ECG Quiz 18

CASSA
CARDIAC ARRHYTHMIA SOCIETY
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ANSWER

The ECG is an important clinical tool but should generally not be expected to be diagnostic without relevant patient information: i.e. it needs to be interpreted in the context of the clinical situation. All the cardio / vascular conditions (a) to (e) should be considered in the differential diagnosis of any sudden onset chest pain.

Before being provided with more patient details, let us first systematically analyse the ECG (recorded at standard speed of 25mm/s and 10mm/mV):

1. Rate and rhythm: regular tachycardia of 132 bpm due to sinus tachycardia and one ventricular premature beat. The PR interval is 120ms – normal. The PR segment is iso-electric.

2. The QRS is abnormal:

   a. QRS width: 110ms (2¾ blocks × 40ms per block). Since normal is ≤100ms, this QRS is slightly wider than it should be.

   b. QRS axis: at 30° this is normal

   c. QRS morphology: a pathological Q-wave is present in Lead III and a small q in aVF but none in Lead II – suggestive but not quite enough evidence for an inferior myocardial infarction. R-wave progression in the chest leads V1-V6 is acceptable. In Lead 1 there is a slurred S-wave. Some delay is noted in the latter part of the QRS with an r' (r "prime") in V1 seen after the initial small r-wave, in keeping with incomplete right bundle branch block (IRBBB).

3. T-waves: In the limb leads, most noticeable is the T-inversion in Lead III. Whilst minor T-inversion in V1 may be normal, extension to involve V2-V4 is abnormal and may reflect either anteroseptal myocardial pathology or the structure immediately under these electrodes, namely, the right ventricle. The ST segments show no marked abnormalities.

In summary: sinus tachycardia, with an abnormal S in Lead I, Q in Lead III, T inversion in Lead III with IRBBB and 'strain' over the right sided chest leads.

These findings, together with more patient details:
A man with no previous cardiac history, no risk factors for ischaemic heart disease, now 6 days post partial resection of polycystic liver disease, still mainly in bed and sudden onset of chest pain with dyspnoea and BP of 75/40, make the diagnosis of acute pulmonary embolism, answer (c), most likely.

In acute pulmonary embolism, although the ECG as a whole (i.e. normal vs. abnormal) is reasonably sensitive, the individual ECG changes are relatively non-specific. Thus, a constellation of abnormalities is often used. Just as we are accustomed to the pattern of pathological Q-waves in at least 2 of 3 inferior leads being required for a diagnosis of inferior myocardial infarction, not fulfilled in this ECG, so here the "S1, Q3, T3" pattern, together with sinus tachycardia, the commonest finding, and evidence of right ventricular strain (the T-inversion and delay of right bundle conduction) is almost pathognomonic of pulmonary embolism in a patient who presents in this way.

Care needs to be taken in interpreting the ECG signs/patterns as studies have found all these abnormalities in the absence of pulmonary embolism. Also, as Table 1 shows, there is not only extreme variability in the reported incidence of the various ECG abnormalities but the ECG may even be normal. This variability is due to the variable size of the pulmonary embolus, the variable timing of a sometimes transient embolism and the variable resultant haemodynamic effect. It is reported that if hypotension or shock occur, ECG changes are present in almost all cases.
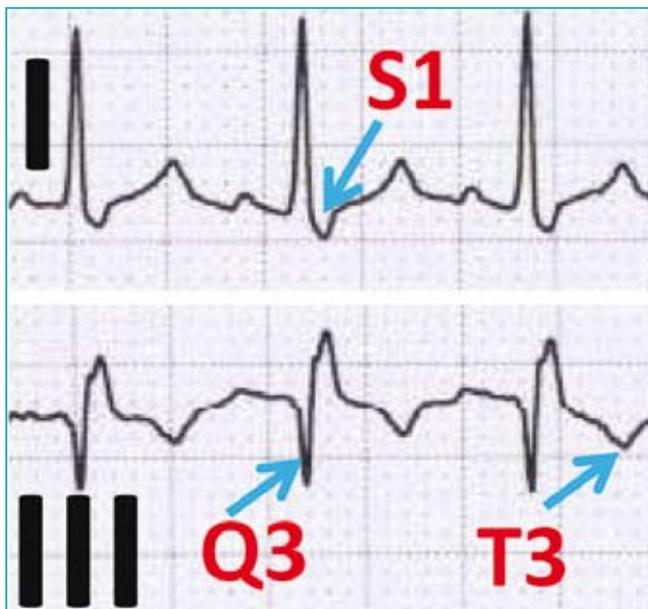
FIGURE 1: The "S1, Q3, T3" pattern
A relatively rare ECG sign in pulmonary embolism. Abnormal S-waves which are usually seen in Lead I may also occur in Lead aVL; S waves are abnormal if >0.15mV or >1.5mm on standard recording. The pathological Q-waves seen here in Lead III may also sometimes occur in aVF but not in Lead II. T-wave inversion may be widespread in the anterior V leads.

TABLE I: ECG changes in Pulmonary Embolism
Sinus tachycardia (in 48-73%)
Negative / inverted T in anterior V leads (26-50%)
Q in Lead III (48-53%); Q sometimes also in aVF, not in Lead II
T-inversion in Lead III (20%-32%)
Incomplete RBBB or complete RBBB (14-65%)
"S1, Q3" or "S1, Q3, T3" (12-25%) or "S in aVL"
Right atrial abnormality (6-33%)
Atrial tachyarrhythmias (A Tachycardia / AFib) (14-38%)
No significant abnormalities (20-24%)

The percentages are based on a summary of results quoted in Chou's Electrocardiography in Clinical Practice. Ed. Surawicz B, Knilans T. 6th edition. Saunders Elsevier.

CONCLUSIONS / LESSONS

■ The patient context is important when commenting on or interpreting the ECG.

■ Pulmonary embolism needs to be considered in any patient presenting with chest pain or haemodynamic instability, especially if the ECG does not show typical acute myocardial ischaemia or infarction.

■ A multitude of ECG abnormalities, singly usually non-specific, strengthens the case for pulmonary embolism.

■ A normal ECG does not exclude pulmonary embolism.

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