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EDITORIAL COMMENT

Repeat Transcatheter Aortic Valve Implantation

The Importance of Getting it Right the First Time Round!*

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Transcatheter aortic valve replacement (TAVR) is increasingly being performed among younger patients with longer life expectancies.[1] Lifetime management is now a paramount concept when evaluating patients for surgical aortic valve replacement (SAVR) or TAVR as their index procedure, including considerations for repeat interventions later in life. Although TAVR-in-SAVR is well understood and frequently performed,[2] options for redo intervention after TAVR are less clear.[3,4] SAVR after degenerated TAVR portends more complex procedures that are associated with higher mortality and morbidity compared with SAVR for native valves.[5] TAV-in-TAV (redo TAVR) involves several important considerations and clinical experience is still pretty limited. For one, unlike TAV-in-SAV, the native aortic leaflets are still present when performing TAV-in-TAV.[6] The risk of direct coronary occlusion or sinus of Valsalva (SOV) sequestration and subsequent coronary access are important concerns. In addition, other aspects that are unique to TAVR include asymmetric shortening, prosthesis tilt, prosthesis frame deformation, leaflet asymmetry, etc., which may all have a bearing on subsequent implants.[7] TAV-in-TAV can be procedurally complex and the hemodynamic performance of new transcatheter heart valve (THV) after redo TAVR can be suboptimal.[3,8]

Several reports have described the clinical, anatomical, and technical determinants of outcomes after TAV-in-TAV.[3,9,10] Many of these data were based on studies in Western populations. There is a paucity of data regarding issues with TAV-in-TAV among more diverse groups of patients. Patients of Asian origin typically have a smaller body mass index and aortic anatomy than their non-Asian counterparts, with an attendant higher risk of SOV sequestration and coronary occlusion. In this issue of *JACC: Asia*, Miyawaki et al[11] report the results of their single-center study from Kokura Memorial Hospital, Japan, on patients undergoing TAVR. A total of 1,122 patients with pre- and post-TAVR computed tomography (CT) images between 2016 and 2022 were included. Balloon-expandable valves (BEVs) (Edwards Sapien S3) were more commonly used (69.5%); 85% were either 23 or 26 mm in diameter, and self-expanding valves (SEVs) (Medtronic Evolut R or Pro) were implanted in the rest; 82% were either 26 or 29 mm in diameter. Risk of SOV sequestration for future redo TAVR was defined as a TAVR commissure level located above the ST-junction (STJ) and THV-to-STJ distance <2.0 mm in each coronary sinus (2 mm being the approximate size of a 6-F diagnostic coronary catheter) on routine follow-up CT scanning. Based on this definition, a *potential* risk of coronary occlusion on either side was identified among an astonishingly high number of patients: 52.1% of BEVs and 71.3% of SEVs (more common on left). On multivariable analysis, independent predictors of SOV sequestration with redo TAVR were smaller STJ diameter, higher implantation of initial THV prosthesis for both SEV and BEV, as well as greater degree of oversizing and shorter STJ height in BEV. THV commissure in front of the coronary ostium was noted in ~6% of BEV patients and ~46% of SEV patients, which would render bioprosthetic or native aortic scallop intentional laceration to prevent iatrogenic coronary artery obstruction

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TABLE 1 Summary of Studies on CIT Identified Risk of Sinus Sequestration With TAV-in-TAV

First Author, Year	Country of Origin	Definition of Sinus Sequestration	Reported Risk of Sinus Sequestration for Future Redo TAVR in ≥1 Coronary Artery	Proportion With Risk Not Potentially Remediable Using Leaflet Modification Procedures (%)
Miyawaki, 2023 (n = 1,122)[11]	Japan	TAVR commissure level located above the STJ AND THV-to-STJ distance <2.0 mm in each coronary sinus	52.1% Sapien S3 (BEV), 71.3% Evolut R/Pro (SEV)	BEV: 6.5% LCA, 5.3% RCA SEV: 45.0% LCA, 46.7% RCA
Ochiai, 2023 (n = 418)[12]	Japan	TAVR commissure level located above the STJ AND THV-to-STJ distance <2.0 mm in each coronary sinus	17.6% in the HIT group (n = 108) and 5.3% of patients in the CIT group (n = 150) for Sapien S3 (BEV) 64.0% in the HIT group (n = 50) and 41.8% in the CIT group with Evolut R/PRO/PRO + (SEV)	BEV: 9.5% HIT, 12.5% CIT SEV: 39.6% HIT, 52.9% CIT
Ochiai, 2020 (n = 411)[13]	United States	TAVR commissure level above the STJ and distance between TAV OR THV-STJ distance <2.0 mm in each coronary sinus	2% Sapien S3 (BEV), 45.5% Evolut R/Pro (SEV)	BEV: 11.9% SEV: 45.2%
Sato, 2023 (n = 308)[14]	Japan	TAVR commissure level located above the STJ AND THV-to-STJ distance <2.0 mm in each coronary sinus	39% Sapien S3 (BEV)	NA
Chen, 2022 (n = 288)[15]	China	1) Both the VTSTJ and STJ-commissure distances were <2.0 mm if the THV commissure level was between the coronary ostium and the STJ OR 2) either the VTSTJ distance or the VTA distance was <2.0 mm if the THV commissure level was above the STJ	25.7% VenusA-valve (SEV)	61.5% for LCA, 58.8% for RCA
Forrestal, 2022 (n = 81)[16]	United States	TAVR commissure level located above the STJ AND THV-to-STJ distance <2.0 mm in each coronary sinus	23% Evolut PRO/PRO + (SEV)	NA
Rogers, 2020 (n = 137)[17]	United States	TAVR commissure level located above the STJ AND THV-to-STJ distance <2.0 mm in each coronary sinus	13.1% Sapien S3 (BEV)	8.7%

BEV = balloon-expandable valve; CIT = conventional implantation technique; HIT = high implantation technique; LCA = left coronary artery; NA = not available; RCA = right coronary artery; SEV = self-expanding valve; TAVR = transcatheter aortic valve replacement; THV = transcatheter heart valve; STJ = sinotubular junction; VTA = virtual transcatheter valve to aorta; VTSTJ = virtual transcatheter heart valve to sinotubular junction.

(BASILICA) as an unfeasible option to mitigate against the risk of coronary obstruction.

The authors are to be applauded for their excellent and impactful analysis. Of note, the analysis by Miyawaki et al[11] is one of the largest to date to evaluate the CT-predicted risk of sinus sequestration in an Asian patient population. The methodology pursued seems robust. For instance, the authors excluded patients with prior bypass grafting from their analysis. The study further assessed independent predictors of SOV sequestration with TAV-in-TAV after both SEVs and BEVs, which may help operators optimize their initial implant. For instance, aiming for higher implantation depths to lower pacemaker rates should be balanced against the risk of coronary obstruction with future implants.[12] Similarly, efforts should be made to avoid undue oversizing (>5%-10%) when sizing a THV for the initial implant.[6] Leaflet modification techniques such as BASILICA may soon become an essential skillset for TAVR operators, although as noted in this study, even that may not always mitigate against coronary obstruction in a substantial proportion of patients. A higher risk of SOV sequestration with SEVs may also factor into valve choice, along with other factors, such as durability and hemodynamics.

The study also should be interpreted in the context of certain limitations. Because this is a CT-based simulation exercise, a key component is the definition used to define the risk of SOV sequestration. This distinction is important when comparing the rates of potential coronary occlusion across these studies (**Table 1**). Next, although clinical experience is limited, reported TAV-in-TAV coronary obstruction rates are generally comparable to TAV-in-SAV (~2%-5%); reconciling these with a potential 50% to 70% risk outlined in this study is challenging.[2,3] Further, in addition to design of the first THV, the choice of the second THV may additionally influence the risk of coronary obstruction. For instance, it may be possible to lower the neoskirt height for SEVs by deliberately implanting a short-stent frame BEV lower inside the first THV and allowing the leaflets of the first to overhang rather than to be pinned fully open, particularly if the failure mode is aortic regurgitation.[8] This can be hard to account for in studies such as the current one, which typically assume the worst case scenario in which the first TAVR leaflets are pushed completely open by the second TAV and seal the stent frame circumferentially. Some important details are not available for this study. For instance, the authors do not report how they defined commissural level in cases of Sapien 3 implantations, a key component in defining CT-identified risk of SOV sequestration. Bench studies have defined the neoskirt height for Sapien S3 as 23-mm and 26-mm THVs (most Sapien 3 THVs used in this study) to be below the top of the frame by 1.5 and 1.8 mm, respectively (not at the top of the frame, as commonly perceived).[18] Further, CT-based assessments can suffer from blooming and other artifacts. These seemingly minor differences in measurement could have large clinical impacts. Second, compared with other similar reports in Asian populations,[11,12,14,15] the current analysis had a significantly older patient population with smaller reported body surface areas. Finally, the study spanned a relatively long duration time (2016 to 2022). During such a time period, many of the preceding concepts have evolved and could have affected the study results.

Overall, the current analysis contributes to the growing body of literature regarding predicting risk of SOV sequestration and thereby potential coronary obstruction with redo TAVR, especially among Asian patients. This is likely to be an important problem for TAVR operators in the future and we will need to continue research into ways of surmounting this challenge going forward. The planning for redo TAVR should begin with meticulous planning of the initial TAVR procedure: every consideration should be pursued to optimize the initial implantation in case a subsequent implant is necessary down the road.

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