Case Report

# Correlation of Arm Position and Exercise Test Interpretation

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ST-segment changes during exercise testing can be attributed mainly to ischemia, but also, in some patients, to other physiological parameters, such as body position or hyperventilation, making ECG exercise test interpretation more complex. Here we describe the case of a patient who had an electrocardiographically positive exercise test, in order to illustrate the correlation between arm position and ST changes during exercise testing.

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The standard interpretation of the exercise stress test includes an evaluation of symptoms, exercise capacity, hemodynamics and changes in the electrocardiogram. ST-segment depression is the most common and important electrocardiographic finding, suggesting the diagnosis of heart ischemia, most often due to underlying coronary artery disease. Nevertheless, ST-segment shifts are known to be related, not only to ischemia, but also to other physiological parameters, for example body position (upright or supine)[1,2] and hyperventilation.[1,3-7]

Here we present the case of a patient who had an electrocardiographically positive exercise test, in order to illustrate the effect of arm position on the ST-segment during the test. Shifting the patient's left arm to the upright and behind the head position during the recovery period led to normalization of the existing ST-segment depression.

## Case presentation

A 56-year-old man underwent exercise testing in our department on the recommendation of his cardiologist, based on his risk factors. The patient had been a smoker for 35 years, on about 20 cigarettes per day, he had hypercholesterolemia and mild hypertension (up to 150/90 mmHg). His working habits were mainly sedentary. He had a normal body mass index and no family history of coronary heart disease. He had no typical angina symptoms, but he complained of atypical chest pains, mainly during daytime, but not associated with fatigue, physical exercise or psychological stress. He was under medication for his cholesterol and on a salt-free diet for the time being for his hypertension.

The patient underwent a treadmill exercise test according to the Bruce protocol, using the 3 additional right precordial leads,[8] for 9 minutes, reaching the maximum heart rate allowed for his age (based on the 220-age index) without having any kind of symptoms or excessive blood pressure response. The patient's test was diagnosed as positive at the end of the exercise phase, based on ST-segment depression greater than 1 mm in the lateral leads[9] that appeared during the last minute of exercise.

In the recovery phase, the patient originally lay down with his arms beside his body in a resting position, while the ST-segment depression in the lateral leads continued to be recorded. However, when he happened to move his left arm to a position upright and behind his head, an improvement in the ST-segment depression (ST-segment "normalization") was observed—a somewhat unexpected finding to observe just as a result of arm shifting. When the patient was asked to return to the standard supine position he was in at the beginning of the recovery phase, the ST-segment changes reappeared and showed progressive deterioration through the 4th and 5th minutes of the recovery (Figure 1).

The patient subsequently underwent arterial catheterization in order to rule out the presence of coronary artery disease (CAD). Coronary angiography showed no CAD, in spite of the positive non-invasive testing.

After this incident, we made a point of asking patients with a similarly positive exercise test to move their left arm to a position upright and behind their head in order to check whether this phenomenon of ST-segment normalization would occur. Since most test-positive patients (including those who exhibited ST-segment normalization) subsequently underwent arterial catheterization to determine the presence or not of CAD, we collected the coronary angiography data of the cohort of patients who showed the ST-segment normalization phenomenon. According to the angiographic findings, no patient who exhibited this normalization of the exercise ST-segment depression had CAD, whether the ST depression was recorded during the exercise and the recovery period (for at least up to the 4-5th minute), or exclusively during the recovery period.

## Discussion

ST-segment depression is the most common and important sign of a positive exercise test.[9] It is known that ST-segment shifts can also be attributed to other physiological parameters, such as body position[1,2] or hyperventilation,[1,3-7] in some patients. That is the main reason why an exercise ECG is recorded in both supine and upright positions for every patient, and also why the hyperventilation phase has been implemented in standard treadmill exercise testing. Regarding the role of body position in ECG recordings, shifts in the heart position when moving between the upright and supine positions, slight though they

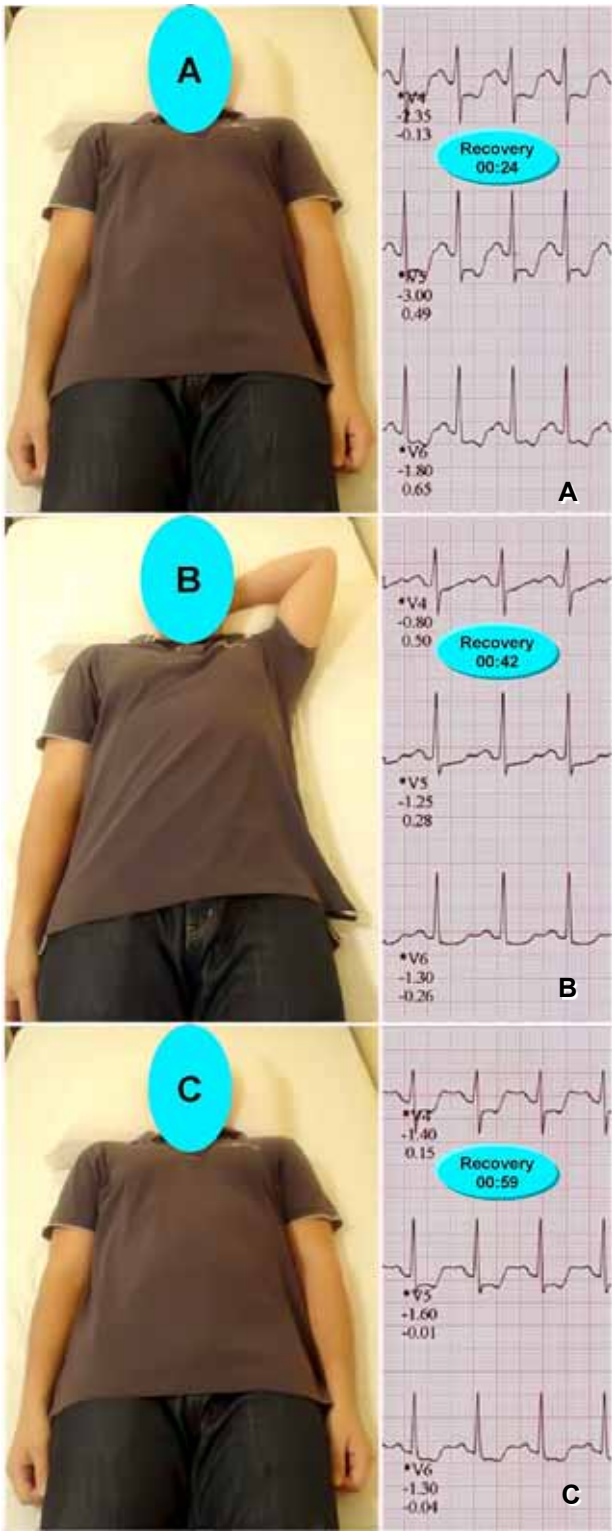


**Figure 1.** A. A positive exercise stress test with ST-segment depression in leads $V_4$, $V_5$, $V_6$ in a patient with normal coronary vessels. The patient's body is supine immediately after peak exercise, B. Improvement of the ST-segment changes when the left arm is moved to a position upright and behind the head, C. Subsequent deterioration of the ST-segment changes on return to the standard supine position with both arms lying alongside the body.

be, may not only affect the cardiac axis but can also cause ST-segment alterations. In light of this, the assumption that any other movement leading to a shift in heart position may also have similar effects on the ECG, during either rest or exercise testing, would seem to be logical.

This report describes the association between a change of left arm position during recovery time from supine to upright and behind the head, and the consequent ST-segment normalization in a patient with a positive exercise test (test considered positive due to ST-segment depression that was recorded during exercise and persisted into the recovery period). In spite of the strongly positive result of the test (given the subsequent deterioration of the ST-segment changes through the 4th-5th minute of the recovery phase), the patient had no CAD, as was confirmed by coronary angiography.

The normalization of the ST-segment depression as a result of a posture change was a chance observation, but it was subsequently also observed in other patients with positive tests. Thus, the phenomenon does not appear to be unique to the specific patient, but also occurs more widely, even if only in a limited number of patients.

It seems that shifting the left arm to a position upright and behind the head may act as a "corrective" factor for false-positive exercise testing recordings exhibiting ST-segment depression in some patients who have no real CAD, as shown definitively by coronary angiography. The most probable mechanism to which this phenomenon can be attributed is a change in heart position resulting from the change in alignment of the left arm, "correcting" the falsely depicted electrical abnormality, appearing as ST-segment depression, even when there is no ischemic disease as a substrate. This case suggests that ST-segment normalization may represent a sign of a false-positive exercise test result, possibly obviating the need for further diagnostic evaluation of a patient by interventional means.

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