ST elevation and atypical chest pain

Introduction

Figure 1 illustrates the electrocardiogram (ECG) of a 42-year-old man who presented with sharp central chest pain that initially worsened with inspiration but did not appear to vary with his position. Describe the key features of the ECG and the differential diagnosis.

The electrocardiogram

This ECG demonstrates diffuse, concave ST segment elevation in the chest and limb leads (particularly leads II, III and aVF), ST depression in lead aVR and PR segment depression in V6. There is a lack of reciprocal ST changes, an important feature differentiating acute pericarditis from acute myocardial infarction (AMI). In addition, the ST:T wave amplitude ratio is greater than 0.25 in lead V6, a finding frequently indicative of acute pericarditis. These findings are further discussed later.

The pathognomic clinical feature of a pericardial friction rub was auscultated along the lower left sternal border. However, the symptoms, signs and ECG changes can be mistaken for AMI and early repolarization (a normal variant, often seen in young males, characterized by ST elevation only in the chest leads) from which it must be differentiated.

Acute pericarditis

Acute pericarditis occurs when there is diffuse inflammation of the pericardial sac and may involve the subepicardial layer (myopericarditis). It may be caused by a number of different infectious and inflammatory processes. The ECG changes are the result of myocardial injury and epicardial irritation, and is abnormal in 90% of patients with acute pericarditis.

The evolution of the ECG in pericarditis

Classically, the ECG evolves through four distinct stages, although this is only seen in 50% of cases.

1. Stage I represents early pericardial inflammation and usually lasts a few days but may continue for up to 2 weeks. The typical ECG changes are diffuse concave ST elevation, ST depression in aVR or V1, PR depression, low voltage QRS complexes and the absence of reciprocal ST changes
2. During stage II, the ST segments normalize to baseline and there is flattening of T waves. This may last several days to weeks
3. In stage III (typically after 2–3 weeks) the T waves invert and may remain inverted for several weeks
4. During stage IV gradual normalization of the T waves occurs (Marinella, 1998; Chan et al, 1999).

If pericarditis is associated with pericardial effusion then the ECG may demonstrate QRS voltage reduction and QRS and T wave electrical alternans (the beat-to-beat variability in QRS and T wave voltage amplitude caused by excessive cardiac mobility).

PR depression is an early sign in stage I and tends to precede ST elevation because the epicardial irritation producing ECG changes occurs more readily in the thin atrial subepicardium and produces an atrial injury pattern (Baljepally and Spodick, 1998). The PR depression is the atrial counterpart of ST elevation hence there may be PR elevation in aVR or V1 (Spodick, 1973). Depression of the PR segment can occur alone without ST changes but is not specific for acute pericarditis, as it is also seen in atrial infarction and early repolarization.

ST elevation is widespread, and often seen in all leads. The involvement of chest and limb leads would indicate occlusion of more than one coronary artery territory, which is rarely seen in AMI. In acute pericarditis, the patient is usually clinically stable without the autonomic features seen in massive myocardial infarction – suggesting the extensive ECG changes are out of context of the patient's presentation. This widespread ST elevation is virtually diagnostic in acute pericarditis. It is the most sensitive finding.

Localization of ST segment changes to differentiate pericarditis from AMI

The ST segment axis can be used for the differential diagnosis in the early acute phase of acute diffuse pericarditis and AMI (Kouvaras et al, 1990). In acute pericarditis, the frontal ST axis is often 30–60° (mean 45°), thus ST elevation may be greatest in lead II, but ST elevation is also seen in III and aVL. Reciprocal ST depression is seen in the opposite lead, aVR.

In inferior AMI caused by right coronary occlusion, the ST axis is often close to 120° (lead III), with ST elevation seen in the inferior leads (but greatest in III) and reciprocal ST depression in the opposite leads aVL and I. In left dominant coronary circulation (20%) inferior AMI, the ST axis is often close to 90° (lead aVF) with equal ST elevation in II and III, and equal reciprocal depression in aVR and aVL. In lateral infarction, the ST axis is close to -30° (ST elevation in aVL), and reciprocal depression in III. Therefore, there is always reciprocal ST depression between III and aVL in AMI whereas acute pericarditis does not result in ST depression in aVL (Wang et al, 2003).

This reinforces the point that no clear coronary artery territory is affected on surface ECG in pericarditis since it is a diffuse inflammatory process at the myocardial–pericardial interface, as opposed to myocardial infarction which is usually obeys anatomical boundaries. However, the ST axis is not helpful if there is regional or localized pericarditis, for example post-AMI.

Relationship between the degree of ST segment elevation and the T wave

The ratio of the amplitude of the onset of the ST segment to the amplitude of the T wave in V6 has been shown to differentiate acute pericarditis from normal ECGs. This is calculated by dividing the ST elevation in mm by the tallest point of the T wave. A value greater than or equal to 0.25 suggests acute pericarditis (Ginzton and Laks, 1982).

Patients with typical ST elevation are more likely to develop T wave inversion later during recovery from acute pericarditis (Bruce and Spodick, 1980). Over a period of days to weeks, with resolution of inflammation, the ST segments normalize and T wave inversion develops which also later normalizes. In AMI T wave inversion usually occurs within hours before the ST segments become isoelectric.

Prominent ST elevation of acute myocarditis can appear similar to the ECG changes in AMI. Further differentiation from AMI includes the degree of ST elevation, which does not usually exceed 5 mm in pericarditis; lack of PR depression in AMI unless there is atrial infarction; absence of Q waves in pericarditis; absence of T wave inversion at the time of ST elevation in pericarditis. Loss of R wave progression and arrhythmia are common in AMI but not seen in acute pericarditis. **BJHM**

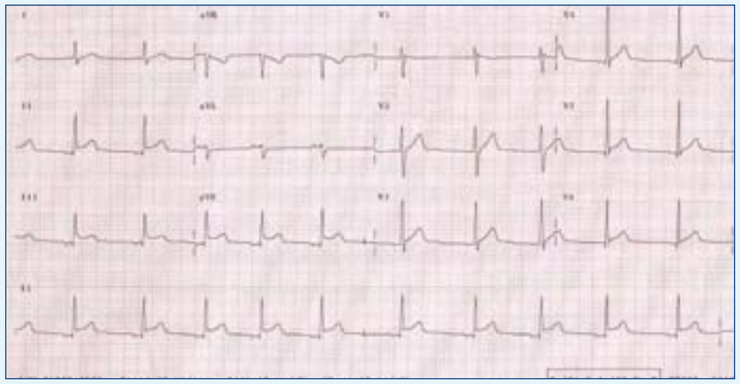

Figure 1. The electrocardiogram on presentation.

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KEY POINTS

- Pericarditis presents with diffuse concave ST segment elevation usually not confined to a specific coronary artery territory.
- ST segment elevation in acute myocardial infarction is convex and the location on surface electrocardiogram usually obeys the anatomical distribution of the coronary arteries.
- The ratio of ST segment amplitude to T wave amplitude is ≥0.25 in lead V6 in pericarditis.
- T wave inversion can occur during the recovery phase similar to that following a coronary event.