Structural Heart
The Journal of the Heart Team

Structural Heart
The Journal of the Heart Team

ISSN: 2474-8706 (Print) 2474-8714 (Online) Journal homepage: https://www.tandfonline.com/loi/ushj20

Predicting LVOT Obstruction in Transcatheter Mitral Valve Replacement for Failed Surgical Annuloplasty

Stefano Cannata, Salvatore Pasta, Marco Turrisi, Giovanni Gentile, Giuseppe Romano, Giuseppe Raffa, Michele Pilato & Caterina Gandolfo

To cite this article: Stefano Cannata, Salvatore Pasta, Marco Turrisi, Giovanni Gentile, Giuseppe Romano, Giuseppe Raffa, Michele Pilato & Caterina Gandolfo (2020): Predicting LVOT Obstruction in Transcatheter Mitral Valve Replacement for Failed Surgical Annuloplasty, Structural Heart, DOI: 10.1080/24748706.2020.1752421

To link to this article: https://doi.org/10.1080/24748706.2020.1752421

Publisher: Taylor & Francis & Cardiovascular Research Foundation

Journal: *Structural Heart*

DOI: 10.1080/24748706.2020.1752421

Predicting LVOT Obstruction in Transcatheter Mitral Valve Replacement for Failed Surgical Annuloplasty

Stefano Cannata[1], MD, Salvatore Pasta[2], PhD, Marco Turrisi[3], MD, Giovanni Gentile[4], MD, Giuseppe Romano[3], MD, Giuseppe Raffa[3], MD, Michele Pilato[3], MD, Caterina Gandolfo[1], MD

1- Unit of Interventional Cardiology- Department of cardiothoracic surgery- IRCCS-ISMETT (Mediterranean Institute for Transplantation and Advanced Specialized Therapies) - UPMC-Palermo- Italy
2- Bioengineering Division, Department of Engineering, University of Palermo, Italy

3- Department of cardiothoracic surgery- IRCCS-ISMETT (Mediterranean Institute for Transplantation and Advanced Specialized Therapies)- UPMC-Palermo- Italy

4- Radiology Unit- Department of Diagnostic and Therapeutic Services. IRCCS-ISMETT (Mediterranean Institute for Transplantation and Advanced Specialized Therapies)-UPMC – Palermo, Italy

Short title: Predicting LVOT obstruction in TMVR-in-ring

[*]**Address for correspondence:**

Caterina Gandolfo, MD

[1]Unit of Interventional cardiology, Department of cardiothoracic surgery-

IRCCS-ISMETT (Mediterranean Institute for Transplantation and Advanced Specialized Therapies)

- UPMC- Palermo- Italy

Via E. Tricomi 5,

Phone: 091 2192111

email: cgandolfo@ismett.edu

A 70 years-old woman with diabetes and end-stage chronic kidney disease was referred at our institute after multiple heart failure episodes. Her clinical history was characterized by coronary artery by-pass graft (CABG) coupled with surgical mitral valve annuloplasty using a 28 mm 3 D Memo ring 5 years earlier. Echocardiography showed severe mitral regurgitation (**Figures 1A and 1B**) in the context of moderate left ventricular dysfunction. After multidisciplinary discussion, a consensus was reached to perform a transseptal transcatheter mitral valve-in-ring (TMVR) because of the high surgical risk. The pre-procedure analysis, on both computed tomography (CT) and transesophageal echocardiography (TOE), incorporated anterior mitral valve leaflet length (24 mm), basal septum thickness (11 mm), mitral-aortic angle (36°) and the mitral annulus to IVS distance (25.1 mm). Pre-procedural prediction modeling was then performed utilizing computer-aided design (CAD) of the neo-LVOT based on cardiac-gated computed tomography followed by fluid-dynamic analysis in order to evaluate the hemodynamic related to the neo-LVOT. Patient-specific reconstruction of heart anatomy and ring device was done using Mimics (Materialise Leuven, Belgium), whereas the implantation of the balloon-expandable Sapien 3 Ultra into the ring and the hemodynamic assess (mitral regurgitation, neo-LVOT gradient) were carried out using the computational approach as previously descripted **[1] (Figures 2A and 2B)**. CAD-based pre-procedural modeling predicted a preserved neo-LVOT (area of 482 mm2 at the end-systolic phase **- Figure 2F**) and the fluid dynamic analysis **(Figure 2G)** showed no significant increase in velocity and gradient at neo-LVOT. Thus, the procedure was performed under general anesthesia with TOE and fluoroscopy guidance. Transseptal puncture was done using standard technique. After performing a balloon septoplasty, a 26 mm Sapien 3 Ultra (Edwards Lifesciences) was advanced and deployed by slow inflation during rapid pacing (**Figures 1B and 1C**). Post-implantation TOE demonstrated perfect valve function and absence of LVOT obstruction (**Figures 1E and 1F**). Pre-discharge CT confirmed a preserved neo-LVOT area as predicted by computed simulation (**Figure 2C to 2F)**.

The risk of LVOT obstruction is a major concern with TMVR and is multifactorial including a small LVOT, large mitral-aortic angle, hypertrophic septum, long left anterior leaflet [2]. Preprocedural multimodality imaging approach including echocardiography and MSCT is essential in patient selection. Patient-specific computed modeling accurately predicted the neo-LVOT area, the anterior leaflet displacement and flow velocity quantification through the neo-LVOT. Moreover, it is known that the incidence of paravalvular leak in TMVR-in-ring is higher compared to valve-in-valve procedure and could require further intervention [3]. Therefore, the use of S3

Ultra, which has a 40% higher outskirt compared to the S3, could have the advantage to reduce the incidence of paravalvular leak and improve patient outcomes.

Finally, the application of personalized computer simulation may be of value in the decision-making process predicting the risk for LVOT obstruction, offering insights into the post-implant hemodynamic mechanism and optimizing therefore selection and outcomes of patients with failed annuloplasty undergoing TMVR. Particularly in presence of borderline predicted neo-LVOT, the fluid dynamic analysis could be crucial in the decision-making process allowing to predict an increase in velocity and gradient at neo-LVOT. Future study in a large patient cohorts is warranted to validate the model and find a cut-off to define a small neo-LVOT area.

Funding
The authors have no funding to report.

Disclosure statement
The authors have no conflicts of interest to disclose.

Patient consent for publication has been obtained by the authors.

References

1. Lee JJ, D'Ancona G, Amaducci A, Follis F. et al. Role of computational modeling in thoracic aortic pathology: a review. Journal of cardiac surgery 2014, Sep; 29(5):653-62.

2. Blanke P, Naoum C, Dvir D et al. Predicting LVOT obstruction in transcatheter mitral intervention: the concept of Neo-LVOT. JACC cardiov Imaging 2017, April; 10(4):482-485.
3. Yoon SH, Whisenant BK, Bleiziffer S, et al. Transcatheter mitral valve replacement for degenerated bioprosthetic valves and failed annuloplasty rings. J Am Coll Cardiol 2017 Aug 29; 70:1121–31.

Figure legends

Figure 1. Valve in ring procedure.

(A-B) Pre-procedure echocardiography (TOE) showing severe MR and 3-D reconstruction. (C-D) Deployment of S3 Ultra in mitral ring and final fluoroscopy. (E-F) Post-procedure TOE confirmed perfect valve function

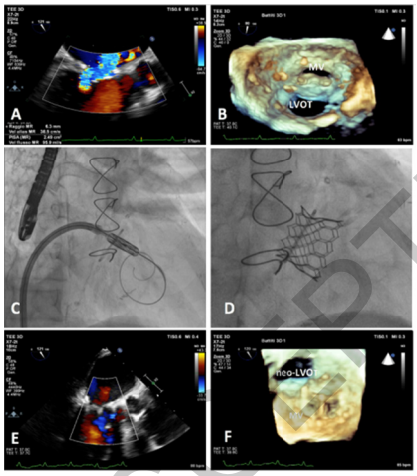

Figure 2. Patient specific simulation and post-implant computed tomography (CT)

(A) Computer simulation integrating CT-derived patient-specific anatomy with the virtual implant of S3 Ultra. Displacement of the anterior mitral leaflet (black arrow). (B) Predicted neo-LVOT area (Aortic view). (C-D) End-systolic 3-chamber view on cardiac computed tomography and 3D reconstruction after TMVR, the elongation of the LVOT defines the neo-LVOT (white area). (E) Cross sectional images of neo- LVOT. (F) Cross sectional imaging of neo-LVOT (455 cm^2) compared to predicted neo-LVOT area (482 cm^2) at the computed modeling (aortic view) (G) Configuration of the flow during a complete cardiac cycle for TMVR-in-ring