

**EXERCISE-INDUCED ST-SEGMENT
DEPRESSION: RELATIONSHIP TO
NONOCCLUSIVE CORONARY
ARTERY SPASM**

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Exercise-induced ST-segment depression: Relationship to nonocclusive coronary artery spasm

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Angina pectoris is a clinical syndrome that is caused by a transient imbalance between myocardial oxygen supply and demand. Exertional angina most commonly occurs in patients with fixed coronary artery stenoses and is often associated with transient ST-segment depression, which reflects subendocardial ischemia. Patients with coronary artery spasm classically have angina at rest and transient

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Fig. 1. Baseline coronary angiogram showing a nonsignificant stenosis in the proximal left anterior descending artery.

ST-segment elevation, associated with transmural myocardial ischemia. This report describes a patient with exertional angina and ST-segment depression according to the exercise ECG who was found to have nonocclusive coronary artery spasm, without associated significant fixed coronary artery stenoses.

A 67-year-old woman presented with a 2-week history of chest pain during exertion, which was characterized as a feeling of pressure that was unaccompanied by dyspnea or palpitations and that lasted approximately 5 minutes before it resolve spontaneously. There was no previous history of chest pain. Results of a physical examination and the resting ECG were normal. The patient underwent treadmill exercise testing, and at 1 minute into the second stage (Bruce protocol) experienced chest pressure; the exercise ECG revealed 2.5 mm downsloping ST-segment depression in the inferolateral leads. Several hours after the test, the patient experienced severe chest and left arm pain at rest, which lasted 20 minutes before it resolved spontaneously. An ECG that was performed in the emergency room while the patient was free of pain revealed no signs of myocardial ischemia. Myocardial infarction was ruled out by serial determinations of cardiac enzyme levels, and the patient was referred for further evaluation with cardiac catheterization. Coronary angiography revealed a normal appearing dominant right coronary artery and left circumflex artery and a left anterior descending artery, which was normal except for a smooth, tubular 30% diameter stenosis in the proximal portion (Fig. 1). Ergonovine testing was then performed with 50, 150, and 200 μ g given intravenously. After the 200 μ g dose, ST-segment depression and

chest pressure were reproduced, and nonocclusive spasm of the left anterior descending artery was observed on repeat angiogram at the site of the previously noted mild luminal narrowing (Fig. 2). Quantitative angiography (Phillips Digital Coronary Imaging, Phillips Medical Systems North America, Shelton, Conn.) documented a luminal stenosis of 77% during the vasospastic episode. ST-segment depression and chest pressure were reversed after the administration of intracoronary nitroglycerin. Repeat quantitative angiography after administration of nitroglycerin showed a return to the previously seen 30% stenosis. Neither contralateral nor ipsilateral collaterals to the left anterior descending artery were seen in the resting state after administration of ergonovine or nitroglycerin. The patient began receiving a calcium channel antagonist.

Exercise-related ST-segment depression usually occurs in association with fixed coronary artery disease. However, there have been several reports that patients with coronary artery spasm may have abnormal exercise tests, including ST-segment depression.¹⁻⁶ Waters et al.⁴ performed exercise tests on 82 patients with variant angina and angiographically demonstrated coronary artery spasm; exercise-related ST-segment elevation was seen in 25 patients, ST-segment depression in 21 patients, and no ST-segment abnormality in 36 patients. In contrast to the patient discussed in this report, the majority of patients with exercise-related ST-segment depression and angiographically demonstrated coronary artery spasm have concomitant fixed coronary artery stenosis, which may account for ECG signs of subendocardial ischemia. Another explanation for ST-segment depression in patients with coronary artery spasm



Fig. 2. Coronary angiogram after ergonovine infusion, showing significant focal spasm of the proximal left anterior descending artery.

is that the ST-segment depression is a marker for the presence of collateral coronary circulation. Tada et al.⁵ postulated that during episodes of severe obstructive vasospasm, collateral blood flow is augmented through channels that are not visualized in the absence of the pressure gradients, which are provoked during intense spasm. The increased flow to the area of jeopardized myocardium prevents transmural ischemia, and subendocardial ischemia (manifested as ST-segment depression) is present. Of note, no such collateral flow was demonstrated in this case. A third possibility is that ST-segment depression occurs secondary to subendocardial ischemia that results from nonocclusive spasm,^{6,7} as appears to be the case in this patient. Boden et al.⁶ reported on a patient with exercise-induced coronary artery spasm, ST-segment depression, and otherwise normal coronary arteriography; the authors proposed that the ST-segment depression resulted from subtotal occlusion, which led to subendocardial ischemia, as opposed to the ST-segment elevation that was associated with critical occlusion, which led to the transmural ischemia that is usually associated with coronary artery spasm. The present case report and the report of Boden et al.⁶ support the observations of Maseri et al.,⁷ who described a continuous spectrum of clinical manifestations of coronary artery spasm. Exertional chest pain syndromes that are associated with ST-segment depression during exercise are typically due to fixed atherosclerotic coronary artery lesions, which limit blood flow to the myocardium during periods of increased demand, but the present case demonstrates that inability to match myocardial oxygen supply and demand during exercise may occur as a result of a dynamic

process such as vasospasm. The diagnosis of coronary artery spasm should be considered in patients with exercise-related ST-segment depression in whom no significant fixed coronary disease is found and should be pursued with ergonovine testing.

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