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CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

FIRST-IN-HUMAN/EARLY REPORTS

Transseptal Balloon-Assisted Translocation of Mitral Leaflet for Mitral Calcification

A First in Human Experience

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ABSTRACT

We present a first in human experience of transseptal balloon-assisted translocation of a mitral anterior leaflet (BATMAN) to facilitate transcatheter mitral valve replacement in a patient with severe mitral annular calcification who was at high risk of left ventricular outflow tract obstruction. (JACC Case Rep. 2025;30:102767) © 2025 Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

An 89-year-old woman with severe mitral regurgitation (MR), mitral stenosis, and mitral annular calcification (MAC) was admitted to Abbott Northwestern Hospital (Minneapolis, Minnesota, USA) with acute, decompensated diastolic heart failure. The patient was evaluated by a multidisciplinary heart team and was deemed to be at high surgical risk given her age and comorbidities, including severe pulmonary disease and renal insufficiency. She previously had been evaluated for transcatheter mitral valve replacement (TMVR) trials but was declined because of a high risk for left ventricular outflow tract (LVOT) obstruction.

TAKE-HOME MESSAGES

- Transseptal BATMAN for TMVR is a novel technique to prevent LVOT obstruction, especially in patients with very elongated AMLs, and it can be performed safely with an experienced team and with extensive preprocedural planning.
- Risks include uncontrolled balloon dilatation of the AML resulting in extension of tear superiorly in the aortomitral curtain, or laterally to avulse the trigone from the annulus. Dedicated advanced imaging, including 3-dimensional multiplanar reconstruction, can be useful to avoid these complications and improve performance with precision.
- Rapid ventricular pacing can facilitate accurate leaflet traversal during electrosurgery.

INVESTIGATIONS

Transesophageal echocardiography (TEE) showed preserved biventricular function, severe MR and

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ABBREVIATIONS AND ACRONYMS

AML = anterior mitral leaflet

BATMAN = balloon-assisted translocation of the mitral anterior leaflet

CT = computed tomography

JR4 = Judkins right 4

LAMPOON = laceration of the anterior mitral leaflet to prevent outflow obstruction

LV = left ventricle

LVOT = left ventricular outflow tract

MAC = mitral annular calcification

MR = mitral regurgitation

TEE = transesophageal echocardiography

TMVR = transcatheter mitral valve replacement

mitral stenosis, with MAC. The mean mitral gradient was 8 to 15 mm Hg, and there was systolic anterior motion of a long anterior mitral leaflet (AML), which measured 27 mm and had dynamic septal contact (Video 1). No significant LVOT gradient was present. Contrast-enhanced, gated cardiac tomography (CT) showed severe MAC involving 270° of the annulus and confirmed the presence of the elongated AML. Simulation of placement of a 29-mm Sapien 3 Ultra Resilia valve (Edwards Lifesciences) with 20% atrialized showed a neo-LVOT area <200 mm^2 and a skirt neo-LVOT area of 225 mm^2 at end-systole (**Figures 1A and 1B**). The mitral annular area measured 499 mm^2. Given these CT measurements and the highly elongated AML, leaflet modification was needed. However, because of its excessive length, we believed that laceration of the AML to prevent outflow obstruction (LAMPOON) would not be sufficient, and it also could be technically challenging. Thus, we proceeded with balloon-assisted translocation of the mitral anterior leaflet (BATMAN).

MANAGEMENT

The procedure was performed using general anesthesia and under TEE guidance. A Sentinel device (Boston Scientific) was placed. Transfemoral, transseptal puncture was performed inferoposteriorly with a 7-F Mullins sheath and a Baylis C0 needle (Baylis Medical). Over an Inoue wire (0.025-inch, Toray), a 26-F DrySeal sheath (Gore Medical) was placed in the right femoral vein, followed by balloon septostomy with a 14 mm × 40 mm Atlas Gold balloon (Becton, Dickinson). Subsequently, an 8.5-F medium-curve Agilis sheath was placed in the left atrium, and the Inoue wire was removed. A 6-F, Judkins right 4 (JR4) guide loaded with a 0.035-inch Quick-Cross microcatheter (Philips) and a 0.014-inch Astato XS 20-g guidewire (Asahi Intec) was introduced. The assembly was carefully directed to the midportion leaflet of the A2 scallop under TEE guidance.

Initially, there was severe mitral leaflet movement when targeting the electrosurgery assembly, thus creating a high risk for inaccurate placement because the wire was slipping across the leaflets during its passage. This movement was addressed with rapid ventricular pacing to relatively "freeze" the leaflets. The rapid pacing created perpendicularity to the electrosurgery assembly and facilitated accurate traversal (Videos 2A and 2B). After traversal, the Quick-Cross microcatheter was advanced into the left ventricle (LV), and the Astato guidewire was exchanged for a 0.014-inch, 300-cm Runthrough wire (Terumo). The AML was ballooned with a 4 mm × 20 mm, noncompliant coronary balloon. Subsequently, balloon-assisted tracking was performed to advance the JR4 guide catheter into the LV. This step was performed because the Quick-Cross microcatheter did not provide adequate support to advance a stiff Safari wire (Boston Scientific) into the LV (Videos 3A and 3B). Once the JR4 guide catheter was placed, the coronary wire and balloon were removed, and the Safari wire was introduced.

An intra-aortic balloon pump was then placed through left femoral artery access for prophylactic hemodynamic support. The 14 mm × 40 mm Atlas Gold balloon used for septostomy was then introduced over the Safari wire to dilate the AML at 10 atm to help ensure subsequent passage of the Sapien prosthesis (Video 4). BATMAN was performed carefully and in a controlled manner, with close attention to the aortomitral curtain on TEE. A 26-mm Edwards Sapien Ultra Resilia valve was delivered and placed with balloon inflation using an additional 2 mL under rapid ventricular pacing (Videos 5A and 5B).

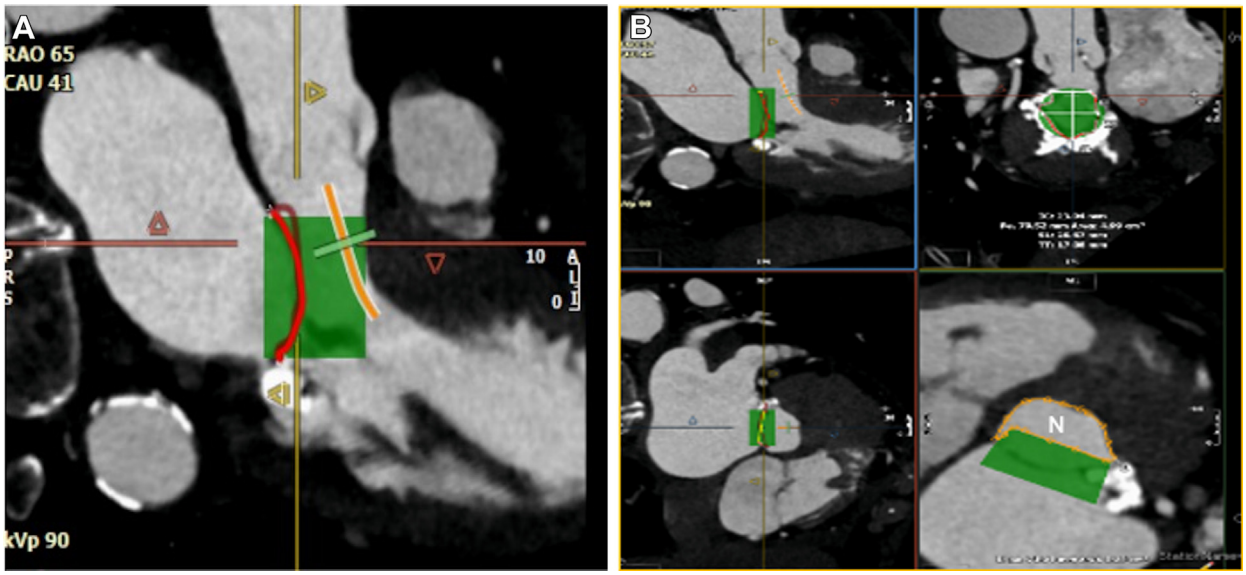
There was no LVOT obstruction after valve deployment, with a peak-to-peak invasive gradient of 5 mm Hg at rest and 15 mm Hg after a premature ventricular beat. There was complete relief of MR, normal prosthetic leaflet movement, and a mean mitral gradient of 1 mm Hg (Video 6). The interatrial septum was closed with a 25-mm Gore Cardioform device, followed by a figure-of-8 suture for the femoral venous access. There was no evidence of bleeding, stroke, or hemodynamic instability following the procedure. The patient was subsequently discharged home.

DISCUSSION

TMVR can be used for the management of mitral valve disease, both MR and mitral stenosis as well as severe MAC, in high-risk patients. Nonetheless, LVOT obstruction remains problematic for TMVR procedures and can occur in 13% to 22% of these patients.[1] Predictors of LVOT obstruction following TMVR include septal hypertrophy, small LVOT dimensions, an acute aortomitral angle, and an elongated AML among others.[2-4]

Multiple techniques have been described to mitigate the risk of LVOT obstruction, including alcohol septal ablation, radiofrequency ablation, LAMPOON, and septal scoring.[5-7] In our patient, the neo-LVOT was <200 mm^2, and the skirt neo-LVOT was only

FIGURE 1 Risk of Left Ventricular Outflow Tract Obstruction



(A) Contrast-enhanced, cardiac computed tomography showing the potential for left ventricular outflow tract obstruction from placement of a 20% atrialized, 26-mm Sapien prosthesis (Edwards Lifesciences) (S). (B) Measurement of the neo-left ventricular outflow tract (N). Ao = aorta; CAU = caudal; LA = left atrium; LV = left ventricle; N = neo-LVOT; RAO = right anterior oblique; S = Sapien.

225 mm^2, leaving little room for error while performing mitigating measures for managing LVOT obstruction. In our case, we believed that BATMAN was the preferred choice because of the highly elongated leaflet and the presence of systolic anterior motion at rest.

The BATMAN procedure was first described as a transapical procedure but has since evolved into a transseptal approach to facilitate TMVR.[1,7-10] Our procedure is the first to describe a transseptal BATMAN for a patient with severe MAC. A major advantage to this approach is the immediate amelioration of the risk of LVOT obstruction with minimal procedural steps and equipment exchanges in a minimally invasive, transseptal approach. Translocation of the AML permits flow through the open cells of the Sapien prosthesis, thereby avoiding the AML curtain that increases the risk of LVOT obstruction (Video 7). BATMAN allows the target area for electrosurgery to be minimized. Ideally, the target area is >5 mm from the mitral annulus. We also found that rapid ventricular pacing helped ensure accurate leaflet wiring crossing, a key new description that mitigates the risk of untoward cardiac perforation. Nevertheless, challenges to this procedure that must be overcome include ensuring apposition of the prosthesis to the mitral annulus, and minimizing uncontrolled balloon dilatation of the AML, which can result in an extension of the tear superiorly in the aortomitral curtain or laterally into the trigone that can lead to avulsion from the annulus. A puncture too close to the mitral annulus could increase the risk of untoward balloon dilatation and aortic root injury.

CONCLUSIONS

The BATMAN procedure is a novel and feasible procedure to facilitate TMVR in patients at high risk of LVOT obstruction. The transseptal approach can be safely performed in patients with severe MAC by an experienced team and with extensive preprocedural planning. Additional studies are required to confirm long-term results.

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Dr Hamid has served as a consultant for Abbott Structural, AMX, 4C Medical Technologies, Edwards Lifesciences, Philips, Siemens, Valcare Medical, VDyne, W.L. Gore & Associates, xDot, and Laza. Dr Bapat has served as a consultant for Edwards Lifesciences, Medtronic, and Abbott. Dr Cavalcante has served on the Speakers Bureau for 3mensio; and has served as a consultant for 4C Medical Technologies, Abbott, Anteris, Boston Scientific, Edwards Lifesciences, Medtronic, Siemens, VDyne, and W.L. Gore & Associates. Dr Sorajja has served as

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KEY WORDS imaging, mitral valve, valve replacement

APPENDIX For supplemental videos, please see the online version of this paper.