CASE REPORT

Acute Coronary Syndromes Presenting with Transient Diffuse ST Segment Depression and ST Segment Elevation in Lead aVR not Caused by “Acute Left Main Coronary Artery Occlusion”: Description of Two Cases

Edward Kim, M.D., and Yochai Birnbaum, M.D.

From the Section of Cardiology, Baylor College of Medicine, Houston, TX

Background: Diffuse ST-segment depression in the inferior + anterolateral leads with ST-segment elevation in lead aVR has been described as characteristic of diffuse circumferential subendocardial ischemia caused by acute subtotal occlusion of the left main coronary artery.

Methods: Here we describe two patients admitted for acute neurological disorders who developed transient diffuse ST-segment depression in the inferior + anterolateral leads with ST-segment elevation in lead aVR, associated with elevation of cardiac troponin-I.

Results: In both cases subsequent coronary angiography did not show significant left main stenosis or “left main equivalent” narrowings.

Conclusions: As both patients had acute neurological disorders, a possible association between the two conditions is discussed.

Ann Noninvasive Electrocardiol 2013;18(2):204–209

acute coronary syndrome; electrocardiography; left main stenosis; ST depression; aVR; coronary angiography

Numerous reports have suggested that the typical electrocardiographic (EKG) manifestation of acute coronary syndromes associated with circumferential subendocardial ischemia due to subtotal occlusion of the left main coronary artery is widespread ST segment depression with inverted T waves in the inferior and precordial leads (maximally in leads V₄–V₆) associated with ST segment elevation in lead aVR.^{1–8}

Although diffuse ST segment depression with ST segment elevation in lead aVR can be seen in patients with cardiomyopathies, left ventricular hypertrophy with repolarization changes, and left bundle branch block, the pattern is more chronic and does not significantly change over a short period of time. Transient evolution of diffuse ST segment depression with ST segment elevation in lead aVR is considered highly predictive of

acute coronary syndrome related to left main coronary artery or diffuse three-vessel disease-induced ischemia, especially when seen in patients with typical chest pain.

Here we are reporting two patients with transient characteristic “left main acute ischemia” EKG pattern (ST elevation in lead aVR and diffuse horizontal ST segment depression) associated with transient mild elevation of cardiac markers who are confirmed on coronary angiography not to have either left main coronary artery disease or proximal multivessel disease. Both patients did not receive antipsychotic medications that may induce ST-T change.

Our first patient is a 68-year-old African American male with a history of smoking, hypertension, hyperlipidemia, and seizure disorder admitted for a generalized tonic clonic seizure. He was chronically

Address for correspondence: Yochai Birnbaum, M.D., Professor of Medicine, One Baylor Plaza MS: BCM620, Houston, Texas 77030. Fax: 713-798-0270; E-mail: ybirnbau@bcm.edu

©2012, Wiley Periodicals, Inc.
DOI: 10.1111/anec.12002

Figure 1. Patient 1: Baseline EKG shows sinus rhythm with nonspecific ST-T changes. Subsequent EKG shows diffuse ST segment depression in leads II, III, aVF, V₂–V₆; T-wave inversion in leads V₃–V₆; mild ST elevation in lead aVL and significant ST elevation in lead aVR. Coronary angiography shows left main coronary artery without stenosis, No stenosis was identified in the left anterior descending or left circumflex arteries. There is 30% luminal stenosis in the mid-right coronary artery.

on divalproex for antiseizure therapy. EKG on admission showed nonspecific ST-T changes. Blood pressure was 141/72 mmHg, and heart rate 106 bpm, SpO₂ 94% on room air. Subsequent EKG showed new diffuse horizontal ST segment depression in the inferior and anterolateral precordial leads with ST segment elevation in lead aVR (Fig. 1). Echocardiogram showed an ejection fraction of 55–60% with wall motion abnormalities in the basal inferior and inferoseptal segments. There was no evidence of left ventricular hypertrophy. (Intraventricular septal wall thickness in diastole 0.9 cm, left ventricular posterior wall thickness in diastole 0.7 cm, left ventricular end diastolic diameter 4.8 cm.) Cardiac troponin-I peaked at 1.75 ng/mL (normal range 0–0.15 ng/mL). Serum electrolytes were within normal limits. He was treated with aspirin, clopidogrel, and intravenous heparin. Following medical stabilization and resolution of seizures with levetiracetam (Keppra, UCB Pharmaceuticals, Smyrna, GA, USA) and valproic acid, coronary angiography was performed, which revealed nonobstructive coronary disease with a 30% luminal stenosis in the mid right coronary artery (Fig. 1). On subsequent EKGs these changes resolved (Fig. 3A). The patient denied any history of angina or heart failure symptoms prior to or during admission.

Our second patient is a 63-year-old female with a history of smoking, hypertension, hyperlipidemia, and depression admitted for right-sided neglect, facial droop, and aphasia. She was treated for presumed ischemic stroke with intravenous tissue plasminogen activator (tPA). Chronic medical therapy prior to hospitalization included Citalopram, Losartan, and Simvastatin. On arrival her blood pressure was 228/110 mmHg, heart rate 79 bpm, SpO₂ 99% on room air. Admission EKG showed mild ST segment depression in leads II, V3–V5 with minimal (<0.5 mm) ST segment elevation in lead aVR (Fig. 2). Subsequently blood pressure decreased. However, repeat EKG showed diffuse horizontal ST segment depression in the inferior and anterolateral precordial leads with ST segment elevation in aVR. Echocardiogram showed preserved left ventricular ejection fraction with no regional wall motion abnormalities or left ventricular hypertrophy (intraventricular septal wall thickness 0.9 cm, left ventricular posterior wall thickness 1 cm, left ventricular end diastolic diameter 4.2 cm). Cardiac troponin-I peaked at 3.66 ng/mL (normal range 0–0.15 ng/mL). She was medically stabilized and initially treated only with

aspirin, due to recent administration of tPA. She denied symptoms of chest pain or shortness of breath during the hospitalization. Coronary CT suggested significant focal calcified atherosclerosis in the distal left main and proximal left anterior descending coronary artery, as well as at the juncture of the proximal/mid right coronary artery. However, the assessment of the degree of luminal stenosis was limited by significant calcification. Follow-up coronary angiography revealed a small diffusely diseased left anterior descending coronary artery with 50–60% stenosis in the proximal and distal segment as well as a 50–60% stenosis in the proximal right coronary artery. No significant luminal narrowing was seen in the left main coronary artery on multiple views (Fig. 2). On subsequent EKGs these changes resolved (Fig. 3B).

These findings raise the possibility that acute intracranial events can mimic transient EKG findings suggestive of left main/multivessel disease-induced acute ischemia. Both cases had increased levels of cardiac troponin-I, suggesting myocardial necrosis. Thus, we cannot exclude the possibility of diffuse subendocardial ischemia/infarction induced by vasospasm secondary to the neurological condition (leading to sympathetic activation?). However, in both cases significant narrowing of the epicardial coronary arteries were not seen. As coronary angiography was delayed, we cannot exclude the possibility of spontaneous dissolution of an occlusive thrombus by the time angiography was performed (especially in the second case that received intravenous tPA). However, transthoracic echocardiography did not show diffuse left ventricular dysfunction typical for diffuse subendocardial ischemia. It is plausible that transient diffuse subendocardial ischemia could occur secondary to oxygen supply/demand mismatch of the left ventricle. The high blood pressure on presentation of the second case may induce acute transient "strain" or "increased afterload." For example, theoretically severe aortic stenosis with tachycardia, acute anemia, hyperthyroidism, fever, sepsis, respiratory insufficiency, etc. may cause diffuse subendocardial ischemia. However, the current literature portrays this EKG pattern as typical for left main or diffuse three-vessel disease with high sensitivity, specificity, and predictive values. For example, Nikus et al. reported a 93% sensitivity and a 100% specificity for the pattern of transient ST segment depression and negative T waves during pain, maximally in leads

Figure 2. Patient 2: Baseline EKG shows normal sinus rhythm with mild ST depression in leads I, II, V₃-V₅ with minimal (<0.5 mm) ST segment elevation in lead aVR. Subsequent EKG shows sinus rhythm with marked ST segment depression in leads I, II, III, aVF, V₂-V₆ with significant ST elevation in lead aVR. Coronary angiography revealed a small diffusely diseased left anterior descending coronary artery with 50-60% stenosis in the proximal and distal segment, diffuse disease in the left circumflex artery without significant narrowing, as well as a 50-60% stenosis in the proximal right coronary artery. No significant luminal narrowing was seen in the left main coronary artery on multiple views.

Figure 3. Follow-up EKGs of the first (A) and second (B) patient. The diffuse ST segment depression in the inferior + anterolateral leads resolved in the first patient and improved in the second patient. ST segment elevation in lead aVR resolved in the first patient and improved in the second patient.

V4–V5 for left main, left main equivalent, or severe three-vessel disease.⁹ Kosuge reported a sensitivity of 78% and specificity of 86% for ST elevation in lead aVR >0.5 mm for left main or three-vessel disease.⁴ It is repeatedly emphasized that in about 30% of patients with acute myocardial infarction, the presenting symptoms are atypical, especially in elderly patients, females, and diabetic patients.¹⁰ Both of our cases did not complain of chest pain; however, altered mental status due

to their neurological events may have obscured typical symptoms. Moreover, both patients had elevated cardiac troponin-I, indicative of myocardial damage. The current recommendations by the AHA/ACCF/HRS for “resting EKGs that reveal ST-segment depression greater than 0.1 mV in eight or more body surface leads coupled with ST-segment elevation in aVR and/or V₁ but are otherwise unremarkable,” is that the automated interpretation should suggest “Ischemia due to multivessel

or left main coronary artery obstruction."¹¹ On the other hand, in series of patients with non-ST elevation acute coronary syndromes due to left main stenosis, the prevalence of "circumferential subendocardial ischemia" EKG pattern is relatively low. For example, Atie reported that only 60% of the patients had ST elevation in lead aVR and 67% had maximal ST depression in lead V₄. The average number of leads with ST-T changes was only 6.4.¹ More recently, Taglieri et al. reported that only 24 out of 57 patients (42%) with non-ST elevation acute coronary syndromes due to left main stenosis had ST elevation in lead aVR with ST depression in other leads.¹² Only 52 out of the 187 patients with significant left main stenosis or three-vessel disease had ST elevation in aVR with ST depression in other leads.¹²

Thus, our cases with two different neurological conditions question the specificity and predictive value of "LM pattern" EKG criteria alone for the diagnosis of significant left main/multivessel-induced acute ischemia. The predictive accuracy of the EKG pattern will probably be higher in patients with higher pretest probability of isolated acute coronary syndromes. However, patients may present with multiple medical problems (e.g., acute ischemic stroke accompanied with hypertension and coronary artery disease) and/or atypical presentation other than typical chest pain. In such cases excluding left main coronary artery-induced ischemia could be difficult.

REFERENCES

1. Atie J, Brugada P, Brugada J, et al. Clinical presentation and prognosis of left main coronary artery disease in the 1980s. *Eur Heart J* 1991;12:495-502.
2. Frierson JH, Dimas AP, Metzendorff MT, et al. Critical left main stenosis presenting as diffuse ST segment depression. *Am Heart J* 1993;125:1773-1777.
3. Nikus KC, Eskola MJ. Electrocardiogram patterns in acute left main coronary artery occlusion. *J Electrocardiol* 2008;41:626-629.
4. Kosuge M, Kimura K, Ishikawa T, et al. Predictors of left main or three-vessel disease in patients who have acute coronary syndromes with non-ST-segment elevation. *Am J Cardiol* 2005;95:1366-1369.
5. Yamaji H, Iwasaki K, Kusachi S, et al. Prediction of acute left main coronary artery obstruction by 12-lead electrocardiography. ST segment elevation in lead aVR with less ST segment elevation in lead V(1). *J Am Coll Cardiol* 2001;38:1348-1354.
6. Nikus K, Pahlm O, Wagner G, et al. Electrocardiographic classification of acute coronary syndromes: A review by a committee of the International Society for Holter and Non-Invasive Electrocardiology. *J Electrocardiol* 2010;43: 91-103.
7. Sclarovsky S, Nikus KC, Birnbaum Y. Manifestation of left main coronary artery stenosis is diffuse ST depression in inferior and precordial leads on ECG. *J Am Coll Cardiol* 2002;40:575-6; author reply 576-577.
8. Nikus K, Jarvinen O, Sclarovsky S, et al. Electrocardiographic presentation of left main disease in patients undergoing urgent or emergent coronary artery bypass grafting. *Postgrad Med* 2011;123:42-48.
9. Nikus KC, Eskola MJ, Virtanen VK, et al. ST-depression with negative T waves in leads V4-V5—a marker of severe coronary artery disease in non-ST elevation acute coronary syndrome: A prospective study of Angina at rest, with troponin, clinical, electrocardiographic, and angiographic correlation. *Ann Noninvasive Electrocardiol* 2004;9:207-214.
10. Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of patients with acute myocardial infarction). *J Am Coll Cardiol* 2004;44:E1-E211.
11. Wagner GS, Macfarlane P, Wellens H, et al. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: Part VI—Acute ischemia/infarction: A scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society. Endorsed by the International Society for Computerized Electrocardiology. *J Am Coll Cardiol* 2009;53:1003-1011.
12. Taglieri N, Marzocchi A, Saia F, et al. Short- and long-term prognostic significance of ST-segment elevation in lead aVR in patients with non-ST-segment elevation acute coronary syndrome. *Am J Cardiol* 2011;108:21-28.