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False ST elevation in a modified 12-lead surface electrocardiogram☆

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Abstract Precise recording of the standard 12-lead electrocardiogram (ECG) is technically time consuming. Placing limb leads on the torso has the major advantages of ease of use, increased speed of application, and decreased artifact. This modified ECG frequently substitutes for the standard 12-lead ECG in intensive care units to detect ischemia, although its implementation should be limited to interpreting arrhythmias. We describe a patient who was misdiagnosed with acute inferior myocardial infarction in a modified 12-lead ECG. To the best of our knowledge, this is the first case report regarding detection of false ST elevations in this setting. Always, a standard 12-lead ECG is recommended to evaluate any ST-T changes.

Keywords: Electrocardiology; Modified surface electrocardiology; ST elevation

Introduction

The Mason-Likar electrocardiogram (ECG) lead adaptation for stress testing relocates arm electrodes to the medial border of deltoid, 2 cm below the lower border of the clavicle in the right and left infraclavicular fossae, and the left leg electrode to the anterior axillary line midway between the iliac crest and the costal margin (Fig. 1).[1-3] This modified ECG frequently substitutes the standard 12-lead ECG in the emergency departments and intensive care units (ICUs) and has the major advantages of ease of use, increased speed of application, and decreased artifact.[3] Nonetheless, it is associated with major ECG changes[3,4] and is not recommended as routine practice. We describe a patient who was diagnosed with an acute inferior myocardial infarction (MI) by a modified 12-lead ECG. Both a serial standard and modified 12-lead ECG confirmed the false ST elevations in the inferior leads recorded previously in the modified 12-lead ECG.

Case report

A 71-year-old white man with a history of intermittent chest pain, dilated cardiomyopathy, and severe peripheral vascular disease was closely monitored in the coronary care unit (CCU) after an acute anterior MI (Fig. 2). Because of an episode of nonsustained ventricular tachycardia on day 2 after admission, a modified 12-lead ECG was performed that revealed significant new ST elevations in inferior leads plus reciprocal ST depressions in aVR and aVL suggesting acute inferior MI (Fig. 3). Just before an emergency angiography, a standard 12-lead ECG was performed in the catheterization laboratory that was negative for any new ST elevations in inferior leads (Fig. 4). On assumption that ST elevations in inferior leads were false, the procedure was cancelled. Then, 3 minutes apart, two 12-lead surface ECGs were obtained. In the first ECG (Fig. 5A), the limb leads were connected to the torso (a modified 12-lead ECG), and in the second one, they were connected to their standard places on the extremities (a standard 12-lead ECG) (Fig. 5B). Although precordial tracings were almost identical in both ECGs, only the modified 12-lead ECG showed significant ST elevations in the inferior leads. The conclusion was false ST elevations in the inferior leads in the modified 12-lead surface ECG in the setting of the existing precordial ST elevation.

Discussion

Einthoven considered the heart to be at the center of an equilateral triangle in which the base spans the chest from shoulder to shoulder and the apex rests on the symphysis pubis. However, because the symphysis pubis does not lend itself to electrode placement and the electrical field at either

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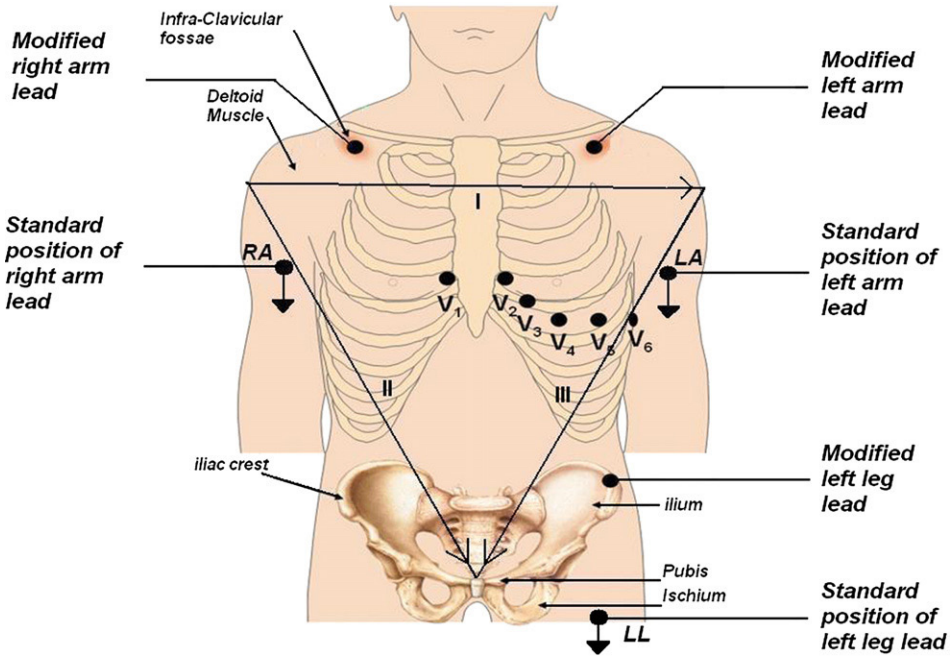

Fig. 1. Standard and modified positions of limb leads. Right leg lead (not shown) is the ground connection and any site on the subject's body can be used for its attachment.

hip is essentially the same as at the symphysis, he chose to use the left leg as the inferior vertex. Therefore, in standard 12-lead ECG, the electrodes should be attached to the distal extremities, but the site of attachment is not crucial because the arms and legs act as linear conductors (Fig. 1). However, when electrodes are placed on the torso, that is, inside the shoulders and hips, the sides of Einthoven triangle are altered, and the ECG is changed. By convention, the patient is grounded in relation to the ECG machine by means of a cable connected to the right leg. Because the ground connection furnishes neither a positive nor a negative pole for any of the leads, any site on the subject's body can be used for its attachment.[5] Therefore, ECG changes because of upward movement of lower extremity leads just apply to the left leg lead. These ECG changes are described during exercise tolerance tests.

The Mason-Likar modification of the standard 12-lead ECG requires that the extremity electrodes be moved to the

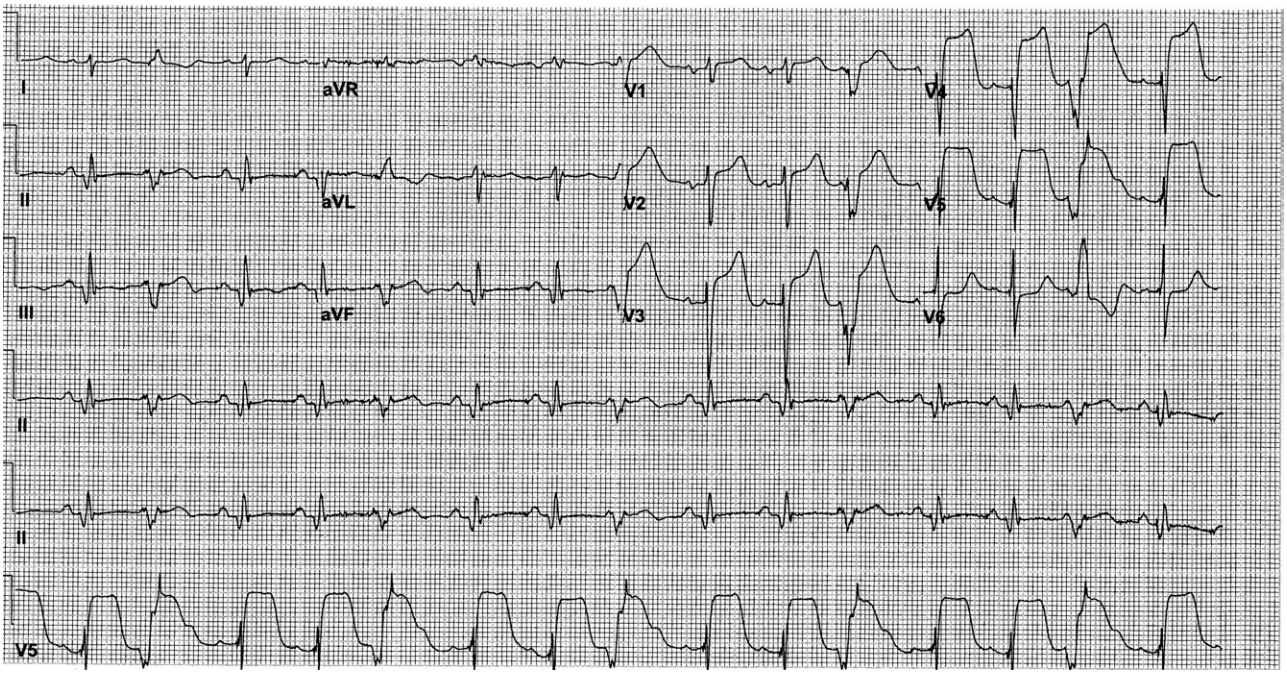

Fig. 2. Hyperacute anterior and possible old inferior MI plus several premature ventricular contractions in a standard 12-lead ECG on the day of admission.