An Introduction to the 12 lead ECG & Acute MI changes

a lecture for student nurses

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12 Lead ECG Interpretation

By the end of this lecture, you will be able to:

- Understand the 12 lead ECG in relation to the coronary circulation and myocardium
- Perform an ECG recording
- Identify the ECG changes that occur in the presence of an acute coronary syndrome.
- Begin to recognize and diagnose an acute MI.

What is a 12 lead ECG?

- Records the electrical activity of the heart (depolarization and depolarization of the myocardium)

- Views the surfaces of the left ventricle from 12 different angles

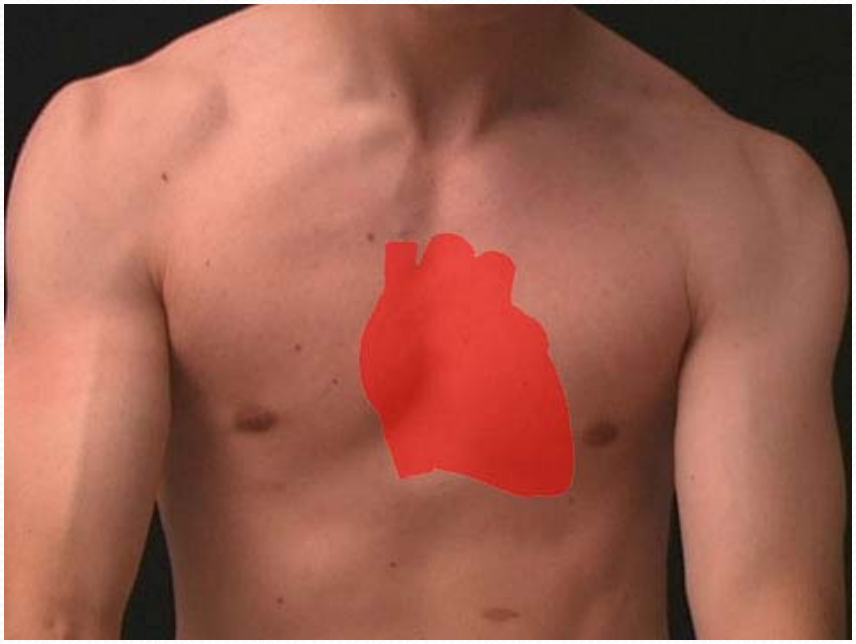
Anatomy and Physiology Review

- A good basic knowledge of the heart and cardiac function is essential in order to understand the 12 lead ECG

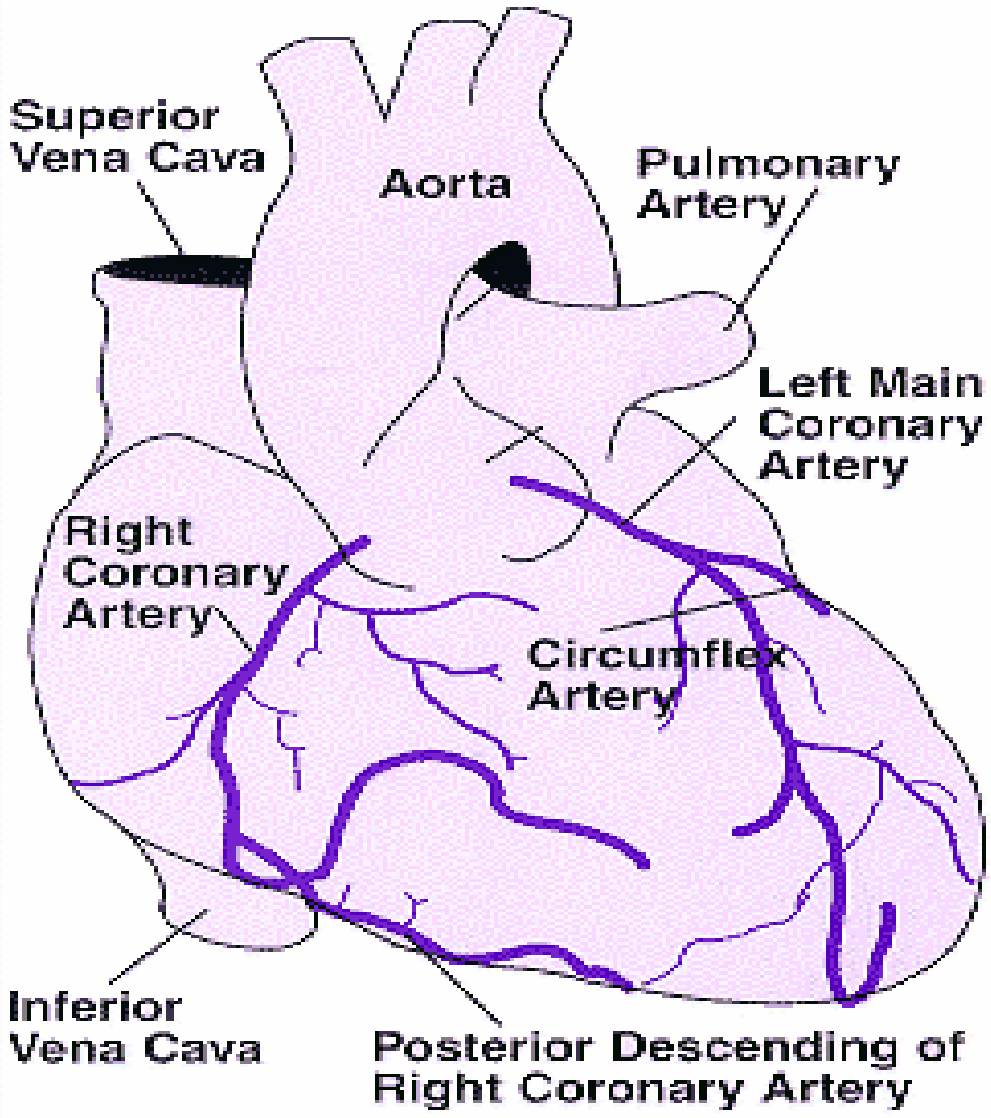
- Anatomical position of the heart
- Coronary Artery Circulation
- Conduction System

Anatomical Position of the Heart

- Lies in the mediastinum behind the sternum
- between the lungs, just above the diaphragm
- the apex (tip of the left ventricle) lies at the fifth intercostal space, mid-clavicular line



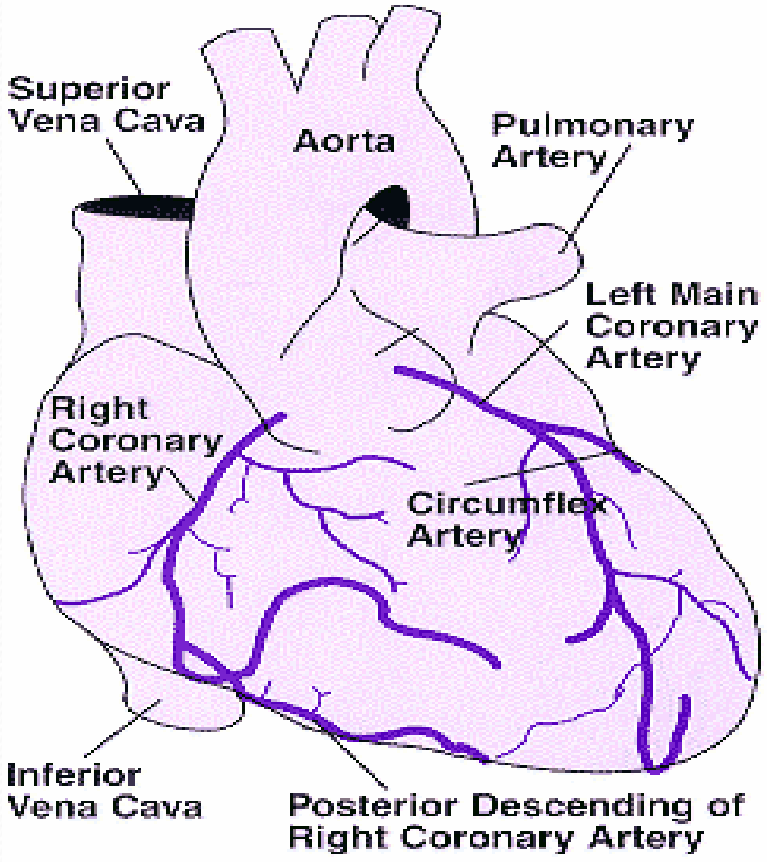
Coronary Artery Circulation



Coronary Artery Circulation

Right Coronary Artery

- right atrium
- right ventricle
- inferior wall of left ventricle
- posterior wall of left ventricle
- 1/3 interventricular septum



Coronary Artery Circulation

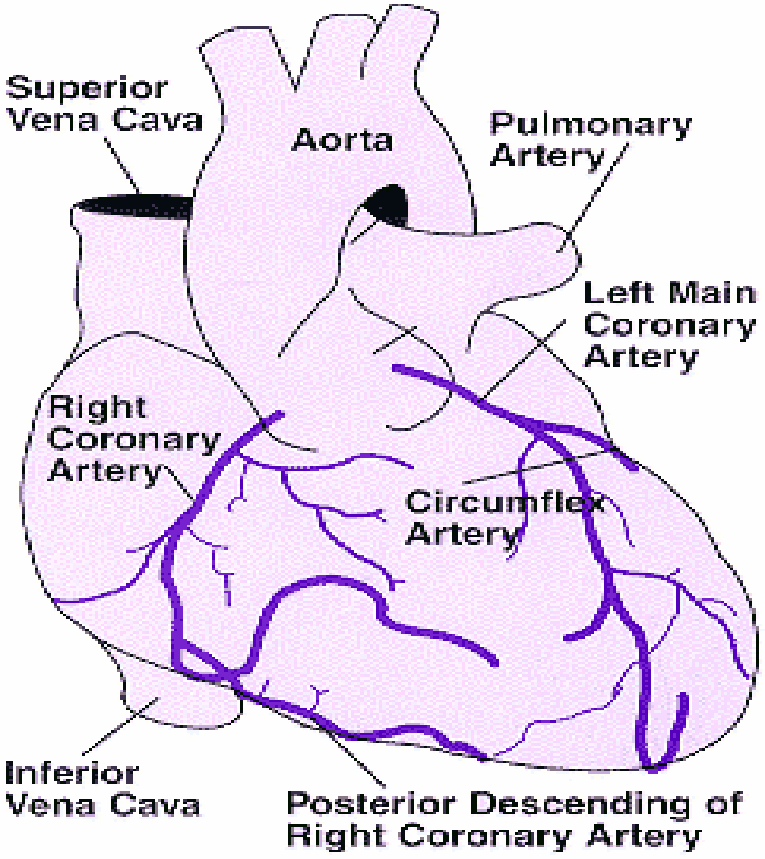
Left Main Stem Artery divides in two:

Left Anterior Descending Artery

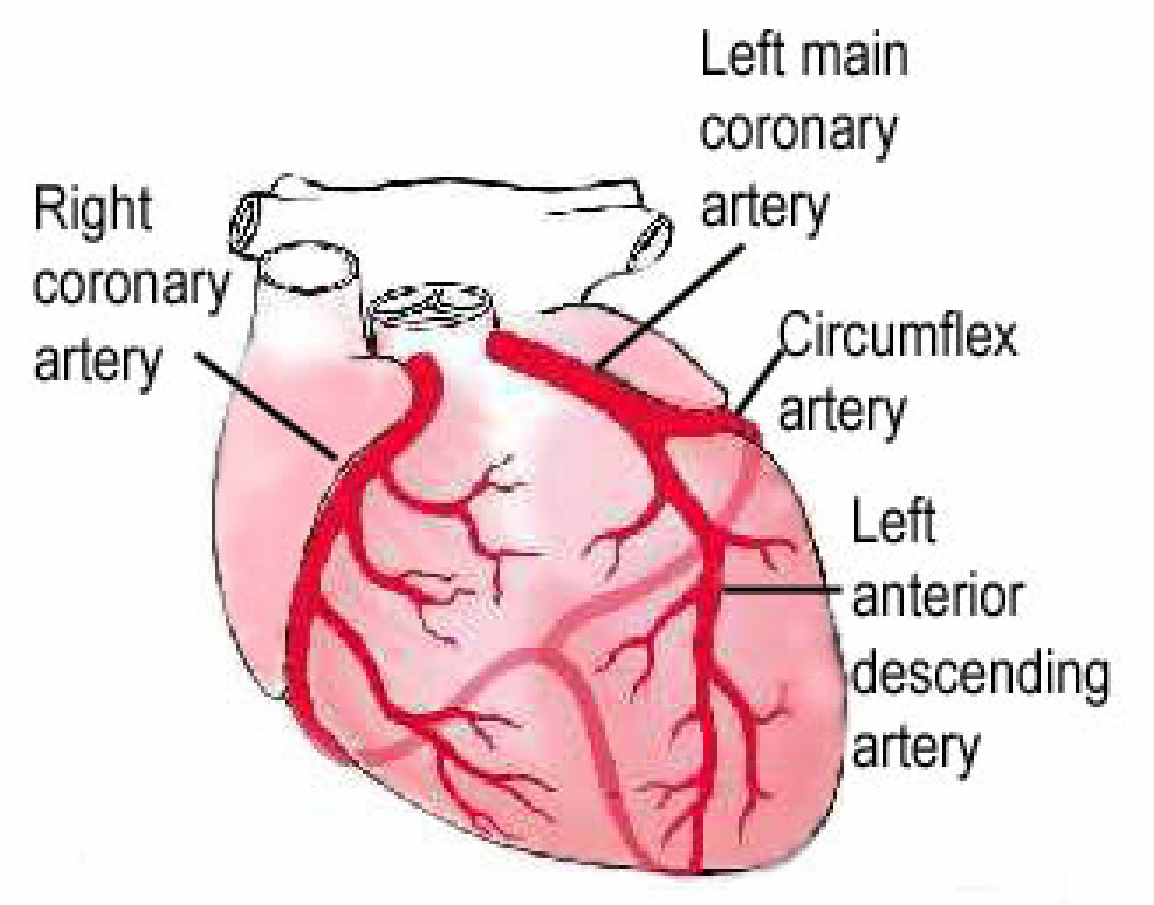
- antero-lateral surface of left ventricle
- 2/3 interventricular septum

Circumflex Artery

- left atrium
- lateral surface of left ventricle



Coronary Artery Circulation



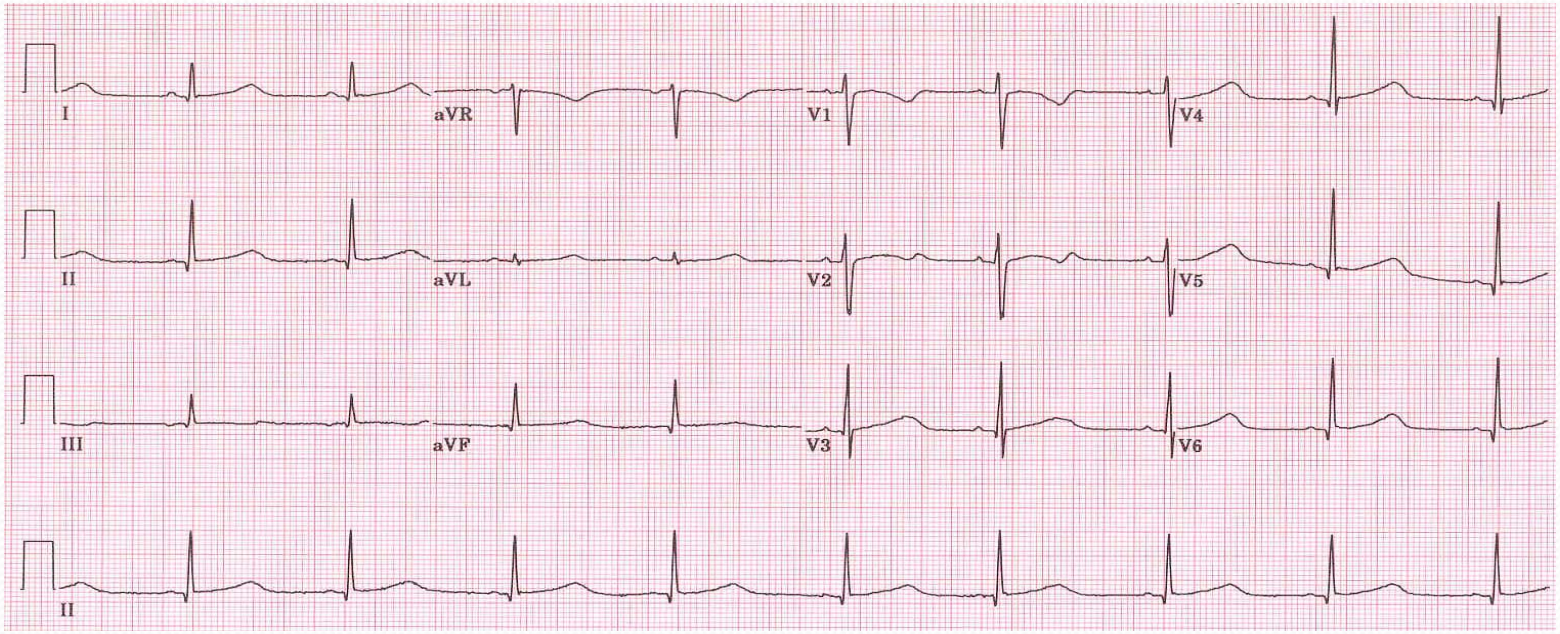
The standard 12 Lead ECG

6 Limb Leads

avR, avL, avF, I, II, III

6 Chest Leads (Precordial leads)

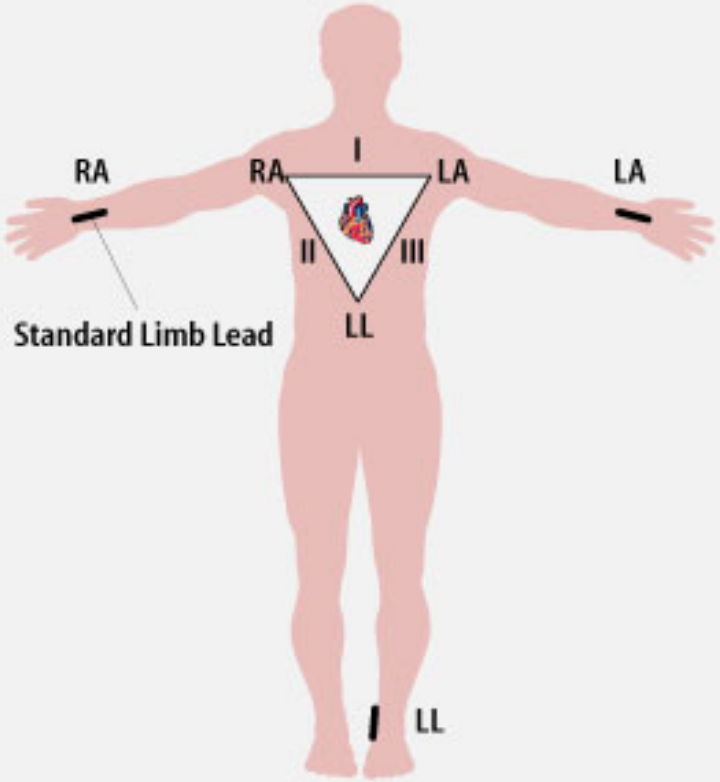
V1, V2, V3, V4, V5 and V6

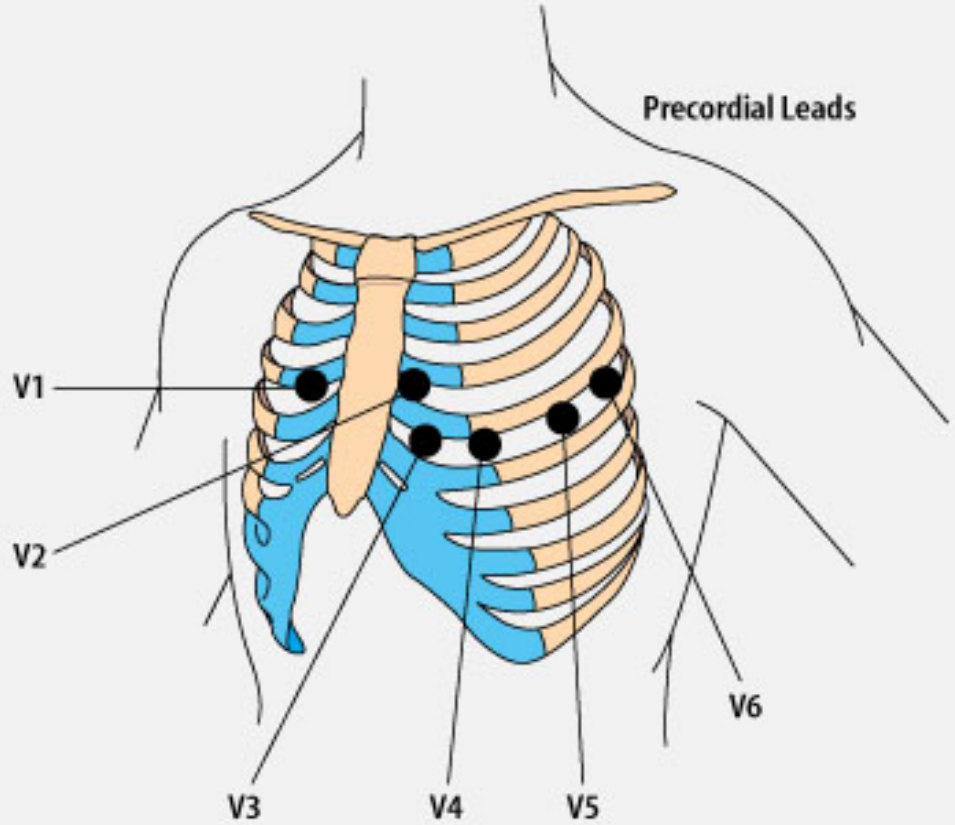


Rhythm Strip

Limb leads

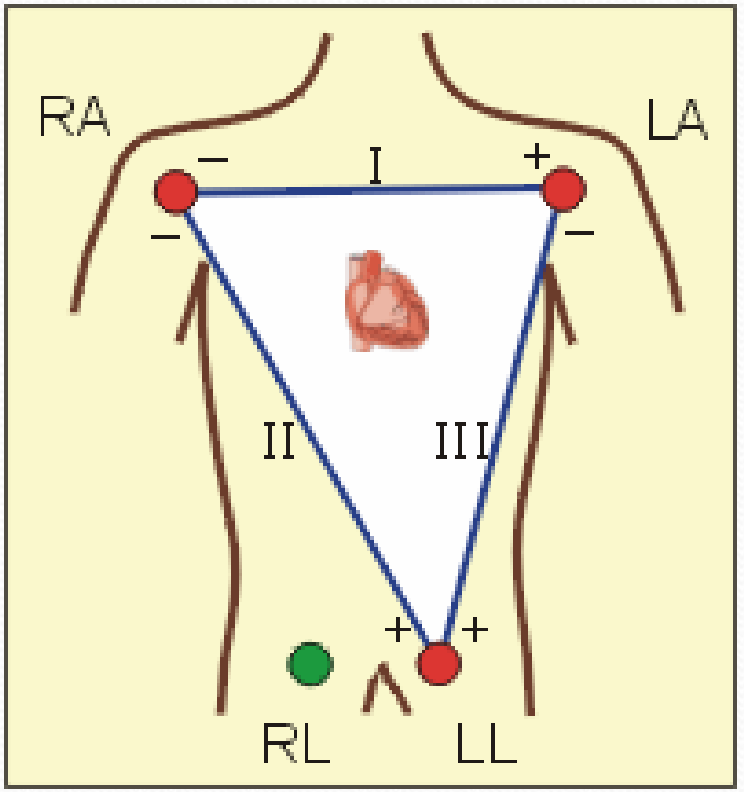
Chest Leads





Limb Leads

3 Unipolar leads



- avR - right arm (+)
- avL - left arm (+)
- avF - left foot (+)

- note that right foot is a **ground lead**

Limb Leads

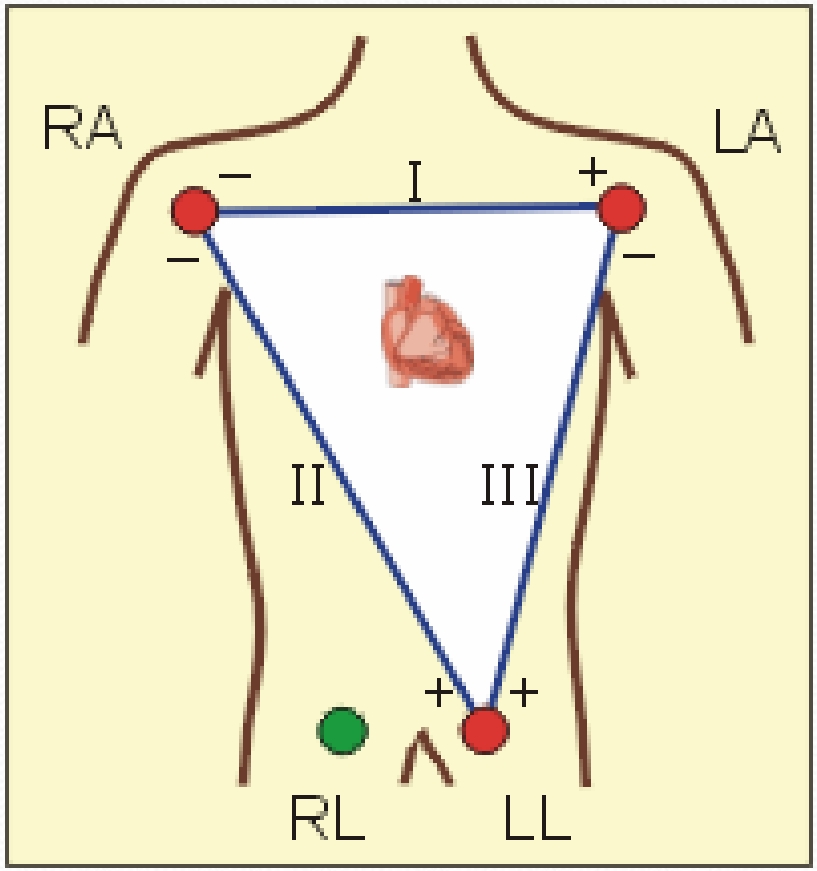
<u>3 Bipolar Leads</u>

form (Einthovens Triangle)

<u>Lead I</u> - measures electrical potential between right arm (-) and left arm (+)

<u>Lead II</u> - measures electrical potential between right arm (-) and left leg (+)

<u>Lead III</u> - measures electrical potential between left arm (-) and left leg (+)



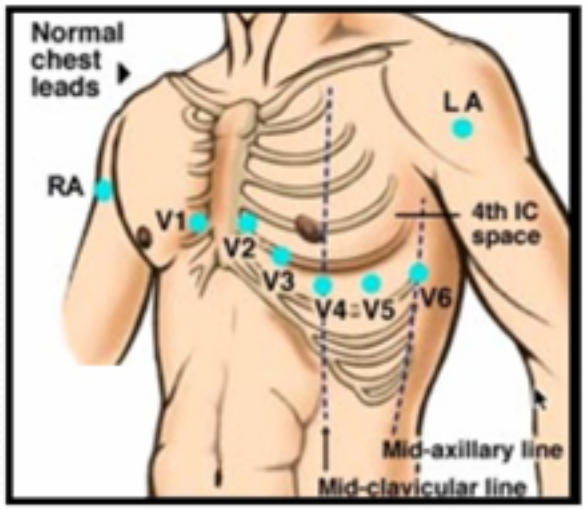
Chest Leads

6 Unipolar leads

Also known as precordial leads

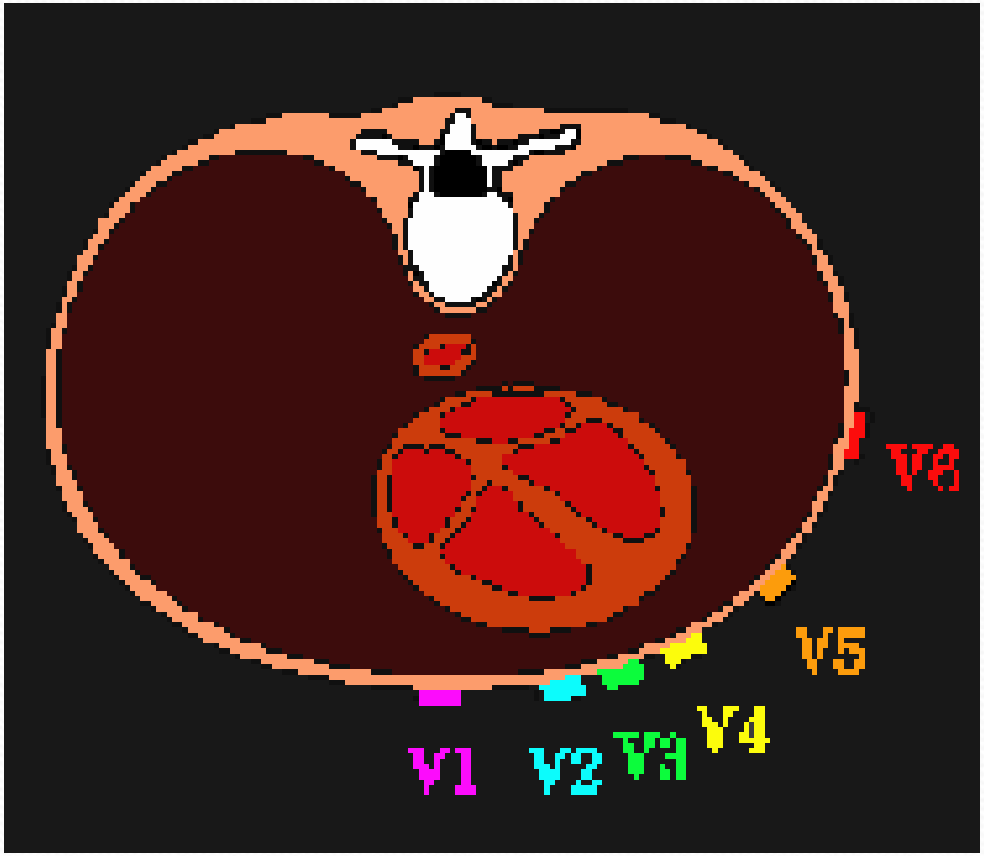
V1, V2, V3, V4, V5 and V6 - all positive

Precordial or Chest Leads



V_1 4th intercostal (right)
V_2 4th intercostal (left)
V_3 Between V_2 & V_4
V_4 Midclavicular (mid-collarbone)
V_5 5th intercostal space (anterior axillary line)
V_6 5th intercostal (midaxillary line)

Chest Leads

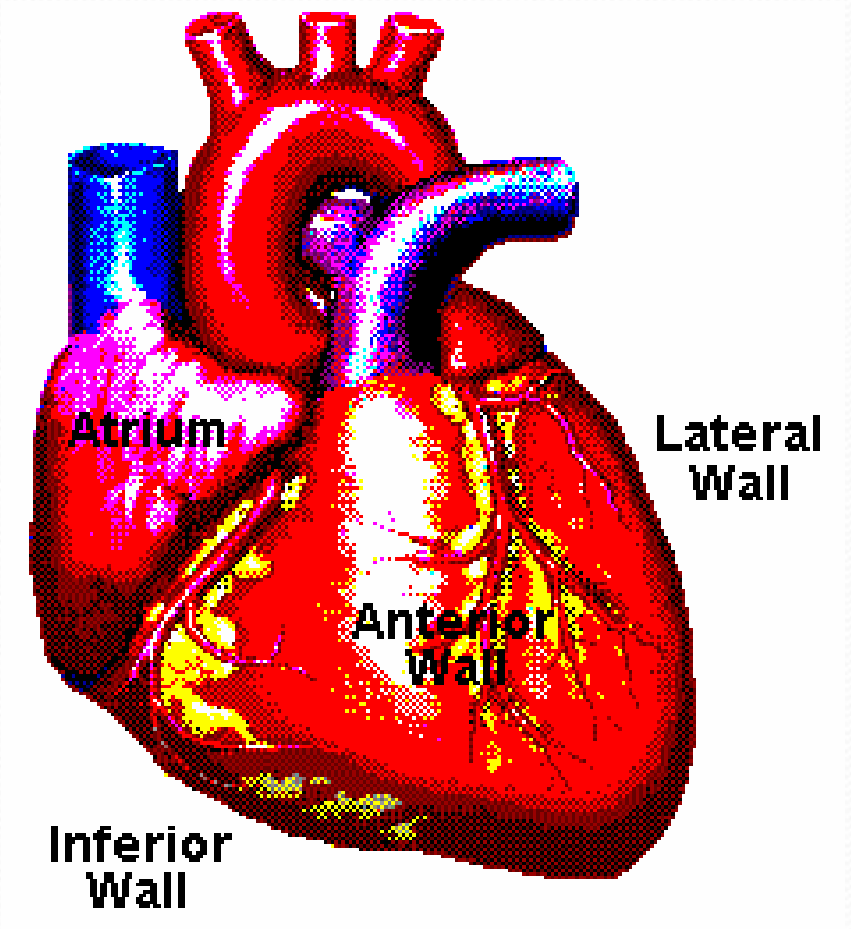


Think of the positive electrode as an ‘eye’…

the position of the positive electrode on the body determines the area of the heart ‘seen’ by that lead.

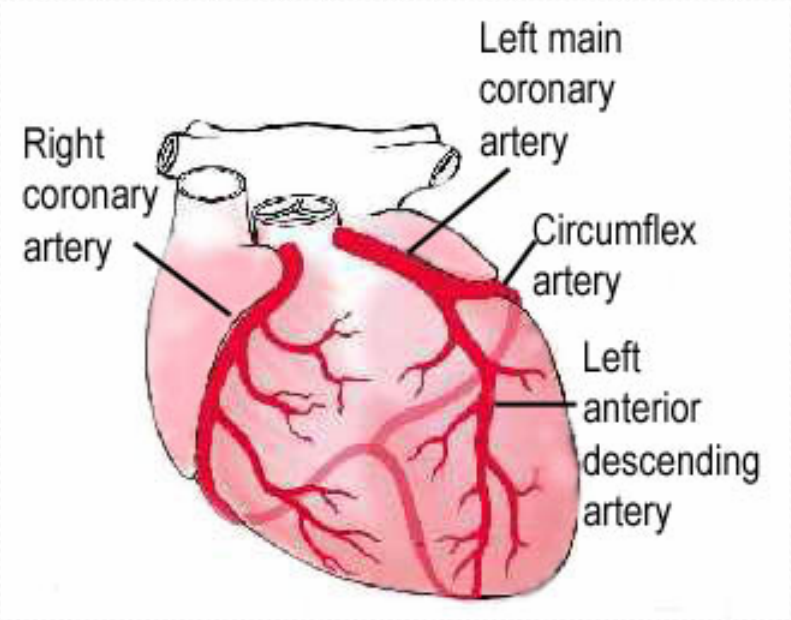
Surfaces of the Left Ventricle

- Inferior - underneath
- Anterior - front
- Lateral - left side
- Posterior - back



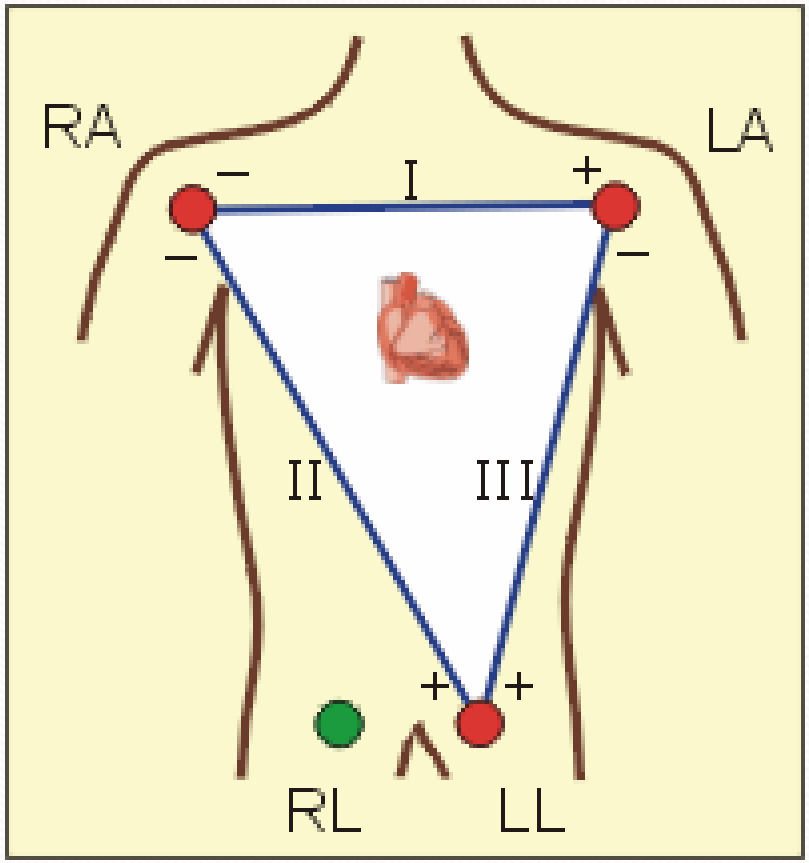
Inferior Surface

- Leads **II, III and avF** look UP from below to the inferior surface of the left ventricle
- Mostly perfused by the **Right Coronary Artery**



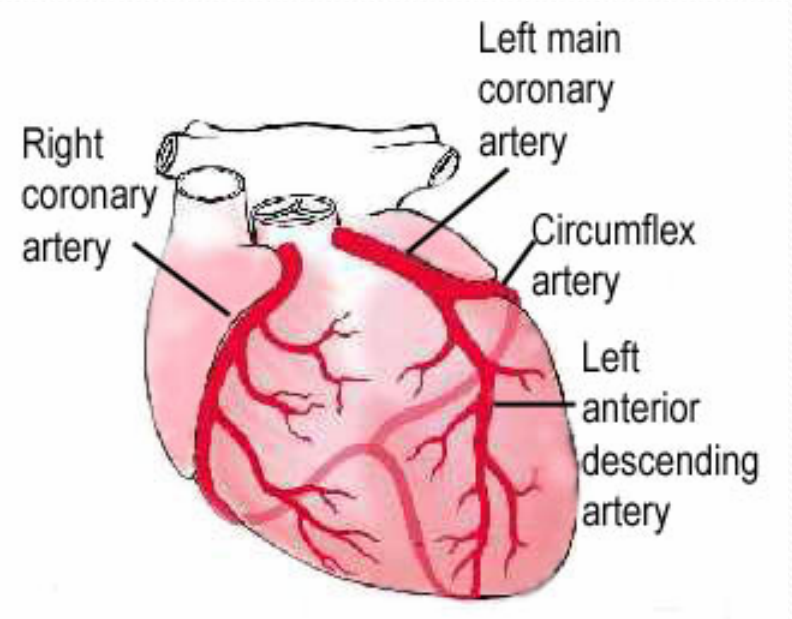
Inferior Leads

- **II**
- **III**
- **aVF**



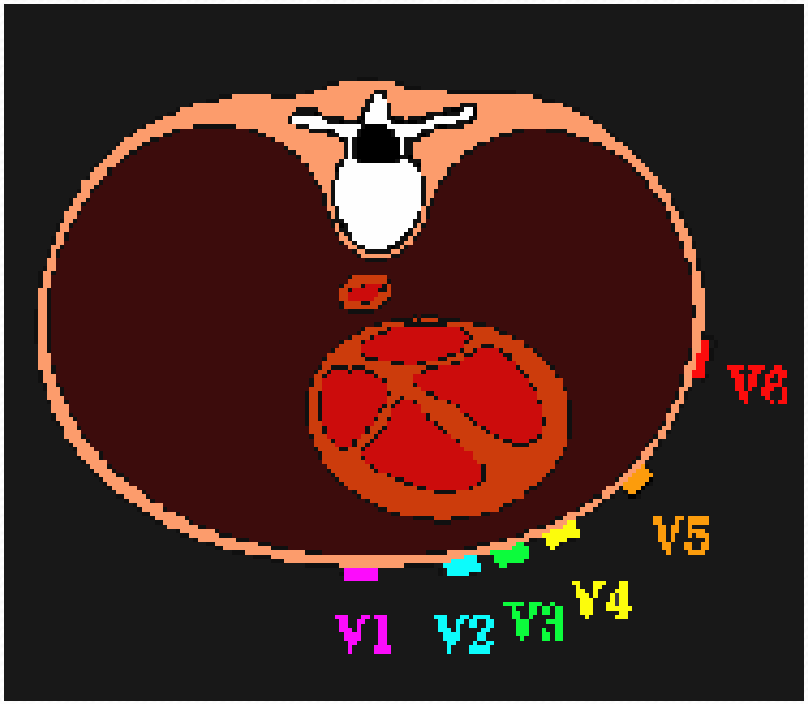
Anterior Surface

- The **front** of the heart viewing the left ventricle and the septum
- Leads **V2**, **V3** and **V4** look towards this surface
- Mostly fed by the **Left Anterior Descending** branch of the Left artery



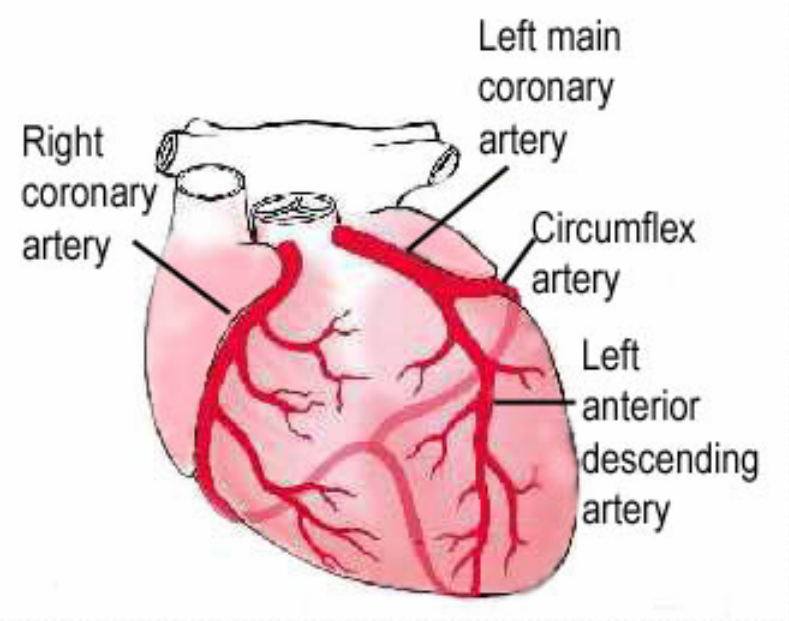
Anterior Leads

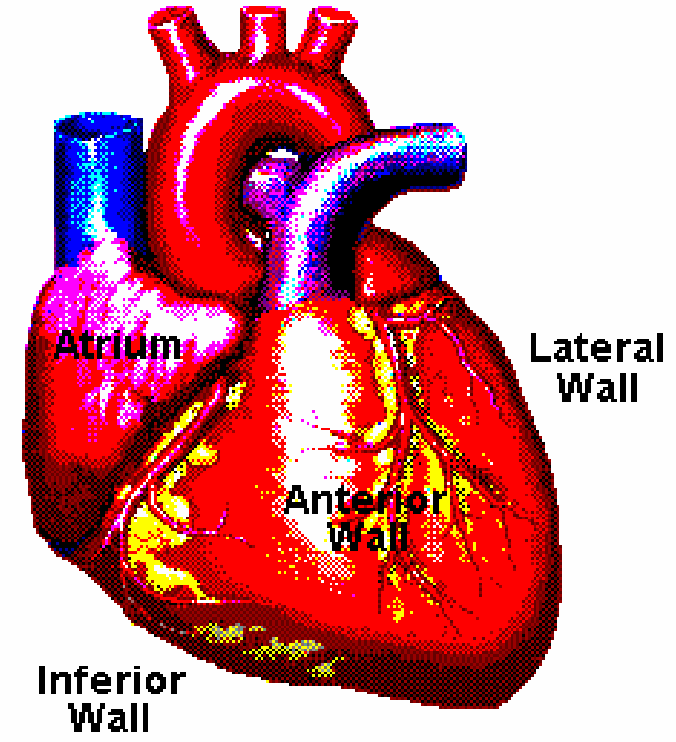
- V2
- V3
- V4



Lateral Surface

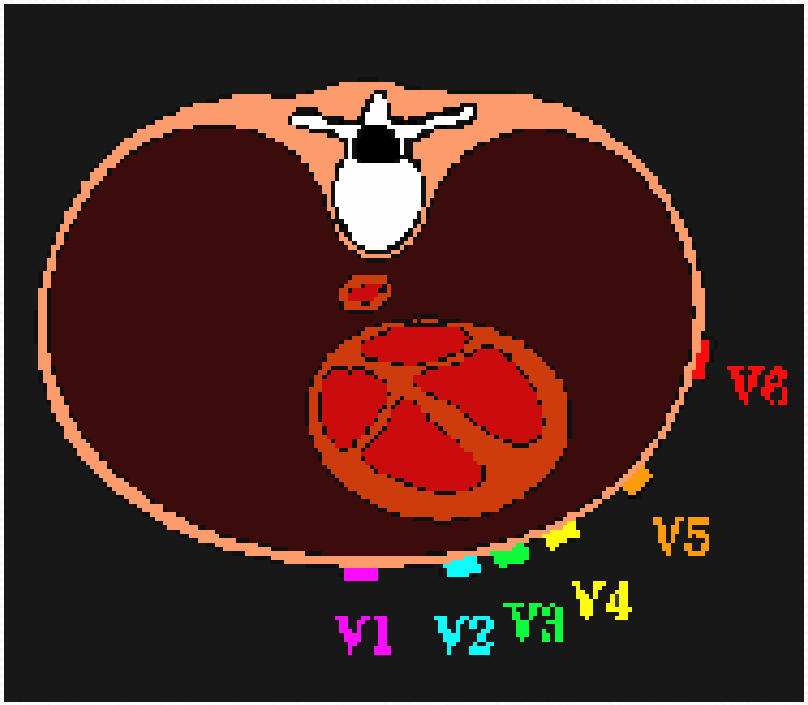
- The left sided wall of the left ventricle
- Leads **V5** and **V6, I** and **avL** look at this surface
- Mostly fed by the **Circumflex branch** of the left artery



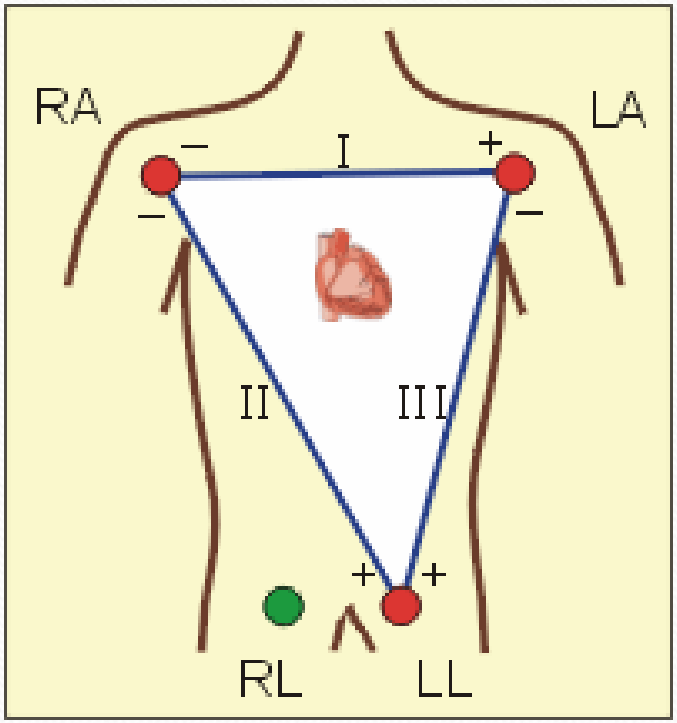


Lateral Leads

V5, V6,

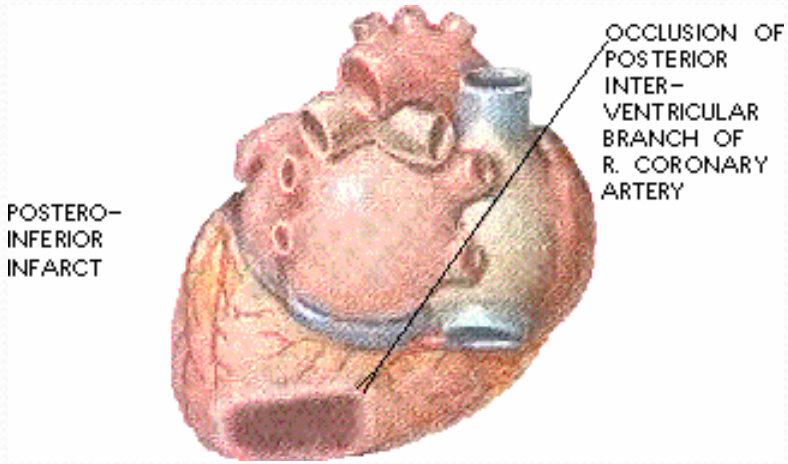


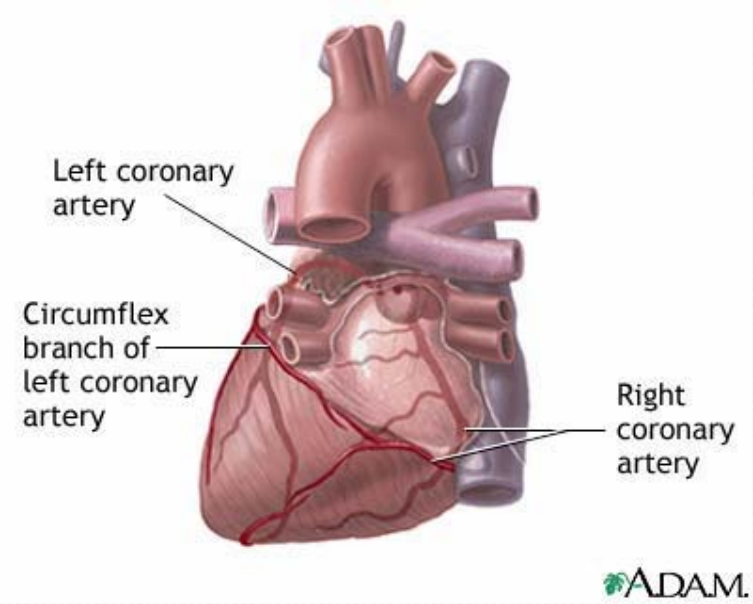
I, aVL



Posterior Surface

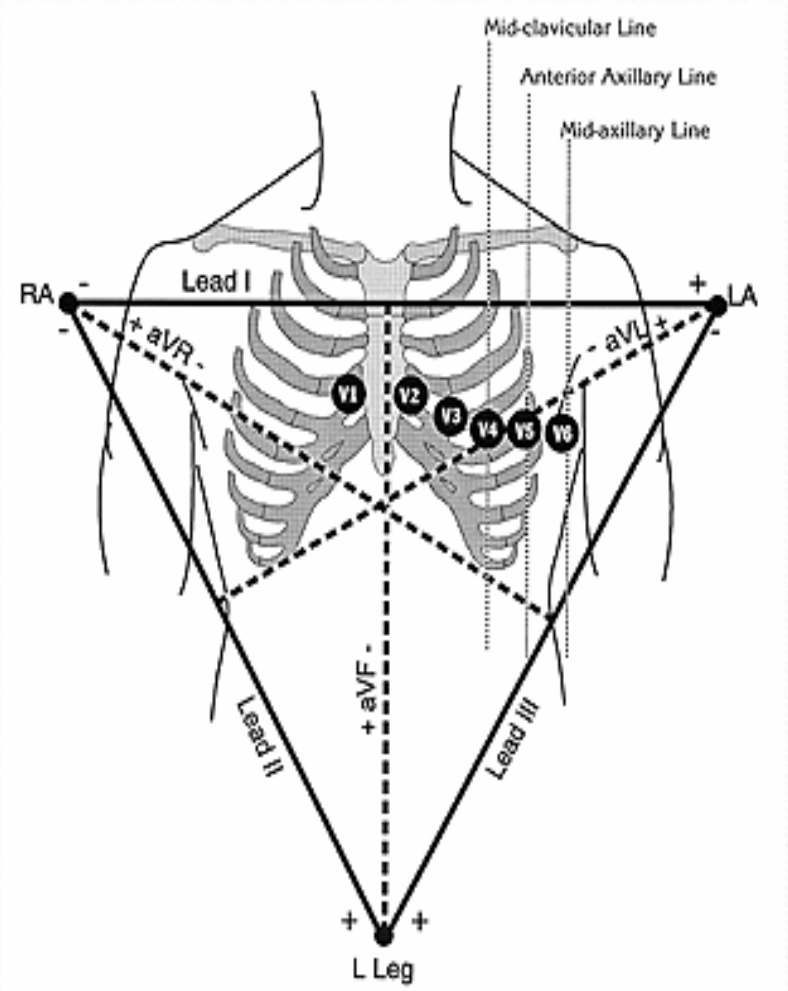
- Posterior wall infarcts are rare
- Posterior diagnoses can be made by looking at the anterior leads as a mirror image. Normally there are inferior ischaemic changes
- Blood supply predominantly from the **Right Coronary Artery**





RIGHT

LEFT



Inferior
II, III, AVF

Antero-Septal
V1,V2, V3,V4

Posterior
V1, V2, V3

Lateral
I, AVL, V5, V6

ECG Waveforms

- Normal cardiac axis is downward and to the left
- ie the wave of depolarisation travels from the right atria towards the left ventricle
- when an electrical impulse travels towards a positive electrode, there will be a ***positive*** deflection on the ECG
- if the impulse travels away from the positive electrode, a ***negative*** deflection will be seen

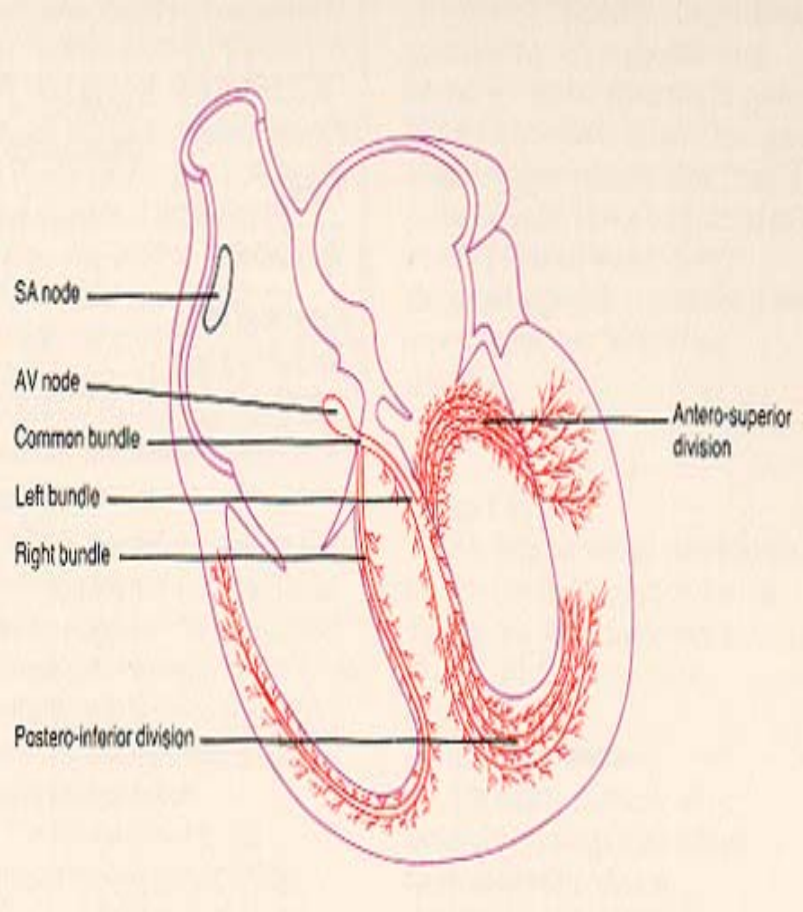
ECG Waveforms

- Look at your 12 lead ECG's
- What do you notice about lead avR?
- How does this compare with lead V6?

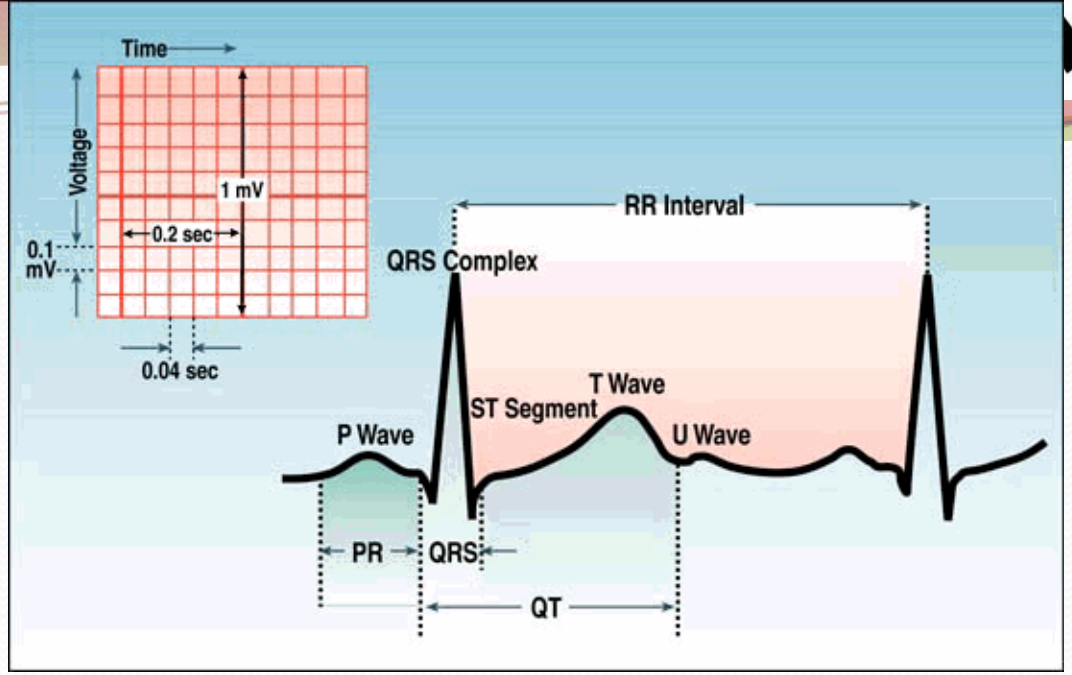
An Introduction to the 12 lead ECG

Part II

Basic electrocardiography



- Heart beat originates in the SA node
- Impulse spreads to all parts of the atria via internodal pathways
- ATRIAL contraction occurs
- Impulse reaches the AV node where it is delayed by 0.1second
- Impulse is conducted rapidly down the Bundle of His and Purkinje Fibres
- VENTRICULAR contraction occurs



The P wave represents atrial depolarisation

the PR interval is the time from onset of atrial activation to onset of ventricular activation

The QRS complex represents ventricular depolarisation

The S-T segment should be iso-electric, representing the ventricles before repolarisation

The T-wave represents ventricular repolarisation

The QT interval is the duration of ventricular activation and recovery.

ECG Abnormalities

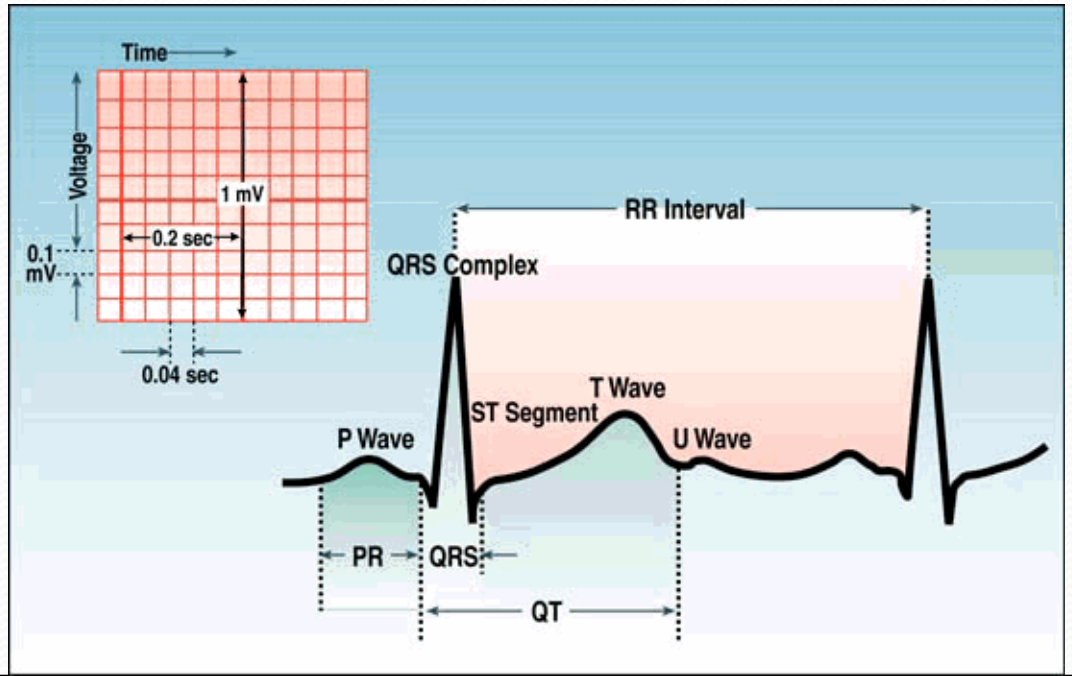
Associated with ischaemia

Ischaemic Changes

- S-T segment elevation
- S-T segment depression
- Hyper-acute T-waves
- T-wave inversion
- Pathological Q-waves
- Left bundle branch block

ST Segment

- The ST segment represents period between ventricular depolarisation and repolarisation.
- The ventricles are unable to receive any further stimulation
- The ST segment normally lies on the isoelectric line.

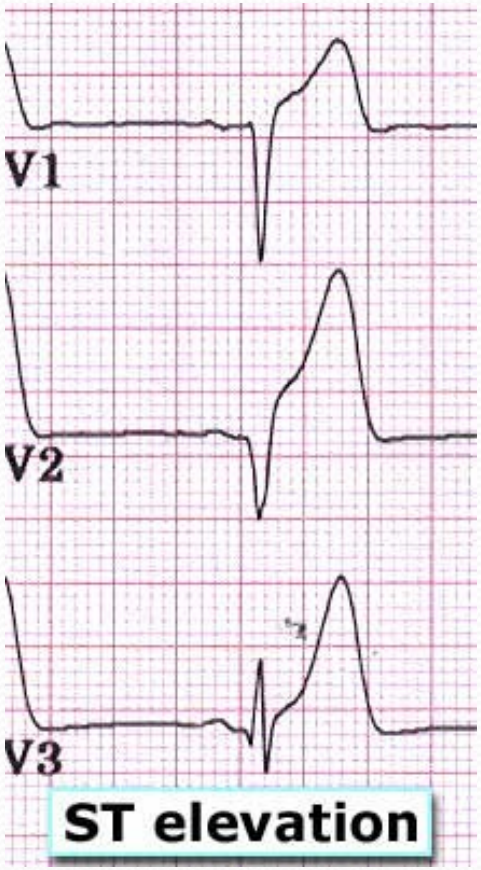


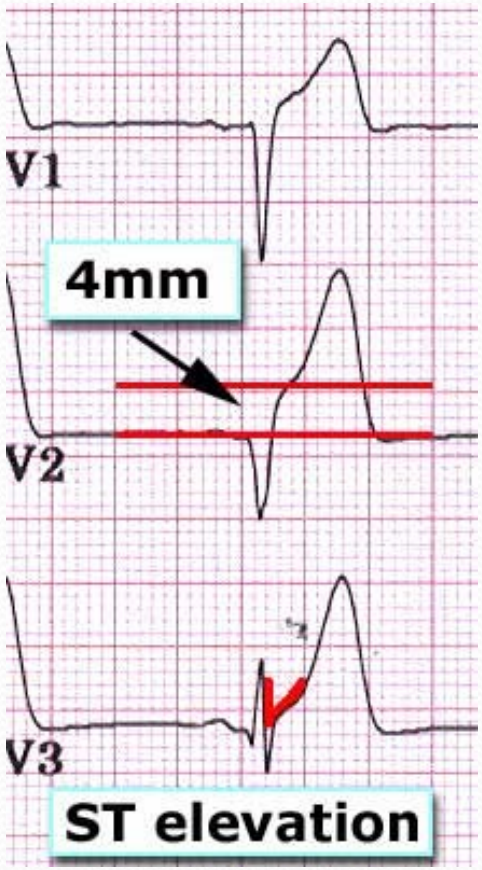
ST Segment Elevation

The ST segment lies above the isoelectric line:

- Represents myocardial injury
- It is the **hallmark** of Myocardial Infarction
- The injured myocardium is slow to repolarise and remains more positively charged than the surrounding areas
- Other causes to be ruled out include pericarditis and ventricular aneurysm

ST-Segment Elevation






I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

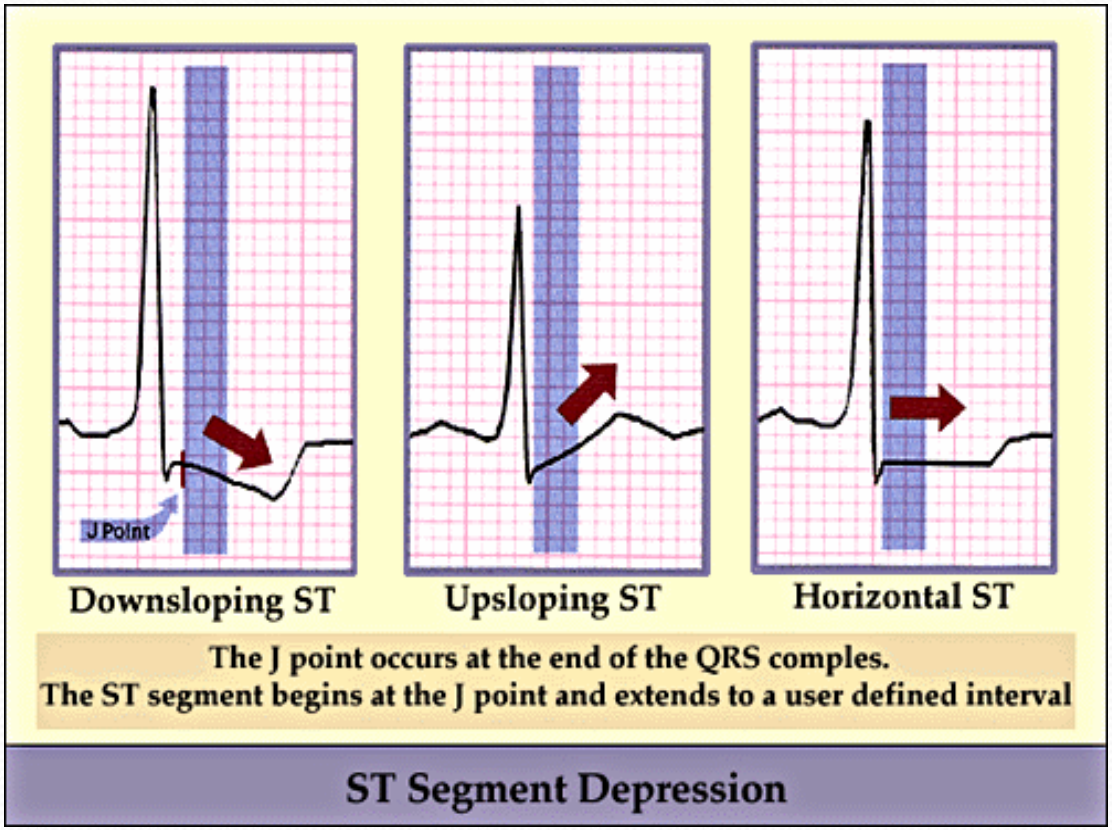
Myocardial Infarction

- A medical emergency!!!
- ST segment curves upwards in the leads looking at the threatened myocardium.
- Presents within a few hours of the infarct.
- Reciprocal ST depression may be present

ST Segment Depression

Can be characterised as:-

- Downsloping
- Upsloping
- Horizontal



Horizontal ST Segment Depression

Myocardial Ischaemia:

- **Stable angina -** occurs on exertion, resolves with rest and/or GTN
- **Unstable angina -** can develop during rest.
- **Non ST elevation MI -** usually quite deep, can be associated with deep T wave inversion.
- Reciprocal horizontal depression can occur during AMI.

Horizontal ST depression

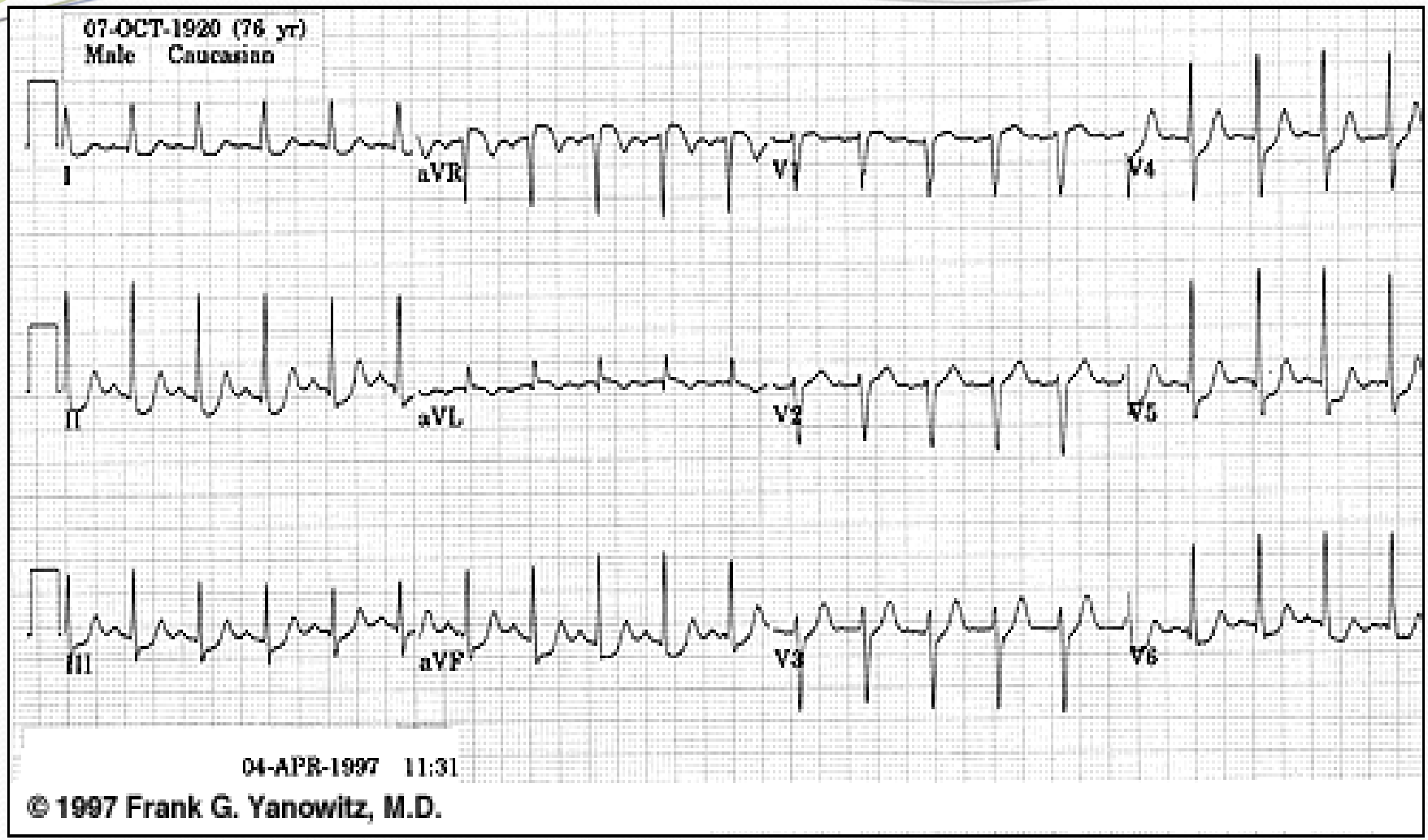
ST Segment Depression

Downsloping ST segment depression:-

- Can be caused by digoxin.

Upward sloping ST segment depression:-

- Normal during exercise.


07-OCT-1920 (76 yr)
Male Caucasian
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
04-APR-1997 11:31
© 1997 Frank G. Yanowitz, M.D.

T waves

- The T wave represents ventricular repolarisation
- Should be in the same direction as and smaller than the QRS complex
- Hyperacute T waves occur with S-T segment elevation in acute MI
- T wave inversion occurs during ischaemia and shortly after an MI

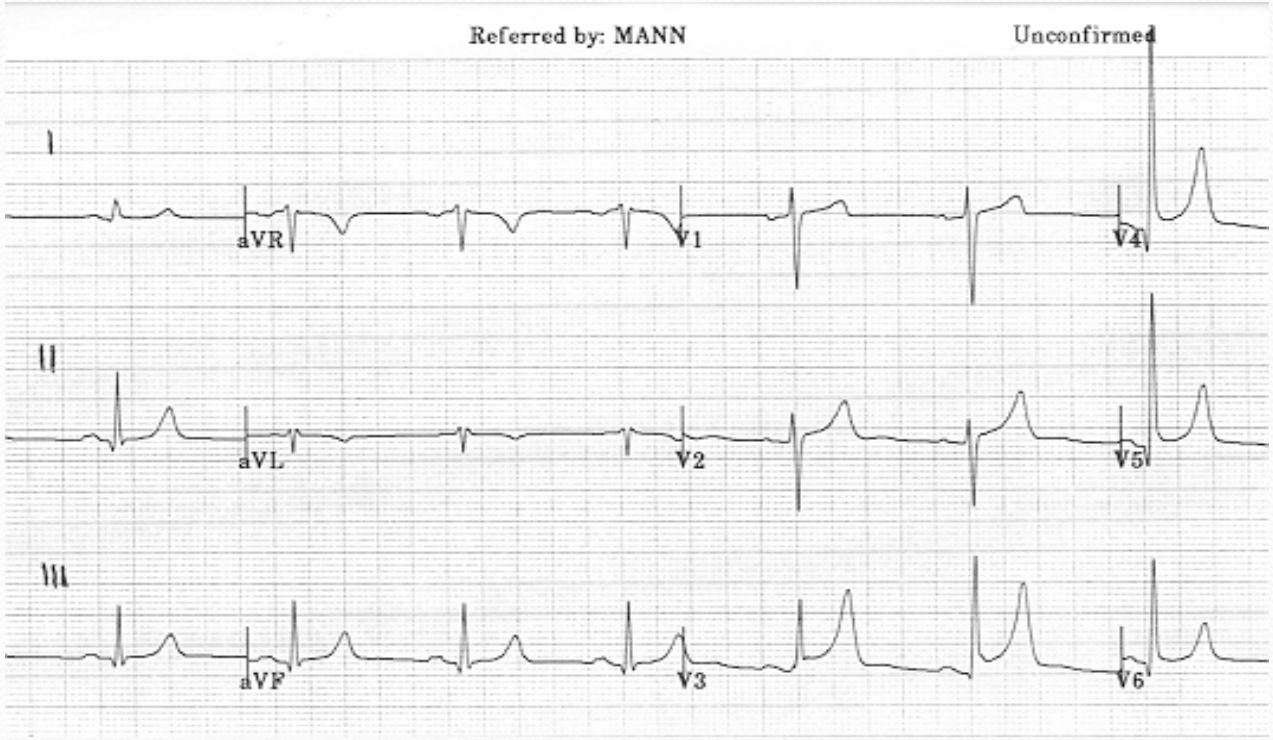
T waves

Other causes of T wave inversion include:

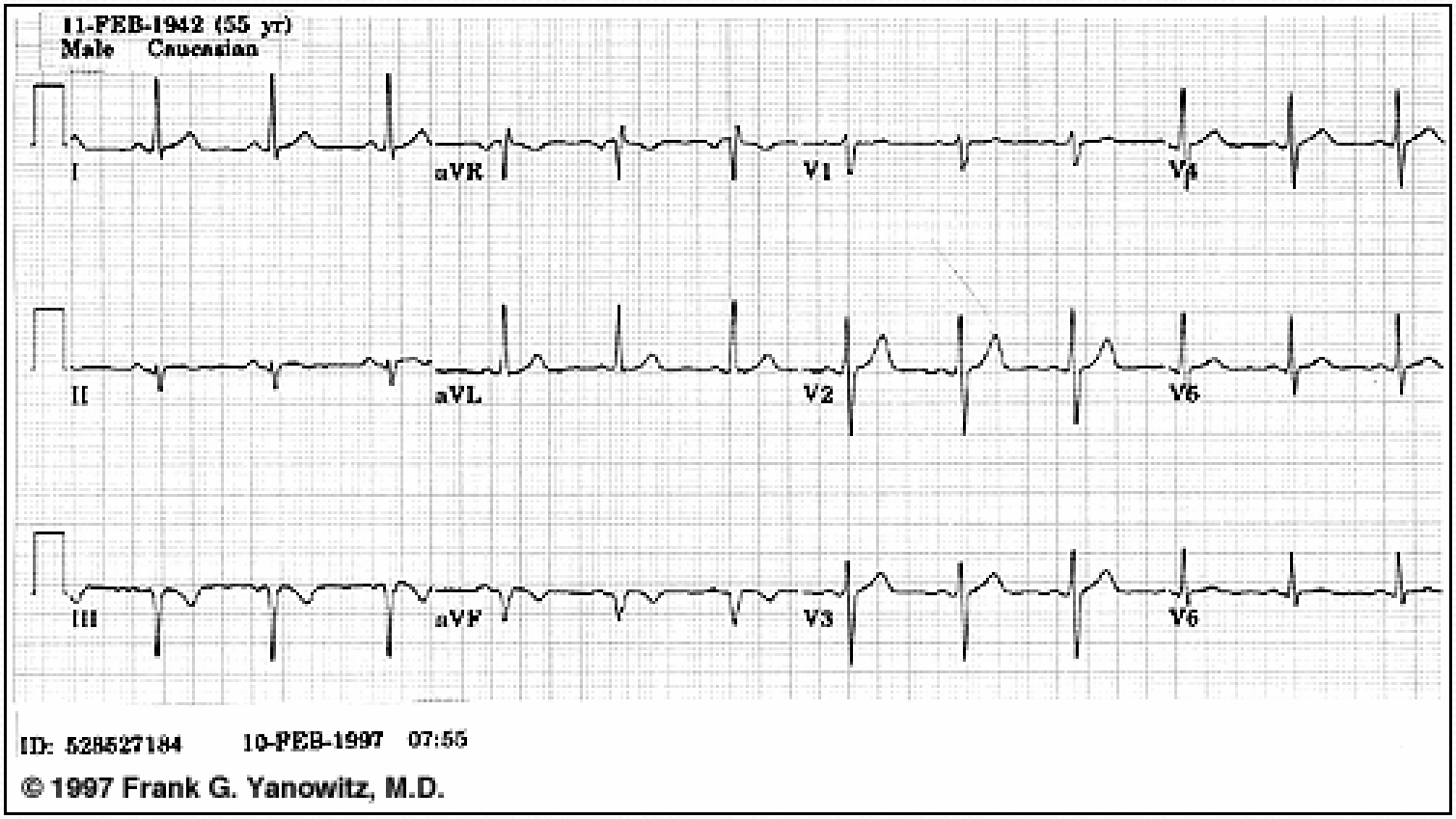
- Normal in some leads
- Cardiomyopathy
- Pericarditis
- Bundle Branch Block (BBB)
- Sub-arachnoid haemorrhage

- Peaked T waves indicate hyperkalaemia

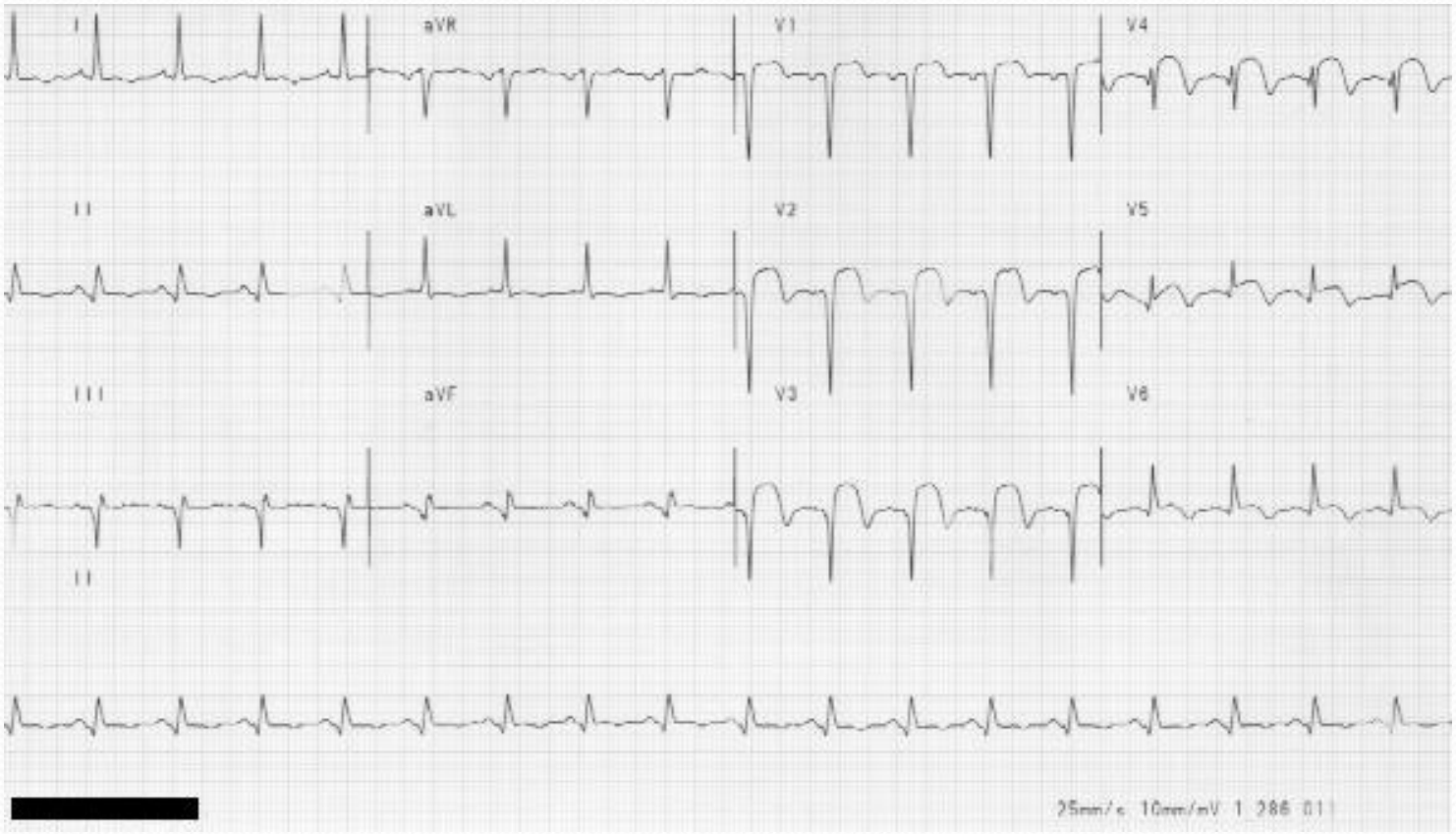
Hyperacute T waves



Inferior T-wave inversion



T wave inversion in an evolving MI

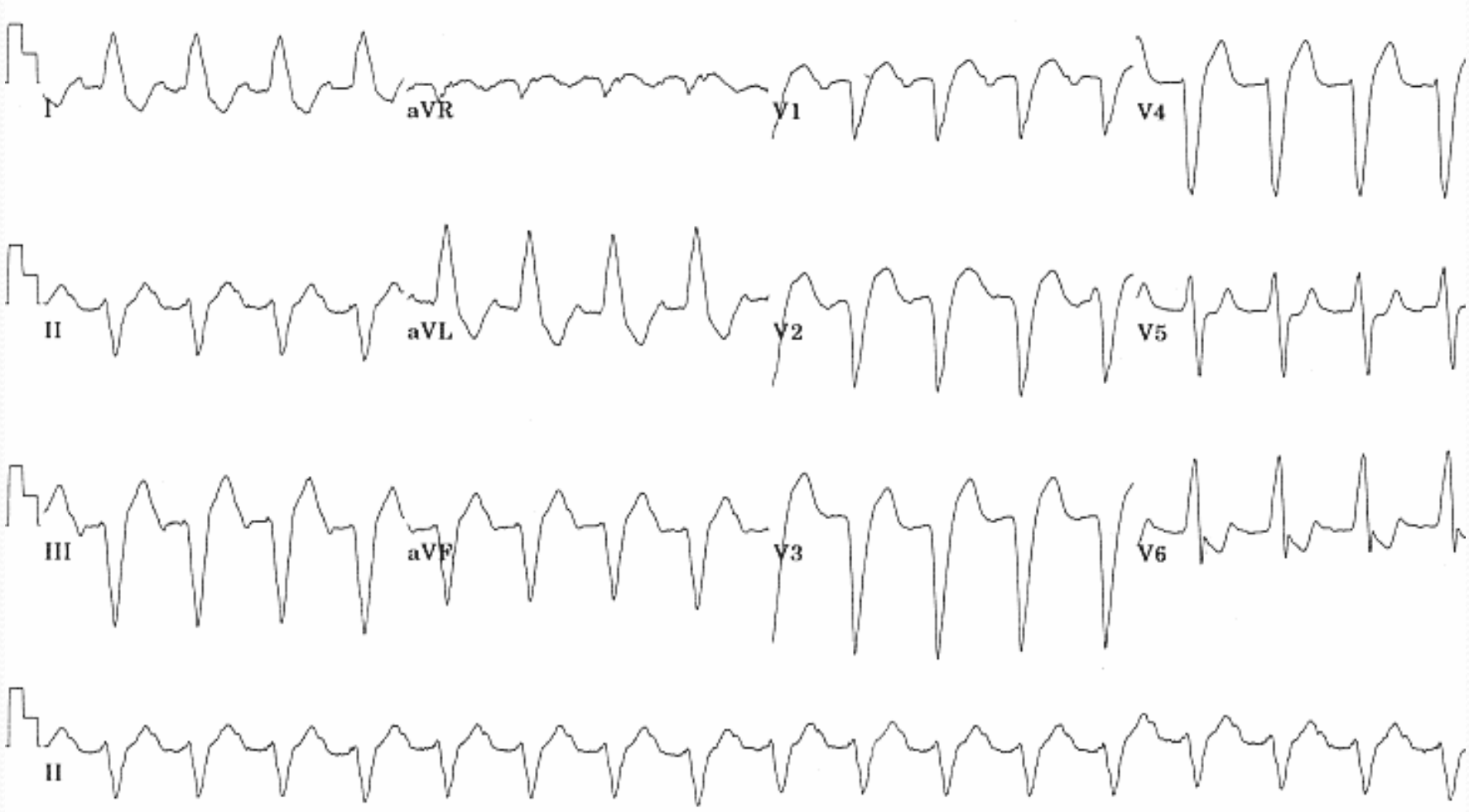


QRS Complex

May be too broad (more than 0.12 seconds)

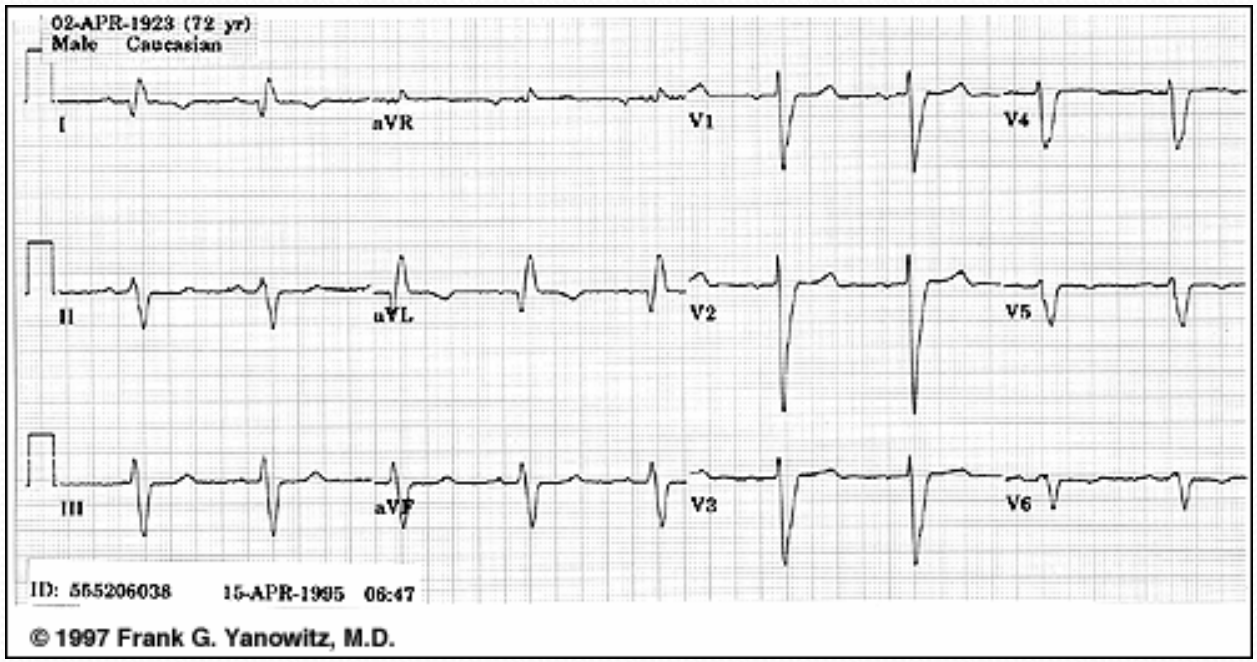
- A delay in the depolarisation of the ventricles because the conduction pathway is abnormal
- A Left Bundle Branch Block can result from MI and may be a sign of an acute MI.

Wide QRS (LBBB)



QRS Complex

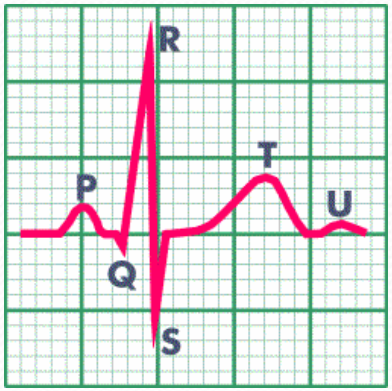
- **May be too tall.**
- This is caused by an increase in muscle mass in either ventricle. (Hypertrophy)



Q Waves

Non Pathological Q waves

Q waves of less than 2mm are normal

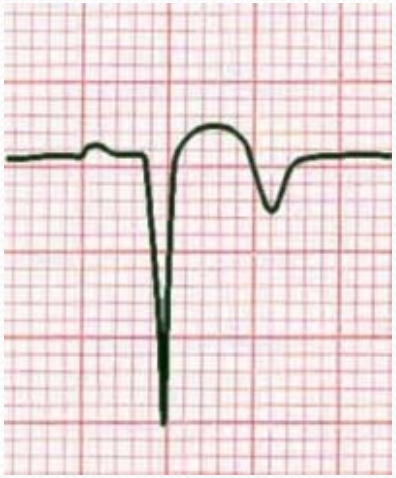


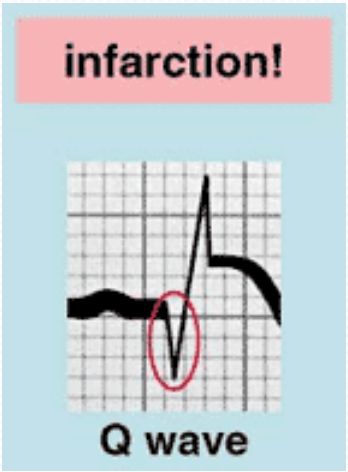
Pathological Q waves

Q waves of more than 2mm

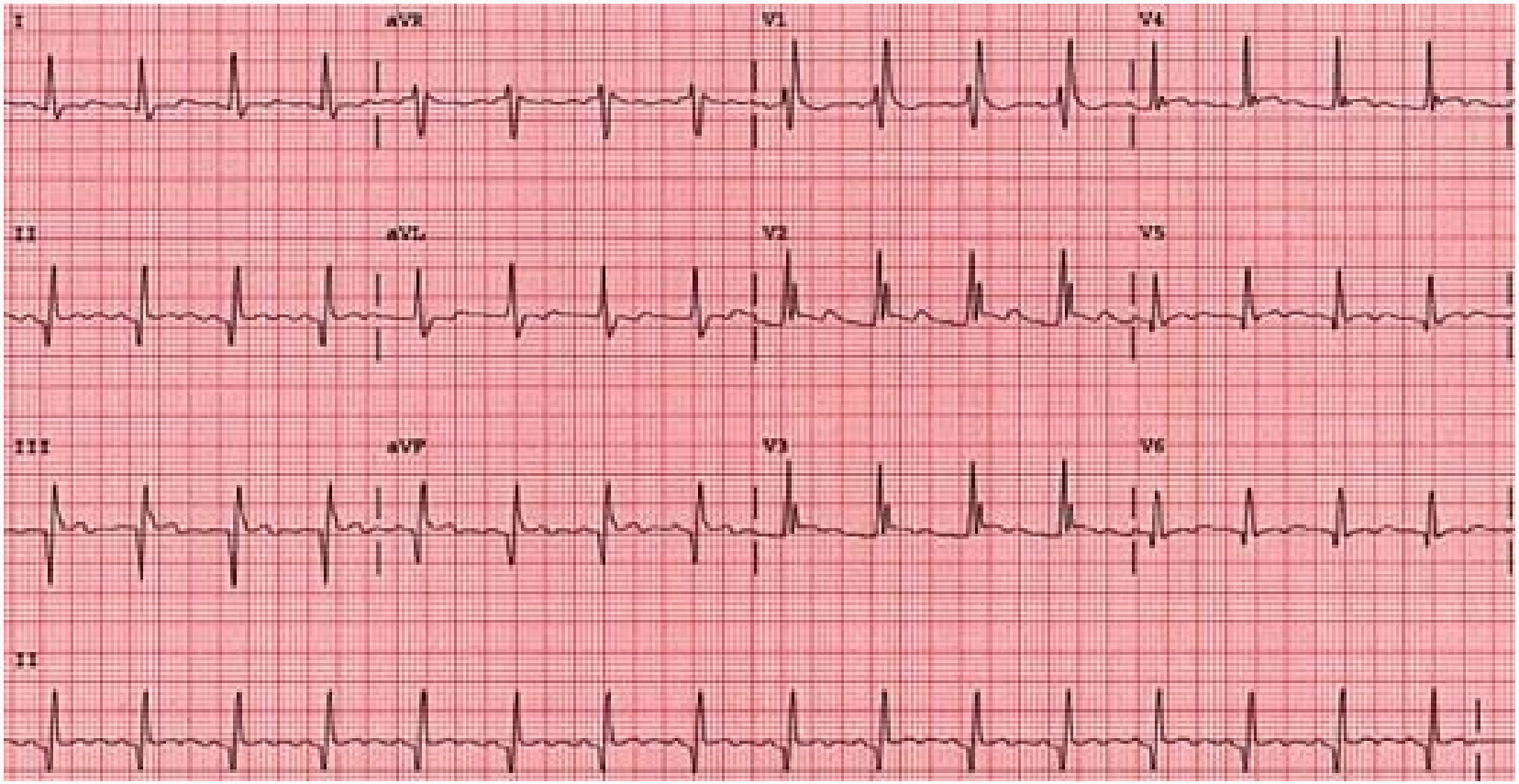
indicate full thickness myocardial damage from an infarct

Late sign of MI (evolved)





Pathological Q waves



Any Questions?

ECG Interpretation in Acute Coronary Syndromes

The ECG in ST Elevation MI

The Hyper-acute Phase

Less than 12 hours

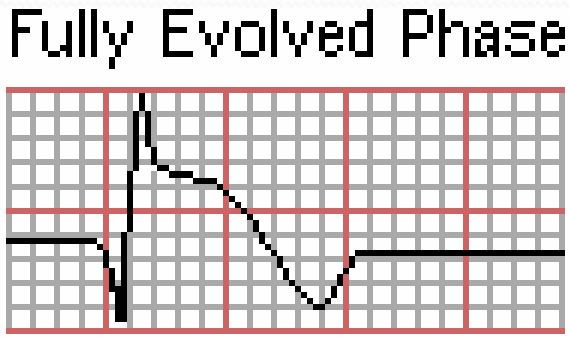
- “ST segment elevation is the hallmark ECG abnormality of acute myocardial infarction” (Quinn, 1996)
- The ECG changes are evidence that the ischaemic myocardium cannot completely depolarize or repolarize as normal
- Usually occurs within a few hours of infarction
- May vary in severity from 1mm to ‘tombstone’ elevation


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

The Fully Evolved Phase

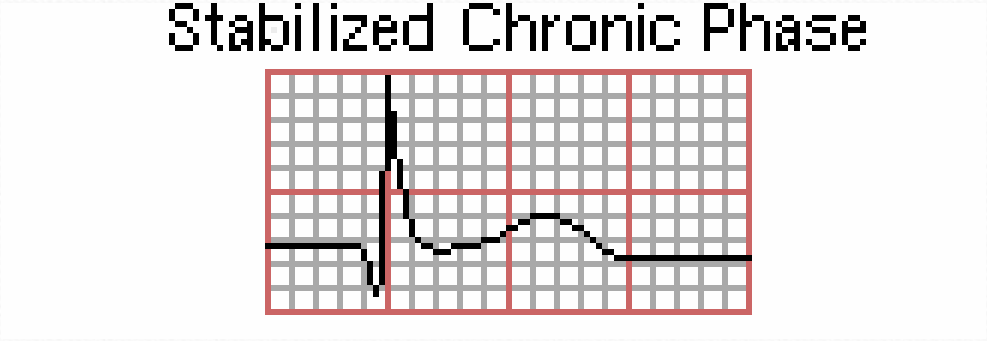
24 - 48 hours from the onset of a myocardial infarction

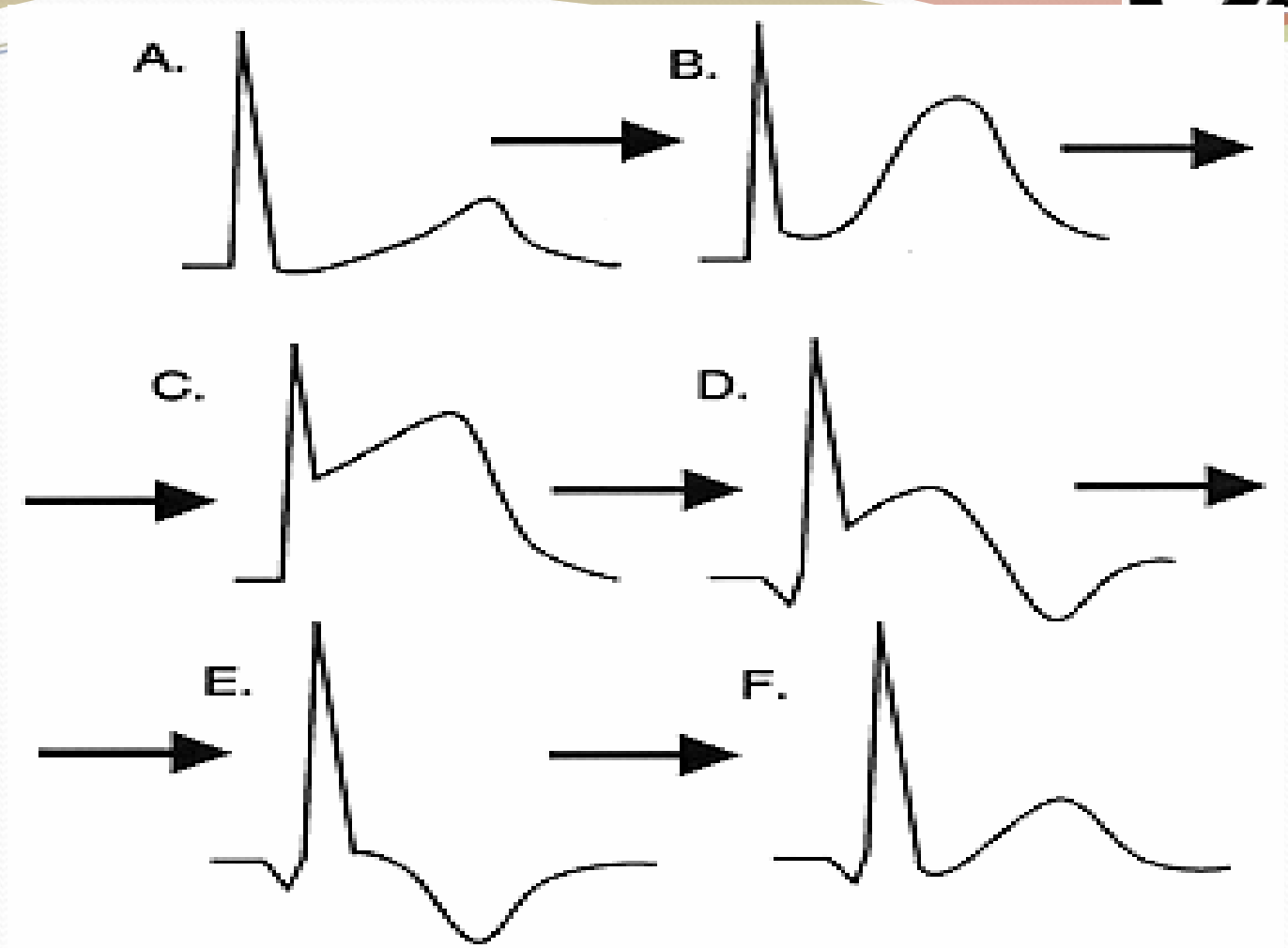
- ST segment elevation is less (coming back to baseline).
- T waves are inverting.
- Pathological Q waves are developing (>2mm)



The Chronic Stabilised Phase

- Isoelectric ST segments
- T waves upright.
- Pathological Q waves.
- May take months or weeks.





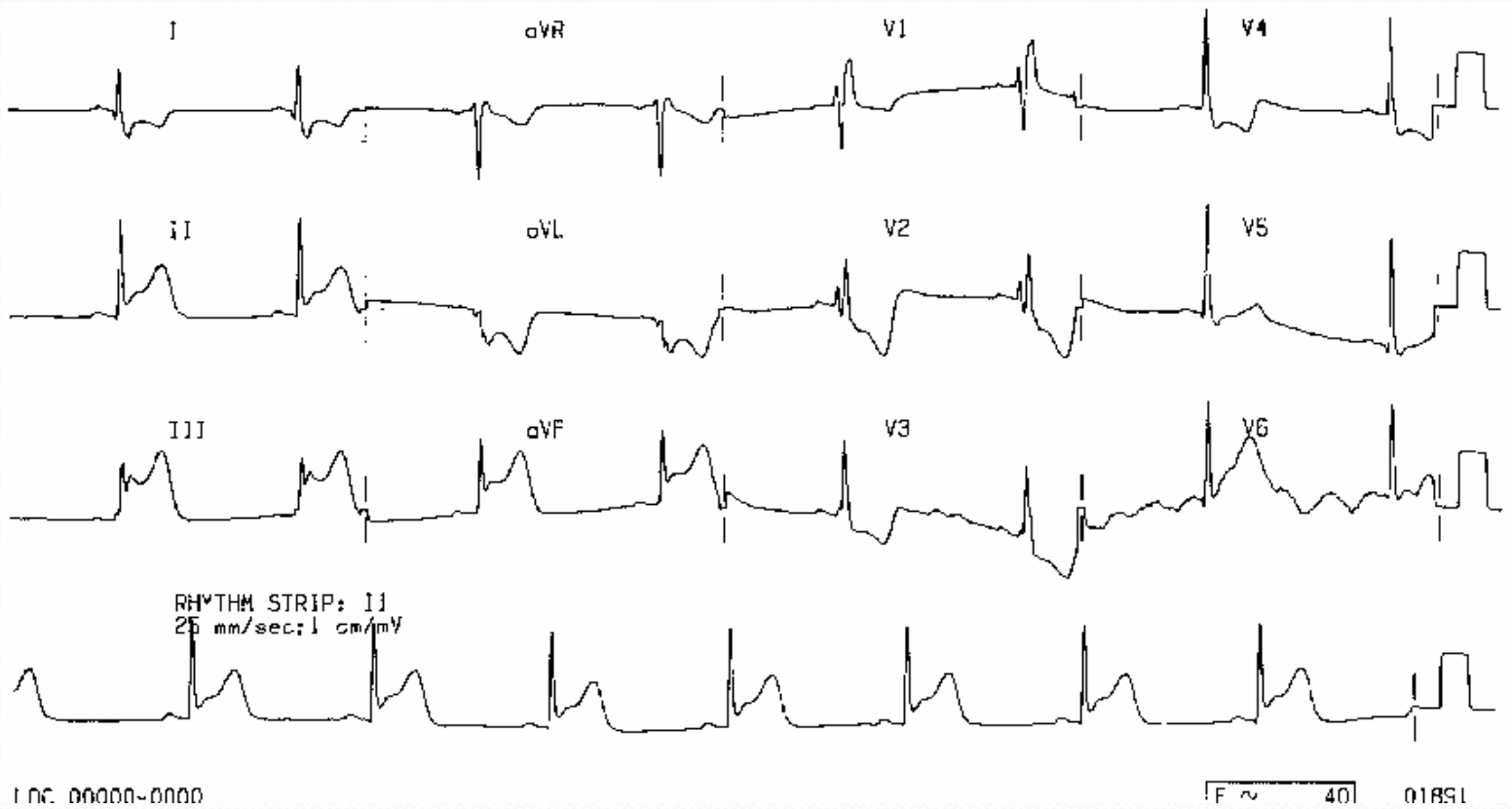
Evolution of Acute MI

Reciprocal Changes

Reciprocal Changes

- Changes occurring on the opposite side of the myocardium that is infarcting

Reciprocal Changes



The ECG in Non ST Elevation MI

Non ST Elevation MI

- Commonly ST depression and deep T wave inversion
- History of chest pain typical of MI
- Other autonomic nervous symptoms present
- Biochemistry results required to diagnose MI
- Q-waves may or may not form on the ECG

Changes in NSTEMI

The ECG in Unstable Angina

- Ischaemic changes will be detected on the ECG during pain which can OCCUR AT REST
- ST depression and/or T wave inversion
- Patients should be managed on a coronary care unit
- May go on to develop ST elevation

Unstable Angina
ECG during pain