Review of: "Mitral surgical redo versus transapical transcatheter mitral valve implantation"

David Muller, Sara Hungerford

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Review for “Mitral surgical redo versus transapical transcatheter mitral valve implantation”.

Sara Hungerford MBBS and David W.M. Muller MBBS, MD

Redo surgery for degenerated biological mitral valve (MV) prostheses or failed annuloplasty is estimated to occur in more than one-third of all patients with biological mitral valves (1). Although redo surgery remains the gold standard in management for these patients, for those with complex comorbidities such as congestive cardiac failure, the appropriateness and timing of mitral valve surgery remains controversial because of a high peri-operative mortality and lack of clear survival advantage (2, 3). Recent advances in transcatheter valve technologies have created an environment in which transcatheter mitral valve replacement (TMVR) techniques have emerged. Trans-apical ‘valve-in-valve’ TMVR (TA-TMVR) with the Sapien XT/3™ (Edwards Lifesciences, Irvine, CA) is one such option. Details of this procedure have been described previously (4-6). To-date, direct comparison of redo surgical MV replacement (SMVR) and TA-TMVR has not been performed.

In this issue of PLOS ONE, *Zubarevich et al (Mitral surgical redo versus transapical transcatheter mitral valve implantation)* conducted a retrospective, non-randomized single center study to investigate the difference in outcomes between high-risk patients who underwent either SMVR or TA-TMVR (7). Patients were included if they required a redo mitral valve procedure for either a dysfunctional biological mitral valve prosthesis or a failed ring-annuloplasty. Exclusion criteria included concomitant coronary artery bypass grafting, but patients were not excluded if surgical tricuspid valve annuloplasty was performed for significant tricuspid regurgitation (7). Seventy-four patients were enrolled (33 SMVR and 41 TA-TMVR). Evaluation included a comparison of baseline demographic and clinical characteristics, transthoracic echocardiogram (TTE), hemodynamic parameters, intra-operative variables and post-operative outcomes.

Primary endpoints were defined as 30-day and 1-year mortality. The secondary endpoint was defined as the development of any procedural complication(s) (7).

From the outset, there was a significant difference in age (SMVR vs TA-TMVR) (63.7 vs 73.6 years; p=0.001), Euroscore (18.2 vs 21.2%; p=0.024), STS-score (10.2 vs 11.9%; p=0.003), left ventricular (LV) ejection fraction (EF) (52 vs 46%; p=0.03) and mean pulmonary artery systolic pressure (50 vs 63mmHg; p=0<0.001) which somewhat confounds subsequent analysis (7). There was, however, no significant difference in pre-operative severity of MR or TR (7). Patients who underwent SMVR had a longer procedural time and duration in ICU (4 vs 2 days; p<0.001) as might have been expected (7). There was no significant difference between the two groups in inpatient mortality (15.2 vs 7.3%; p=0.45), 30-day (15.2 vs 9.8%; p=0.50), 1-year or 3-year mortality (p=0.19), although there was a trend towards higher short-term mortality in the SMVR group. Inversely, there was a trend towards increased 1-year (25.4 vs 18.3%; p=0.19) and 3-year mortality in the TA-TMVR group. There was no stroke, vascular complication, or myocardial infarction across the entire cohort. Both procedures were generally well tolerated with cardiogenic shock occurring sparingly (12 vs 7%; p=N/S) (7). Overall, the study demonstrated that both SMVR and TA-TMVR could be completed safely with a high technical procedural success rate even though TA-TMVR patients had poorer pre-morbid function (7).

For patients with degenerative biological mitral valve prostheses or failed annuloplasty, although redo SMVR remains the gold standard of care, this study presents TA-TMVR as a possible alternative in patients presenting with a high peri-operative risk. Since the Sapien XT/3™ was approved for mitral valve-in-valve replacement by the US Food and Drug Administration in 2017, more than 1500 patients worldwide have been treated by this approach (8). Procedural technical success was 96.8% in one recent study, with 5.4 % all-cause mortality at 30-days and 16.7% at 1 year (9). The 2016 and 2020 Mitral Valve in Valve/Mitral Valve in Ring/Valve in Mitral Annular Calcification Transcatheter Valve Therapies Registry published reports also demonstrated similarly high rates of procedure success and a favorable mortality compared with the STS predicted risk of peri-operative mortality (8, 10, 11). In the current study, *Zubarevich et al.* report comparable on-table procedural success rates, although the 30-day and 1-year mortality rates of 9.8 and 25.4% respectively were slightly higher than in the STS Registry. Trans-septal access for TMVR, which was not performed in this study, has previously been associated with lower all-cause mortality than TA-TMVR (9), which may explain this finding.

Patients treated with SMVR were observed to have higher in-hospital and 30-day mortality rates than TA-TMVR. By 1- and 3-years, however, the inverse relationship was true (7). There are several possible explanations for this. Firstly, SMVR patients who underwent concomitant TV surgery were not excluded from this study. As such, 39.4% of patients in the surgical arm also underwent TV repair. Although the premise that concomitant TV surgery is not known to influence peri-procedural mortality is used by the

study author(s) as rationale for inclusion, this represents a major limitation. To what extent this influenced the trend towards increased short-term mortality in the SMVR group but a relative decrease in long-term mortality (18.3 vs 25.4%) is unclear (7). A transient decline in myocardial contractile performance due to cardiac stunning is well recognised for patients following cardio-pulmonary bypass, whereas TMVR off-pump on a beating heart has previously been observed to present fewer haemodynamic challenges (12, 13). Residual MR severity is also known to be an important determinant of long-term survival in transcatheter treated populations (14). Post-operative MR $\geq$1+ was reported in 17.1% of TA-TMVR patients (vs 0%; p=0.15) (7). Detailed data on procedural and recurrent MR are not reported in this study, and recurrent MR may well explain the trend towards late mortality observed in the TA-TMVR group.

Overall, despite baseline differences between the two study populations, this study lays an important foundation stone to future transcatheter device selection in patients with a degenerative biological mitral valve prosthesis or failed annuloplasty and prohibitive surgical risk. The study demonstrated that both SMVR and TA-TMVR can be completed safely, with a high technical procedural success rate and comparable rates of MR elimination, morbidity and mortality (7). The maximal benefit of a transcatheter strategy appears to be in the early post-operative period, however questions surrounding long-term TA-TMVR durability and what this might mean for patient outcomes, remain unanswered.

REFERENCES:

1. Vohra HA, Whistance RN, Roubelakis A, Burton A, Barlow CW, Tsang GM, et al. Outcome after redo-mitral valve replacement in adult patients: a 10-year single-centre experience. Interact Cardiovasc Thorac Surg. 2012;14(5):575-9.
2. Mehaffey HJ, Hawkins RB, Schubert S, Fonner C, Yarboro LT, Quader M, et al. Contemporary outcomes in reoperative mitral valve surgery. Heart 2018;104(8):652-6.
3. Kilic A, Acker MA, Gleason TG, Sultan I, Vemulapalli S, Thibault D, et al. Clinical outcomes of mitral valve reoperations in the United States: An analysis of The Society of Thoracic Surgeons National Database. Ann Thorac Surg 2019;107(3):754-9.
4. Eleid MF, Whisenant BK, Cabalka AK, Williams MR, Nejjari M, Attias D, et al. Early outcomes of percutaneous transvenous transseptal transcatheter valve implantation in failed bioprosthetic mitral valves, ring annuloplasty, and severe mitral annular calcification. JACC Cardiovasc Interv. 2017;10(19):1932-42.
5. Sengupta A, Yazdchi F, Alexis SL, Percy E, Premkumar A, Hirji S, et al. Reoperative mitral surgery versus transcatheter mitral valve replacement: A systematic review. J Am Heart Assoc 2021;10(6):e019854.

6. Simonetto F, Purita PAM, Malerba M, Barbierato M, Pascotto A, Mangino D, et al. Surgical redo versus transseptal or transapical transcatheter mitral valve-in-valve implantation for failed mitral valve bioprosthesis. Catheter Cardiovasc Interv 2021;97(4):714-22.

7. Zubarevich A, Szczechowicz M, Arjomandi Rad A, Vardanyan R, Marx P, Lind A, et al. Mitral surgical redo versus transapical transcatheter mitral valve implantation. PLoS One. 2021;16(8):e0256569.

8. Grover FL, Vemulapalli S, Carroll JD, Edwards FH, Mack MJ, Thourani VH, et al. 2016 Annual Report of The Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy Registry. J Am Coll Cardiol. 2017;69(10):1215-30.

9. Whisenant B, Kapadia SR, Eleid MF, Kodali SK, McCabe JM, Krishnaswamy A, et al. One-year outcomes of mitral valve-in-valve using the SAPIEN 3 transcatheter heart valve. JAMA Cardiol 2020;5(11):1245-52.

10. Simonato M, Whisenant B, Ribeiro HB, Webb JG, Kornowski R, Guerrero M, et al. Transcatheter mitral valve replacement after surgical repair or replacement: comprehensive midterm evaluation of valve-in-valve and valve-in-ring implantation rom the VIVID Registry. Circulation. 2021;143(2):104-16.

11. Guerrero M, Vemulapalli S, Xiang Q, Wang DD, Eleid M, Cabalka AK, et al. Thirty-day outcomes of transcatheter mitral valve replacement for degenerated mitral bioprostheses (valve-in-valve), failed surgical rings (valve-in-ring), and native valve with severe mitral annular calcification (valve-in-mitral annular calcification) in the United States: data from the Society of Thoracic Surgeons/American College of Cardiology/Transcatheter Valve Therapy Registry. Circ Cardiovasc Interv 2020;13(3):e008425.

12. Hungerford S, Bart N, Jansz P, Kay S, Emmanuel S, Namasivayam M, et al. Improved right ventricular function following transapical transcatheter mitral valve implantation for severe mitral regurgitation. Int J Cardiol Heart Vasc 2021;32: doi:10.1016/j.jcha.2020.100687.

13. Hungerford S, Hayward C, Muller DWM. Transapical transcatheter mitral valve implantation in heart failure: haemodynamic challenges for a new frontier. Heart Lung Circ. 2021; doi:10.1016/j.hlc. 2021.07.014.

14. Orban M, Orban M, Lesevic H, Braun D, Deseive S, Sonne C, et al. Predictors for long-term survival after transcatheter edge-to-edge mitral valve repair. J Interv Cardiol. 2017;30(3):226-33.