

Acute Anterior ST-Elevation Myocardial Infarction

and Electrical Storm Secondary to
Nondominant Right Coronary Artery Occlusion

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A 42-year-old man emergently presented with chest pain and anterior ST elevation. Refractory ventricular arrhythmias and shock developed rapidly. A coronary angiogram revealed the acute occlusion of a nondominant right coronary artery. After percutaneous coronary intervention, the anterior ST elevation and ventricular arrhythmias resolved. The electrocardiographic pattern was a result of isolated right ventricular infarction that in turn caused profound electrical and hemodynamic instability. We discuss the cause and pathophysiology of this patient's case, and we recommend that interventional and general cardiologists be aware that anterior ST elevation can be caused by the occlusion of a nondominant right coronary artery. (*Tex Heart Inst J* 2014;41(3):335-7)

We present the case of a patient whose anterior ST elevation in the presence of acute myocardial infarction was caused by the occlusion of a nondominant right coronary artery (RCA). Infrequently, precordial ST elevation can be caused by acute occlusion of the RCA or of one of its branches—a manifestation of isolated right ventricular (RV) infarction¹ that in this instance was not initially recognized during our search for the infarct-related artery. We discuss the patient's case and the rare cause of his cardiac presentation.

Case Report

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In October 2009, a 42-year-old man emergently presented with a 2-hour history of chest pain and diaphoresis. His medical history revealed nothing relevant. Immediately upon the patient's arrival, he developed sustained, pulseless, monomorphic ventricular tachycardia. Cardiopulmonary resuscitation was initiated, and he underwent electrical cardioversion to sinus tachycardia. The post-resuscitation electrocardiogram (ECG) showed precordial ST elevation. The patient was immediately taken to the cardiac catheterization laboratory, and an intra-aortic balloon pump was placed.

A coronary angiogram showed left dominance (Fig. 1). The left anterior descending coronary artery (LAD) was mildly diseased, had Thrombolysis In Myocardial Infarction-3 flow, and wrapped around the apex. The upper branch of a bifurcating first obtuse marginal branch was occluded (Fig. 1). This occlusion appeared to be chronic, given the presence of a tapered stump.² The dominant left circumflex coronary artery was otherwise free of disease. The RCA had a proximal occlusion (Fig. 2). The initial revascularization strategy—attempted recanalization of the occluded obtuse marginal branch—was unsuccessful. Ventricular fibrillation (VF) recurred despite the administration of amiodarone and lidocaine. At this point, it was recognized that the nondominant RCA might be the culprit infarct-related artery, and percutaneous coronary intervention (PCI) was begun.

Thrombectomy was performed with use of a 6F right coronary bypass guiding catheter, a 182-cm ChoICE™ intermediate guidewire (Boston Scientific Corporation; Natick, Mass), and an Export® XT Aspiration Catheter (Medtronic, Inc.; Minneapolis, Minn). Angioplasty of the proximal vessel, with use of a 3 × 15-mm Quantum™ Maverick® balloon catheter (Boston Scientific), restored coronary blood flow. A 2.75 × 32-mm TAXUS® Liberté™ bare-metal stent (Boston Scientific) was deployed. Be-

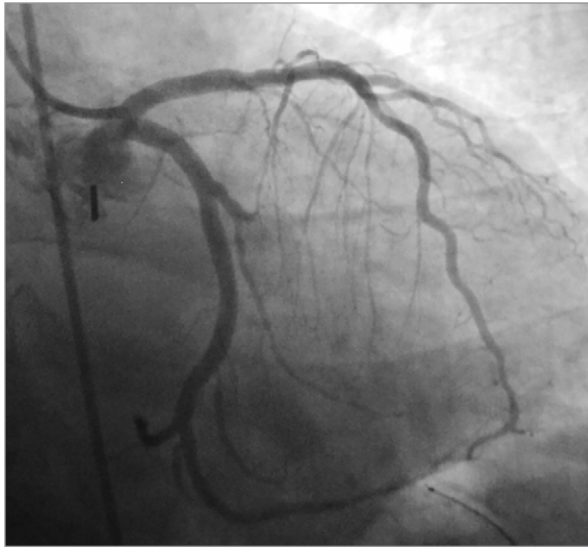


Fig. 1 Left coronary angiogram (caudal projection) shows the dominant left circumflex coronary artery and chronic occlusion of an obtuse marginal branch.

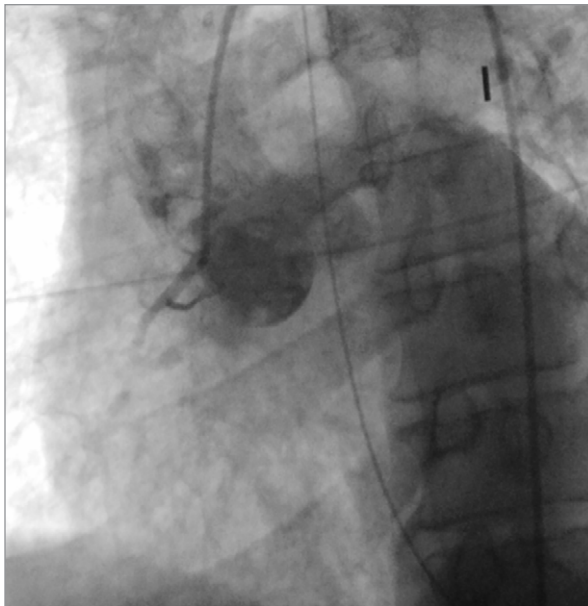


Fig. 2 Angiogram shows the occluded right coronary artery.

cause of catheter damping and transient VF, the ostium of the RCA was stented with a 2.75 × 16-mm TAXUS Liberté bare-metal stent.

Figure 3 shows the revascularized RCA. Immediately after PCI, an ECG showed complete resolution of the anterior ST elevation. Throughout the procedure, the patient had undergone defibrillation a total of 19 times; however, no VF recurred after revascularization of the RCA. The patient died of anoxic brain injury 20 days into this hospitalization.

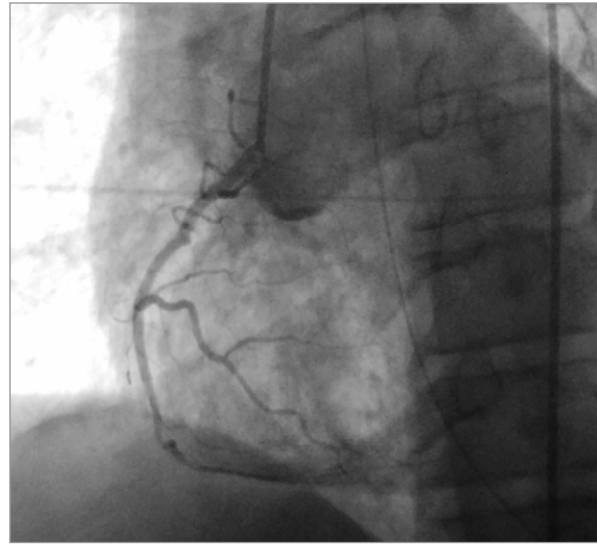


Fig. 3 Right coronary angiogram shows the artery after revascularization.

Discussion

The ECG remains one of the best bedside predictors of clinically significant coronary artery disease. On surface ECG, the mean vector of electrical forces predicts the regional current of injury. Elevation across the precordium (leads V₁ through V₅) usually indicates anteroseptal left ventricular (LV) infarction caused by acute or subacute occlusion of the LAD or one of its branches.³

Right ventricular infarction complicates 14% to 84% of inferior LV infarctions and usually results from occlusion of the RCA proximal to the RV marginal branches.⁴ In a dominant-RCA occlusion, it is postulated that the forces of inferior LV infarction obscure the anterior forces of RV infarction, resulting in the typical pattern of inferior ST elevation without anterior elevation. Because a nondominant RCA supplies only the RV free wall, the occlusion of this vessel is not associated with inferior LV infarction, and anterior ST elevation might manifest itself.⁵ In 1984, an elegant canine study validated the development of this ECG pattern in myocardial infarction.¹

Innumerable variations in coronary anatomy exist, and occlusion can produce unpredictable electrical and hemodynamic consequences. The anatomically split RCA, sometimes referred to as a double RCA, features a split posterior descending artery (PDA), and the anterior subdivision of the RCA leads to the distal portion of the PDA. This branch supplies the posterior septum, the inferior wall of the LV, and the free wall of the RV. The posterior bifurcation of the RCA courses through the atrioventricular groove and forms the uppermost portion of the PDA.⁶ Patients with occlusion of the anterior subdivision of the split RCA have presented with precordial ST-segment elevation because of

RV free-wall involvement. The inferior wall of the LV might or might not be involved.^{7,8}

The association between anterior ST elevation and the occlusion of a dominant RCA or its branches has been described within the context of PCI, when occlusion of the major acute marginal branch complicates PCI of a dominant RCA.^{5,9-12} A similar pattern has been observed during acute occlusion of a proximal RCA, when the distal RCA circulation has been collateralized from branches of the left coronary artery.^{13,14}

Anterior ST elevation can also result from the acute occlusion of a nondominant RCA, as in our patient's case. Finn and Antman¹⁵ used magnetic resonance imaging to reveal RV infarction in a patient who presented with anterior ST elevation caused by a severely stenotic nondominant RCA. To our knowledge, anterior ST elevation caused by the thrombotic occlusion of a nondominant RCA has been reported in only 3 cases.¹⁶⁻¹⁸ Our patient's case shows that acute occlusion of a nondominant RCA can also be complicated by recurrent malignant ventricular arrhythmias.

We recommend that interventional and general cardiologists be aware that anterior ST elevation can be caused by the occlusion of a nondominant RCA. The ECG pattern is a result of isolated RV infarction, which in turn can cause profound electrical and hemodynamic instability.

References

1. Geft IL, Shah PK, Rodriguez L, Hulse S, Maddahi J, Berman DS, Ganz W. ST elevation in leads V1 to V5 may be caused by right coronary artery occlusion and acute right ventricular infarction. *Am J Cardiol* 1984;53(8):991-6.
2. Safian RD, Freed MS. Chronic total occlusion. In: *Manual of interventional cardiology*. 3rd ed. Royal Oak (MI): Physicians' Press; 2001. p. 287-99.
3. Zimetbaum PJ, Josephson ME. Use of the electrocardiogram in acute myocardial infarction. *N Engl J Med* 2003;348(10):933-40.
4. Kinch JW, Ryan TJ. Right ventricular infarction. *N Engl J Med* 1994;330(17):1211-7.
5. van der Bolt CL, Vermeersch PH, Plokker HW. Isolated acute occlusion of a large right ventricular branch of the right coronary artery following coronary balloon angioplasty. The only true 'model' to study ECG changes in acute, isolated right ventricular infarction. *Eur Heart J* 1996;17(2):247-50.
6. Angelini P, Villason S, Chan AV Jr, Diez JG. Normal and anomalous coronary arteries in humans. In: Angelini P, editor. *Coronary artery anomalies: a comprehensive approach*. Baltimore: Lippincott Williams & Wilkins; 1999. p. 27-79.
7. Sawaya FJ, Sawaya JL, Angelini P. Split right coronary artery: its definition and its territory. *Tex Heart Inst J* 2008;35(4):477-9.
8. Erbagci H, Davutoglu V, Turkmen S, Kizilkan N, Gumusburun E. Double right coronary artery: review of literature. *Int J Cardiovasc Imaging* 2006;22(1):9-11.
9. Koh TW, Coghlan JG, Lipkin DP. Anterior ST segment elevation due to isolated right ventricular infarction during right coronary angioplasty. *Int J Cardiol* 1996;54(3):201-6.
10. Acikel M, Yilmaz M, Bozkurt E, Gurlertop Y, Kose N. ST segment elevation in leads V1 to V3 due to isolated right ventricular branch occlusion during primary right coronary angioplasty. *Catheter Cardiovasc Interv* 2003;60(1):32-5.
11. Marinakis A, Lampropoulos K. Precordial ST elevation due to isolated ventricular branch occlusion after stent implantation in the right coronary artery. *Rev Esp Cardiol* 2009;62(11):1338-40.
12. Eichhofer J, Curzen N. Images in cardiovascular medicine. Unexpected profound transient anterior ST elevation after occlusion of the conus branch of the right coronary artery during angioplasty. *Circulation* 2005;111(9):e113-4.
13. Muhammad KI, Kapadia SR. Anterior ST-segment elevation with right coronary artery occlusion: a unique case of isolated right ventricular infarction. *Angiology* 2008;59(5):622-4.
14. Wilson JM, Kalife G, Rogers M, Strickman NE, Massumi A. Unusual electrocardiographic presentation of right ventricular myocardial infarction. *Tex Heart Inst J* 1996;23(4):305-9.
15. Finn AV, Antman EM. Images in clinical medicine. Isolated right ventricular infarction. *N Engl J Med* 2003;349(17):1636.
16. Porter A, Herz I, Strasberg B. Isolated right ventricular infarction presenting as anterior wall myocardial infarction on electrocardiography. *Clin Cardiol* 1997;20(11):971-3.
17. Celik T, Yuksel UC, Kursaklioglu H, Iyisoy A, Kose S, Isik E. Precordial ST-segment elevation in acute occlusion of the proximal right coronary artery. *J Electrocardiol* 2006;39(3):301-4.
18. Collins N, Elliott V, Seidelin P. True isolated right ventricular infarction with tombstone anterior ST elevation. *Heart* 2007;93(3):374.