ECG CHANGES IN ACUTE MYOCARDIAL (AMI)

Shakhnozakhon A. Kholboboyeva - senior lecturer
Central Asian Medical University (Fergana, Uzbekistan)
vahobovasahnoza@gmail.com

Abstract. *Acute myocardial infarction (AMI) is one of the most critical cardiovascular emergencies, primarily caused by sudden occlusion of coronary arteries, leading to ischemia and necrosis of heart muscle tissue. The electrocardiogram (ECG) is the most accessible, rapid, and reliable diagnostic tool used to detect and monitor AMI.*

This article reviews the characteristic ECG changes seen in AMI, including ST-segment elevation, ST-segment depression, pathological Q wave formation, and T wave inversion. It distinguishes between ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI), explaining their diagnostic criteria and ECG features.

Keywords: *Acute Myocardial Infarction (AMI), electrocardiogram (ECG), ST-segment Elevation,ST-segment Depression,pathological Q wave, twave Inversion, STEMI, NSTEMI, cardiac Ischemia, myocardial necrosis.*

Introduction.

Acute myocardial infarction (AMI) is a condition resulting from the death or injury of myocardial (heart muscle) cells in specific areas of the heart, primarily due to obstruction or restriction of blood flow in the coronary arteries. AMI is most commonly caused by blockage of the coronary arteries and can be accurately diagnosed with an electrocardiogram (ECG). This condition is one of the leading causes of death worldwide[1]. Early diagnosis and prompt treatment of AMI play a critical role in saving a patient's life. Electrocardiography (ECG) is one of the most essential, simple, and rapid tools for diagnosing AMI.

During a myocardial infarction, significant changes occur in the heart's electrical activity, and an ECG helps detect these changes. Additional aspects such as QRS widening, ventricular arrhythmias, and interval changes (P-R, QRS, QT) are also discussed. The importance of ECG in localizing infarcted regions (anterior, inferior, lateral, posterior) and evaluating infarct severity and progression is emphasized.

This annotation highlights the pivotal role of ECG interpretation in the early diagnosis, treatment guidance, and prognosis of acute myocardial infarction.

ECG Changes in Acute Myocardial Infarction

Multiple changes can appear on the ECG during an acute myocardial infarction. These changes depend on the infarct location, as well as the onset, duration, and severity of the infarction. AMI can lead to the following ECG changes:

Types of AMI Based on ECG Changes

AMI can be divided into two main types according to ECG changes:

1. **ST-Elevation Myocardial Infarction (STEMI)**
2. **Non-ST-Elevation Myocardial Infarction (NSTEMI)**

1. STEMI (ST-Elevation Myocardial Infarction)

Main ECG changes:

• **ST-segment elevation** – Occurs due to alterations in the electrical activity of the myocardial area affected by ischemia. If the ST-segment elevation is 1 mm or more in at least two contiguous leads, a STEMI diagnosis is made.

• **ST-segment depression in reciprocal leads** – Indicates ischemia in the opposite wall of the heart [2].

• **Appearance of pathological Q waves** – A sign of myocardial necrosis, typically developing 12–24 hours after infarction onset.

• **T-wave inversion** – Seen in the later stages of ischemia.

STEMI Localization and ECG Leads Affected:

Infarct Location	Affected Leads	Reciprocal Leads
Anterior Wall	V1–V4	II, III, aVF
Lateral Wall	I, aVL, V5–V6	III, aVF
Inferior Wall	II, III, Avf	I, aVL
Posterior Wall	V7–V9 (or tall R in V1–V2)	—

2. NSTEMI (Non-ST-Elevation Myocardial Infarction)

In NSTEMI, myocardial ischemia and necrosis are present, but there is no ST-segment elevation.

ECG changes:

• **ST-segment depression** – Indicates ischemia.

• **T-wave inversion** – Another indicator of ischemia.

• **Absence of Q waves** – Because necrosis is usually limited.

• **Elevated cardiac troponin levels in blood tests** – Essential for diagnosis.

Additional ECG Findings

• **Hyperacute T waves** – Can be seen in the early stages of infarction.

• **Cardiac arrhythmias** – May appear as complications of infarction (e.g., ventricular tachycardia, fibrillation, etc.).

ST-Segment Elevation (ST-Elevation)

ST-segment elevation is considered the hallmark sign of acute myocardial infarction. It results from full-thickness (transmural) myocardial ischemia due to oxygen deprivation[3]. This elevation is typically seen in infarctions affecting the entire wall thickness of the heart muscle.

ST-elevation may appear in one or several ECG leads, for example:

• **Left ventricular infarction**: ST-segment elevation in leads V1–V4.

• **Right ventricular infarction**: ST-elevation in right-sided leads V4R–V6R.

• **Aortic region infarction**: ST-elevation in leads I, aVL, V5–V6.

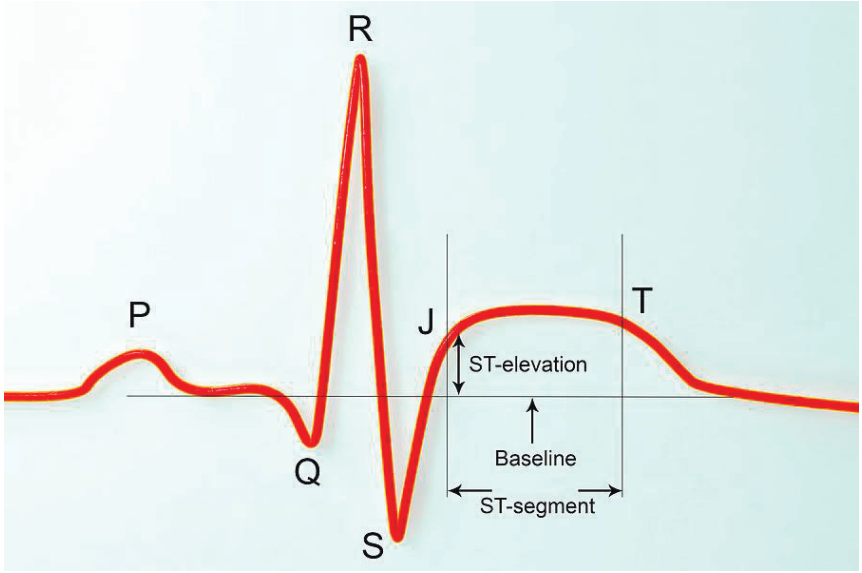

Fig. 26. Schematic Representation of Myocardial Infarction on an

Electrocardiogram (ECG)

Appearance of the Q Wave (Widening of the Q Wave)

The Q wave indicates complete or partial myocardial cell death during an infarction. In the early stages of a myocardial infarction, Q waves become significantly widened and deepened. This condition is usually observed in areas affected by a full-thickness (transmural)infarction.If a Q wave is visible on the ECG, it signifies serious and irreversible damage to the affected myocardial region.A widened Q wave typically indicates that the infarction occurred within the past 2–6 hours[4].

T Wave Changes (T Wave Inversion) (Figure 27)

The T wave changes during the later stages of an infarction, typically becoming inverted. This inversion reflects disturbances in the repolarization process.T wave inversion usually occurs within 12–48 hours after the onset of a myocardial infarction.A deeply inverted T wave may indicate a severe or acute infarction.During the recovery phase of the infarction, the T wave gradually normalizes and returns to its original shape[5].

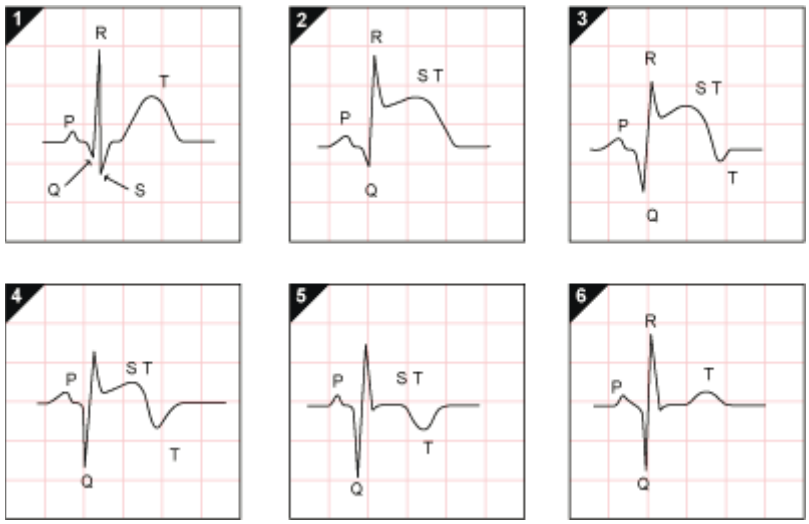

Fig. 27. Schematic Representation of Myocardial Infarction on an Electrocardiogram

ST-Segment Depression (ST Depression)

ST-segment depression may be observed in the early stages of myocardial infarction or during the pre-infarction period. It mainly results from a subendocardial infarction or short-term myocardial ischemia.This condition reflects partial alteration of the electrical activity in the ischemic region, which manifests as a downward shift (depression) of the ST segment on the ECG.ST-segment depression is often associated with pre-infarction phases or minor ischemic attacks[6].

Widening of the QRS Complex

Due to the death of ischemic myocardial cells caused by acute myocardial infarction, the QRS complex may become widened and occasionally distorted.These changes are related to ischemic alterations in the myocardium.**Ventricular Arrhythmias**[7]. Myocardial infarction may lead to the development of ventricular arrhythmias detectable on ECG, such as ventricular extrasystoles, ventricular tachycardia,orventricularfibrillation[8].Ventricular arrhythmias can occur in the early stages of infarction and often indicate severe ischemic damage to the heart.

Shortened or Prolonged Waves and Intervals

Other ECG changes associated with myocardial infarction include:

- Prolongation or shortening of the P-R interval
- Widening of the QRS complex
- Prolongation or shortening of the QT interval[9].

ECG Analysis an[1]. d Localization of Myocardial Infarction

During the acute phase of myocardial infarction, the location of the damage can be identified by analyzing different ECG leads. Typically, the following changes help localize the infarct:

- **Anterior infarction**: ST elevation and presence of Q waves in leads V1–V4
- **Inferior infarction**: ST elevation in leads II, III, and aVF
- **Lateral infarction**: ST elevation in leads I, aVL, V5–V6
- **Posterior infarction**: ST elevation in leads V7–V9[10].

Conclusion. Timely and accurate identification of ECG changes in acute myocardial infarction is crucial for saving the patient's life. ECG plays a vital role in the early diagnosis of infarction, its localization, and guiding treatment decisions. Healthcare professionals must be able to correctly interpret these changes. Acute myocardial infarction is typically represented on the ECG by ST-segment elevation, the appearance of pathological Q waves, T wave inversion, ST-segment depression, ventricular arrhythmias, and other abnormalities. These ECG changes provide essential information about the infarct's location, severity, and rogression.ECG analysis also helps monitor post-infarction conditions and the recovery process.

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