CASE REPORT

A false-positive ST segment elevation during exercise stress test

Sunil Kumar Srinivas, Iranna S Hirapur, Shivakumar Bhairappa, Cholenahally Nanjappa Manjunath

Department of Cardiology,
Sri Jayadeva Institute of
Cardiovascular Sciences and
Research, Bangalore,
Karnataka, India

Correspondence to
Dr Sunil Kumar Srinivas,
sunilbmc98@gmail.com

SUMMARY

A 56-year-old man with multiple risk factors undergoing evaluation for chest pain developed ST elevations in multiple leads during exercise stress test. These ST elevations were not classical of ischaemic pattern. The coronary angiogram showed normal coronaries. The false-positive ST elevation was due to an error in the computer-synthesised averaging algorithm.

BACKGROUND

Exercise-induced ST elevation can occur in a significant coronary artery disease or in a previous myocardial infarction with Q waves or rarely due to average algorithm errors. We describe here a patient who presented with chest pain and developed ST elevation during stress test. On further evaluation, it was found that the ST elevation was a false-positive finding due to an averaging algorithm error.

CASE PRESENTATION

A 56-year-old male smoker presented with chest pain for a 2-month duration. He was a diabetic for 5 years. Physical examination was normal. The baseline ECG and echocardiogram were normal. The lipid profile was within normal limits and the blood sugar was under control. For further assessment, he was subjected to a treadmill test under

Bruce protocol. Pretest-linked median ECG¹ was normal (figure 1). During stage 1 (after 90 s), the patient developed ST segment elevation in lead I, aVL and V1–V6 (figure 2). Raw ECG showed baseline variations and could not be interpreted. He complained of localised epigastric pain and the test was terminated at that point. ST segments normalised immediately on recovery. On careful examination of the test report, it was suspected that ST elevation was due to computer-synthesised algorithms secondary to artefacts causing baseline variations in raw ECG. Since the patient had multiple risk factors, further evaluation was considered. A coronary angiogram was done which showed normal epicardial coronaries (figure 3A,B). Provocative tests for coronary spasm were negative. It was concluded that exercise-induced ST segment elevation was due to computer-synthesised algorithms. The patient was advised a healthy lifestyle, diabetic control and discharged.

DISCUSSION

Exercise-induced ST segment elevation can occur in an infarct territory where Q waves are present or in a non-infarct territory.² The latter is uncommon, occurring in 1% of patients with obstructive coronary disease.² It can also rarely be a false-positive finding due to an averaging algorithm error.

Figure 1 Normal pretest-linked median ECG.

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Figure 2 ST segment elevation in lead I, aVL and V1–V6 during the first stage of the Bruce protocol.

The stress testing system has the option of displaying ECG as a raw rhythm or linked-median rhythms. The advantage of linked rhythm is that they are corrected for noises and baseline wanders. However, the drawback of linked rhythms is that when the computer outputs concatenated average cycles instead of raw signal, it is a potential source of errors. Such errors commonly occur when there are motion artefacts or muscle hypertrophy or electromagnetic interference. Transient Q waves³ as well as ST elevation and depression in computer-synthesised rhythms that are not seen in raw ECG have been described earlier.⁴

These changes can be confirmed by both non-invasive and invasive ways. First, if the linked median rhythms show ST elevation but the raw ECG is normal, then the elevation is due to error in the computer-synthesised algorithms.⁴ Second, if the ST elevation in limb leads is real, it has to follow the mathematical relationship ($LI+LIII=LII$, $aVR+aVL+aVF=0$) that exists between voltages of the limb leads in the 12-lead ECG.⁵ However, this does not apply to chest leads. Our patient had a baseline variation in raw ECG and ST elevation involving both limb and chest leads. So both the above methods were not applicable. Third, if the suspicion is high, an imaging modality such as a CT coronary angiogram can be done. Invasively, a

conventional coronary angiogram can also be done to confirm the findings if the suspicion remains high and the non-invasive modalities are not contributory.

The exact mechanism by which the signal averaging algorithms produce these changes is not known. The manufacturer feels that an ECG manifestation is caused by an error in the formation of median complexes.

In the present ECG, there are certain clues indicating that the ST elevation was false positive. First, there is a baseline variation in the raw ECG without classical ST elevation. Second, all chest leads show significant ST elevation except V5. ST elevation in V5 is minimal when compared with other chest leads. This again does not follow the normal pattern. But if the patient has significant risk factors, further evaluation needs to be considered to rule out coronary artery disease as was done in this case.

There are several causes of non-ischaemic ST segment elevation that are not related to exercise. Common causes include the normal early repolarisation pattern, acute pericarditis, myocarditis, tumour invasion or trauma to the ventricle, hypothermia, post-DC cardioversion, intracranial haemorrhage, hyperkalaemia, hypercalcaemia and drugs like Type 1C antiarrhythmic agents. These causes can be ruled out based on the clinical presentation and appropriate investigations.

Figure 3 (A) Normal left coronary arteries. (B) Normal right coronary artery.

Learning points

- ▶ ST elevations during exercise stress test can falsely occur due to an error in the computer-synthesised algorithms.
- ▶ Careful examination of the linked rhythm as well as raw ECG will give clues to the real findings.
- ▶ If suspicion persists, further tests (imaging) need to be done to rule out coronary artery disease.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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