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Differential Diagnosis of ST segment elevation on ECG

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Abstract. ST-segment elevation on ECG is crucial for emergent reperfusion therapy of acute myocardial infarction with ST-segment elevation. Because acute myocardial infarction (STEMI) is not the most common cause of ST-segment elevation amongst chest pain patients, we need to consider other factors like reciprocal changes to shore up the diagnosis. In this review, we would like to present statements which are manifested with ST-segment elevation on ECG and to show clues which can help to make differentiations between them. The clinical setting and specific electrocardiographic criteria often allow identification of the cause. In writing this paper, we hope for quicker and better stratification of patients with ST-segment elevation on ECG, which will lead to being better outcomes.

Keywords: ST-segment elevation, Myocardial infarction, Pericarditis, Early repolarization.

Introduction

Chest pain is a common chief complaint in the emergency department (ED). This symptom accounts for 5 to 20 % of all ED admissions [1], being the second most common reason to present to the ED in the United States of America [2]. Patients presenting to the emergency department (ED) with acute chest pain potentially of ischemic origin are evaluated with three principal tools: the history of the event, the 12-lead electrocardiogram (ECG), and cardiac enzymes and other serum markers of myocardial injury. Despite advances in the pathophysiology and treatment of coronary artery disease, acute coronary syndromes (ACS) remain a major cause of morbidity and mortality in both industrialized and developing countries [3,4.5].
Reperfusion therapy has improved treatment outcomes of ST-segment elevation myocardial infarction (STEMI). In patients with a clinical suspicion of myocardial ischemia and ST-segment elevation, reperfusion therapy needs to be initiated as soon as possible [6]. New ESC guidelines for management of acute myocardial infarction with ST-segment elevation recommend 12-lead ECG recording and interpretation at the point of first medical contact, with the maximum delay of 10 minutes [7]. Responsibility for appropriate management of STEMI, relay to the fast and accurate interpretation of ECG bay emergency physician. This can be challenging because the cause of ST-segment elevation isn't only acute myocardial infarction, but also a lot of other conditions from benign to life-threatening. Purpose of this clinical review is to help in distinguishing specific clinical conditions with ST-segment elevation on ECG.

Morphology of ST-segment elevation on ECG

Normal ST-segment should not be quite flat, it should be upward concave, or said with other words it should be as take-off form. ST-segment which loses its upward concavity and becomes straight or upward convex, it's a sign of acute myocardial infarction (Figure 1). This phenomenon was described by Pardee (1920) [8].
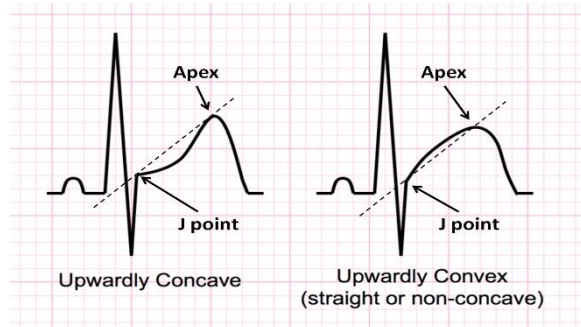

Figure 1. Morphology of ST-segment elevation.

Causes of ST-segment elevation

In differential diagnosis of ST-segment elevation on ECG are included: (1) St-segment elevation myocardial infarction; (2) "J" wave syndrome; (3) Pericarditis; (4) ST-segment elevation due to abnormalities of QRS complex; and (5) Other processes.

Brady et al in their study have evaluated most common causes of ST elevation in patients with chest pain in the ED: left ventricular hypertrophy (LVH) 25%, left bundle branch block (LBBB) 15%, benign early repolarization (BER) 12%, right bundle branch block (RBBB) 5%, nonspecific bundle branch block 5%, left ventricular aneurysm 3%, acute pericarditis 1%, ventricular paced rhythm 1%, and undefined ST-segment elevation 17%. [9].

ST-segment elevation in patients with acute myocardial infarction

Diagnosis of ST-segment elevation myocardial infarction (STEMI), which indicates emergency reperfusion therapy, is confirmed when ST-segment is equal or higher than following cut-points, in at least two contiguous leads of the same anatomical area (using standardization of 1.0 mV = 10 mm)[10]:

1. Men age $\geq$ 40 years: $\geq$ 2 mmin V_2-V_3 and $\geq$ 1 mm in all other leads.
2. Men age < 40 years: $\geq$ 2.5 mmin V_2-V_3 and $\geq$ 1 mm in all other leads.
3. Women (any age) $\geq$ 1.5 mmin V_2-V_3 and $\geq$ 1 mm in all other leads.

To confirm STEMI we can use algorithm proposed from Stephanie et all. (2012) [11], which involves four simple steps (Picture 2):

1. Is there ST elevation of at least 1 to 2 mm in 2 anatomically oriented leads)?
2. Is sum of the Q wave in lead V1/V2 + R-wave in lead V5/V6 less than 35 mm?
3. Is the QRS complex less than 0.12 second in width?
4. Is there ST-segment depression present in at least 1 lead?
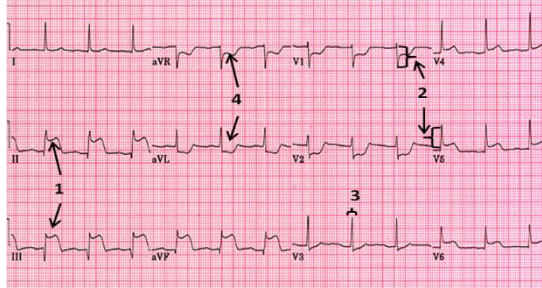
Figure 2. Anterolateral STEMI. (1) ST elevation of at least 1 to 2 mm in 2 anatomically oriented leadas. (2) Sum of the Q wave in lead V_1/V_2 + R-wave in lead V_5/V_6 less than 35 mm. (3) QRS complex less than 0.12 second in width. (4) ST depression in at least 1 lead.

In cases where all four criteria of this algorithm are fulfilled, diagnosis of STEMI is confirmed. In cases where even only one criterion isn't fulfilled, then a diagnosis of STEMI can be in some degree of doubt.

J Wave syndromes

The appearance of prominent J wave in the ECG is considered a sign of hypothermia, hypercalcemia, the Brugada syndrome, early repolarization pattern, or other arrhythmogenic syndromes. Here we will discuss only about early repolarization and Brugada Syndrome.

Early repolarization pattern – mostly is seen in young healthy adults (predominantly in males) during regular health check-ups. The following ECG changes are characteristic for early repolarization (Picture 3):
1. Concave elevation of ST-segment most pronounced in the precordial leads.
2. The characteristic sign of early repolarization is the notch or slur at the end of QRS.

Even it was thought that early repolarization is a benign ECG pattern, in a large number of recent studies it was shown that is not right. Early repolarization pattern in inferior leads of a standard ECG is associated with increased risk of death from cardiac causes in middle-aged subjects [12,13].

No needs for treatment of subjects with early repolarization pattern on ECG, ICD (Intracardiac defibrillator) implantation is recommended only in patients with early repolarization syndrome who have survived sudden cardiac death.
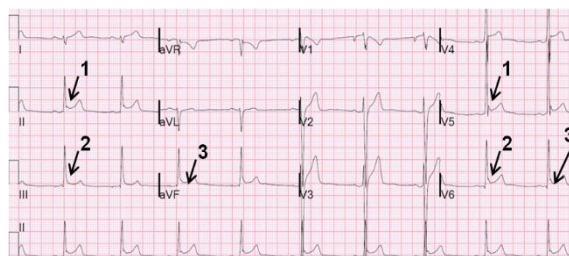
Figure 3. ECG trace with all signs of early repolarization. (1) Notch on terminal part of QRS complex. (2) Slur on terminal part of QRS complex. (3) concave upward ST-segment elevation.

Brugada syndrome – is rare cardiac arrhythmia characterized by specific changes on ECG: Right Bundle Branch Block (RBBB) associated with persistent elevation of ST-segment in right precordial leads. This condition is genetically transmitted as an autosomal dominant syndrome with incomplete penetrance. Currently, it is believed to be responsible for 12% of SCD cases and 20% of SCD in patients with structurally normal hearts [14].

Originally, three repolarization patterns were described: a) Type-1 ECG pattern, in which a coved ST-segment elevation ≥ 2 mm is followed by a negative T-wave, with little or no isoelectric separation, with this feature being present in > 1 right precordial lead (from V1 to V3); b) Type-2 ECG pattern, also characterized by a ST-segment

elevation but followed by a positive or biphasic T-wave that results in a saddle-back configuration; c) Type-3 ECG pattern, a right precordial ST-segment elevation ≤ 1 mm either with a coved-type or a saddle-back morphology [15] (Figure 4).
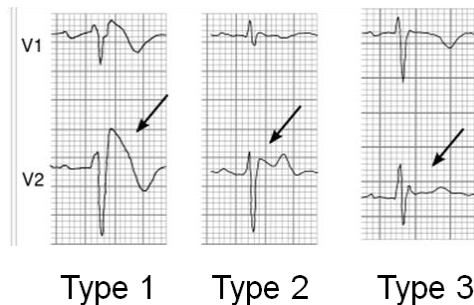

Figure 4. Three repolarization patterns of Brugada Syndrome.

The second consensus report of 2005 recommends ICD implantation in BS patients who have survived cardiac arrest (Class 1) or have a history of syncope and documented ventricular arrhythmia (Class 2A). Electrophysiology Study (EPS) is only recommended for investigations if there are associated supraventricular arrhythmias [16].

Acute pericarditis

Pericarditis is an acute inflammatory disease of the pericardium. Clinical manifestations are presented by chest pain, a pericardial friction rub, and by repolarization changes in the ECG. For the diagnosis of acute pericarditis are required 2 of these 3 elements. The electrocardiogaphic patterns of acute pericarditis were first reported in 1929 by Scott, Feil and Katz. ECG changes during acute pericarditis include: (1) Widespread concave ST-segment elevation and PR depression; (2) Reciprocal ST depression and PR elevation in lead aVR (±V1); (3) Commonly sinus tachycardia (Figure 5).
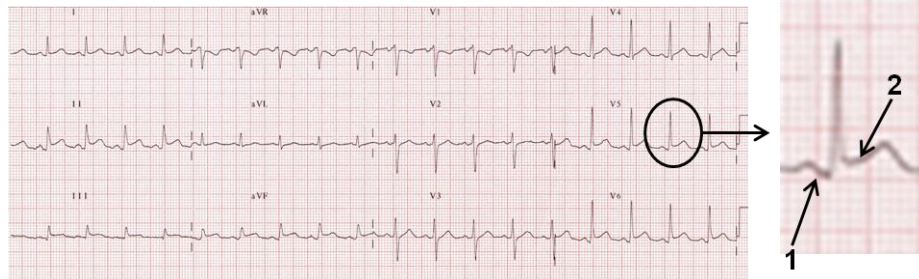
Figure 5. Typical ECG trace of acute pericarditis: (1) PR depression; (2) Concave upward ST elevation.

Left Bundle Branch Block (LBBB) and Acute Myocardial Infarction (AMI)

In patients with LBBB identifying AMI on ECG is difficult, but not impossible. To make difference between pure LBBB and LBBB in case with AMI we can use Sgarbossa Criteria [17]:

1. Concordant ST elevation > 1mm in leads with a positive QRS complex (score 5)
2. Concordant ST depression > 1 mm in V1-V3 (score 3)
3. Excessively discordant ST elevation > 5 mm in leads with a negative QRS complex (score 2).

A total score of ≥ 3 has a specificity of 90% for diagnosing AMI.

Conclusions

Although many conditions affect the ST segment, it can respond in only two ways: it can become either elevated or depressed. There are several causes of ST-segment elevation besides acute myocardial infarction. Some of these conditions can be misdiagnosed as acute infarction, resulting in unwarranted thrombolytic therapy or emergency angiography. Many times, the shape of the ST-segment elevation, the leads involved, other features of the electrocardiogram, the clinical setting in which the elevation occurs, and most important, awareness of the conditions that mimic infarction can help differentiate the conditions.

Just because electrocardiography is a basic skill in EM doesn't mean that our skills should be basic.

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