

Electrocardiogram patterns in acute left main coronary artery occlusion

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Received 6 April 2008; revised 10 June 2008; accepted 17 June 2008

Abstract

Acute coronary syndrome with subtotal occlusion of the left main coronary artery is rather frequently encountered in the catheterization laboratory, whereas survival to hospital admission of sudden total occlusion of the left main coronary artery is rare. The typical electrocardiographic (ECG) finding in cases with preserved flow through the left main is widespread ST-segment depression maximally in leads V4–V6 with inverted T waves and ST-segment elevation in lead aVR. In acute myocardial ischemia without (or with minor) myocardial necrosis, the ECG pattern is transient, whereas persistent ECG changes, usually without development of Q waves, are indicative of myocardial injury. In acute total left main occlusion, severe ischemia may be manifested in the ECG by life-threatening tachyarrhythmias, conduction disturbances, and ST-segment deviation. Because of the potential for life-saving therapeutic options by invasive therapy, the ECG markers of the serious condition should be recognized by the medical profession. Left main occlusion should be suspected in severely ill patients with widespread ST-segment depressions, especially in leads V4–V6 with inverted T waves or ST elevation involving the anterior precordial leads and the lateral extremity leads I and aVL. In addition, lead aVR ST elevation accompanied by either anterior ST elevation or widespread ST-segment depression may indicate left main occlusion.

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Keywords:

Left main; ECG; Acute coronary syndrome; Myocardial infarction; Ischemia

Introduction

In most individuals, the left main coronary artery (LMCA) supplies approximately 75% of the left ventricular myocardial mass. Significant stenosis, both in stable coronary artery disease and acute coronary syndrome, places the patient at risk of life-threatening left ventricular dysfunction and malignant arrhythmias. Patient prognosis of LMCA disease can be improved with bypass surgery. Percutaneous coronary intervention, especially with drug-eluting stents, has increasingly been used as an alternative, especially in patients who are poor candidates for surgery.

Significant LMCA disease is present in 4% to 10% of patients undergoing diagnostic coronary angiography, but total occlusion is encountered in only 0.04% to 0.42% of cases.¹ Right coronary artery (RCA) dominance and well-developed collateral channels are almost exclusively present. Left main disease is usually accompanied by significant disease elsewhere in the coronary tree, which usually leads to

symptoms and presentation before complete obstruction occurs. Left ventricular ejection fraction may be normal in patients with good collateral flow from the RCA and no previous myocardial infarction (MI).

Left main occlusion with ST-segment depression

Energy demands are highest and blood supply most precarious in the inner layers of the myocardium. Sudden imbalance between oxygen supply and demand may result in subendocardial ischemia. When the ischemia is severe and extensive, practically all the left ventricular subendocardium may suffer from energy depletion. In animals, a constriction of the LMCA results in a significant decrease in the endocardial-to-epicardial flow ratio and a significant increase of end-diastolic left ventricular transmural pressure.² Also in patients, extensive ischemia of the left ventricle impairs the relaxation of the left ventricle. The sudden increase in left ventricular pressure causes circumferential subendocardial ischemia, which may further exacerbate the ischemic process by increasing the tension of the myocardium and decreasing blood flow.³ In the electrocardiogram (ECG), widespread ST-segment

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depression with negative T waves appear (Fig. 1). In patients with rest angina, ischemic ST-depression associated with inverted T waves maximally in leads V4-V5 has been associated with LMCA disease.^{4,5} The same ECG pattern was described in autopsy-proven circumferential (“ring-like”) subendocardial MI in the 1950s,⁶ but it has also been present in cases with acute total occlusion of the LMCA (Fig. 2).⁷⁻⁹

In acute aortic dissection, coronary malperfusion occurs in 1% to 9% and is treated as acute thrombotic occlusion.¹⁰ The patients are often misdiagnosed and treated as coronary emergencies. Thrombolytic therapy may cause catastrophic hemorrhage with cardiac tamponade. “Functional left main coronary obstruction” indicating diastolic compression of the left main in diastole has been reported in transesophageal echocardiography.¹⁰⁻¹² In 2 of the 3 cases, ECG changes typical for circumferential subendocardial ischemia were described, whereas in 1 patient with right bundle branch block (RBBB), the patient showed transient anterior ST-segment elevation. In a patient in profound cardiogenic shock, where emergency percutaneous coronary intervention was unsuccessful, the left coronary artery was also occluded by an intimal dissection flap. The RCA was normal with no evident collateral flow in coronary angiography.¹³ The ECG was typical for circumferential subendocardial ischemia, including ST-segment elevation in lead aVR. The diagnosis was verified by autopsy.

ST-segment elevation in lead aVR, aVL, and V1

ST-segment elevation in lead aVR has been associated with left main- or 3-vessel disease and with adverse outcome.¹⁴⁻¹⁷ In 1 series, 13 patients with acute MI caused by total occlusion of the LMCA were encountered during 8 years, representing 2% of cases admitted for emergent



Fig. 2. Coronary angiography showing a thrombotic occlusion of the LMCA.

cardiac catheterization with acute MI or unstable angina pectoris.¹⁸ Of 13 patients, 8 had ST elevation in the precordial leads with varying patterns of ST-segment depression. Four patients had widespread ST-segment depression without ST-segment elevation in the precordial leads. All patients, except the one with ventricular fibrillation, had ST-segment depression in the inferior extremity leads. ST-elevation in lead aVR was present in 69% of patients, and 5 out of 6 nonsurvivors had ST-segment elevation in both leads aVR and aVL.

In a descriptive study of 16 patients by Yamaji et al¹⁹ ST-segment elevation in lead aVR with less elevation in lead V1 proved to be an important predictor of total or subtotal left main obstruction in patients admitted within 12 hours from the onset of acute MI. Most of their patients also had ST-segment elevations in the precordial leads, maximally in leads V2-V4. Patients with left main disease more often had

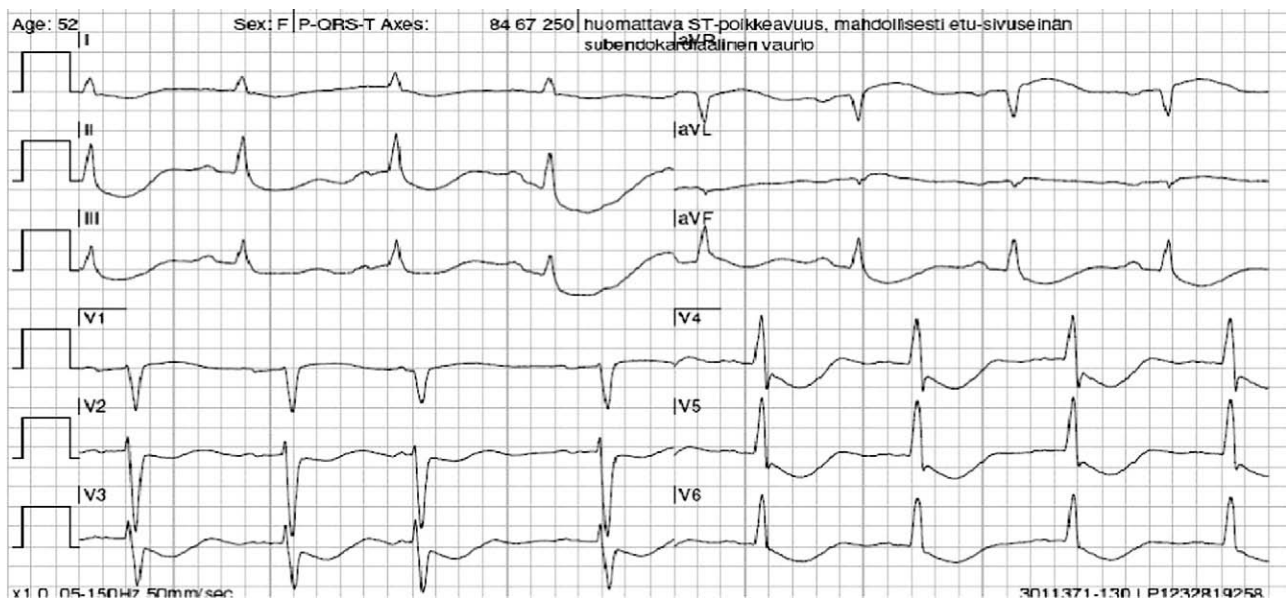


Fig. 1. The ECG (50 mm/s) from a 52-year-old woman with thrombotic LMCA occlusion shows widespread ST-segment depression maximally in leads V4-V6 and extremity leads II, III, and aVF. The T waves are inverted in the leads with maximal ST-segment depression, and the ST segment is elevated in lead aVR. There is also slight ST-segment elevation in leads aVL and V1.

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