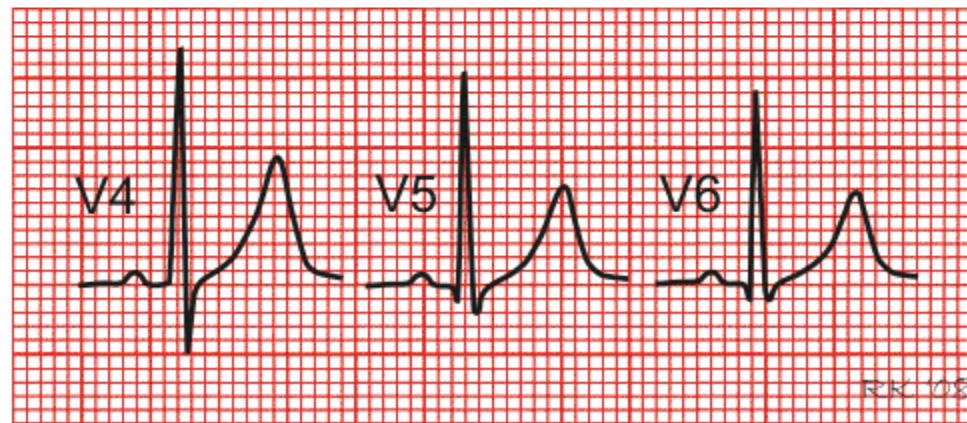
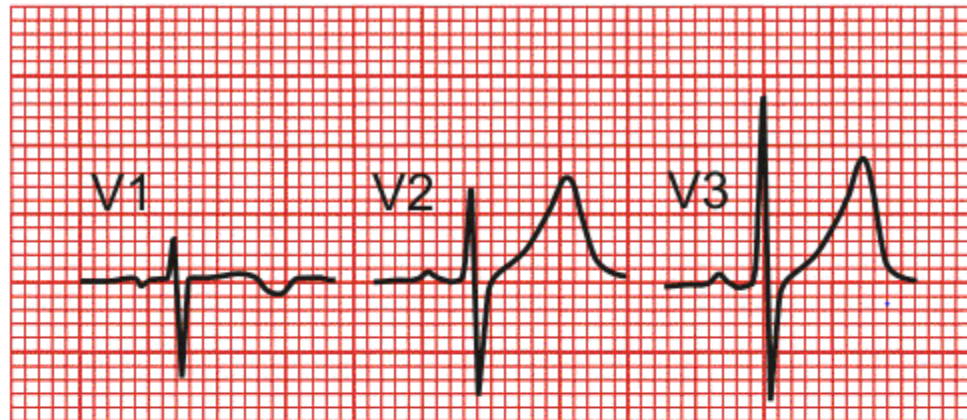
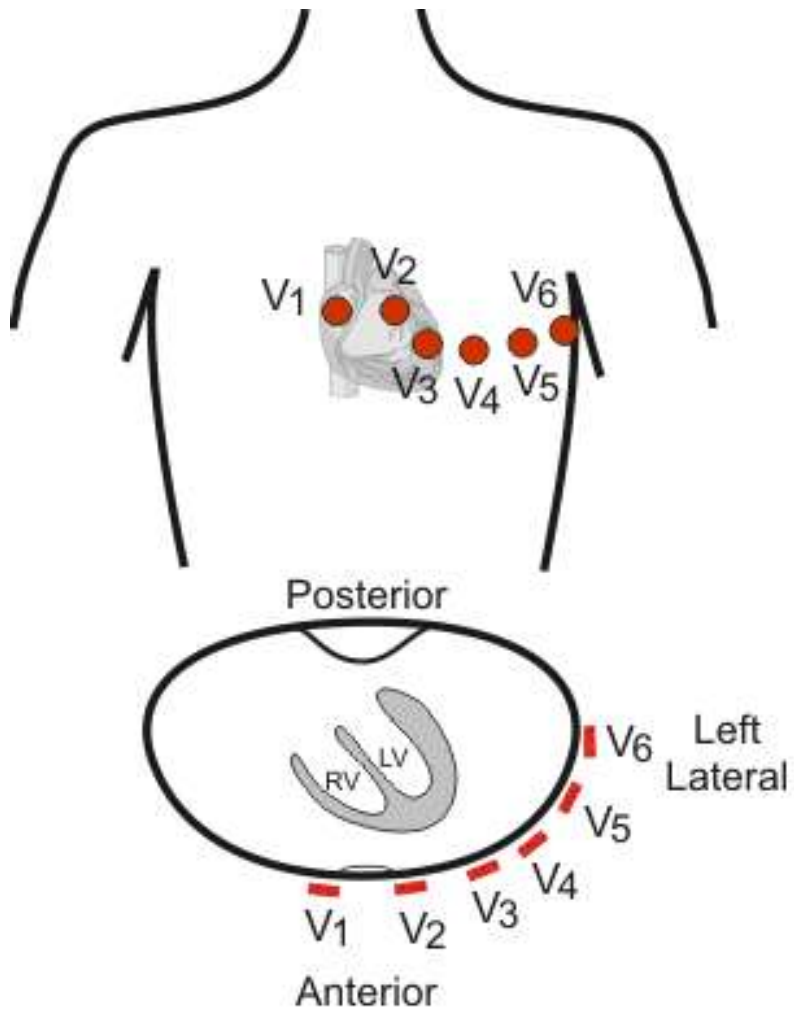
# Nomenclature of QRS complexes

- Usually different phases of myocardial activation occur separated by time.
- Positive deflections are called R waves
- Negative deflections are Q and S waves



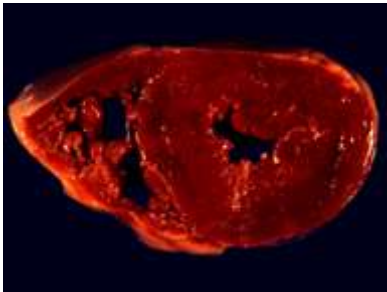
# Normal QRS



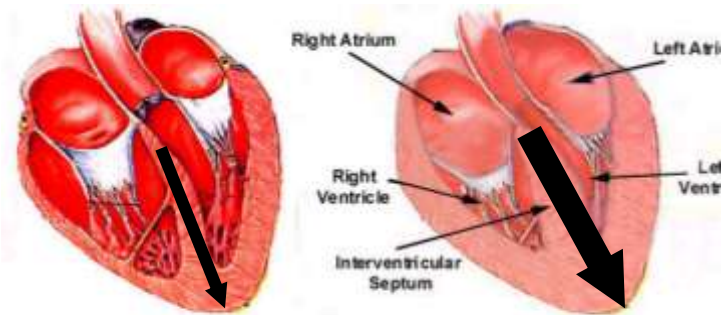


# Left Ventricular Hypertrophy

As the heart muscle wall thickens there is an increase in electrical forces moving through the myocardium resulting in increased QRS voltage.



LVH



Normal Heart

Hypertrophied Heart

Increased QRS voltage

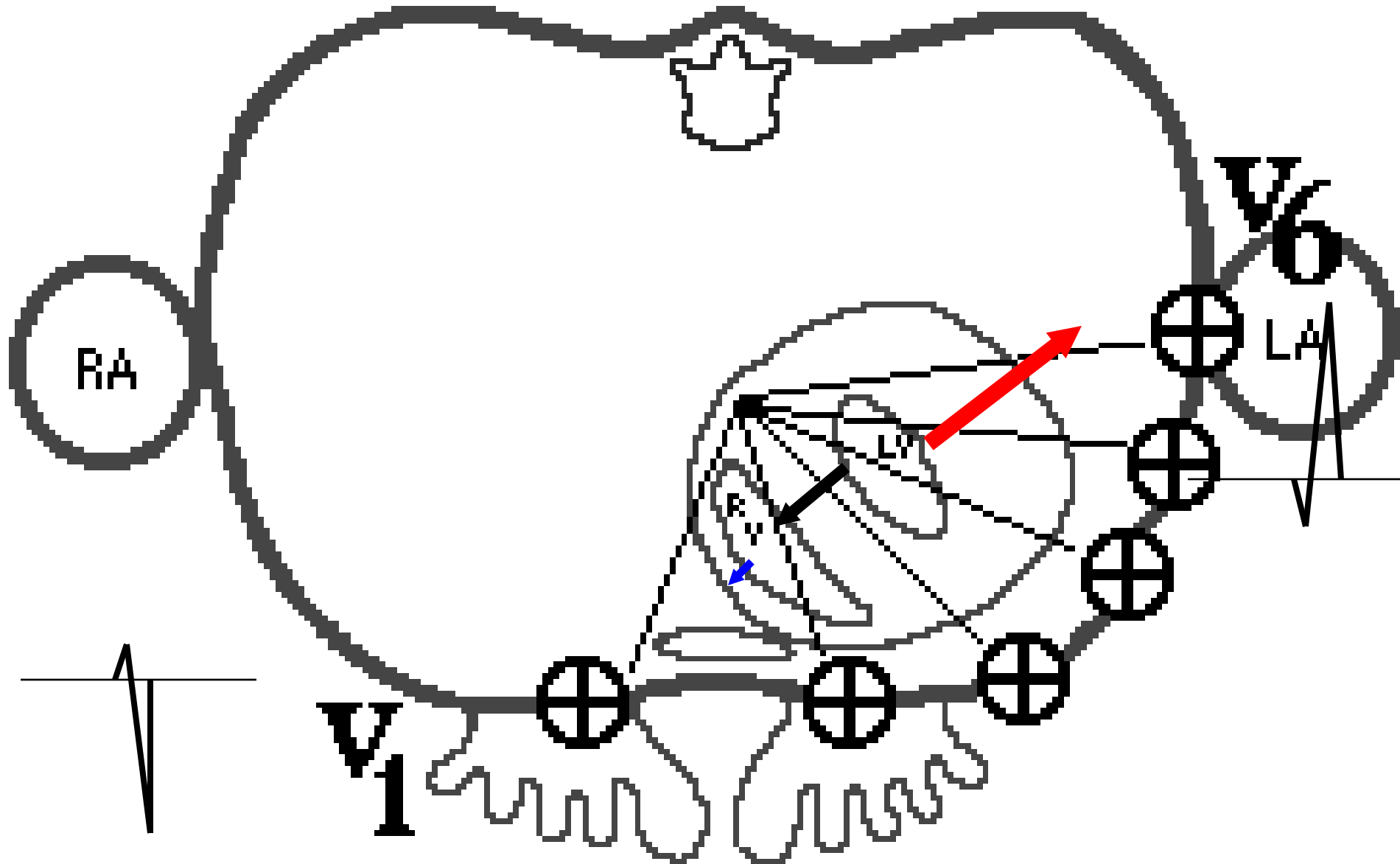


Normal

LVH

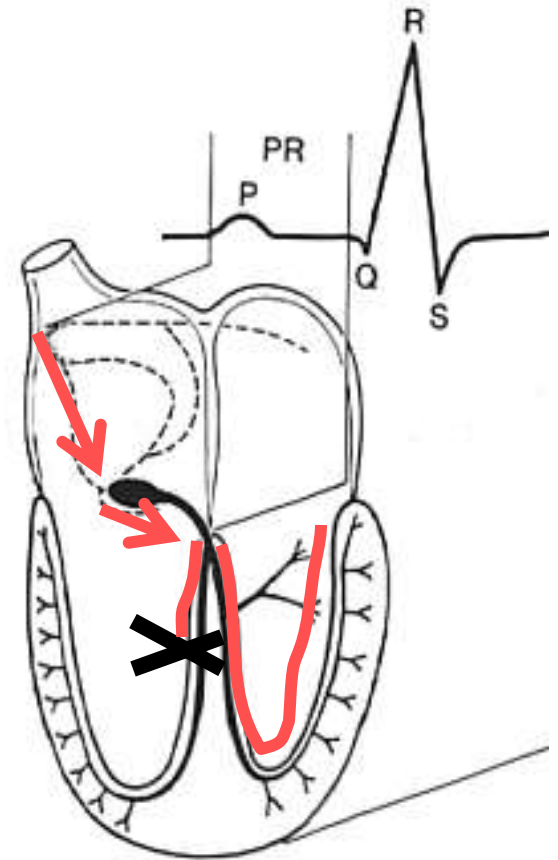
ECHOCARDIOGRAM

# QRS in LVH

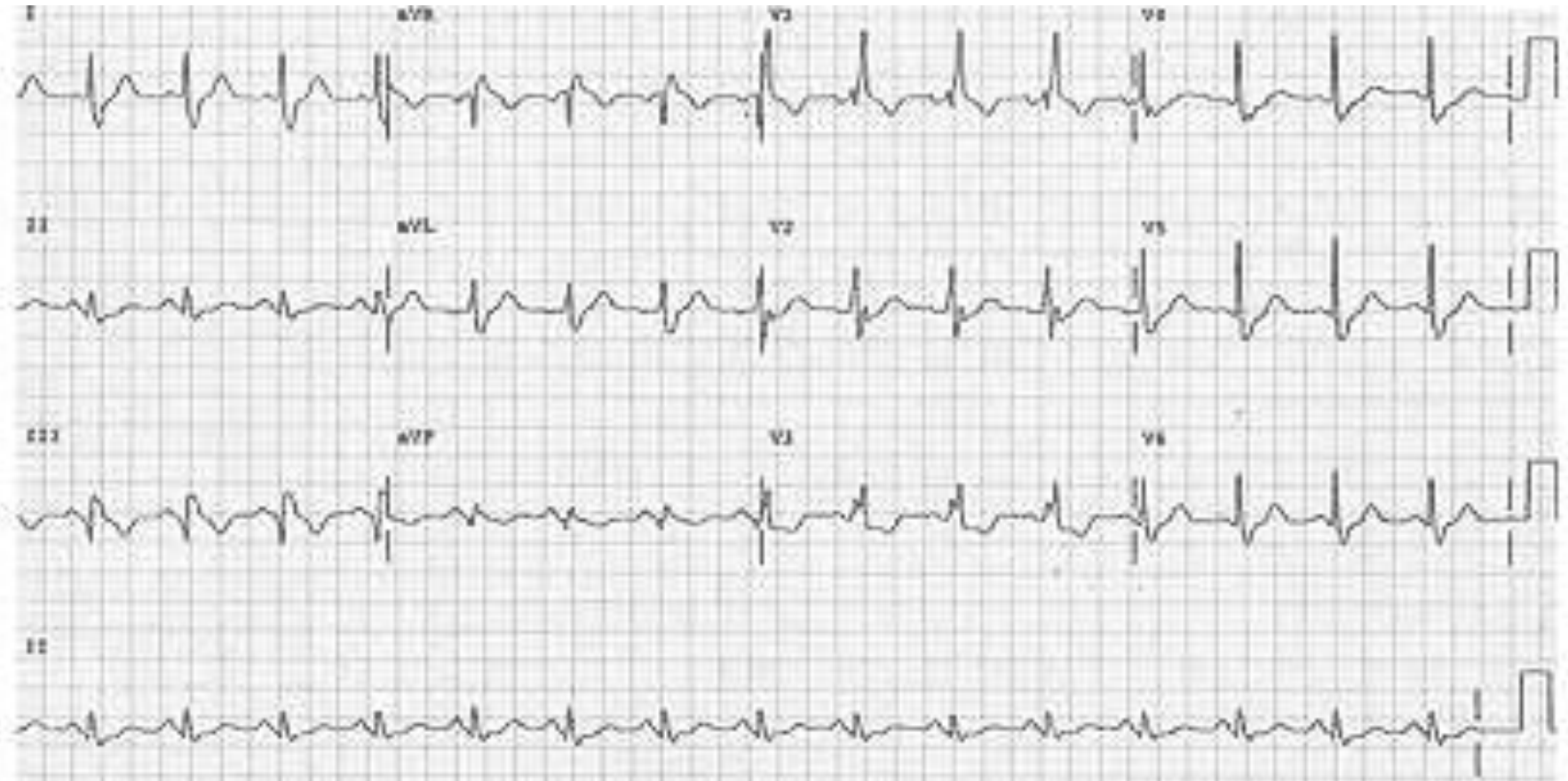


# Right Bundle Branch Block

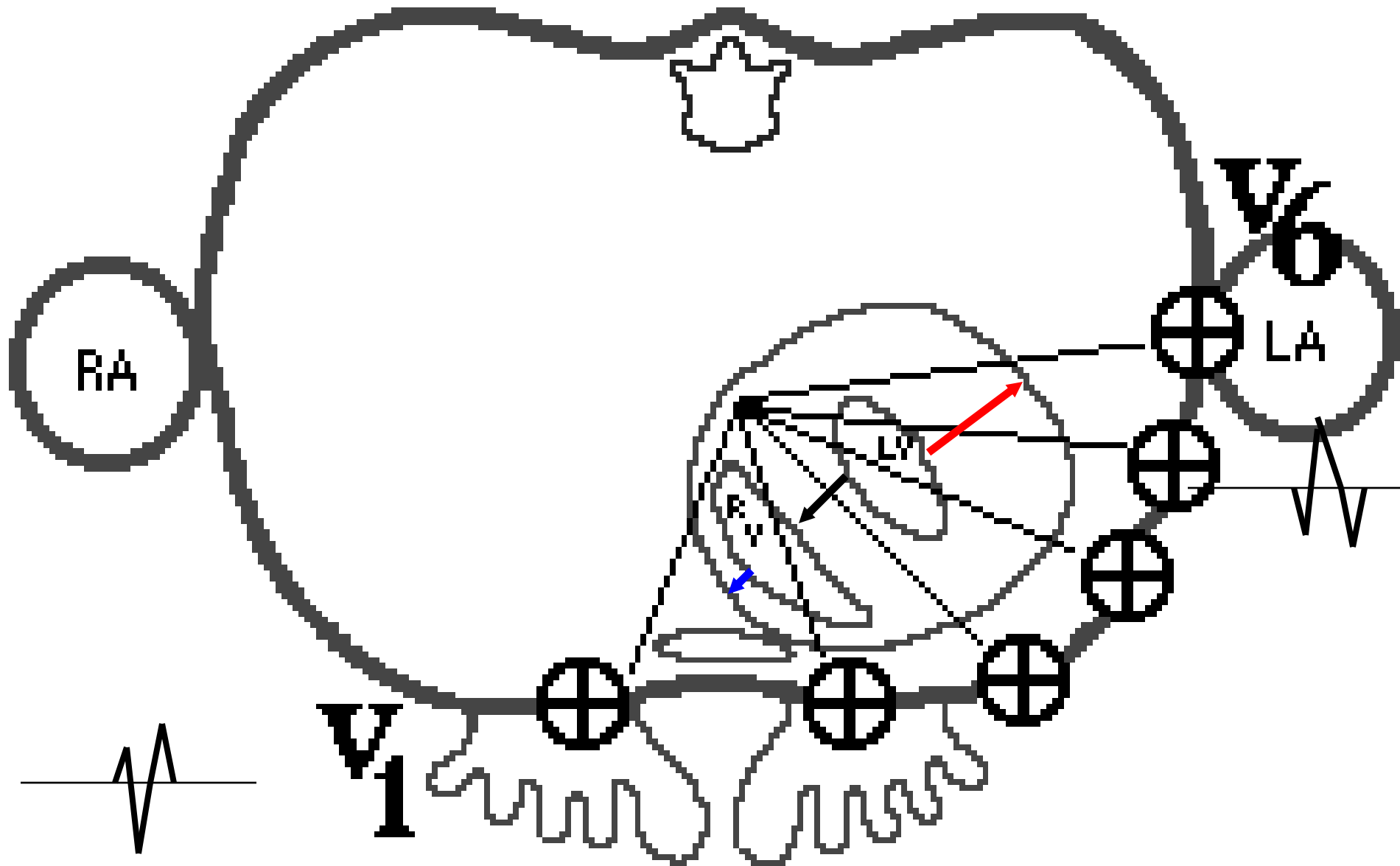
Activation of the right ventricular myocardium in right bundle branch block is via myocardial myocardial conduction from the septum and left ventricle. This means that the RV component of the ECG occurs late (prolonging the duration of the ECG) and separate from LV component (making it more visible).



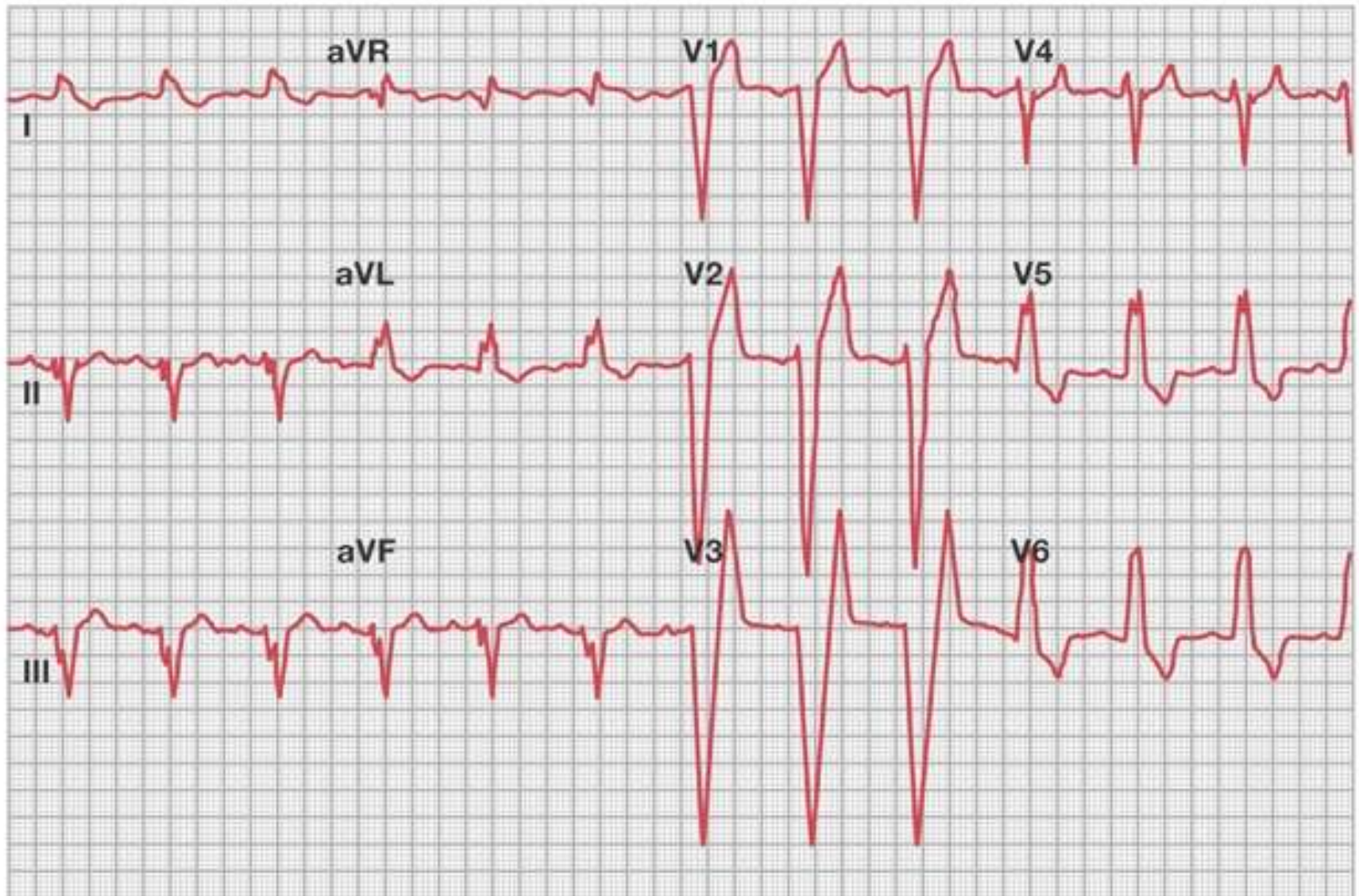
# Right bundle branch block



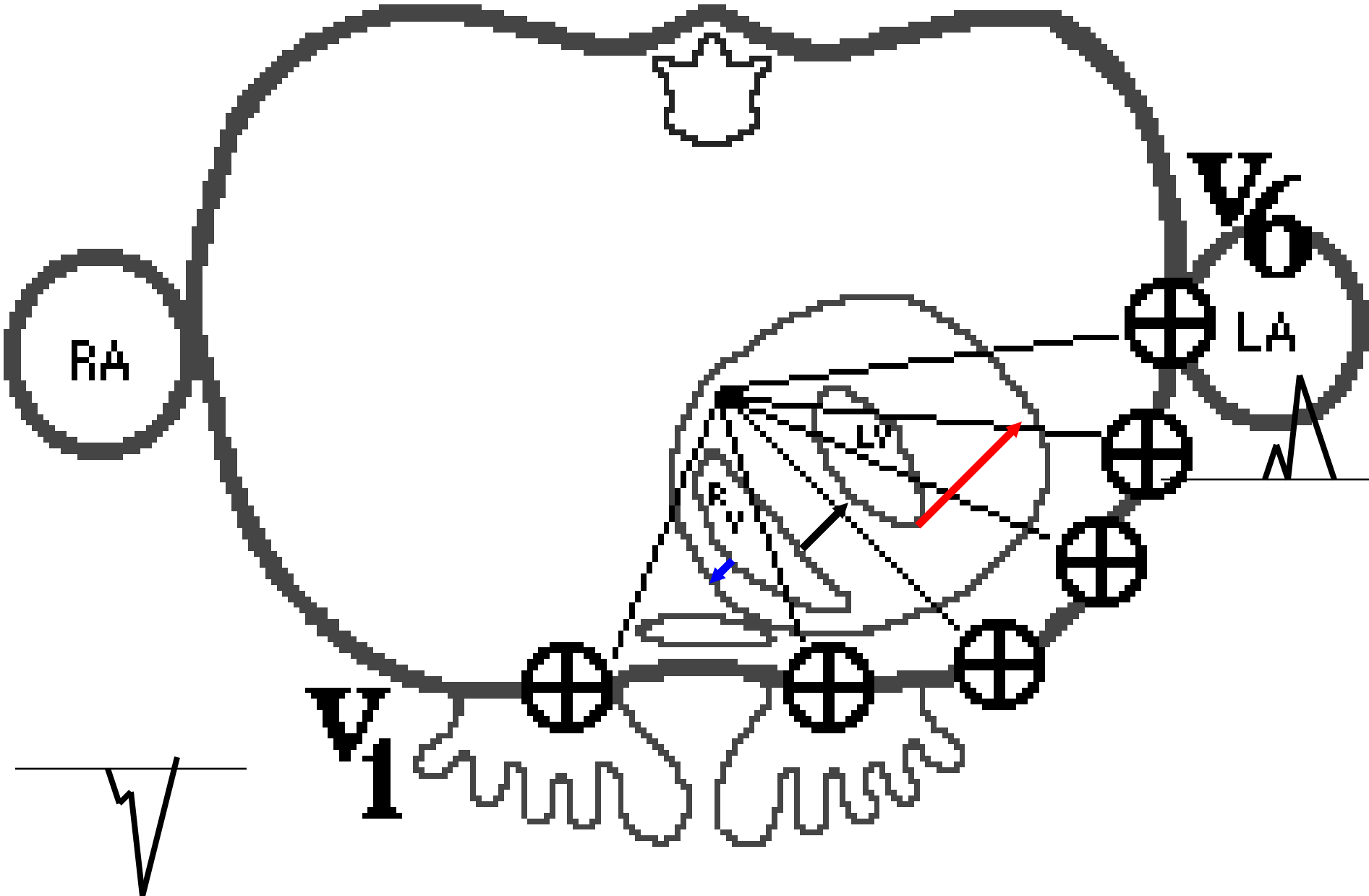
# Right Bundle branch block



# Left bundle branch block



# Left Bundle Branch Block



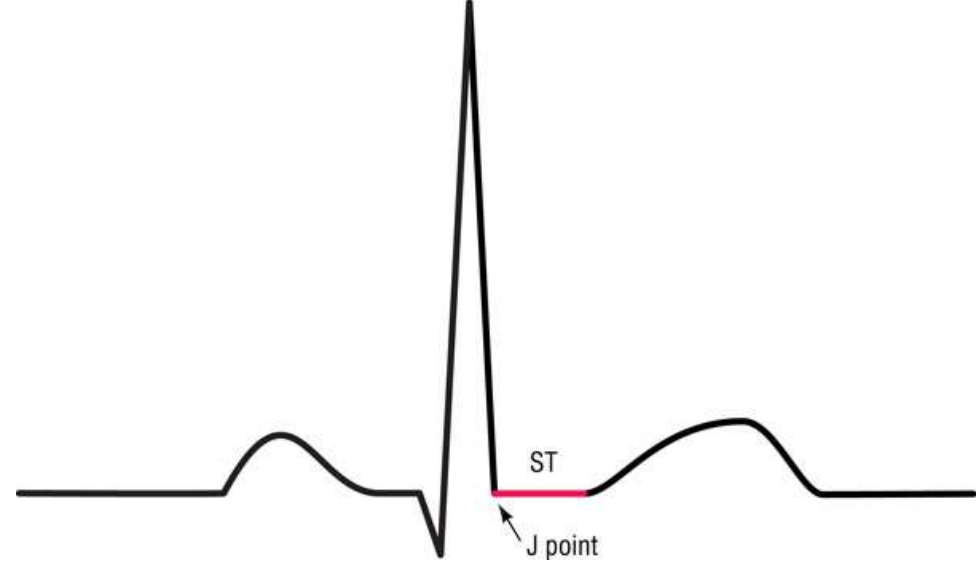
# ST Segment on ECG

- ST segment is isoelectric period on the ECG when entire myocardium is depolarised and repolarisation has not started
- Changes in ST segment often indicative of cardiac ischemia or injury
- Other causes common
  - Hypertrophy, BBB, drugs, pacing, pre-excitation, hypokalaemia

# T Wave

- Caused by ventricular repolarisation
- Number of normal variations exist some due to body morphology and ethnic background, especially V1-3
- T wave may be delayed, prolonged and or abnormal shape in long QT syndrome
- Changes in T wave may be early sign of ischemia.
- T waves changes will occur in infarction

# ST Segment



ST segment  
is at baseline



ST segment  
is elevated



ST segment  
is depressed

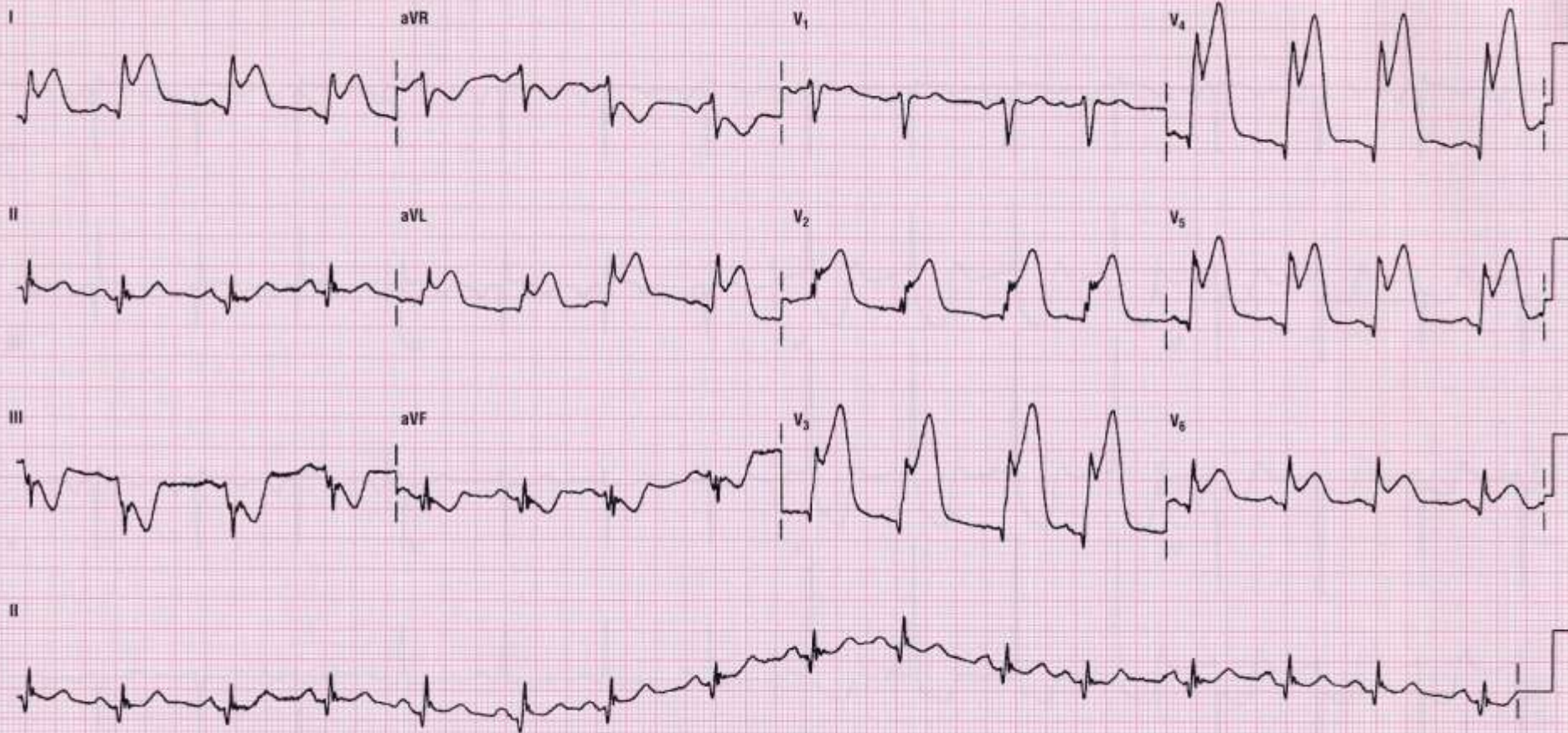
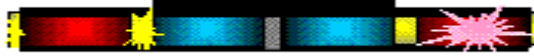


# Glossary of ECG Changes due to Ischemia

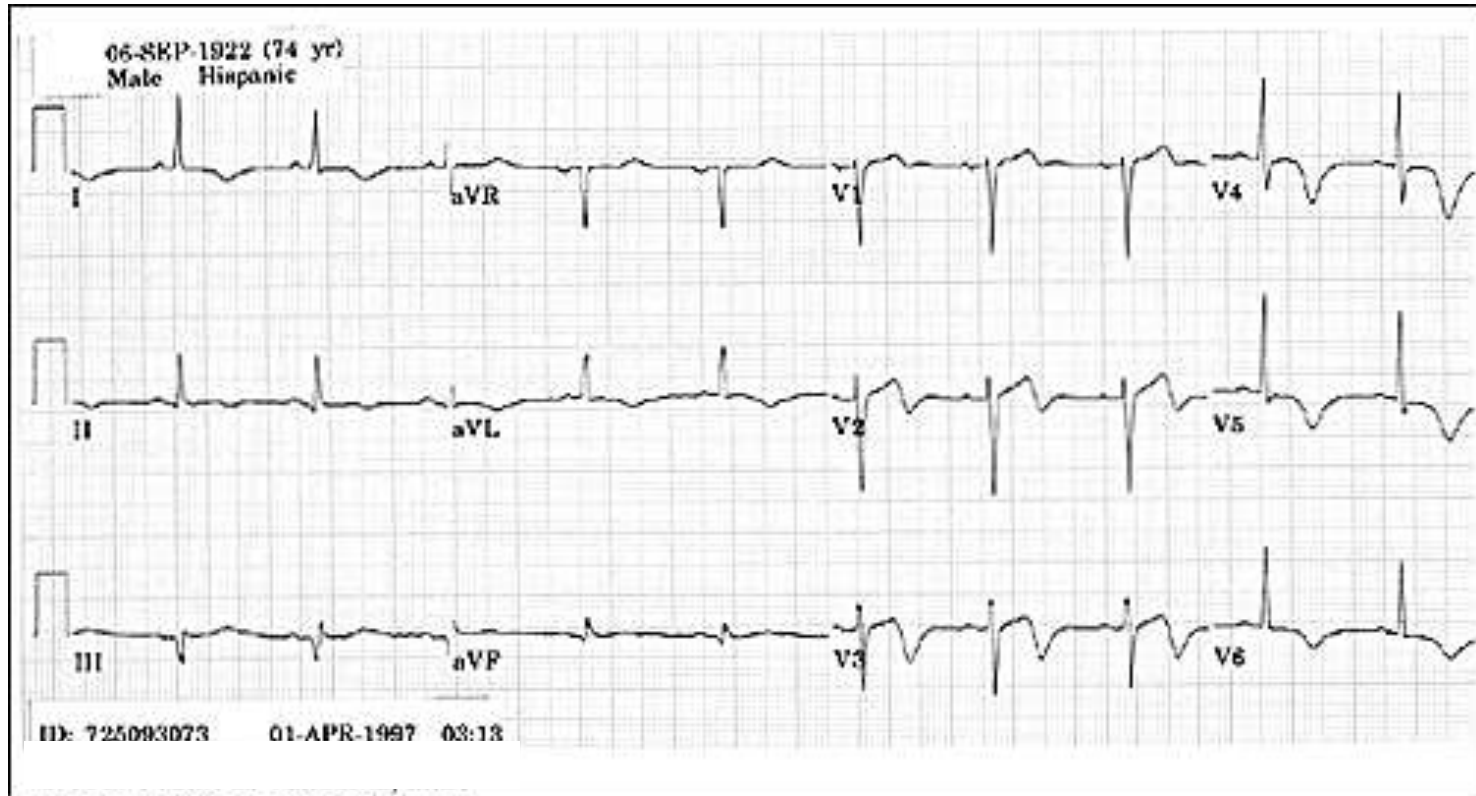
- S-T segment depression
  - Planar, horizontal, downsloping, upsloping
- Hyper-acute T-waves
  - Peaked
- T-wave inversion
  - Terminal T wave
- S-T segment elevation
  - Tombstones
- Pathological Q-waves
- Left bundle branch block

# Horizontal ST depression





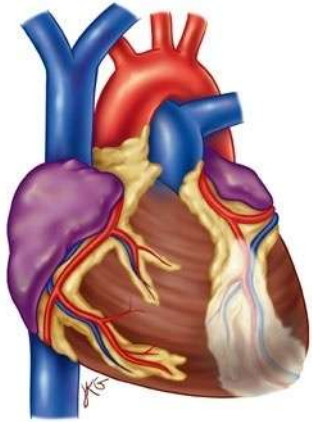
# Non ST elevation MI



- Convex downward ST segment depression only (common)
- Convex upwards or straight ST segment elevation only (uncommon)
- Terminal T wave changes
- Symmetrical T wave inversion only (common)
- Qt prolongation

# Myocardial Infarction “Triad”

Ischemia (typically reversible)

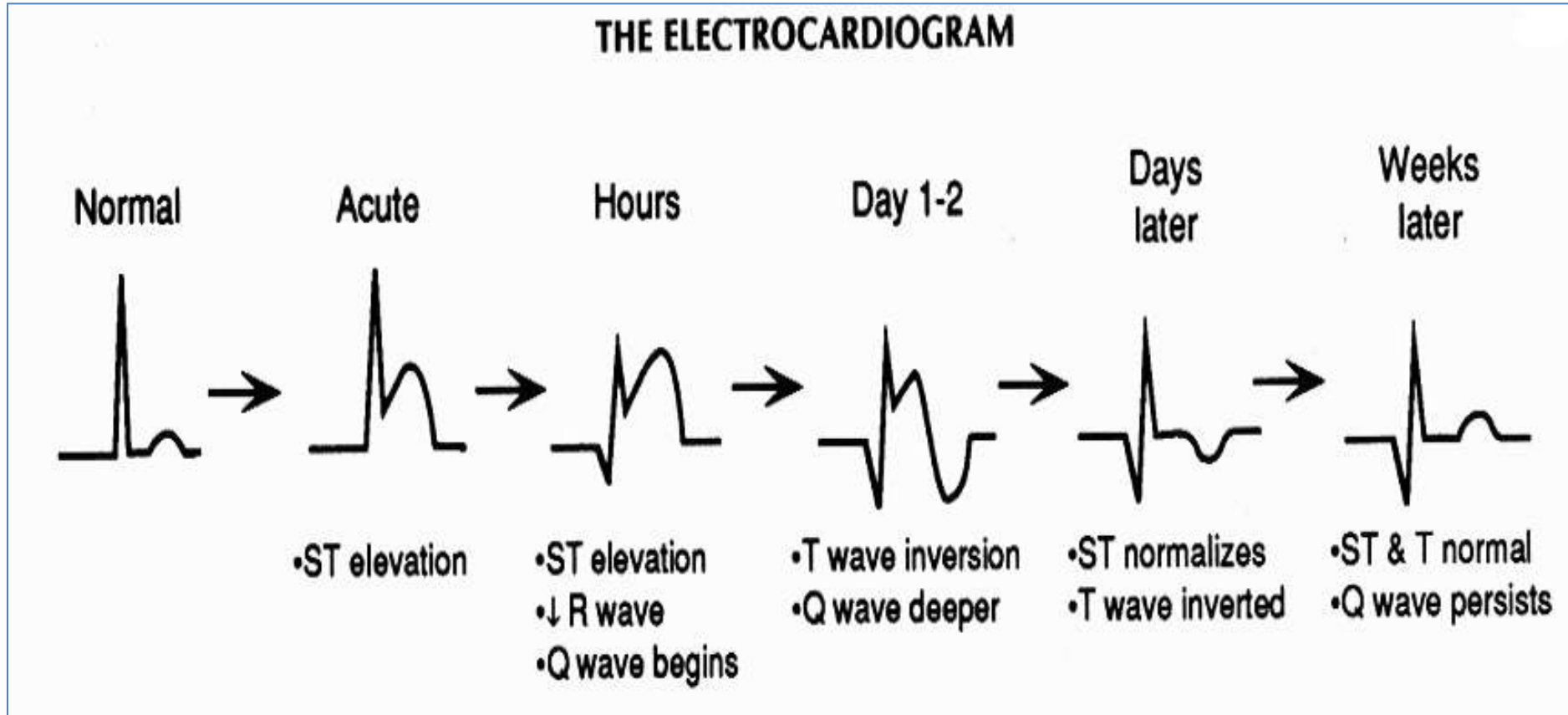


Injury (early infarct)

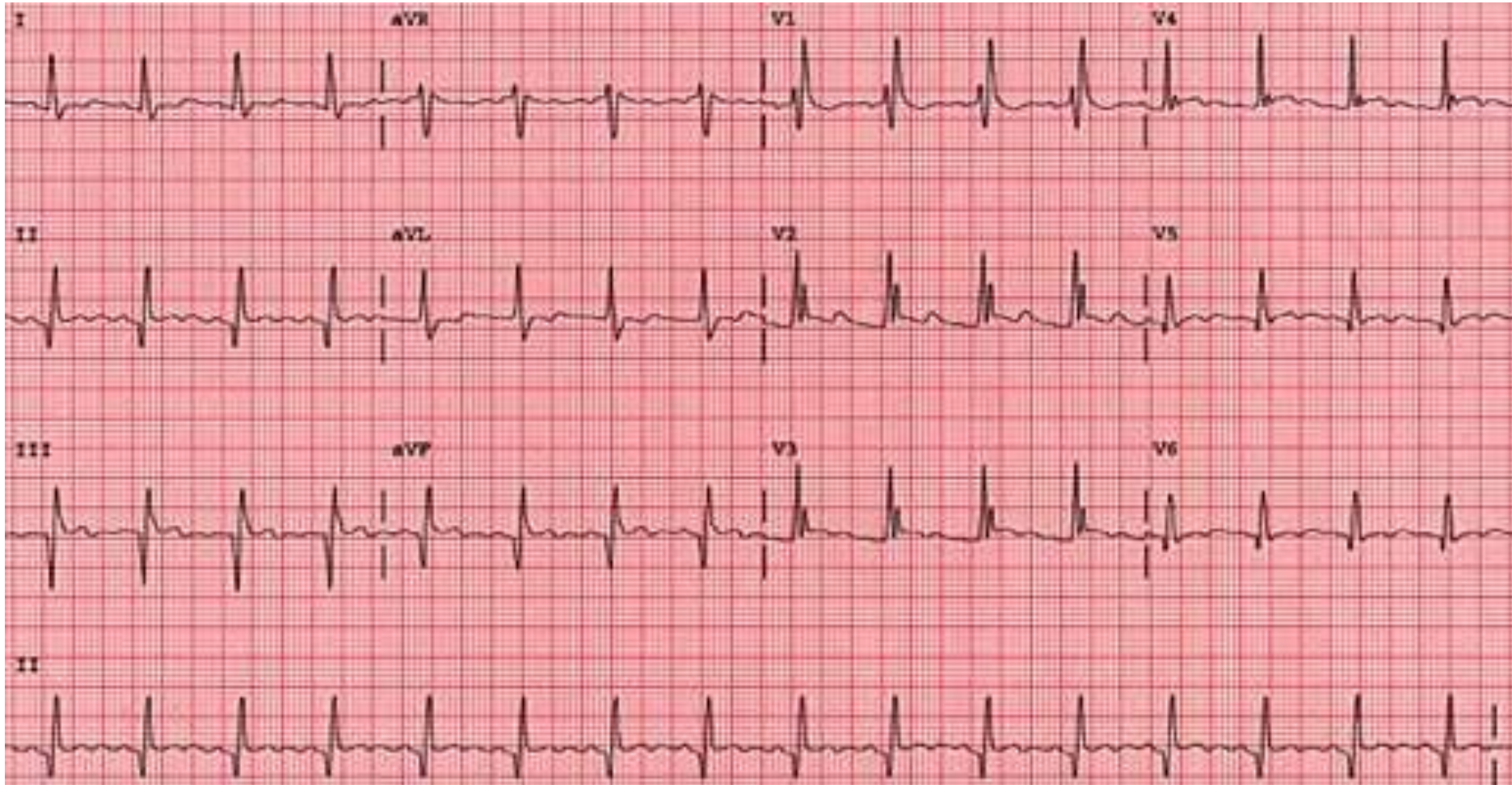
Infarction (necrosis)

Injury will precede infarction but does not have to progress to infarction

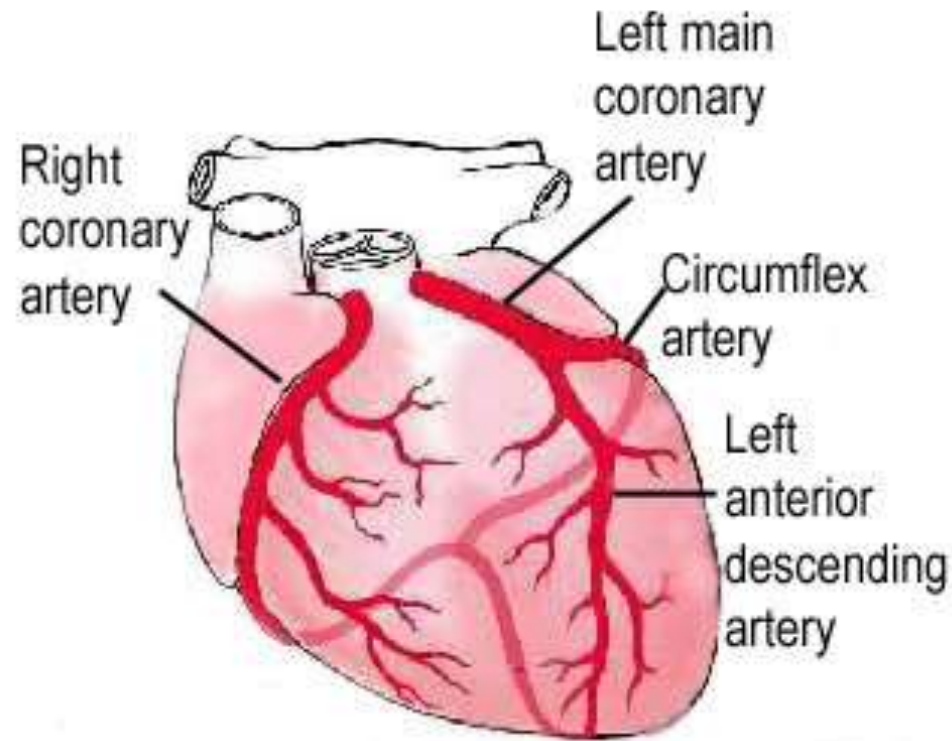
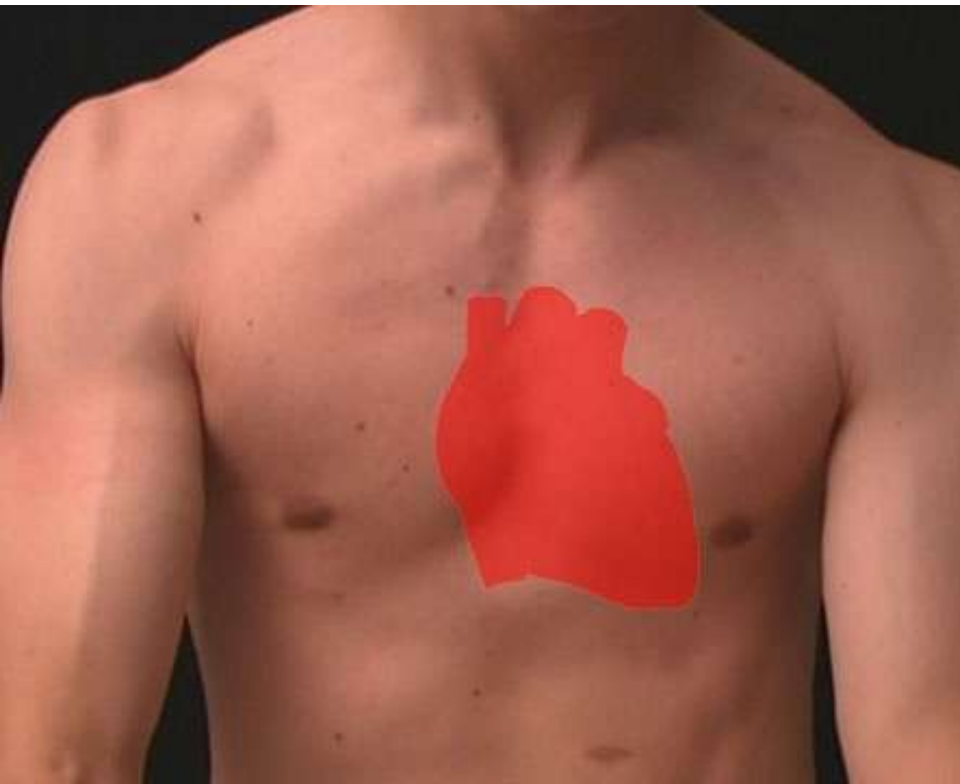
# Progression of ST and Q Waves (MI)

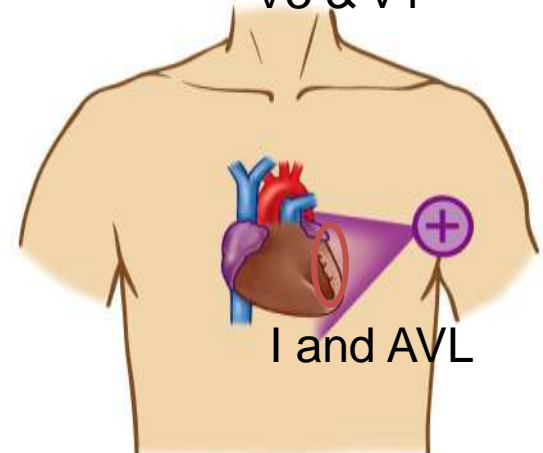
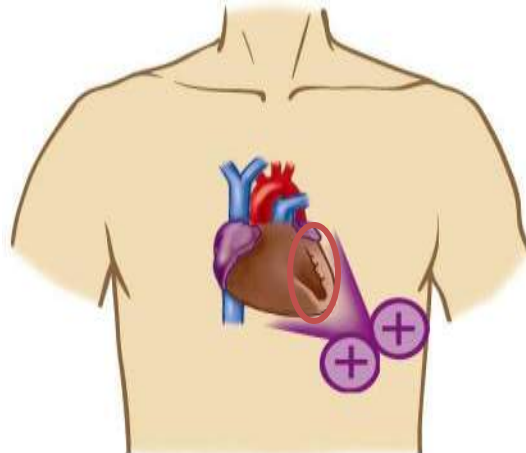
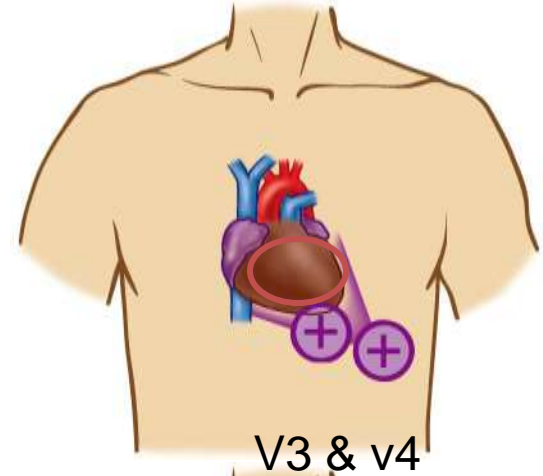
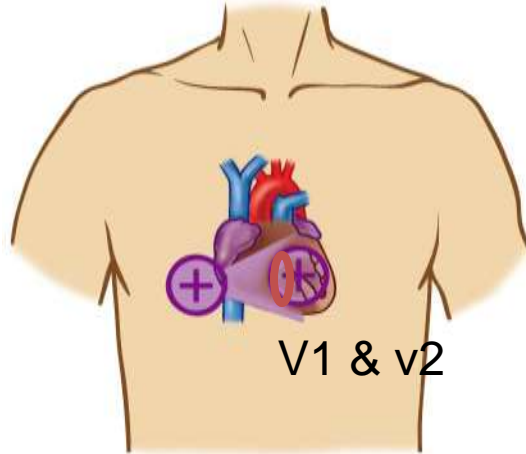
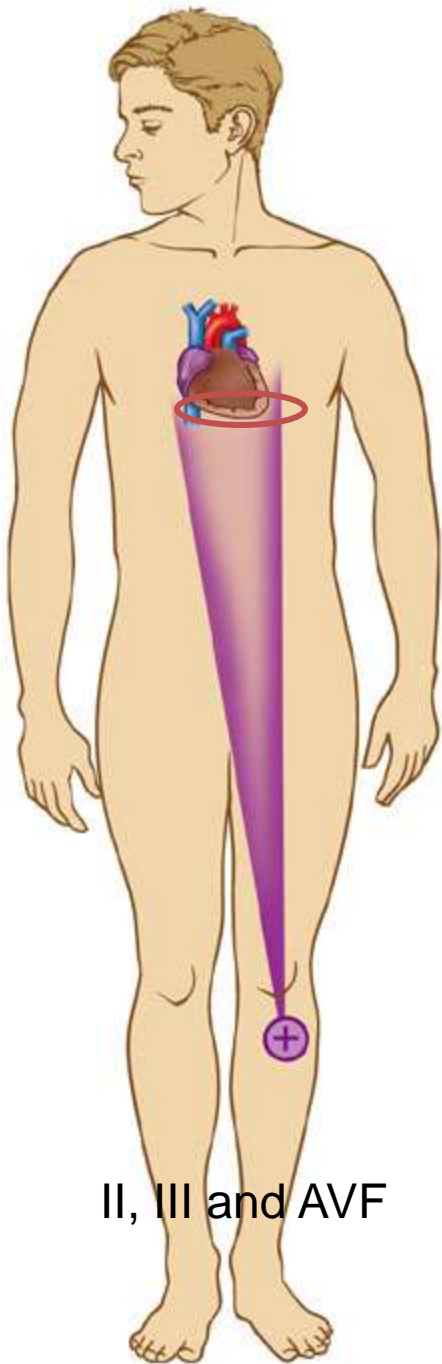


# Pathological Q waves



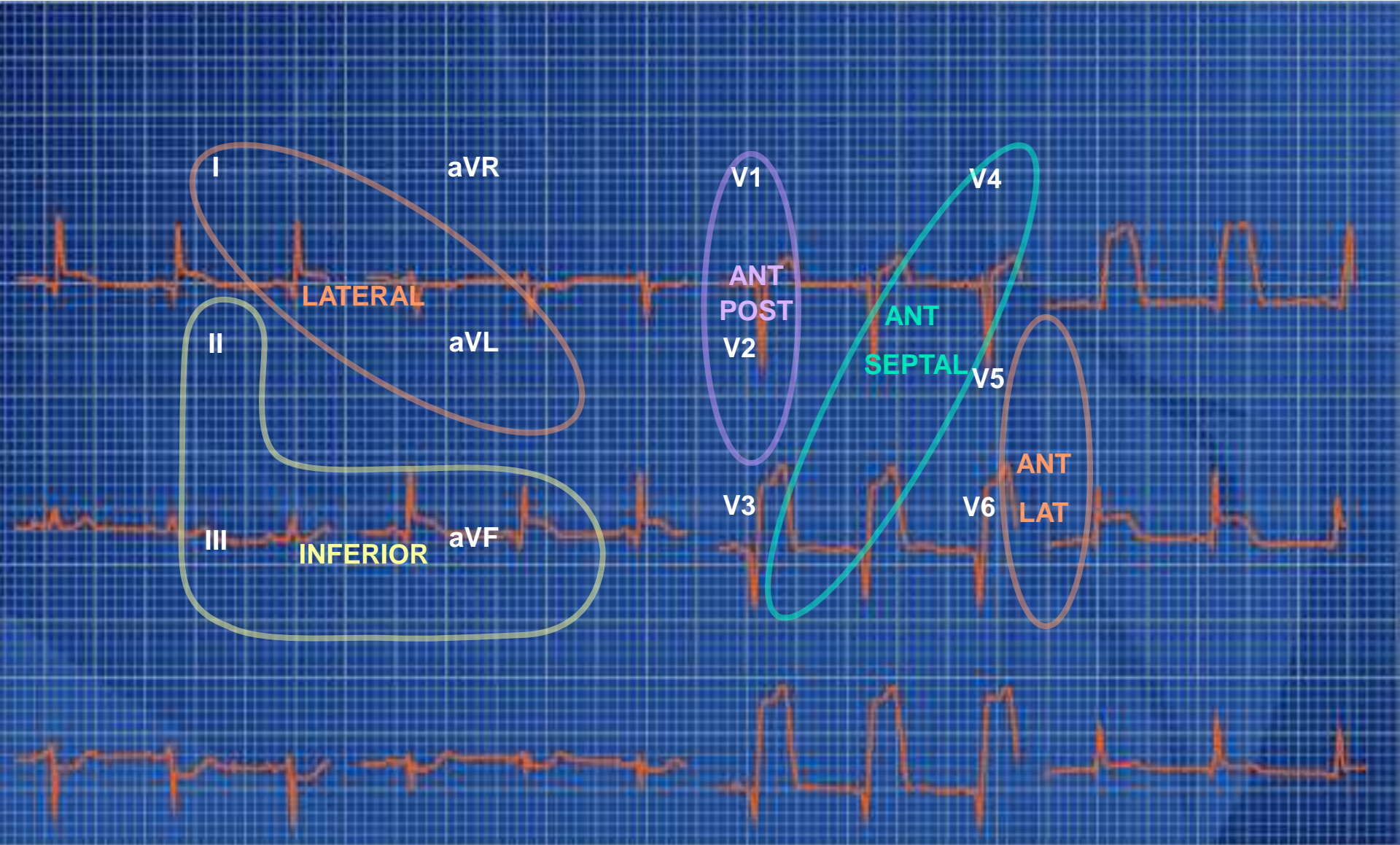
# Coronary Artery Circulation

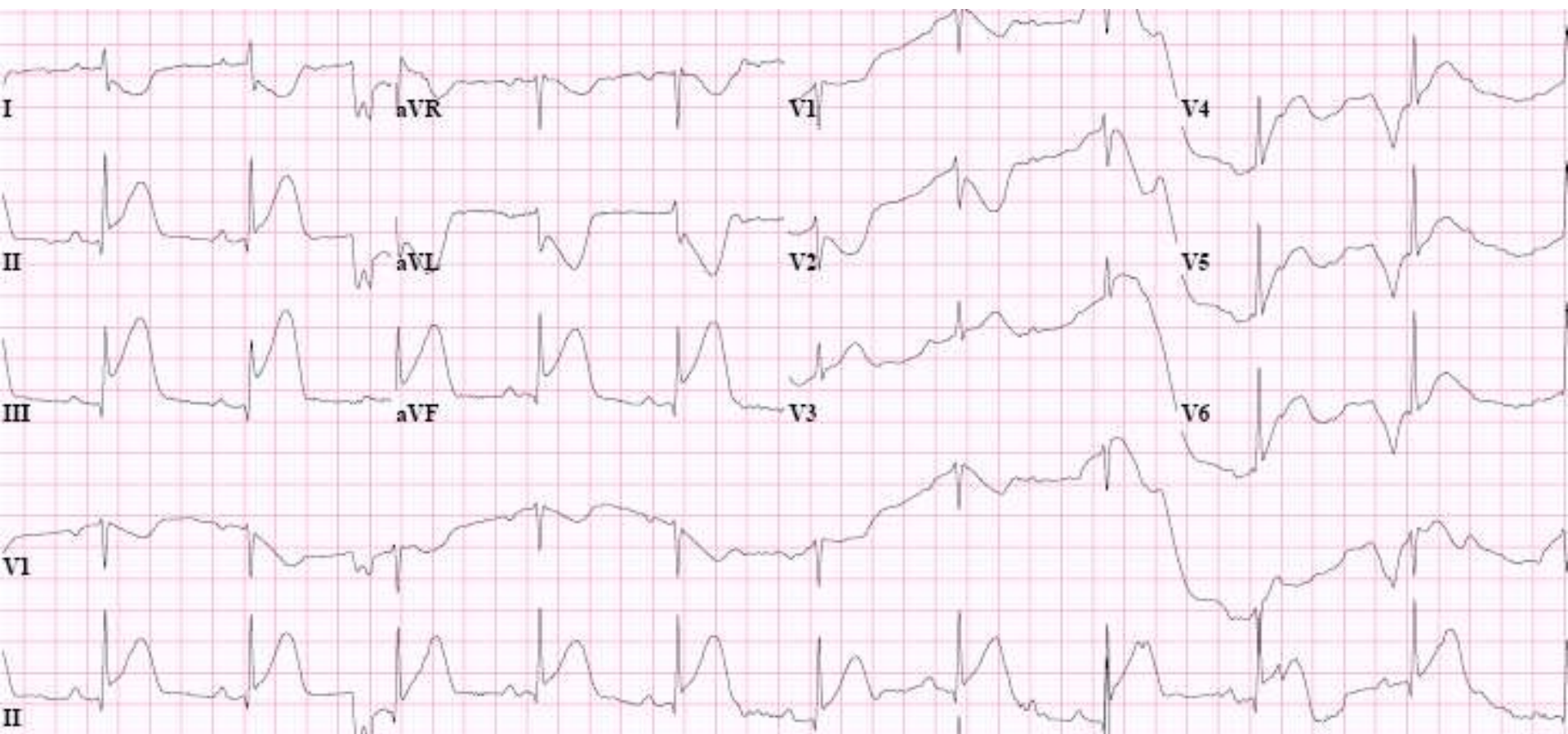




*Where the positive electrode is positioned, determines what part of the heart is seen!*

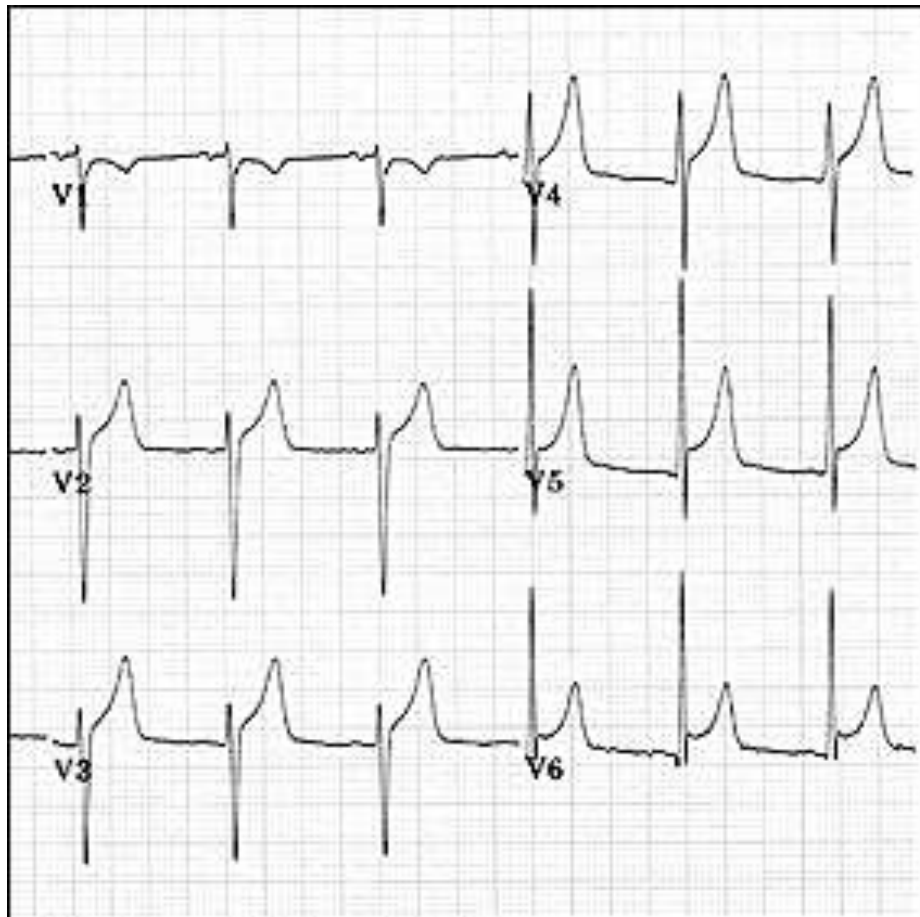
# Infarct Location by ECG





# Normal Variant "Early Repolarization"

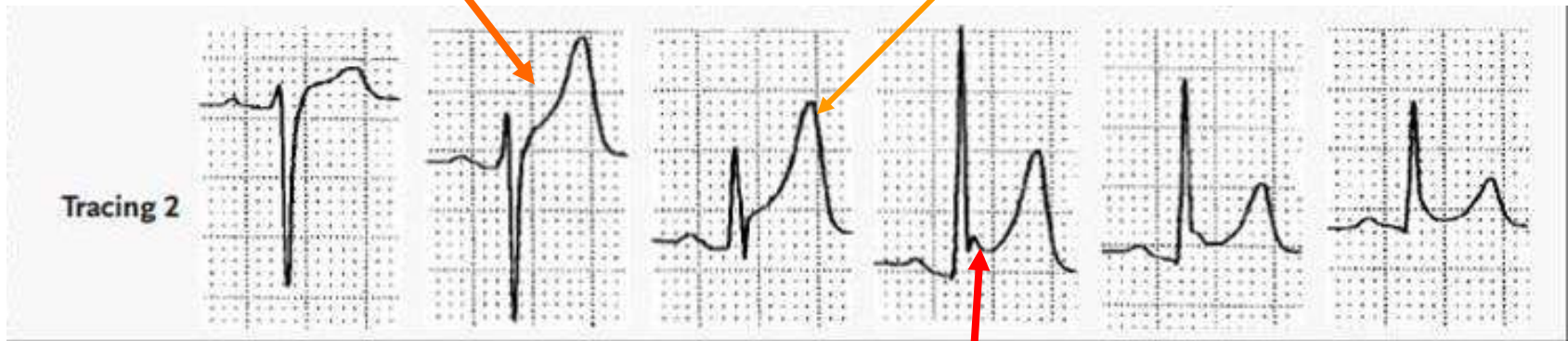
- "Early Repolarization": note high take off of the ST segment in leads V4-6. The ST elevation in V2-3 is generally seen in most normal ECG's. The ST elevation in V2-6 is concave upwards, another characteristic of this normal variant.



# “Benign” Early Repolarization

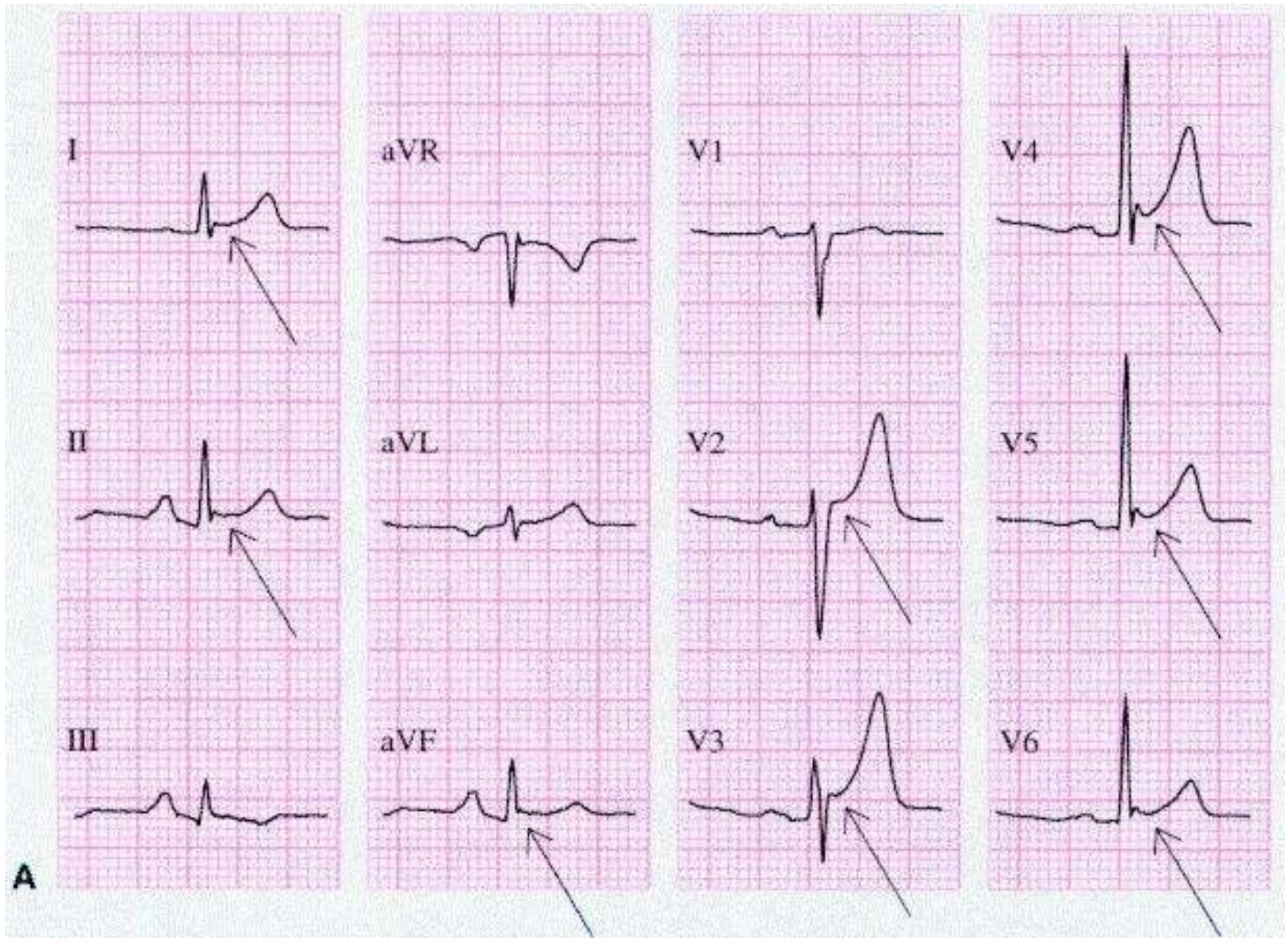
Concave STE

Large amplitude T wave



Notching or slurring of J point

# Pericarditis

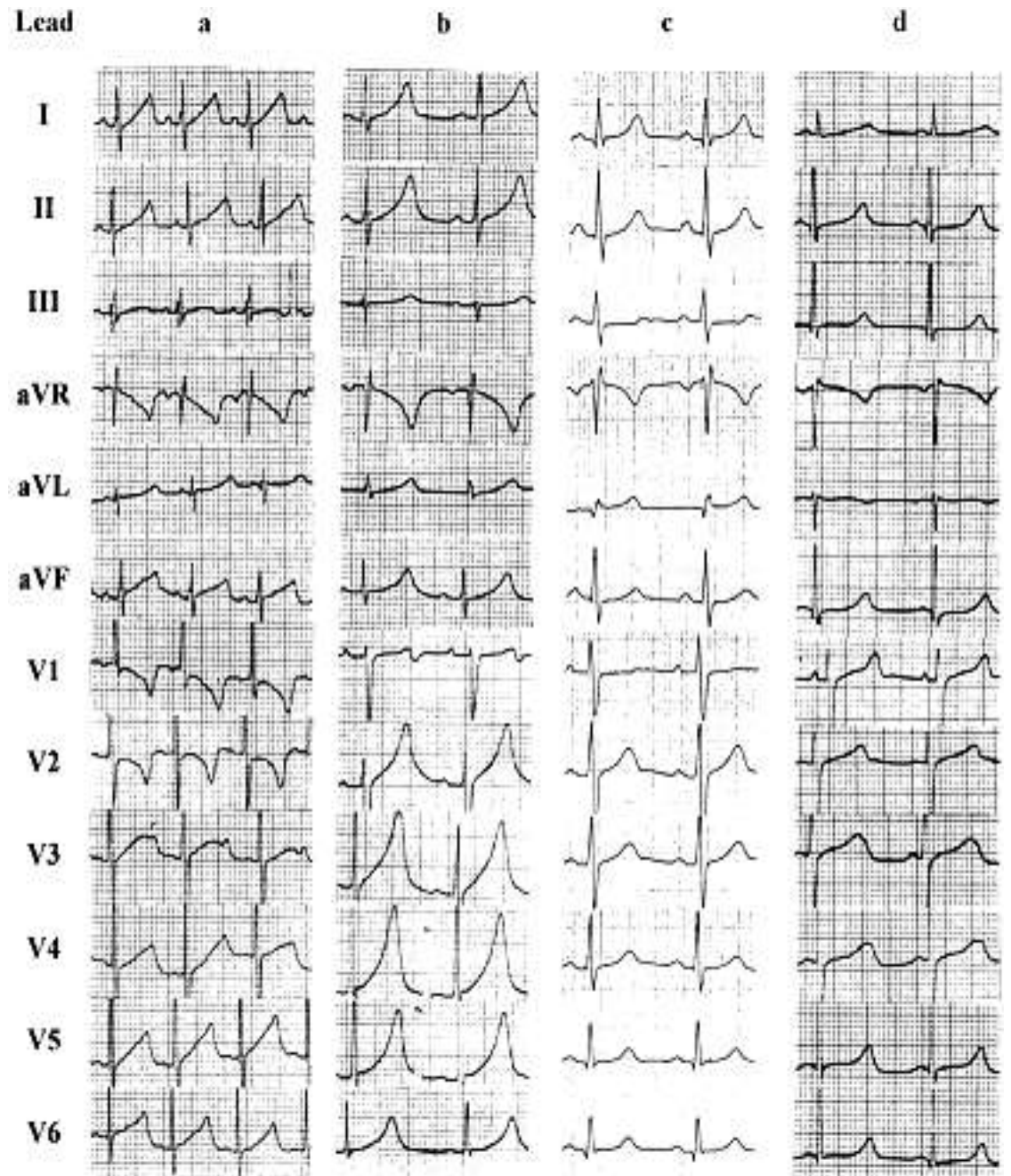


# ECG Changes of AMI vs Pericarditis

- Clinical circumstances
- STE in pericarditis – concave
  - AMI – obliquely flat or convex
- STE in pericarditis – diffuse
  - AMI – territorial
- PR Depression – pericarditis
- T inversion in pericarditis occurs only after  
ST normalized

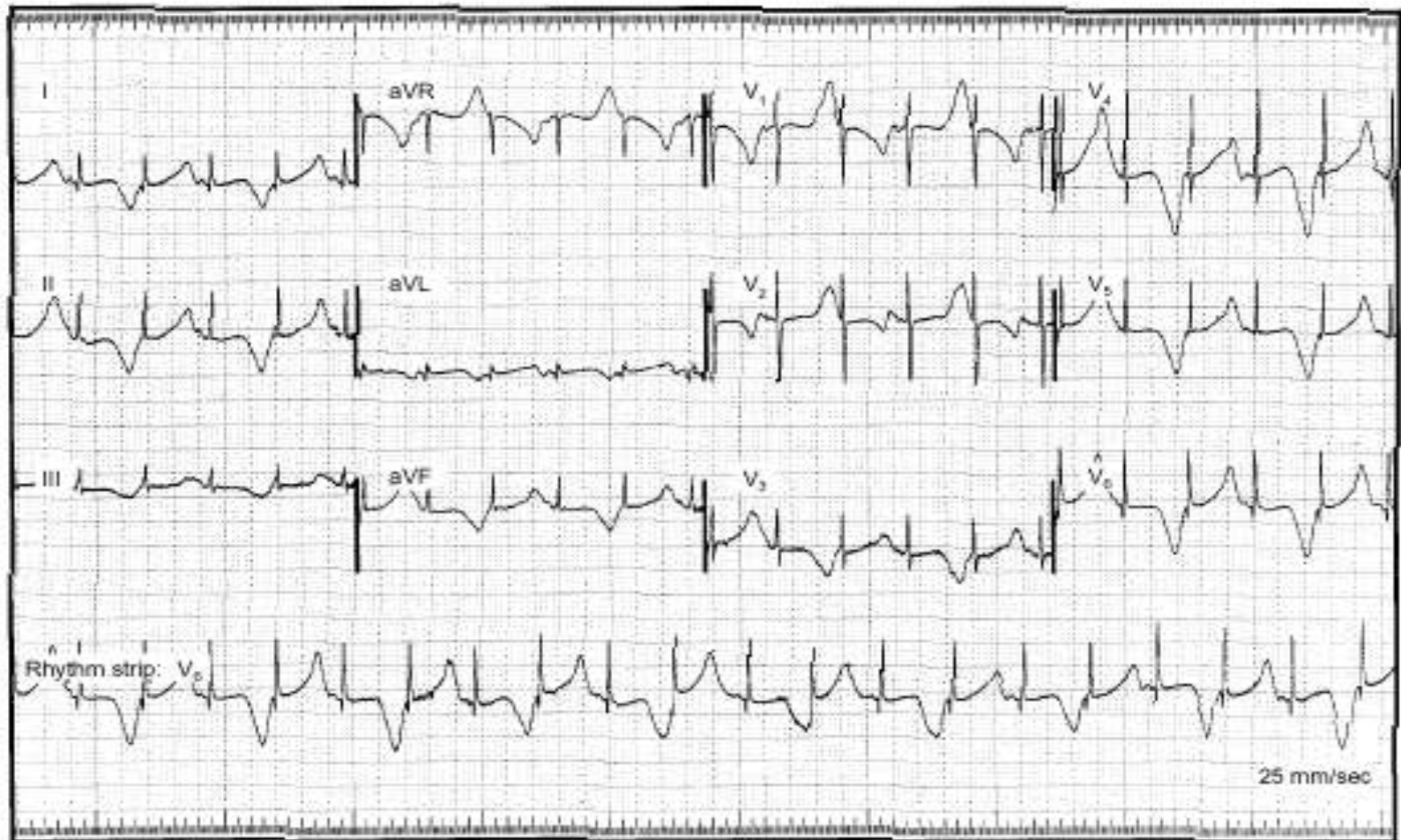
# LQT1

## Characteristic ECG Patterns

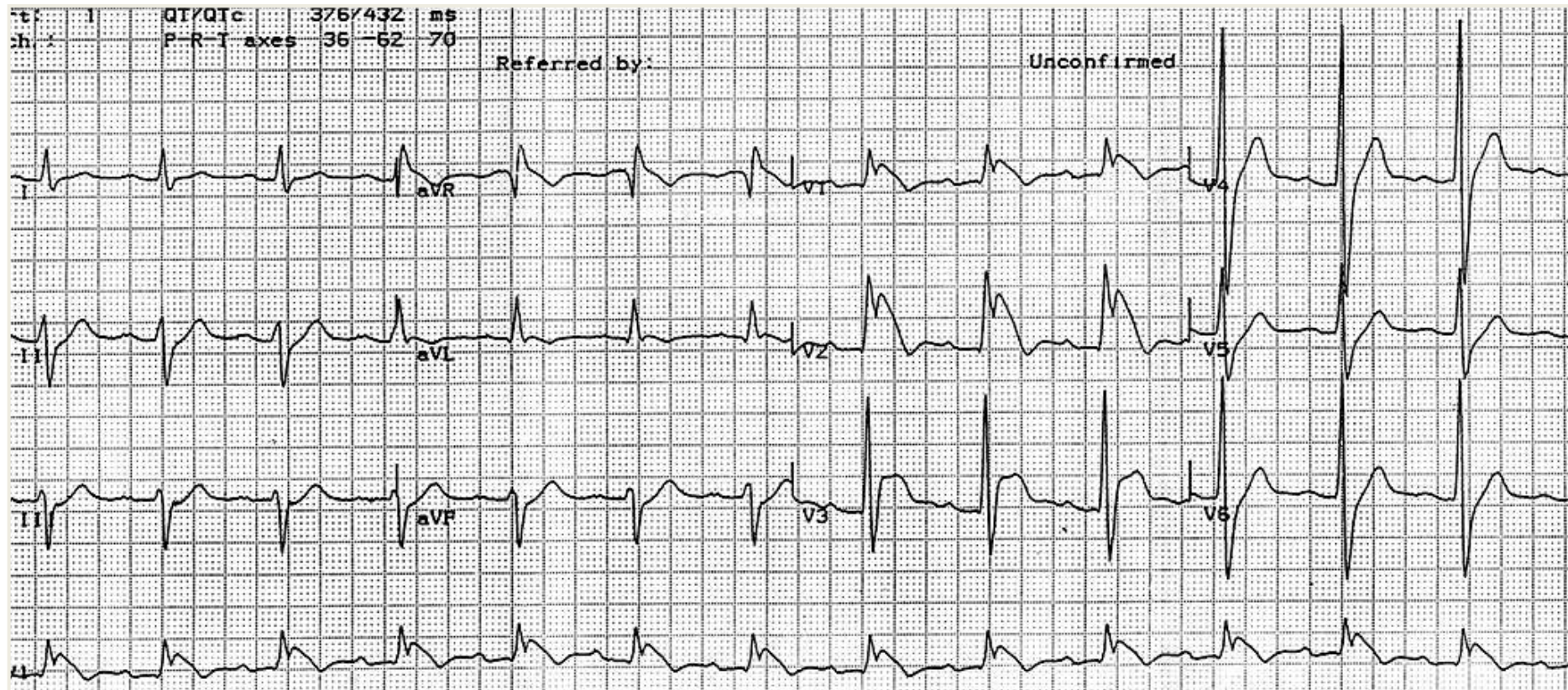


Zhang et al  
Circulation, 2000

# Phenotype 1: JLNS 2 year old boy with syncope and deafness



# Brugada Syndrome



Doctor can you explain the ECG in layman's terms?

...wiggly line good, straight line bad!

