Unstable Angina in a Patient With Anomalous Origin of the Left Main Coronary Artery From the Right Sinus of Valsalva

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Anomalous coronary arteries are rare. Although most are not clinically significant, the most clinically important coronary anomaly is origin of the left main coronary artery from the right sinus of Valsalva, which can be associated with sudden death. We present a case of a 37-year-old man with unstable angina who underwent cardiac catheterization and was found to have this type of anomaly, which was later confirmed by coronary computed tomography angiography. Diagnosis and management of patients with this coronary anomaly are discussed.
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Key words: Anomalous coronary artery • Left main coronary artery • Sudden death • Ischemia • Coronary artery disease

Anomalous coronary arteries are rare, and are usually diagnosed incidentally by coronary angiography. The most clinically important coronary anomaly is origin of the left main coronary artery from the right sinus of Valsalva, which can be associated with sudden death. We present a case of a 37-year-old man with unstable angina who underwent cardiac catheterization and was found to have an anomalous left main coronary artery originating from the right sinus of Valsalva. Coronary computed tomography angiography (CTA) confirmed the diagnosis, and delineated an interarterial course of the left main artery between the pulmonary artery and the aorta. We provide a brief review of the literature and discuss the diagnosis and management of patients with this type of coronary anomaly.

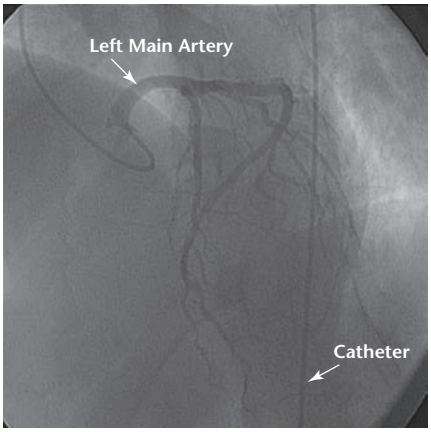
Case Report

A 37-year-old man with a history of hypertension, hyperlipidemia, and obstructive sleep apnea presented with substernal chest pain at rest associated with shortness of breath and diaphoresis. Over the previous 6 months, the patient had experienced stable angina pectoris. His medications included metoprolol, fosinopril, and simvastatin. He denied smoking and alcohol or drug use. The family history was notable for sudden death in his father at age 35 years.

The electrocardiogram showed normal sinus rhythm and nonspecific T-wave changes.

Serum levels of cardiac enzymes were within normal limits. Transthoracic echocardiography revealed normal left and right ventricular systolic function and no significant valvular disease. At cardiac catheterization, it was found that the left main coronary artery (LMCA) originated from the right sinus of Valsalva (RSOV). There was a separate origin of the right coronary artery (RCA), which was nondominant. There was no evidence of atherosclerotic coronary obstruction (Figure 1). Coronary CTA demonstrated the course of the LMCA between the pulmonary artery and the ascending aorta (Figures 2 and 3). Stress sestamibi single-photon emission computed tomography (SPECT) was performed to assess for ischemia. The patient experienced typical angina during exercise associated with 1 mm ST-segment depression but there were no associated defects on perfusion imaging.

Figure 1. *Catheter engaged in left main artery, which originates from the right sinus of Valsalva. The arteries appear angiographically normal.*



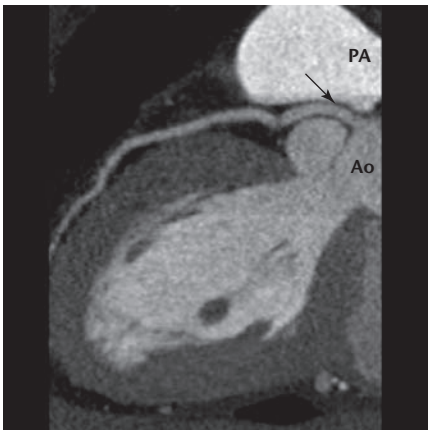


Figure 2. *Longitudinal section on coronary computed tomography angiography demonstrating the course of the left main artery between the pulmonary artery (PA) and the aorta (Ao).*

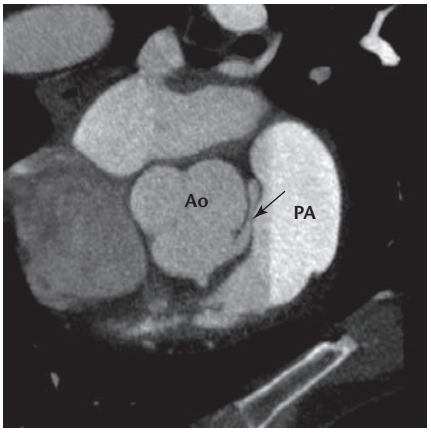


Figure 3. *Cross-section on coronary computed tomography angiography demonstrating the course of the left main artery between the pulmonary artery (PA) and the aorta (Ao).*

The patient was referred for surgical repair. The anomalous left main ostium was seen in the right sinus of Valsalva; the proximal segment was intramural and coursed between the pulmonary artery and the aorta. The left main artery was unroofed from its intramural course, and the ostium was reimplanted to relieve compression between the great vessels. At 1 year postoperative follow-up, the patient was clinically stable and free of angina.

Discussion

Epidemiology

The largest published series reported a prevalence of 1.3% of anomalous coronary artery (ACA) anatomy among 126,595 patients undergoing coronary angiography.[1] Most coronary artery anomalies are not clinically significant, but certain variants may be responsible for syncope, angina, arrhythmias, or sudden death. The potentially malignant anomalies include origin of a coronary artery from the opposite sinus of Valsalva, origin from the pulmonary artery, single coronary artery, and large coronary artery fistulae.[1] ACA accounts for approximately 20% of cases of sudden death in young athletes.[2] The most frequent coronary artery anomaly causing sudden death in children and young athletes is origin of a coronary artery from the opposite sinus of Valsalva.[3]

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Anatomic Patterns

The left main artery may follow 1 of 4 pathways after originating from the RSOV: septal (or intramuscular), anterior free wall, retroaortic, or the interarterial pathway.[4] The interarterial

course of the LMCA has been associated with angina, syncope, or sudden cardiac death. In an autopsy study of 249 patients with coronary artery anomalies, 142 (59%) experienced death of apparent cardiac cause. A total of 49 deaths were associated with origin of the LM from the RSOV; of these, 57% were sudden deaths, and 64% of sudden deaths occurred during or immediately after exercise. Anomalous origin of the RCA from the left sinus of Valsalva accounted for 52 deaths, of which 25% were sudden, and 45% of sudden deaths were related to exercise. High-risk anatomy included an interarterial course of the aberrant artery and anatomic abnormalities at the aortic origin, such as ostial ridges.[5]

Mechanism of Ischemia

Pathophysiologic mechanisms that might explain sudden death include ischemia, dynamic arterial obstruction, vasospasm, and ventricular arrhythmias. Ischemia can result from compression of the LMCA between the aorta and the pulmonary arterial trunk, perhaps related to aortic dilatation during exercise. However, because most of the coronary filling occurs during diastole, this explanation seems less likely. Dynamic obstruction can also occur during exercise if an acute angular takeoff of the anomalous vessel creates a slit-like coronary arterial orifice that can collapse during aortic dilatation unrelated to direct extrinsic compression.[6] Results of fractional flow reserve studies performed with dobutamine stimulation in patients with anomalous origins of the LMCA have been physiologically abnormal (0.96 at rest and 0.86 at peak), consistent with dynamic ostial obstruction.[7] Intravascular ultrasound imaging has shown anatomic abnormalities in the arterial wall at the origin of the anomalous vessel, including ostial ridges and absence of adventitia, which can predispose to vessel closure.[8] Vasospasm of the anomalous artery may occur during exertion as a result of increased adrenergic tone or other factors affecting coronary arterial flow dynamics,[9] such as endothelial dysfunction.[10] Repetitive episodes of ischemia may result in myocardial necrosis and fibrosis, creating an unstable electrical substrate predisposing to ventricular arrhythmias.[2]

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Rupture of atherosclerotic lesions with acute arterial occlusion is not frequently seen on histologic studies of ACAs.[6] Obstructive atherosclerotic disease may develop in anomalous segments, but atherosclerosis is no more common in anomalous segments than in other coronary arteries in a given patient.[11]

Clinical Manifestations

Although sudden death may be the initial clinical manifestation of anomalous coronary anatomy, up to 30% of patients resuscitated from cardiac arrest in this situation recall premonitory symptoms such as chest pain or syncope, particularly during exercise.[2] These symptoms, especially in young patients, should raise suspicion of a cardiac abnormality, such as hypertrophic cardiomyopathy, long-QT syndrome, or coronary artery anomaly, particularly a coronary artery originating from the contralateral sinus of Valsalva. There is evidence of a genetic basis for ACA origin from the contralateral sinus of Valsalva, and it may be prudent to screen first-degree relatives of patients with this anatomic disorder for similar coronary anomalies.[12]

Diagnostic Evaluation

In the evaluation of suspected anomalous origin of the LMCA from the RSOV, testing should include electrocardiography, Holter monitoring for arrhythmias, echocardiography, stress testing, and coronary angiography. The coronary ostia may be identified by echocardiography, but an alternative imaging modality, such as coronary CTA or magnetic resonance coronary angiography (MRCA) is required.[9,13] Ischemia associated with coronary anomalies is inconsistently reproduced by stress testing[13]; stress testing with radionuclide myocardial perfusion imaging may be useful, however, to evaluate exercise-induced ischemia, the extent of myocardium at risk, and previous infarction.[9] Coronary angiography has been the standard method for diagnosis of congenital coronary anomalies, providing information about the anatomic course of the anomalous segment, distal distribution, and extent of coexisting atherosclerotic disease. However, it may be difficult in some cases to delineate the pathway of the anomalous vessel relative to the aorta and the pulmonary artery during coronary angiography unless special views are obtained.

Coronary CTA has excellent spatial resolution, provides 3-dimensional imaging of the heart and vascular structures, shows the relationship of coronary arteries to the heart and great vessels, and in a few studies has a reported sensitivity of 100% when compared with conventional coronary angiography.[14-16] The sensitivity

of MRCA is slightly lower than that of CTA (approximately 93%),[17] but does not require administration of iodinated radiographic contrast material or entail exposure to ionizing radiation.

Management

Treatment options for patients with anomalous origin of the LMCA from the RSOV include close clinical observation, surgical repair, and percutaneous catheter-based interventions. Ischemic symptoms and the risk of sudden death should guide clinical decisions in the management of patients with anomalous origin of the LMCA from the RSOV. Patients presenting with angina, syncope, malignant ventricular arrhythmia, or aborted sudden death should undergo surgical correction. Because young patients are at highest relative risk for sudden death, even asymptomatic patients under age 30 years should undergo surgical correction. In asymptomatic patients over age 30, the incidence of sudden death is lower, and these patients may be followed medically with periodic stress testing to detect ischemia, arrhythmias, or abnormal coronary perfusion, which may prompt a recommendation for surgical correction.[18] Patients with uncorrected anomalous origin of the LMCA from the RSOV should generally be advised to avoid vigorous exercise, as the phenomena associated with an increased risk of sudden death during exercise may not be regularly reproduced during stress testing.

Surgical repair usually involves unroofing the intramyocardial segment of the LM and creation of an ostium by fenestration of the appropriate coronary sinus and direct anastomosis. Two single-center series have reported favorable outcomes after this procedure, including low operative risk and absence of ischemia on postoperative stress testing.[19,20] Technical considerations include the need for a sufficiently large and unobstructed ostium and avoidance of aortic valve disruption. Another surgical option is coronary artery bypass grafting,[21] but it is limited by concerns about long-term graft patency in the absence of a fixed obstruction of the native artery. There have been case reports of percutaneous intervention with angioplasty and stenting in patients with anomalous origins of the LMCA from the RSOV[22-24] addressing such technical issues as selection of guiding catheters to provide adequate support and coaxial engagement of the ectopic vessel. Because the pathophysiology usually involves abnormal arterial angulation and external compression rather than atherosclerosis, it is unclear whether stenting offers optimum long-term benefits in patients with myocardial ischemia due to ACA anatomy of this type. Because the anomalous coronary segment may have abnormal proximal wall structure, high-pressure stent deployment may be more prone to such complications as arterial perforation and dissection in this situation. There are no data on the frequency of restenosis after coronary stenting in patients with anomalous origin of the LM coronary artery or the relative utility of drug-eluting stents as an alternative to bare metal stents in

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Main Points

- Most coronary artery anomalies are not clinically significant, but certain variants may be responsible for syncope, angina, and arrhythmias. Anomalous origin of the left main coronary artery (LMCA) from the right sinus of Valsalva (RSOV) is potentially lethal.
- Pathophysiologic mechanisms that might explain sudden death include ischemia, dynamic arterial obstruction, vasospasm, and ventricular arrhythmias.
- Up to 30% of patients resuscitated from cardiac arrest in this situation recall premonitory symptoms such as chest pain or syncope, particularly during exercise.
- Ischemia associated with coronary anomalies is inconsistently reproduced by stress testing; therefore, evaluation of suspected anomalous origin of the LMCA from the RSOV should also include electrocardiography, Holter monitoring for arrhythmias, echocardiography, and coronary angiography.
- Treatment options include close clinical observation, surgical repair, and percutaneous catheter-based interventions. Because young patients are at highest relative risk for sudden death, even asymptomatic patients under age 30 years should undergo surgical correction.

anomalous arteries free of atherosclerotic disease.

Conclusions

Coronary artery anomalies are a rare but important cause of angina, syncope, and sudden death, and anomalous origin of the LMCA from the RSOV is potentially lethal. Coronary anomalies should be suspected in young patients presenting with exertional angina or syncope. Coronary CTA and MRCA are increasingly important tools for diagnosis and surgical repair remains the standard treatment. Long-term outcomes after surgical correction are typically favorable. ■

The authors have no real or apparent conflicts of interest to disclose.

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