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Coronary Artery Protection with Chimney Stent in High-Risk Case of Coronary Occlusion in Transcatheter Aortic Valve Implantation

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ABSTRACT

Transcatheter aortic valve implantation (TAVI) has rapidly evolved in the last decade to become the treatment of choice for most patients with severe aortic stenosis. Acute coronary occlusion during TAVI is a rare and life-threatening complication with high morbidity and mortality rates. If coronary occlusion is considered highly likely to occur, a risk reassessment could favor surgical aortic valve replacement. An excessive surgical risk that mandates continuing with the transcatheter strategy requires coronary protection techniques. Coronary protection techniques include; Coronary wire protection, Chimney/snorkel stent technique, “Bioprosthetic Aortic Scallop Intentional Laceration to prevent Iatrogenic Coronary Artery obstruction,” (BASILICA) technique, Splitting devices, and UNICORN procedure. In this case report we present our first experience of the “Chimney/Snorkel stent technique” for coronary protection in a case where coronary occlusion risk was high due to low coronary height, small sinus of Valsalva, and use of balloon-expandable valve.

Keywords: coronary occlusion; Chimney/Snorkel stent technique transcatheter aortic valve implantation.

INTRODUCTION

Transcatheter aortic valve implantation (TAVI) has rapidly evolved in the last decade to become the treatment of choice for most patients with severe aortic stenosis.[1]The widespread use of this treatment has prompted advances in transcatheter heart valve prostheses and TAVI-enabling devices leading to the simplification of the procedure, reduction of the risk of complications, and improved short- and long-term outcomes.[2] Nevertheless, TAVI is still associated with potentially serious complications, including annular or aortic rupture, coronary artery occlusion(CO), myocardial infarction, stroke, or death.[3] Acute CO after TAVI is a rare and life-threatening event with high morbidity and mortality rates. It is estimated to occur in less than 1% of cases and has a reported mortality rate of approximately 40%. The left coronary artery is most commonly affected (88%).[4,5] The incidence of CO in large registries and randomized studies (0.35-4.0%)[5] but there is little information about predictors, clinical presentation, and treatment. The main predictive factors of coronary occlusion include female gender, low coronary ostia height (<12 mm), narrow aortic root (<30 mm at the sinus of Valsalva), patients with previous surgical bioprosthesis, and those receiving balloon-expandable valves.[4]These factors increase the likelihood of displacement of calcified native aortic cusps over the coronary ostium, shown to be the primary mechanism of coronary obstruction after TAVI. Other possible mechanisms involve (1) ostium obstruction by the bioprosthesis itself due to malposition; (2) low coronary ostia height and obstruction of flow even with a well-placed prosthesis; (3) dislodgment of calcium debris; (4) leaflet avulsion and migration into the coronary ostium; (5) aortic dissection; or (6) hematoma extending near or into coronary ostia.[6] If CO is considered highly likely to occur, a risk reassessment could favor Surgical aortic valve replacement. An excessive surgical risk that mandates continuing with the transcatheter strategy requires coronary protection techniques.[7]Coronary protection techniques include; Coronary wire protection, Chimney/Snorkel stent technique, “Bioprosthetic Aortic Scallop Intentional Laceration to prevent Iatrogenic Coronary Artery obstruction,” (BASILICA) technique, Splitting devices, and UNICORN procedure. In the “Chimney/snorkel stent technique” a coronary extension is

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fashioned parallel to the TAVI stent through the use of a coronary stent. In this case report we present our first experience of the “chimney” technique, for coronary protection in a case where CO risk was high due to low coronary height, small sinus of Valsalva, and use of the balloon-expandable valve.

CASE REPORT

A 77-year-old man presented in the outpatient department with a complaint of shortness of breath. ECG showed a normal sinus rhythm. The echocardiographic assessment revealed Concentric LVH, calcified aortic valve, Severe Aortic stenosis peak gradient of 89 mmHg and mean of 60 mmHg, and mild to Moderate aortic regurgitation. On multi-slice computed tomography (MSCT), the mean aortic annulus diameter was 23.7 mm, the annulus perimeter was 74.4 mm, the sinus of Valsalva's mean diameter was 27.4 mm, and the annulus area was 428.7 mm^2. The right and left coronary ostial heights were 13.1 mm and 11.3 mm, respectively as seen in Figure 1. The MSCT also revealed a Tricuspid Aortic Valve. Severe Aortic Valve Calcification as shown in Figure 1 and Figure 2.

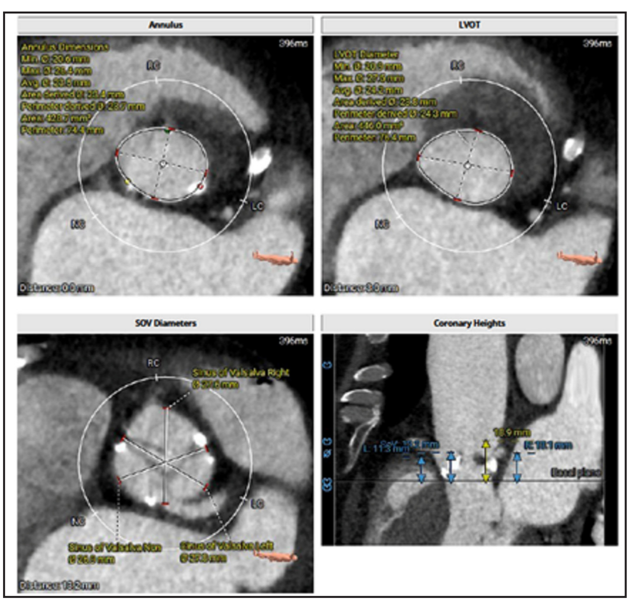

Figure 1. Annulus, LV outflow tract, Sinus of Valsalva.

The average diameters of the right common iliac (6.5 mm), external iliac (5.5 mm), and femoral (7.4 mm)

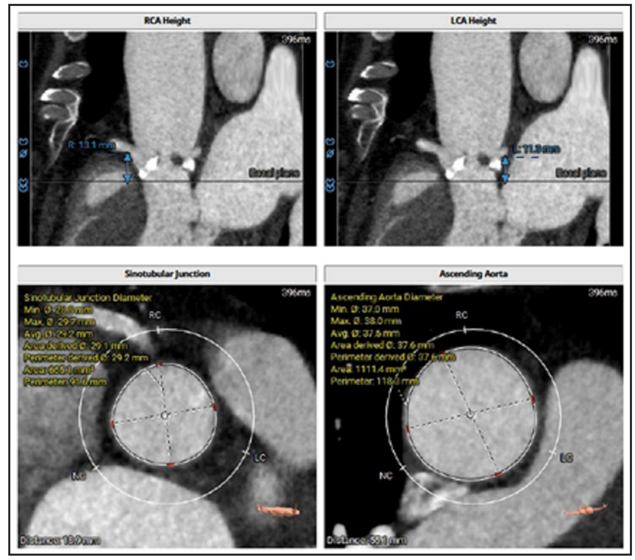

Figure 2. RCA, Left Coronary height, and Sinotubular junction.

arteries were observed to be normal. The average diameters of the left common iliac (6.5 mm), external iliac (5.5 mm), and femoral (7.4 mm) arteries were observed to be normal.

The choice of treatment options and their benefits was discussed with the patient, but the patient opted for TAVI. Written informed consent was obtained from both the patient and his family. A thorough assessment by a comprehensive heart team, consisting of a cardiac surgeon, anesthesiologist, and cardiologist, ensured that all necessary conditions for the intervention were met. The patient then underwent TAVI under local anesthesia and intraoperative transthoracic echocardiography (TTE) imaging guidance. The right and left femoral arteries, right radial artery, and right femoral vein were cannulated. A temporary pacemaker was inserted into the right ventricle through the right femoral vein. To guide valve placement and allow arteriography for positioning, a 6Fr pigtail catheter was introduced through a 6Fr sheath into the noncoronary sinus using the left-right radial artery. The transcatheter heart valve (THV) was delivered through the left femoral artery. After achieving all necessary arterial and venous accesses, intravenous unfractionated heparin was administered to maintain an activated clotting time of over 250 seconds. Through the right femoral artery, A 7 F EBU catheter was used to engage the left coronary system, All-star angioplasty wire was parked in the LAD. A 4x24 mm Promus premier stent (Chimney stent) was parked in the distal LAD with the help of Guidezilla

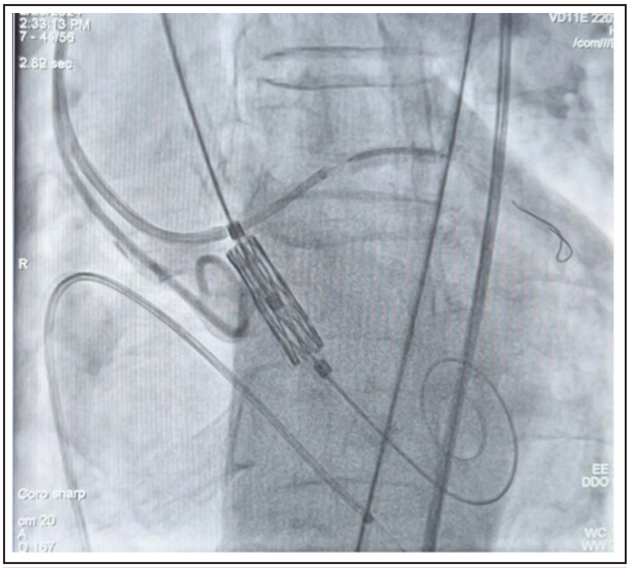

Figure 3. Chimney Stent with TAVI valve.

II Guide Extension Catheter as shown in Figure 3.
Using the left femoral artery access, a J-tipped, soft 0.035 mm wire was advanced into the descending thoracic aorta. Following the procedure, a two suture-mediated closure device (Perclose ProGlide, Abbott Cardiovascular, Abbott Park, IL, USA) was deployed for pre-closure while keeping arterial access through the J-tipped guidewire. Subsequently, a 14Fr Python expandable introducer sheath (Meril Life Sciences Pvt. Ltd., India) was advanced into the femoral artery. A 6Fr AL-1 catheter was threaded through the valve delivery sheath using a 145–150 cm 0.035-inch J-tipped guidewire. It was then switched to a straight-tip wire to navigate through the valve. After crossing the valve, the straight-tip wire was exchanged for a 300 cm J-tipped wire. The AL-1 catheter was replaced with a 6Fr angled pigtail catheter. A reshaped stiff guidewire, SAFARI 2™ (Boston Scientific, Marlborough, MA, USA), was advanced through the pigtail catheter into the left ventricle, positioning the guidewire's transition point above the apex, pointing away from the ventricular wall. The valve was pre-dilatated with an 18X40mm Mammoth balloon. During the balloon inflation, simultaneous aortography was done to ensure the patency of the coronary ostia. A 26 mm BE Myval THV was implanted under pacing at 180 beats/min. The placement was verified through a root aortogram using a pigtail catheter before and after deployment. The BE Myval THV was positioned at the native annulus as shown in Figure 4.

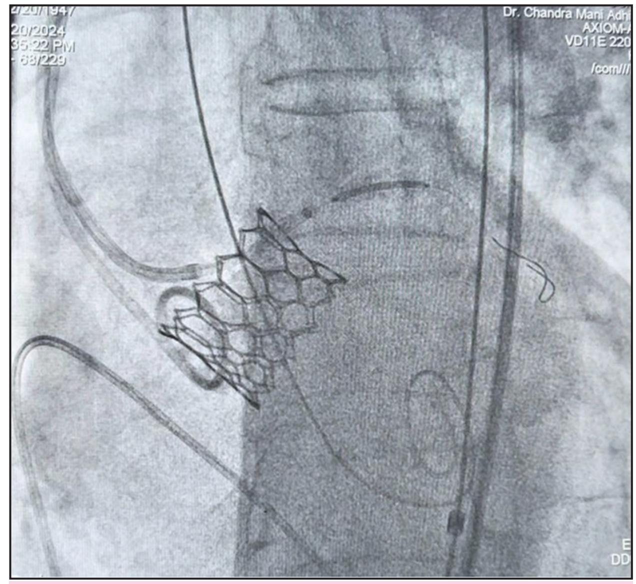

Figure 4. Myval THV with Chimney Stent.

Immediate post-deployment Transthoracic echocardiography (TTE) demonstrated a well-placed valve with

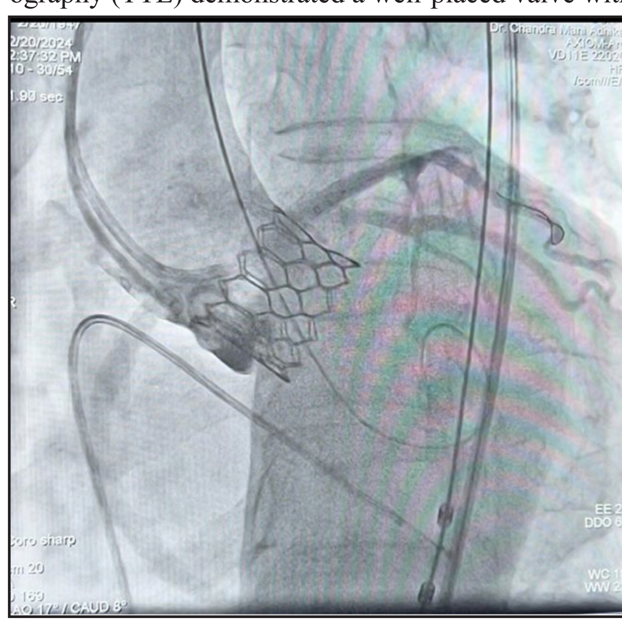

Figure 5.Deployed TAVI valve, Chimney Stent and coronary wire no coronary occlusion.

normal leaflet motion, no paravalvular leakage, and no coronary artery occlusions as shown in Figure 5.
The chimney stent, coronary wire, and guiding catheter were removed. After successful valve

implantation, the introducer sheath, catheter, and guidewires were removed, and the patient was transferred to the cardiac intensive care unit. The postoperative recovery period was uneventful, and echocardiography before discharge showed normally functioning prosthetic valve function with a mean aortic gradient of 11 mmHg and no paravalvular leakage. The patient was discharged on the third day in hemodynamically stable condition.

DISCUSSION

Among the 20 TAVI cases done so far in our center, this is the first case we used the Chimney Stent Technique. As this case is a high-risk case for CO. Low coronary height, Small SOV and use of BEV valve are the risk factors for coronary occlusion. TAVI is a rapidly adopted modality in the treatment of severe aortic stenosis and has expanded from inoperable to high, intermediate, and low surgical-risk patients.[8] TAVI still carries risks for complications that may critically influence the outcome, including coronary artery obstruction. Coronary artery occlusion tends to involve the left coronary artery more frequently than the RCA because of the naturally higher ostial takeoff of the RCA.[9] Coronary obstruction during TAVI for native aortic valve stenosis can occur due to anatomical or procedural-related factors. The established anatomical risk factors for coronary occlusion during TAVI in severe native aortic valve stenosis include the low origin of the coronary arteries, narrow sinus of Valsalva, calcium burden, and location of calcium on the cusp.[4,10,11] Also, although the 10-mm "safety cut-off" for coronary ostia height might help to prevent coronary obstruction during TAVI, approximately one-half of the patients who had this complication exhibited a coronary ostia height greater than 10 mm, suggests that a higher "safety cut-off" might be required and that factors other than coronary height (dimensions of sinuses of Valsalva and/or severe valve calcification) might probably play an important role in the occurrence of this complication. PCI was the preferred strategy for the treatment of coronary obstruction after TAVI. It is noteworthy that PCI was feasible and associated with a 91.3% success rate.[5] Preprocedural assessment of aortic valve anatomy using multidetector computed tomography is a crucial step to minimize and anticipate the potential risk of complications including aortic annulus rupture, perivalvular leak, and coronary occlusion.[9,12,13] Eventually, for patients who are deemed at considerable risk for coronary occlusion pre-TAVI CTA evaluation, transcatheter techniques such as coronary protection with a standard guidewire, placing a snorkel stent, or per performing BASILICA procedure is advisable to prevent and treat the potential occlusion.[14] Intraprocedural CO should be suspected in the presence of high-grade heart blocks, severe hypotension, lethal ventricular arrhythmias, or dynamic ST-segment changes. Therefore, a prompt angiographic assessment of coronary patency is imperative and rescue angioplasty is the mainstay therapy to prevent fatal complications.[15]

CONCLUSION

Our case had risk factors for CO which included; Low coronary height, Small SOV, and use of a BEV valve. The Chimney/Snorkel stent technique is useful in the treatment of CO if it happens during the TAVI procedure. This technique is easy to use. Though CO did not occur in our case this experience will help us to prepare us do complex TAVI procedures in the future.

Conflict of interest: None

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