JACC: CASE REPORTS VOL. 4, NO. 22, 2022

CASE REPORT

INTERMEDIATE

CLINICAL CASE

TAVR in a Patient With Anomalous Origin and Course of the Left Main Coronary Artery

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ABSTRACT

In patients with anomalous coronary arteries with high-risk features, corrective cardiac surgery should be considered. We report the first case of transcatheter aortic valve replacement using a self-expanding Evolut valve, in a patient with a single coronary artery arising from the right coronary cusp and an intramural course of the left main. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2022;4:1467–1471) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENT ILLNESS

An 81-year-old woman with multiple comorbidities presented to the hospital with shortness of breath on exertion, chest discomfort, and orthopnea. Transthoracic echocardiography showed normal left ventricle function and severe aortic stenosis with an aortic valve area of 0.6 cm^2 and, peak velocity of 5 m/s, peak and mean gradients of 107 and 63 mm Hg, respectively. No other abnormality was noted. Hence, she was referred for a transcatheter aortic valve replacement (TAVR).

LEARNING OBJECTIVES

- To be familiar with the term of CAA, high-risk anatomy, related complications, and treatment indications.
- Show the feasibility of TAVR in selected patients with both CAA and severe symptomatic aortic stenosis.
- Discuss future research options regarding CT parameters that may predict poor outcomes.

INVESTIGATIONS

Pre-TAVR computed tomography (CT) revealed a tricuspid aortic valve with a calcium score of 1,714 HU (**Figure 1**). Average annular diameter of 18.6 mm, area of 247 mm^2, and perimeter of 58.1 mm. An anomalous origin of the left main coronary artery (LMCA) from the right sinus, jointly with the right coronary artery, at a single common trunk and ostium, with an intramural course of the LMCA shortly after origin from the common trunk was noted (**Figure 2,** Videos 1 to 3). Furthermore, compression of the proximal LMCA, with a 2:1 ratio of long to short diameter, between the great vessels, known as the "Angelini-Cheong sign" (**Figure 2**) was observed.[1] This single coronary ostium

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received March 21, 2022; revised manuscript received June 17, 2022, accepted June 23, 2022.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2022.06.017

JACC: CASE REPORTS, VOL. 4, NO. 22, 2022
NOVEMBER 16, 2022:1467–1471

ABBREVIATIONS AND ACRONYMS

CAA = coronary artery anomalies

CT = computed tomography

LMCA = left main coronary artery

SCD = sudden cardiac death

TAVR = transcatheter aortic valve replacement

had a height of 18 mm above the aortic valve annular plane.

MANAGEMENT

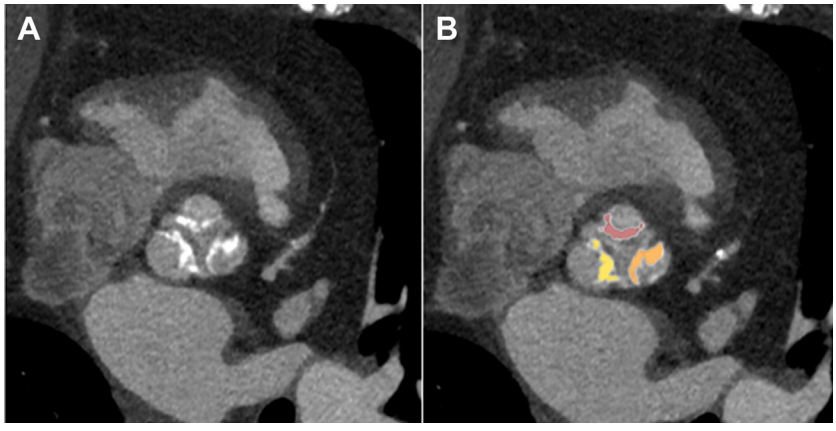
The heart team concluded that given the age of the patient and the lack of prior cardiac history or symptoms, the anomalous course of the LMCA was likely a bystander lesion and not the cause of current presentation. Surgical repair was complex and would have required an aortic valve replacement and repair of the coronary anomaly, which would have involved re-implantation of the left main to left sinus: the Society of Thoracic Surgeons score was 18%. Alternatively, from a technical standpoint for TAVR, the team considered the sinus width, the height of the single coronary ostium above the annular plane, and the anticipated diameter of the TAVR prosthesis. Based on our expertise with self-expandable TAVR prostheses, we planned to use 23-mm Evolut ProPlus (Medtronic). Based on these parameters, the team predicted a low risk of either the native leaflets obstructing the coronary ostium, or of the TAVR valve compressing the interarterial course of coronary artery (**Figure 3,** Video 4). Moreover, the repositionable nature of this prosthesis would permit us to abort the procedure if there was concern of compression during partial deployment.

A coronary angiography was done before the procedure (**Figure 4,** Video 5). The TAVR procedure was done under sedation and local anesthesia. Without pre-dilatation, a 23-mm valve was deployed in cusp overlap view. On initial deployment, the TAVR prosthesis was incompletely expanded; as such, a post-dilatation with an 18-mm balloon under rapid ventricular pacing was performed. Post-procedure angiography confirmed the coronary vessel patency (**Figure 4,** Video 6). There were no ischemic electrocardiographic changes. As such, no further assessment by intravascular ultrasound or functional imaging for ischemia was performed. Follow-up echocardiography showed normal gradients, with mild paravalvular aortic regurgitation, normal left ventricular systolic function, and no new regional wall motion abnormalities. At 1-month follow-up, the patient's symptoms had resolved.

DISCUSSION

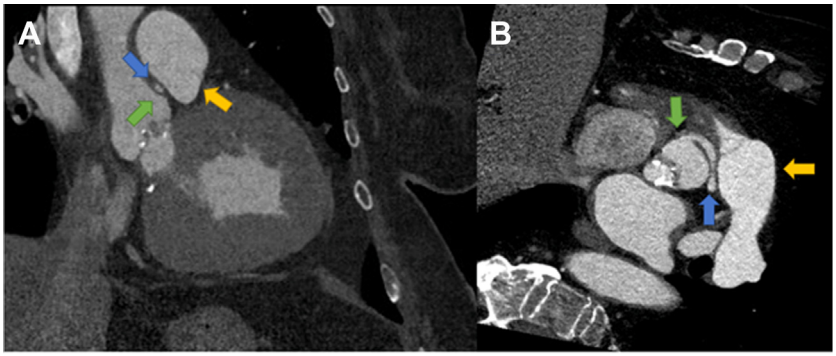
To the best of our knowledge, this is the first reported case of TAVR with an Evolut valve successfully implanted in a patient with abnormal origin of the LMCA from the opposite coronary sinus with an intramural course. Coronary artery anomalies (CAA) are a congenital condition characterized by either abnormal origin or course of the coronary arteries. The overall prevalence of CAA ranges from 0.78% to 1.30% based on coronary angiography and 0.99% to 5.80%, when based on data from coronary CT.[2] Most CAAs do not require further evaluation or intervention. However, some anomalies can cause myocardial

FIGURE 1 Severe Aortic Valve Calcification of All 3 Cusps



Aortic valve calcium **(A)** and calcium score **(B).**

FIGURE 2 Malignant Course of the Left Main Coronary Artery by Cardiac Computed Tomography

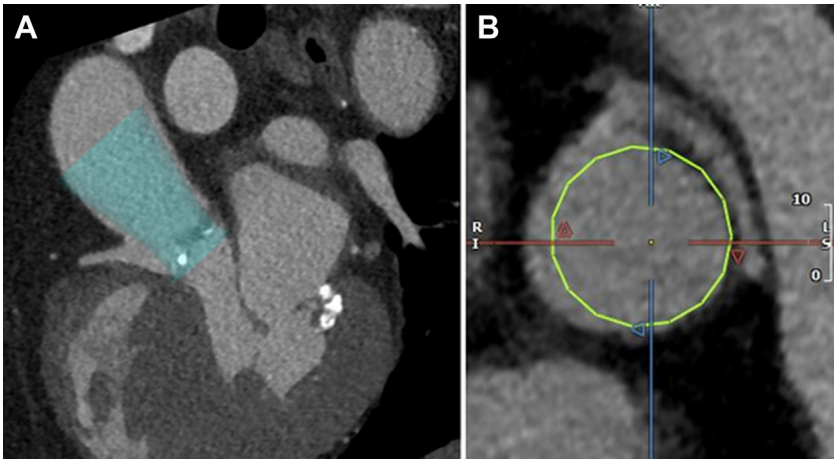


Cardiac computed tomography angiography coronal **(A)** and axial **(B)** images showing the origin **(green arrow)** and the intramural **(blue arrow)** course of the left main coronary artery (between the aorta and the main pulmonary artery, **yellow arrow**). Also seen is a 2:1 ratio of long to short diameter of the left main coronary artery, between the great vessels, known as the Angelini-Cheong sign.

ischemia, leading to clinical manifestations such as angina, myocardial infarction, congestive heart failure, ventricular aneurysms, or sudden cardiac death (SCD).[3] Features such as a high take-off, ostial stenosis, slit-like orifice, acute-angle take-off, intramural or interarterial course, or hypoplasia of the proximal coronary artery have all been proposed as high-risk features for myocardial ischemia and SCD.[3] Dynamic compression of the intramural segments during stress is also associated with increased risk of SCD, especially in young adults with an active lifestyle.[4] Currently, there is no specific data regarding the risk for SCD due to CAA in the elderly population (older than 65 years of age).[5]

There are several reports about TAVR in patients with CAA but only 2 in patients with malignant course of the LMCA.[6,7] Jay et al[6] placed a coronary wire to serve as protection for the LMCA during balloon

FIGURE 3 Valve Simulation Showing No Left Main Coronary Artery Compression



Transcatheter aortic valve replacement valve simulation on the computed tomography angiography images in 3-chamber view **(A)** and en-face view **(B)** predicting no post-procedural left main coronary artery compression.

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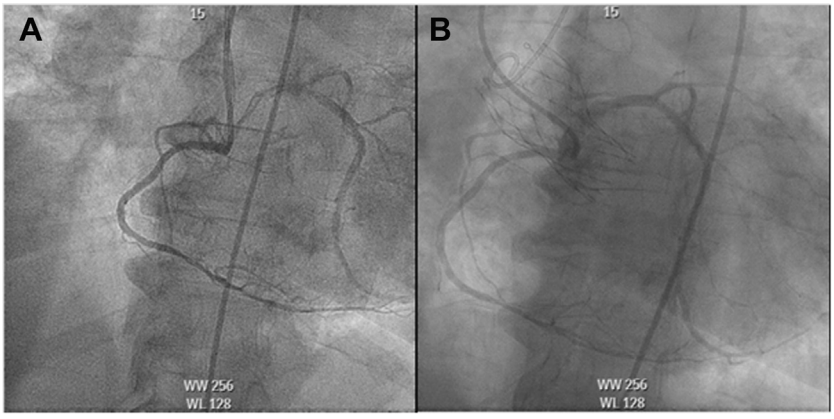
FIGURE 4 Preprocedure and Post procedure Coronary Angiography



Coronary angiography before **(A)** and after **(B)** the transcatheter aortic valve replacement procedure showing the patency of the left main coronary artery.

valvuloplasty and TAVR with a Sapien (Edwards Inc.) balloon-expandable aortic bioprosthesis. In the case by Mizote et al,[7] the patient became hemodynamically unstable immediately after implantation of the mechanical expanding Lotus valve (Boston Scientific Inc.) and was put on an extracorporeal membrane oxygenation. Selective coronary angiogram showed a significant stenotic lesion in the mid portion of LMCA, and a coronary stent was directly implanted at the stenotic lesion with regaining of hemodynamic stability. In this case, the lesion was presumably caused by the compression generated by the implanted Lotus valve.[7] In contrast to the previous case, in our patient, the sinus size, coronary heights, and the absence of plaque in the LMCA were such that there would be minimal expected interaction with the planned Evolut TAVR prosthesis. We believe that these CT parameters, in the context of the planned prosthesis, are crucial when pre-planning such cases. Indeed, our patient remained hemodynamically stable and post valve implantation coronary angiography showed no compromise of the anomalous LMCA. If indeed there was, further evaluation by either intravascular ultrasound or functional imaging would be indicated to determine if stenting the intramural segment with a coronary stent would be indicated.

CONCLUSIONS

We present the first case in the literature of a patient with severe aortic stenosis and anomalous origin of the LMCA from the opposite coronary sinus with an intramural course, who underwent successful TAVR with an Evolut valve. Although surgery is recommended for CAA with high-risk features, TAVR should be considered as an option for selected cases. Those cases should have a thorough heart team discussion, considering all treatment options, including the valve type. Further studies are indicated to confirm CT parameters that may predict outcomes, such as the lack of LMCA calcifications, the virtual distance from the prosthesis frame to the jeopardized artery, and its course.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS aortic valve, computed tomography, coronary vessel anomaly, valve replacement

APPENDIX For supplemental videos, please see the online version of this paper.