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

- Superior Vena Cava
- Aorta
- Pulmonary Artery
- Left Main Coronary Artery
- Right Coronary Artery
- Circumflex Artery
- Inferior Vena Cava
- Posterior Descending of Right Coronary Artery
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

Standard Limb Lead

Precordial Leads

V1

V2

V3

V4

V5

V6
Limb Leads

3 Unipolar leads

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

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

3 Bipolar Leads
form (Einthoven's Triangle)

**Lead I** - measures electrical potential between right arm (-) and left arm (+)

**Lead II** - measures electrical potential between right arm (-) and left leg (+)

**Lead III** - 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
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**
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 0.1 second
- 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 the 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

![ECG tracings showing ST elevation in leads V1, V2, and V3.](image)
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.
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
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