Low Origin of the Coronary Arteries and a Small Aortic Annulus

Complicating Aortic Valve Replacement

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Low origin of the coronary arteries, defined as an origin less than 10 mm above the functional aortic annulus, is not usually considered to be a notable anomaly because functional impairment is not intrinsic. We describe a case of severe complications after surgical aortic valve replacement in a 59-year-old woman who had symptomatic aortic valve stenosis, low origin of both main coronary arteries, and a hypoplastic aortic annulus less than 19 mm in diameter. The aortic prosthesis had to be implanted above the hypoplastic anatomic annulus. An inferior-wall myocardial infarction, hypotension, right-sided heart failure, and atrial fibrillation developed during the early perioperative period. Coronary angiograms showed occlusion of the right coronary artery ostium and critical stenosis of the left coronary ostium. During reoperation, posterior aortic patch annuloplasty enabled lower reimplantation of the prosthetic aortic valve, jointly with right coronary artery–venous grafting.

To prevent potentially severe complications, we recommend that low origin of the coronary arteries be reported before patients undergo surgical aortic valve replacement. If the ostia are not seen when routine coronary angiography is used, computed tomography should be prospectively performed to characterize this anomaly. ***(Tex Heart Inst J 2019;46(3):222-4)***

Key words: *Aortic valve/anatomy & histology/diagnostic imaging; aortic valve stenosis/surgery; heart valve prosthesis implantation/adverse effects/methods; postoperative complications/diagnosis; risk assessment; treatment outcome*

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In the past, we have recommended recognizing the clinical implications of low origin of the coronary arteries (LOCA).[1] Although no intrinsic functional impairment is routinely associated with LOCA (Fig. 1), low origin may lead to substantial complications during aortic valve interventions. We report the case of a patient in whom LOCA and a small aortic annulus led to severe postoperative complications after surgical aortic valve replacement (AVR), and we make recommendations on the basis of our experience.

Case Report

In 2011, a 59-year-old woman living in Mexico City presented with symptomatic aortic stenosis. Four years earlier, progressive dyspnea had led to the diagnosis of a heart murmur. At the current presentation, surgical AVR was recommended.

A preoperative echocardiogram showed an annular diameter of 1.9 cm, an aortic valve area of 0.7 cm^2, and a left ventricular ejection fraction of 0.65. Selective coronary angiograms showed no obstructive coronary artery disease (Fig. 2), nor did they reveal the low origin of both coronary arteries. A ministernotomy was performed, and cardiopulmonary bypass (CPB) was initiated. Intraoperatively, we noted severe aortic valve stenosis and such severe annular hypoplasia that all available prostheses were too large. Deploying the smallest valve available, a 19-mm On-X® (CryoLife, Inc.), resulted in severe stretching of the aortic annulus and the 2 coronary orifices because the prosthetic valve ring was displaced. The patient was weaned from CPB and was taken to the recovery room in stable hemodynamic condition.

At the time of endotracheal extubation on the first postoperative day, the patient reported precordial pain. Hypotension soon developed, and an electrocardiogram indicated inferior-wall injury (Fig. 3). Vasopressors and diuretics were given. The patient's serum creatine kinase level peaked at 2,325 U/L, and her brain natriuretic peptide levels increased to 1,356 pg/mL. An emergency coronary angiogram revealed ostial occlusion of the right coronary artery (RCA) with faint distal filling from collateral flow; the left coronary artery (LCA) ostium had an obvious deformity with stenosis

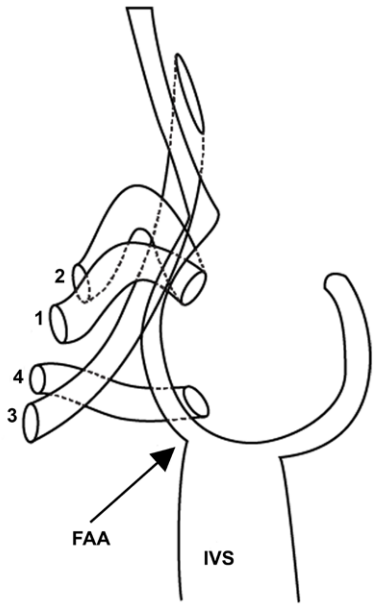

Fig. 1 *Diagram of the aortic root illustrates multiple alternative originations of the right coronary artery from the right sinus of Valsalva.*[1]

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1 = normal position; 2 = uplifted proximal artery at a normal site (Shepherd's crook); 3 = high origin from the ascending aorta; 4 = low origin; FAA = functional aortic annulus; IVS = interventricular septum

(Fig. 4). The RCA originated 10.0 mm above the aortic annulus. On day 3, the patient underwent reoperation, involving surgical annular enlargement with use of CPB. The prosthesis was functioning well; however, both coronary ostia were compromised. On echocardiograms, the right ventricular free wall was akinetic.

We performed a Manouguian aortic annuloplasty procedure,[2] using a rhomboidal Dacron patch and extending the aortic annulus into the anterior wall of the left atrium and mitral valve. The 19-mm On-X prosthesis was reimplanted away from the coronary ostia, and an aortocoronary vein graft was placed in the RCA. The patient's hemodynamic status improved. After 3 days, she was weaned from diuretics and vasopressors. She was discharged from the hospital on day 10 with prescriptions for warfarin, diuretics, and antiarrhythmic medication for paroxysmal atrial fibrillation. On gross and histologic examination, the native aortic valve was trileaflet, calcific, and fibrotic.

Upon routine follow-up examination in 2017, the patient was in New York Heart Association functional class I and had no angina or dyspnea. No heart murmur was detected. An echocardiogram showed total recovery of right ventricular contractility, and rubidium-82 positron-emission tomographic scans showed normal right-sided motion with normal perfusion. The left ventricular ejection fraction was 0.65. At last follow-up

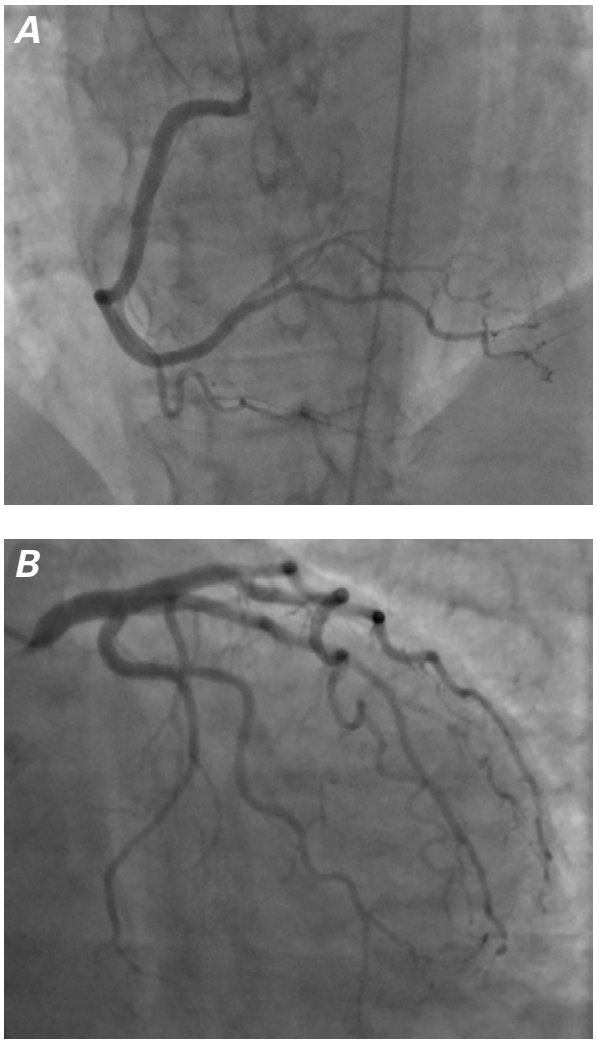

Fig. 2 *Selective coronary angiograms of the **A**) right and **B**) left coronary arteries show normal intrinsic anatomy but no indication of ostial location.*

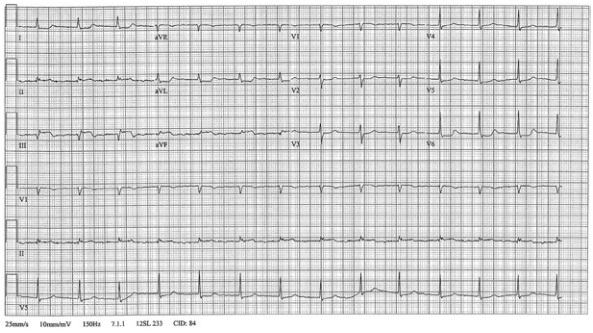

Fig. 3 *Electrocardiogram shows ST-segment elevation in the inferior leads and depression in the lateral leads.*

in 2019, computed tomograms showed a patent RCA vein graft and an unobstructed proximal native RCA, a widely patent left main trunk with no distal obstructive disease, and a well-functioning aortic prosthesis.

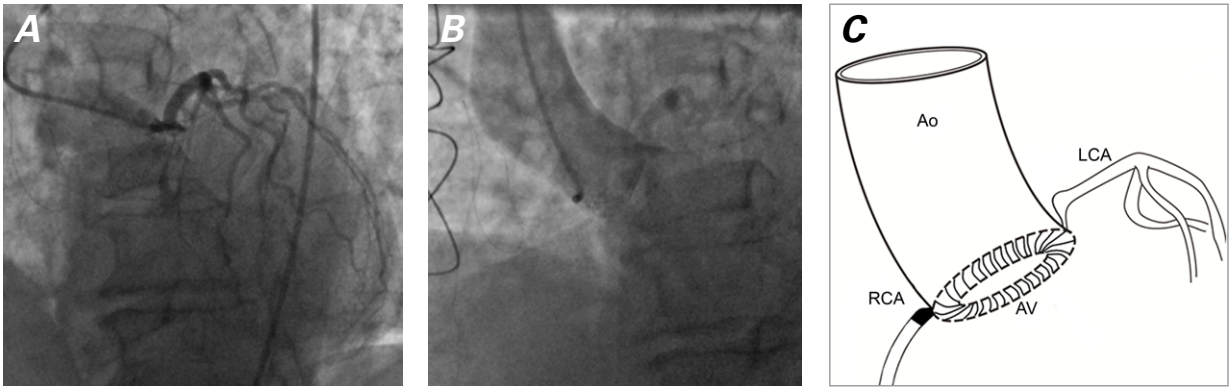

Fig. 4 *Angiograms show **A**) left coronary artery (LCA) ostial stenosis and **B**) right coronary artery (RCA) ostial occlusion. **C**) Diagram shows LCA ostial deformity with stenosis and RCA ostial occlusion.*

Ao = ascending aorta; AV = aortic valve prosthesis

Discussion

This case illustrates the potential clinical consequences of LOCA and a small aortic valve annulus. Although this anomaly usually goes unnoticed, it can adversely affect surgical AVR.

The designation of LOCA is based on the normal range of location of the coronary arteries.[3,4] Human coronary ostia are normally in the middle (RCA) and upper third (LCA) of the respective sinus of Valsalva, up to 5 mm above the sinotubular junction. Multiple variations are possible.[1,3,4] In a preliminary study of the coronary ostial anatomy in 23 postmortem specimens,[3] the normal location of the coronary ostia in the vertical axis was between 2 mm above and 2 mm below the sinotubular junction.[3] In a computed tomographic study in 166 patients, the mean distances of the RCA and the LCA ostia from the functional aortic annulus were 17.2 ± 3.3 and 14.4 ± 2.9 mm, respectively.[4] This finding may establish a clinical definition of LOCA as featuring an ostium less than 10 mm from the functional aortic annulus.[5] In a multicenter registry study of 6,688 patients who underwent transcatheter AVR, a mean LCA ostial height below 10.6 ± 2.1 mm predicted a higher risk of coronary ostial obstruction when compared with a height of 13.4 ± 2.1 mm.[6]

In our patient, the origin of the RCA was 10 mm above the aortic annulus, so the hypoplastic aortic annulus impeded proper placement of the smallest available prosthesis. Adequate separation between the coronary ostia and the prosthesis was achieved only after the annulus was enlarged by means of the Manouguian procedure.[2] During diagnostic studies, we think that if the ostia are not seen on routine coronary angiography, computed tomography should be performed. Low origins should be reported specifically to the surgeon as a case of LOCA. Careful surgical planning and operative caution are advisable in such cases.

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