Editorial

Transcatheter aortic valve replacement aortic root orientation: implications for future coronary access and redo transcatheter aortic valve replacement

Sophia L. Alexis[1], Syed Zaid[2], Aditya Sengupta[1], Stamatios Lerakis[3], Sahil Khera[3], Samin K. Sharma[3], Annapoorna Kini[3], Gilbert H. L. Tang[1]

[1]Department of Cardiovascular Surgery, Mount Sinai Health System, New York, NY, USA; [2]Division of Cardiology, Westchester Medical Center, Valhalla, NY, USA; [3]Division of Cardiology, Mount Sinai Hospital, New York, NY, USA

Correspondence to: Gilbert H. L. Tang, MD, MSc, MBA. Department of Cardiovascular Surgery, Mount Sinai Health System, 1190 Fifth Avenue, GP2W, Box 1028, New York, NY 10029, USA. Email: gilbert.tang@mountsinai.org.

Submitted Feb 26, 2020. Accepted for publication Apr 15, 2020.
doi: 10.21037/acs-2020-av-10
View this article at: http://dx.doi.org/10.21037/acs-2020-av-10

Introduction

As transcatheter aortic valve replacement (TAVR) evolves across the spectrum of younger and low-risk patients, the issue of transcatheter heart valve (THV) orientation during initial deployment is becoming increasingly more important. Lack of commissural alignment may lead to varying degrees of overlap between the neo-commissural posts and coronary arteries, thus disrupting laminar coronary flow and jeopardizing the success of redo-TAVR and coronary re-access procedures (1-5). Furthermore, THV leaflet stress and central aortic regurgitation may theoretically be exacerbated with suboptimal commissural alignment (6,7). While native leaflets are excised and commissures are aligned during surgical aortic valve replacement (SAVR), native leaflets during TAVR often act as barriers over open stent frames and may impair coronary cannulation (1,7). The matryoshka doll analogy comes to mind with redo-TAVR, as layers of leaflets and stents appose each other and the existing THV potentially causes coronary obstruction by creating a cylinder-like effect in the aortic root. We herein give our opinion on the most important features of commissural alignment and the nuances between the two types of commercially available THVs.

Imaging

To ascertain appropriate THV orientation, one must first have reliable imaging. Our group was the first to propose the technique of multi-detector computed tomography (MDCT)-fluoroscopy co-registration to determine THV orientation without post-TAVR MDCT (8). We measure the en-face angle between the left main (LM) and right coronary arteries (RCA) using pre-TAVR MDCT. Then, as described in our initial paper and the ALIGN-TAVR Study, we capture the THV orientation in the three-cusp coplanar fluoroscopic view and co-register it onto our coplanar MDCT axial images using 3Mensio Valves software (Pie Medical Imaging version 9.1, Masstricht, The Netherlands) (4). Based on the fluoroscopic THV orientation, we can superimpose a virtual image of the SAPIEN 3 THV with twelve crowns at the outflow (Edwards Lifesciences LLC, Irvine, CA, USA), or of the Evolut THV with twelve or fifteen crowns (depending on THV size, including the C-tab) at the outflow (Medtronic Inc, Minneapolis, MN, USA), over the MDCT axial annular and sinus of Valsalva images derived from the 3Mensio Valves software (4). Based on this co-registration technique, one can determine if there is severe overlap (0–20°) between a neo-commissure and coronary orifice (4,5,8).

Unique valve features

Evolut

The Evolut valve has a unique "hat" marker that can be positioned during valve deployment in one of four positions: anterior or posterior in the center of the deployment device [center front (CF), center back (CB)] or in the inner curve (IC) or outer curve (OC) of the aortic annulus (4,8). Our group found improved commissural alignment in 198 patients with OC/CF "hat" positions versus 47 patients with IC/CB positions. This translated to a significant reduction in neo-commissure/LM overlap (15.7% *vs.* 66.0%, P<0.001), neo-commissure/RCA overlap (7.1% *vs.* 51.1%, P<0.001), neo-commissure/LM and RCA overlap (2.5% *vs.* 40.4%, P<0.001), and neo-commissure/LM or RCA or both overlap (20.2% *vs.* 76.6%, P<0.001) (4). The best method used to achieve OC/CF "hat" orientation involves starting with the flush port at 3 o'clock when inserting the Evolut delivery catheter into the femoral artery (4).

Because the Evolut valve extends above the sinotubular junction (STJ) and coronary ostia, commissural alignment may facilitate coronary re-access. In a recent state-of-the-art review, our group cautions implanters who use the Evolut THV with a coronary ostium height <10 mm, although this provides reassurance that the narrower waist of this valve in larger sinuses creates a buffer (2).

SAPIEN 3

SAPIEN 3 valve can have 1 commissure crimped at 3, 6, 9, or 12 o'clock orientation relative to the delivery catheter to track the initial deployment orientation. Unlike the Evolut valve, initial Sapien 3 crimping orientation in 483 patients in the ALIGN-TAVR study had no impact on commissural alignment and the incidence of severe coronary overlap, with the exception of a higher incidence of RCA overlap with 6 o'clock crimping (P=0.003) (4).

Rogers *et al.* studied the impact of post-TAVR MDCT analysis on commissural orientation in 137 low-risk patients who mostly received SAPIEN 3 THVs, and found that 8.7% of patients exhibited high-risk alignment, with the THV rising above the ostium and an obstructing commissural post (9). Even with a subgroup intentionally crimping in what was thought to be a favorable position, there was no impact on alignment (P=0.69). Eighteen out of the 137 (13.1%) low-risk patients were flagged for tenuous coronary ostia patency if they were to be considered for TAVR-in-TAVR, as their THV frame rose above the STJ and their valve-to-STJ distance was <2 mm. Their native leaflets against the outer TAVR stent and its leaflets against the inner TAVR stent would effectively form a covered graft, thus encroaching on the coronary ostia (9).

While the lower stent profile of the SAPIEN 3 valve compared to other taller THVs could facilitate easier coronary cannulation above or through the superior aspect of the frame (4), our pilot angiographic study, using a novel aortic root anatomic classification, showed that TAVR-in-TAVR may not be feasible in >20% of SAPIEN 3 TAVR and in >50% among patients with unfavorable aortic root anatomy, in which sinus height is less than THV height (10). This finding was similarly reported by Rogers *et al.* in the Low Risk Trial (9).

Future directions

Surgeons now increasingly consider future valve-in-valve options when performing SAVR in younger patients. This may make them more likely to implant a biologic versus mechanical prosthesis. With a surgical bioprosthesis, TAVR-in-SAVR can be performed even when there is a risk of surgical leaflet-to-coronary obstruction if BASILICA (Bioprosthetic or native Aortic Scallop Intentional Laceration to prevent Iatrogenic Coronary Artery obstruction) can be successfully performed for the deficient sinus/sinus sequestration (11). Performing BASILICA does not provide immunity to neo-commissure/coronary overlap; one has to ensure that the THV neo-commissure does not cover the lacerated opening or it would still cause coronary obstruction. One particular situation where BASILICA may not be possible is in TAVR-in-TAVR, where poor initial alignment may direct the trajectory of the electrified piercing wire into suboptimal territory (1,4).

Conclusions

Given the known correlation between aortic stenosis and coronary artery disease, the ability to safely access the coronaries in TAVR patients for diagnostic and therapeutic purposes is of the utmost importance (2,5,9). With improper alignment, over 30–50% of TAVR cases can potentially have neo-commissure/coronary overlap (4). We have shown that this can be mitigated with optimal "Hat" marker positioning of the supra-annular, Evolut THV (4). The opportunity for re-access by traversing the stent frame will present itself, as TAVR valves are placed in lower risk and younger patients. The surgical literature has shown that younger patients have accelerated prosthetic valve degeneration compared to their older counterparts. Therefore, we need to consider initial TAVR orientation as TAVR-in-TAVR increases in prominence (3). By paying attention to how we deploy valves now, we can help the implanters of the future provide optimal patient care.

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: GHLT has served as a physician proctor for Medtronic and a consultant for Abbott Structural Heart, Medtronic and W. L. Gore & Associates. The other authors have no conflicts of interest to declare.

References

1. Tang GHL, Kaneko T, Cavalcante JL. Predicting Feasibility of post-TAVR Coronary Access and Redo TAVR. More Unknowns than Knowns. JACC Cardiovasc Interv 2020;13:736-8.
2. Yudi MB, Sharma SK, Tang GHL, et al. Coronary angiography and percutaneous coronary intervention after transcatheter aortic valve replacement J Am Coll Cardiol 2018;71:1360-78.
3. Buzzatti N, Romano V, De Backer O, et al. Coronary access after repeated transcatheter aortic valve implantation: a glimpse into the future. JACC Cardiovasc Imaging 2020;13:508-15.
4. Tang GHL, Zaid S, Fuchs A, et al. ALIGNment of Transcatheter Aortic-Valve neo-commissuRes (ALIGN TAVR): Impact on Final Valve Orientation and Coronary Overlap. JACC Cardiovasc Interv 2020;13:1030-42.
5. Tang GHL, Zaid S, Ahmed H, et al. Transcatheter Valve Neo-Commissural Overlap With Coronary Orifices After Transcatheter Aortic Valve Replacement. Circ Cardiovasc Interv 2018;11:e007263.
6. Gunning PS, Vaughan TJ, McNamara LM. Simulation of self-expanding transcatheter aortic valve in a realistic aortic root: implications of deployment geometry on leaflet deformation. Ann Biomed Eng 2014;42:1989-2001.
7. Fuchs A, Kofoed KF, Yoon SH, et al. Commissural alignment of bioprosthetic aortic valve and native aortic valve following surgical and transcatheter aortic valve replacement and its impact on valvular function and coronary filling. JACC Cardiovasc Interv 2018;11:1733-43.
8. Tang GHL, Zaid S, Gupta E, et al. Impact of initial Evolut transcatheter aortic valve replacement deployment orientation on final valve orientation and coronary reaccess. Circ Cardiovasc Interv 2019;12:e008044.
9. Rogers T, Greenspun BC, Weissman G, et al. Feasibility of coronary access and aortic reintervention in low-risk TAVR patients. JACC Cardiovasc Interv 2020;13:726-35.
10. Tang GHL, Zaid S, Gupta E, et al. Feasibility of Repeat TAVR After SAPIEN 3 TAVR. JACC Cardiovasc Interv 2019;12:1290-2.
11. Lederman RJ, Babaliaros VC, Rogers T, et al. Preventing Coronary Obstruction During Transcatheter Aortic Valve Replacement: From Computed Tomography to BASILICA. JACC Cardiovasc Interv 2019;12:1197-216.

Cite this article as: Alexis SL, Zaid S, Sengupta A, Lerakis S, Khera S, Sharma SK, Kini A, Tang GHL. Transcatheter aortic valve replacement aortic root orientation: implications for future coronary access and redo transcatheter aortic valve replacement. Ann Cardiothorac Surg 2020;9(6):502-504. doi: 10.21037/acs-2020-av-10

