Transcatheter Aortic Valve Implantation in Challenging Anatomies

Author: Laith Gergi, EMJ, London, UK

Citation: EMJ Int Cardiol. 2024;12[1]:17-20. https://doi.org/10.33590/emjintcardiol/JUFA1071.

TANJA Rudolph, Heart and Diabetes Center North Rhine-Westphalia, Germany; and Carla Romina Agatiello, Hospital Italiano de Buenos Aires, Argentina, chaired a captivating session exploring the challenges associated with transcatheter aortic valve implantation (TAVI) in patients with complex aortic stenosis. The European Association of Percutaneous Cardiovascular Interventions (EAPCI) hosted the session during the 35th Annual EuroPCR Global Course held in Paris, France, between the 14th–17th of May. The primary objectives of the session were to evaluate and emphasise the importance of detailed CT imaging and pre-procedural planning in TAVI. Moreover, the session focused on how the selected valve and implant techniques in aortic stenosis can be tailored to individual patient anatomy.

THE ERA OF TRANSCATHETER AORTIC VALVE IMPLANTATION

TAVI is a minimally invasive procedure employed in the treatment of patients with symptomatic severe aortic stenosis. Initially, TAVI was an alternative to surgical aortic valve replacement for patients with aortic stenosis identified as inoperable, and for higher-risk patients. However, since the first TAVI procedure more than two decades ago, its application has evolved and expanded across risk groups, encompassing low- and intermediate-risk patients, and becoming the most frequently performed structural technique in interventional cardiology. Nevertheless, a significant challenge for interventional cardiologists is the complex anatomical features that many patients referred for TAVI present with. Therefore, understanding the anatomical obstacles to successful TAVI, and optimising patient selection and device implantation, is crucial in improving prognosis.

LOW CORONARY ARTERY

Low coronary artery, where the distance between the aortic annulus and coronary ostia is short, is a significant challenge in TAVI as it elevates the risk of coronary artery obstruction (CAO), and can impact future coronary access. Lisabeth Rosseel from Algemeen Stedelijk Ziekenhuis in Aalst, Belgium, presented the complexities and strategies in TAVI for patients with highly calcified tricuspid aortic stenosis and low coronary arteries. Rosseel emphasised the critical role of pre-procedural planning, including the precise selection of balloon size and the decision between balloon-expandable valves and self-expanding valves. These choices are essential to avoid complications such as CAO, particularly in patients with low coronary arteries. Though infrequent, CAO is a significant concern due to its severe outcomes. The incidence of CAO in native valves is 0.6%, with a 30-day mortality rate between 8–41%.[1] In valve-in-valve (ViV) procedures, the incidence increases to 2–3% with a 30-day mortality rate of up to 51%.[1] The incidence of CAO in native aortic stenosis is higher than in ViV TAVI as it is more frequently performed, but the risk of obstruction is higher in ViV.[1]

Rosseel explained that CAO mechanisms include leaflet calcification, displacement of calcified leaflets, and obstruction by the transcatheter heart valve (THV) skirt or commissure of the TAVI valve. The diseased native or bioprosthetic leaflets displace towards the coronary artery ostia or the sinotubular junction; otherwise, the skirt of the THV can directly obstruct the coronary artery. Anatomical risk factors in native valve procedures include low coronary height (<10–12 mm), small Sinus of Valsalva (<28–30 mm), and a Vent-to-Coronary distance <4 mm. Rosseel noted a CAO risk in ViV TAVI cases where prior stenting by prosthesis occurred, where the leaflet was mounted on the outside of the prosthesis.

Since the first TAVI procedure more than two decades ago, its application has evolved and expanded across risk groups

CORONARY ARTERY OBSTRUCTION PREDICTION

Rosseel discussed a recent study where researchers developed a novel computed tomography-based multivariate prediction model for CAO from TAVI in native aortic stenosis.[1] This study comprised 60 patients with angiographically confirmed CAO and 1,381 without obstruction, evaluating the relationship between various anatomical artery measurements and CAO. Khan et al.[1] identified that annular area and perimeter, coronary height, sinus width, and STJ height were significantly smaller in patients with CAO, and that CAO was most commonly located in the left coronary artery ostium. The model demonstrated that when the cusp height is higher than the coronary height, with a virtual valve-to-coronary distance ≤4 mm or a culprit leaflet calcium volume >600 mm^3, the patient can be considered high-risk for CAO, and likely requires protection.[1]

TECHNIQUES TO PREVENT AND MANAGE CORONARY ARTERY OBSTRUCTION

To address CAO risks, Rosseel discussed preventive measures in TAVI, including reconsidering surgical aortic valve replacement (SAVR), using retrievable valves, which allow repositioning if CAO risk is identified, avoiding THV oversizing, and deeper valve implantation. More advanced techniques mainly consist of chimney stenting and bioprosthetic or native aortic scallop intentional laceration to prevent iatrogenic coronary artery obstruction during TAVR (BASILICA). The BASILICA technique involves splitting the leaflet via electrocauterisation to maintain coronary flow, and has emerged as a practical protective step.[2] Khan et al.[2] demonstrated that BASILICA is a safe method to avoid CAO, maintaining coronary patency up to 1 year post-procedure, particularly in VIV procedures. Rosseel also covered chimney

> **The incidence of CAO in native aortic stenosis is higher than in ViV TAVI as it is more frequently performed, but the risk of obstruction is higher in ViV**

stenting, where a protective wire is placed in the coronary artery to deploy a stent if necessary. Pre-emptive coronary protection significantly improves survival rates, according to data from the chimney registry.

Rosseel's presentation underscored the importance of individualised approaches and advanced procedural techniques in managing TAVI for patients with low coronary arteries. She expanded by explaining that, in the past, it has been the status quo to protect the coronary artery whenever a risk of CAO is suspected. However, there are new multivariate prediction models that allow interventional cardiologists to detect patients in real risk of CAO who need either protection or alternative strategy. Finally, she stressed the importance of ensuring commissure alignment, detailed pre-procedural planning using CT imaging and simulations to select appropriate methods and devices, and pre-emptive measures, such as BASILICA or chimney stenting for high-risk patients.

VALVE-IN-VALVE TRANSCATHETER AORTIC VALVE IMPLANTATION

Matti Adam, University Hospital Cologne, Germany, presented an insightful session on ViV TAVI. The session focused on the intricacies and challenges of managing structural valve degeneration in patients with previous SAVR. ViV-TAVI has emerged as a vital option for managing deteriorating surgical bioprosthetic valves. However, it is not universally applicable due to potential complications such as patient-prosthesis mismatch (PPM), particularly in patients with small aortic roots or undersized original prostheses. Adam highlighted the 2022 EuroIntervention guidelines, which underline that, while ViV is an established treatment option, it is not feasible in all patients due to the increased likelihood of PPM and thus, CAO, necessitating careful patient selection in ViV-TAVI.

Adam emphasised the diversity of surgical valves; stented, stentless, with internal or external leaflets, and rapid deployment or sutureless designs. These variations necessitate detailed pre-procedural planning to address interactions between the existing surgical valve, native anatomy, and the new TAVI valve.

Effective planning involves a thorough understanding and measurement of the existing surgical valve. Clinicians must know the valve's inner diameter, height, true internal diameter, and left ventricular outflow tract diameter. Accurate patient anatomy assessment is also crucial, focusing on left and right coronary artery height, STJ height, and width. Adam stressed the importance of specific measurements such as the valve-to-coronary and valve-to-STJ distance. These parameters are vital to evaluate the risk of CAO. A valve-to-coronary distance of 4 mm and a valve-to-STJ distance >3.5 mm are considered safe thresholds, while intermediate values (2.5–3.5 mm) necessitate caution.

VALVE CRACKING

High gradients, indicative of PPM, are a significant concern in ViV TAVI, especially with SAVR valves labelled ≤21 mm.[3] Research indicates worse 1-year mortality for patients with SAVR inner diameters <21 mm.[3] Bioprosthetic valve fracture (BVF) is a technique that can alleviate high gradients, enhancing haemodynamic outcomes. This technique involved fracturing the sewing ring of the SAV with high-pressure, non-compliant balloon inflation. Adam presented a publication by Brinkman et al.[4] which demonstrated that THV device success

> ViV-TAVI has emerged as a vital option for managing deteriorating surgical bioprosthetic valves

was higher in patients BVF ViV-TAVI at 93%, compared to 68.4% in patients with ViV-TAVI without BVF. However, a publication by Chhatriwalla et al.[5] showed that mortality increased if BVF was deployed before ViV-TAVI in patients with BVF. Mortality was 4.9% in patients with BVF versus 1.7% in patients without BVF (P=0.02; odds ratio: 2.9; 95% confidence interval: 1.2–2.9).. Nevertheless, the study also revealed that patients with post-implant BVF had an unchanged mortality, but a decreased aortic valve gradient and increased aortic valve area, which had remained unchanged in pre-implant BVF.[5] Therefore, post-implant BVF is likely to yield better results for patients.

Adam's session underscored that ViV-TAVI is a robust treatment for failing surgical valves but requires meticulous planning to address PPM and coronary obstruction. BVF can significantly improve outcomes, and procedural success hinges on comprehensive pre-procedural assessment and strategic planning.

CONCLUSION

The talks by Rosseel and Adam presented at the symposium and highlighted in this feature demonstrate the critical importance of detailed CT imaging and personalised pre-procedural planning in TAVI to navigate the anatomical complexities of aortic stenosis. Advanced techniques and individualised approaches, such as the BASILICA procedure and BVF, are essential for mitigating risks like PPM and CAO, and ensuring optimal outcomes for patients with challenging anatomies.

References

1. Khan JM et al. Coronary obstruction from TAVR in native aortic stenosis: development and validation of multivariate prediction model. Cardiovasc Interv. 2023;16(4):415-25.
2. Khan JM et al. Preventing coronary obstruction during transcatheter aortic valve replacement: results from the multicenter international BASILICA registry. Cardiovasc Interv. 2021;14(9):941-8.
3. Bleiziffer S et al. Long-term outcomes after transcatheter aortic valve implantation in failed bioprosthetic valves. Eur Heart J. 2020;41(29):2731-42.
4. Brinkmann C et al. Outcome of VIV-TAVI with and without BVF. EuroIntervention. 2021;17(10):848.
5. Chhatriwalla AK et al. Outcomes of bioprosthetic valve fracture in patients undergoing valve-in-valve TAVR. Cardiovasc Interv. 2023;16(5):530-9.

