Electrocardiographic Diagnosis of Acute Coronary Syndromes
(Enclosed for use with the April 23, 2001, issue)

Hyperacute T wave: The hyperacute T wave is the earliest electrocardiographic finding encountered in the STE-AMI patient. These T waves are broad-based, asymmetric structures that rapidly evolve to more typical STE.


Giant R wave: The Giant R wave is an intermediate structure between the hyperacute T wave and the typical ST segment elevation.

ST segment elevation: The morphology of the ST segment, when it is elevated in the setting of AMI, most often involves either an obliquely flat or a convex configuration.

Morphology of ST segment elevation: The initial, upsloping portion of the ST segment usually is either flat or convex in the AMI patient (see A). This morphologic observation, however, should only be used as a guideline—it is not infallible. Patients with ST segment elevation due to non-AMI syndromes may demonstrate concavity of this portion of the waveform (see B)—pericarditis and benign early repolarization, respectively.


Reciprocal ST segment depression: In the setting of STE AMI, ST segment depression located in leads distant from the infarction is termed reciprocal change or reciprocal ST segment depression. Reciprocal change is useful diagnostically—its presence strongly suggests AMI—and prognostically—patients with such a finding have larger infarcts, lower resultant ejection fractions, and higher rates of death.

CNS T wave inversions seen in the anterolateral area. This patient presented with severe headache and was found to have extensive subarachnoid hemorrhage by CT scan.

Wellen’s T waves: Wellen’s T waves occur in two basic forms. The upper examples depict the more common pattern—deeply inverted T waves. The less commonly encountered morphology, biphasic T wave, is shown in the lower panel.

Q wave with ST segment elevation: Q waves most often indicate completed infarction and usually appear 9-12 hours after AMI that is not aborted. Q waves may appear as early as 1-2 hours after the onset of AMI. Such patients will present with ST segment elevation and pathologic Q waves.
Figure 14

Anterior AMI: STE is seen in the leads V₁ to V₄, consistent with anterior or wall AMI. This pattern may be described as either anterior or anteroseptal.

Figure 15

Anterolateral AMI: Extensive infarction is seen here with STE in leads V₂ to V₄ (anterior) and leads I, aVL, V₅, and V₆ (lateral), consistent with an anterolateral AMI.

Figure 16

Lateral AMI: Isolated lateral wall AMI is seen with STE in leads I and aVL. Note the STD seen in the inferior and right precordial leads, consistent with reciprocal change. The STD in leads V₁ to V₃ also may represent posterior wall AMI.

Figure 17

Inferior AMI: Inferior wall AMI is seen with STE in leads II, III, and aVF. Note the STD seen in the lateral and right precordial leads, consistent with reciprocal change. The STD in leads V₁ to V₄ also may represent posterior wall AMI.

Figure 18

Inferoposterior AMI: 12-lead ECG of an acute myocardial infarction of the inferior and posterior walls of the left ventricle. In addition to the STE seen in the inferior leads, STD is encountered in the right precordial distribution. This STD is associated with a prominent R wave. These findings are suggestive of posterior wall AMI in addition to the inferior AMI. STD also is seen in leads I and aVL, consistent with reciprocal change.

Figure 19

Isolated posterior AMI: As in Figure 18, STD is noted in the right precordial leads, consistent with an isolated posterior wall AMI.
ECG Supplement to Emergency Medicine Reports, April 23, 2001

Figure 20

Posterior wall AMI: Right precordial (leads V1 to V3) ST segment depression and posterior thoracic leads with STE consistent with posterior wall AMI.

Figure 22

AMI noted with serial ECGs: Adult patient presents with chest pain and an initially normal ECG. With continued pain, serial ECGs are performed that quickly detect change, ultimately diagnostic of AMI.

Figure 21

Right ventricular infarction: A, Right-sided anterior thoracic leads in right ventricular AMI. B, Right ventricular AMI: single lead RV4.

Figure 23

ECGs in the AMI LVH patient: Serial ECG demonstrating interval change consistent with AMI in the LVH pattern.

Figure 24

Benign early repolarization (BER): Serial ECG demonstrating lack of interval change in the BER pattern—confirming a non-infarction cause of the STE.

Figure 25

Left bundle-branch block with electrocardiographic AMI: Serial ECG demonstrating interval change in the LBBB pattern complicated by AMI.
A 15-lead ECG with AMI of inferior, posterior, and right ventricular segments.

Placement of the additional electrocardiographic leads of the 15-lead ECG: Lead RV₄ is placed in a similar position to lead V₄ yet on the right thorax. The posterior leads V₈ and V₉ are placed on the patient's left back—V₈ at the tip of the scapula and V₉ in an intermediate position between lead V₈ and the left paraspinal muscles. The additional “V” notation located lateral to V₈ also may be used and is termed V₇.

12-lead ECG with LVH: No AMI was found in this patient; the ST/T changes represent repolarization change associated with LVH.

The concept of appropriate discordance in the LBBB pattern: The shaded areas note the portions of the waveform which must be evaluated in the LBBB pattern. In all examples listed, “A” depicts the initial portion of the ST segment/T wave complex while “B” refers to the major terminal segment of the QRS complex. The appropriate relationship of the ST segment to the T wave in the LBBB pattern is one of discordance (i.e., the major terminal portion of the QRS complex and the ST segment/T wave complex must be on opposite sides of the iso-electric baseline). This “normal” relationship is seen in the two examples on the left. Abnormal relationships are seen in the two examples on the right—near right, concordant ST segment depression and, far right, concordant ST segment elevation. In both of these cases, such findings suggest acute coronary ischemia.

Left ventricular hypertrophy: Electrocardiographic changes associated with the LVH pattern.
The electrocardiographic criteria suggesting a diagnosis of AMI according to Sgarbossa et al.\(^{18}\) include on the left (1) ST segment elevation greater than one millimeter which is concordant with the QRS complex (score of 5); in the middle (2) ST segment depression greater than 1 mm in leads V\(_1\), V\(_2\), or V\(_3\) (score of 3); and on the right (3) ST segment elevation greater than 5 mm that is discordant with the QRS complex (score of 2). A total score of 3 or more suggests that the patient is likely experiencing an acute infarction based on the electrocardiographic criteria. With a score of less than 3, the electrocardiographic diagnosis is less assured, requiring additional evaluation.

Ventricular paced rhythm with appropriate relationships: The concept of appropriate discordance also may be applied in this instance as it is in the LBBB patient.

AMI in the setting of ventricular paced rhythm: This is a serial ECG performed in the patient seen in Figure 32. Note the progression of STE in the inferior leads and STD in the right precordial leads. While these changes are not diagnostic of AMI, the change noted over approximately 30 minutes in the appropriate patient (i.e., chest pain worrisome for ACS) is highly suggestive of AMI.

Benign early repolarization (BER): Note the STE in all leads except leads I, aVR, aVL, and V₁, as well as the prominent T waves in similar distribution.

Acute pericarditis: Diffuse STE is seen accompanied by PR segment depression in the inferior leads and PR segment elevation in lead aVR.