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STRUCTURAL HEART DISEASE

CASE REPORT: CLINICAL CASE SERIES

Transseptal BATMAN for High-Risk Valve-in-Ring Procedures

A Case Series

Paolo Denti, MD,[a] Matteo Saccocci, MD,[a] Nicola Buzzatti, MD,[a] Guido Ascione, MD,[a] Davide Margonato, MD,[b] Pamela Gatto, MD,[a] Altin Palloshi, MD,[a] Cristiano Sarais, MD,[a] Matteo Longoni, RT,[a] Francesco Maisano, MD[a]

ABSTRACT

Valve-in-ring procedures represent a feasible solution for high-risk patients with surgical repair failure. The risk of left ventricular outflow tract obstruction increases the challenge, and transcatheter approaches to prevent it are technically demanding and often do not resolve it. We demonstrate the feasibility and safety of a transseptal balloon-assisted translocation of the anterior mitral leaflet for valve-in-ring implantation. (J Am Coll Cardiol Case Rep 2024;29:102200)

Transcatheter interventions have become viable solutions for high-risk patients who experience a recurrence of severe mitral regurgitation (MR) after reparative valve surgery. One major challenge in valve-in-ring (ViR) interventions is the heightened risk of left ventricular outflow tract obstruction (LVOTO).[1] The presence of a large anterior mitral leaflet (AML), a bulging septum, or a small left ventricle can increase the risk of LVOTO,[1,2] even with perfect positioning and deployment of the transcatheter bioprosthesis. Some techniques have been described to prevent the occurrence of this life-threatening condition,[3-8] but they are technically demanding and often do not completely resolve the issue. We present the first series of patients successfully treated with a modified transseptal balloon-assisted translocation of the anterior mitral leaflet (BATMAN).

LEARNING OBJECTIVES

- To outline a new technique to prevent LVOTO in patients undergoing TMVR.
- To describe a safe and effective simplified transseptal BATMAN technique.

METHODS

CASE 1. At the beginning of April 2023, we were forced to find a simple and straightforward solution for an extremely challenging patient. A remarkably high-risk Jehovah's Witness patient was admitted for acute heart failure secondary to recurrent severe MR and stenosis following unsuccessful mitral valve surgery repair (edge-to-edge [E-to-E] technique and annuloplasty with a 36-mm complete ring) and tricuspid tissue valve replacement complicated by mediastinitis just 1 year earlier. The patient had permanent atrial fibrillation, diabetes, and severe chronic kidney disease (estimated glomerular filtration rate, 18 mL/min), thus preventing any

From the [a]Department of Cardiac Surgery, Heart Valve Center, IRCCS San Raffaele Hospital, Milan, Italy; and the [b]Department of Cardiovascular Imaging, IRCCS San Raffaele Hospital, Milan, Italy.
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ABBREVIATIONS AND ACRONYMS

AML = anterior mitral leaflet

BATMAN = Balloon-assisted translocation of the anterior mitral leaflet

E-to-E = edge-to-edge

ELASTA = electrosurgical laceration and stabilization

IABP = intra-aortic balloon pump

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

LVOT = left ventricular outflow tract

LVOTO = left ventricular outflow tract obstruction

MP = multipurpose

MR = mitral regurgitation

TEE = transesophageal echocardiography

THV = transcatheter heart valve

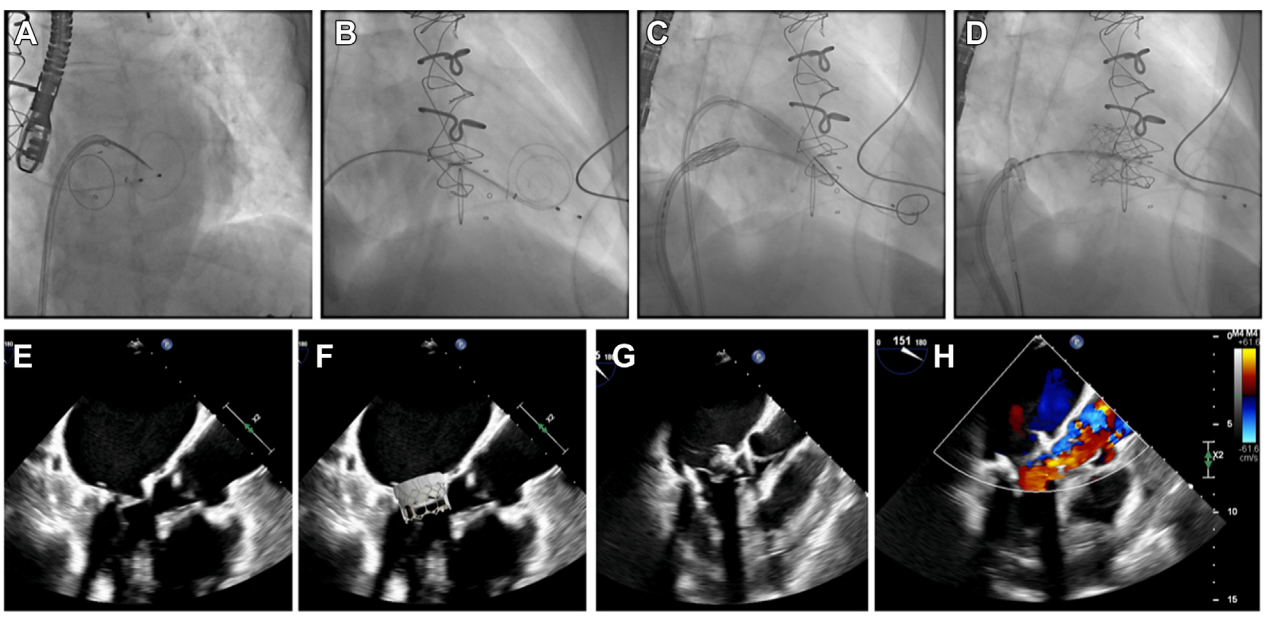
TMVR = transcatheter mitral valve replacement

ViR = valve-in-ring

preoperative cardiac computer tomography planning. Despite chronic anemia (hemoglobin <9.5g/dL, even after treatment with erythropoietin), the patient categorically refused transfusion.

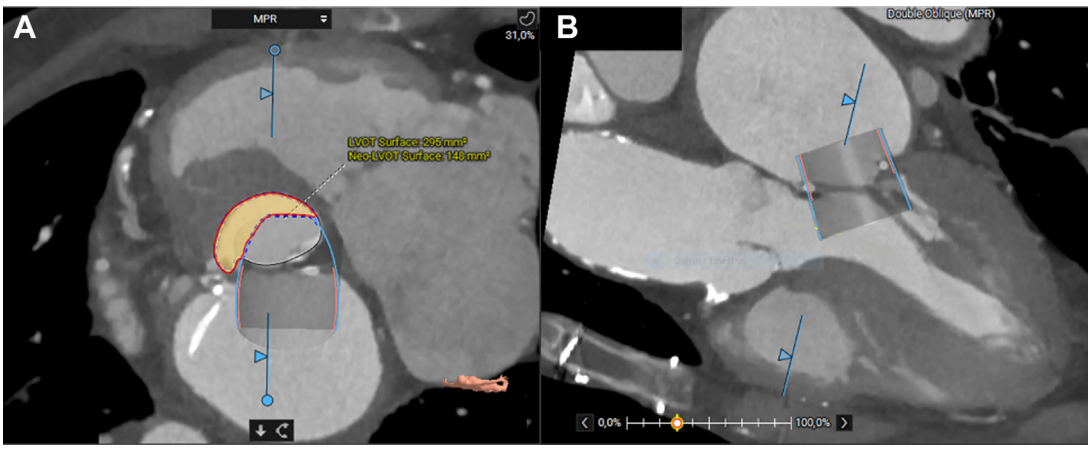
The heart team evaluation considered the patient at extremely high risk for redo surgery and scheduled a ViR procedure despite the high risk of LVOTO resulting from a 90° mitral-aortic angle with a prominent septal bulge (Figures 1E and 1F). Moreover, the presence of E-to-E sutures required advanced leaflet management with electrosurgery. The electrosurgical detachment of MitraClips [Abbott] from the anterior mitral leaflet (ELASTA) procedure[3] did not relieve the risk of obstruction, and the different variations of the laceration of the AML to prevent outflow obstruction (LAMPOON) intervention[9,10] remained quite complex and not the right solution to manage this long anterior leaflet. Looking for an easier and faster option that minimizes the bleeding risk, we planned a modified transseptal BATMAN, a procedure that has to date been performed transapically[6,11] because of its complexity. The intervention was performed with the patient under general anesthesia and with transesophageal echocardiography (TEE) and fluoroscopic guidance. An intra-aortic balloon pump (IABP) was used to maintain hemodynamic stability. After an inferior-posterior transseptal puncture, an Agilis NxT middle-curve (Abbott) and a multipurpose (MP) catheter were advanced in the left atrium. After complete heparinization, under echocardiographic guidance, the center of the anterior leaflet was perforated by using an electrified standard 0.035-inch straight-tip guidewire (Figure 1A). The MP catheter was advanced in the left ventricle and exchanged for a 7-F, 90-cm sheath over a Safari guide. A buddy Safari wire was then advanced in the left ventricle through the 7-F sheath (Figure 1B). Groin hemostasis was achieved by a figure-of-8 suture, and the patient was stable under IABP support. On 1 Safari wire, a 14-F percutaneous transluminal angioplasty balloon (Armada 14 F, Abbott) predilated the septum and was parked in the left atrium. Over the second Safari, a Sapien 3 Ultra (Edwards Lifesciences) delivery system was advanced in the inferior vena cava. After the septostomy, the Sapien 3 was advanced in the LA, above the mitral annulus. To improve the support of the Armada balloon, the first Safari wire was

FIGURE 1 Valve-in-Ring Using a Transseptal Modified Balloon-Assisted Translocation of the Anterior Mitral Leaflet Technique



(A) Perforation of the anterior mitral leaflet. (B) Buddy wire advanced in the left ventricle through the 7-F sheath. (C) Balloon ablation of the anterior mitral leaflet. (D) Successful delivery of the balloon-expandable bioprosthesis. (E and F) High risk of left ventricular outflow tract obstruction resulting from a 90° mitral-aortic angle with a prominent septal bulge. (G and H) The transcatheter heart valve engaged the left ventricular outflow tract entirely without any evidence of left ventricular outflow tract obstruction.

FIGURE 2 Cardiac Computed Tomography Scan

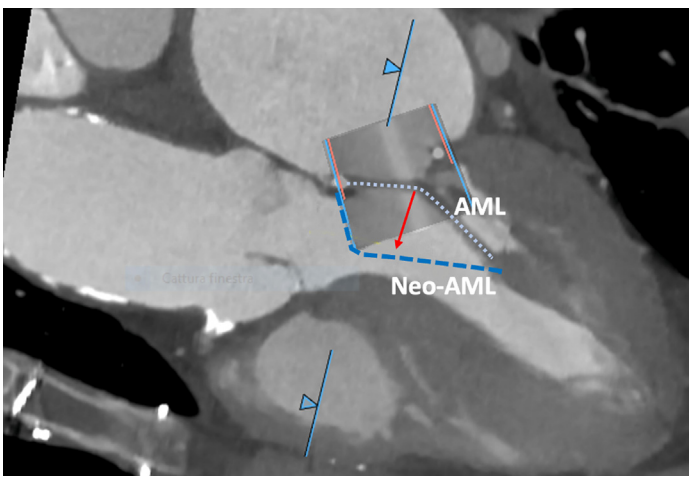


(A and B) Predicted neo-left ventricular outflow tract (LVOT) area after transcatheter heart valve valve-in-ring implantation. LVOT = left ventricular outflow tract.

exchanged with a Back-up Meier guidewire (Boston Scientific), and the anterior leaflet was predilated (Figure 1C). Under relatively stable hemodynamics, the Sapien 3 delivery system was advanced through the anterior leaflet, and under rapid pacing, the valve was successfully delivered (Figure 1D). Engagement, ballooning, and translocation of the AML were clearly visible on echocardiographic and fluoroscopic imaging. LVOTO was constantly monitored by 3-dimensional and 2-dimensional echocardiography. The final TEE images demonstrated a transcatheter heart valve (THV) that entirely engaged the left ventricular outflow tract (LVOT) (Figures 1G and 1H), with the stent in contact with the septum but without LVOTO, thanks to the free-flow area created by the completely translocated AML.

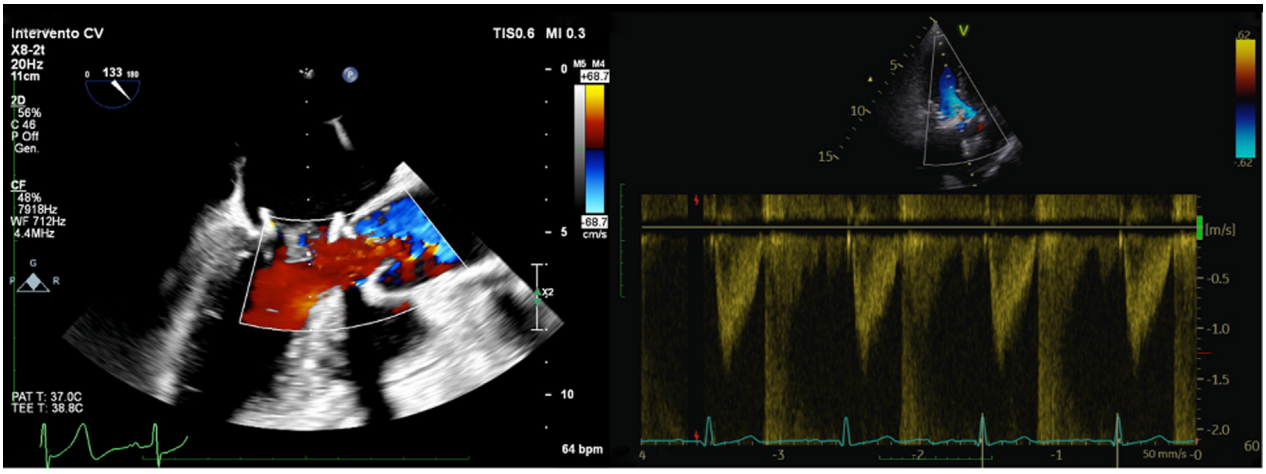
CASES 2 AND 3. We planned the same approach for the next consecutive high-risk patients who presented with MR recurrence after previous mitral valve surgical repair. The second patient was a 59-year-old woman, an active smoker with a history of Hodgkin lymphoma treated by chemotherapy and chest radiation therapy, and multiple comorbidities: left carotid and right subclavian artery vascular interventions; chronic kidney disease; multifactorial chronic anemia. In 2009, she underwent coronary artery bypass grafting and mitral valve repair with annuloplasty (Memo 3D annulus 28 mm, LivaNova), followed by percutaneous left atrial appendage closure for atrial fibrillation. Echocardiography showed severe mitral valve stenosis (mean gradient,16 mm Hg; are a 0.85 cm^2), moderate aortic regurgitation, moderate tricuspid regurgitation, and a systolic pulmonary artery pressure of 40 mm Hg. The risk of LVOTO was evident on the gated computed tomography angiographic scan, which showed a predicted neo-LVOT area <150 mm^2 (Figures 2A and 2B) as a result of the curtain created by the AML on the THV (Figure 3). As in the first described case, a buddy wire transseptal

FIGURE 3 Preoperative Computed Tomography Scan Analysis



Predicted position of the anterior mitral leaflet (neo-AML) (blue line) after transcatheter heart valve implantation. The red arrow shows how the AML (small dot line) will be displaced (neo AML blue interrupted line) with standard valve-in-ring procedure.
AML = anterior mitral leaflet.

FIGURE 4 Postoperative Echocardiography



Correct transcatheter heart valve position, with no flow turbulence or left ventricular outflow tract obstruction. (Left) Color Doppler with no turbulence or significant acceleration. (Right) Transvalvular flow with no evidence of mitral stenosis.

modified BATMAN procedure was executed with no procedural and postprocedural complications. On postoperative echocardiography (Figure 4) and cardiac computed tomography (Figures 5 and 6), there was no evidence of intraventricular flow turbulence or LVOTO.

Patient 3 was over a 70 year-old woman at increased perioperative risk with recurrent MR after mitral valve surgery repair (annuloplasty with complete prosthetic ring and standard posterior leaflet resection) who was proposed for ViR and successfully treated with this novel approach even without IABP support.

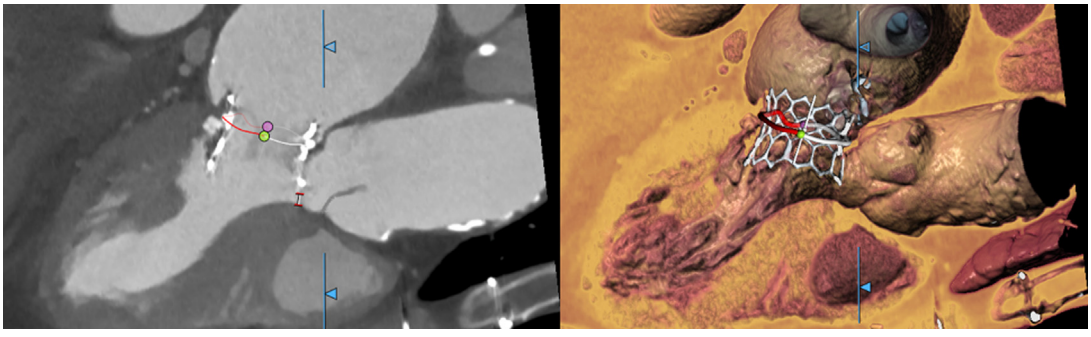
RESULTS

All procedures were successful, and hospitalization was essentially uneventful. Predischarge echocardiographic findings confirmed procedure efficacy with normal THV function, no paravalvular leakage, and no evidence of LVOTO.

DISCUSSION

Besides alcohol and radiofrequency septal ablation, other transcatheter techniques have been described to prevent LVOTO.[8] The septal scoring along the midline

FIGURE 5 Postprocedure Cardiac Computed Tomography Scan



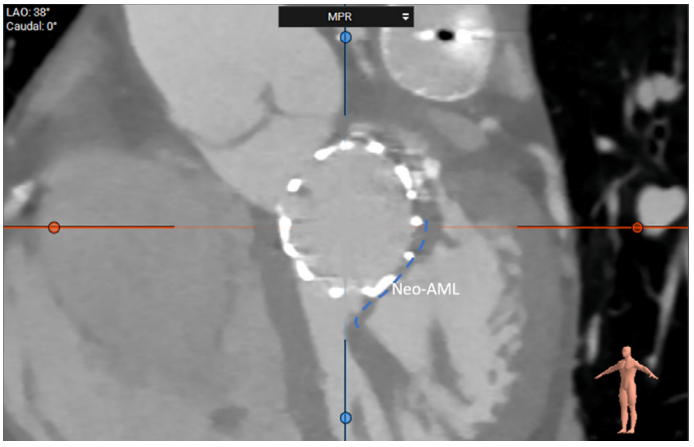
Correct implantation of the transcatheter heart valve. The free flow portion appeared completely positioned in the left ventricular outflow tract as predicted by preoperative imaging reconstruction.

endocardium (SESAME) technique uses transcatheter electrosurgery to lacerate the interventricular septum, and it is still in the preclinical phase.[7] Laceration of the AML by using a dedicated mechanical transcatheter leaflet-splitting device (ShortCut, Pi-Cardia) has been recently described but actually requires transapical access.[12] The LAMPOON intervention, standard or tip-to-base, has demonstrated good results but remains a complex and time-consuming procedure[9,10,13]; its efficacy in the presence of an E-to-E suture is highly unpredictable. The ELASTA3 approach is a valuable solution in cases of previous E-to-E repair interventions but is rarely ineffective in preventing LVOTO. The standard BATMAN is a transapical procedure[6,11] with excellent results regarding outflow tract obstruction prevention, bioprosthesis sealing effect, and chordal-preserving implantation. Translocation of the AML permits free flow through the free cell part of the Sapien 3, thereby avoiding any "curtain" and minimizing the risk of LVOTO, as confirmed in our cases. Our modified BATMAN technique presents many advantages: the transseptal approach makes it even simpler; the buddy wire strategy (2 separate guidewires across AML) enables a seamless transition between leaflet ablation and THV implantation under hemodynamic stability with no need for cardiopulmonary bypass. Furthermore, the double-wire approach is extremely useful in patients with previous surgical or transcatheter E-to-E repair. In fact, the simultaneous ballooning of the AML creates a single new orifice allowing immediate and easy ViR implantation, sliding the E-to-E suture and the anterior leaflet/apparatus to the posterior ventricular wall. To guarantee safety and avoid major complications such as mitral-aortic junction damage, this technique should be used only in the presence of a complete prosthetic mitral ring.

CONCLUSIONS

The modified BATMAN is a feasible and safe procedure for TMVR in patients with a high risk of LVOTO even in the presence of a double-orifice mitral valve.

FIGURE 6 Postoperative cardiac Computed Tomography Scan



Evidence of anterior mitral leaflet translocation after the balloon-assisted translocation of the anterior mitral leaflet (AML) procedure. Dotted lines shows the translocated anterior mitral leaflet. AML = anterior mitral leaflet; LAO = left anterior oblique; MPR = dedicated view aligned to the S3 bioprosthesis.

The transseptal approach and the double-wire strategy make the procedure reproducible and predictable. Additional studies are required to confirm midterm and long-term results.

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ADDRESS FOR CORRESPONDENCE: Dr Matteo Saccocci, Department of Cardiac Surgery, IRCCS San Raffaele Hospital, 60 Via Olgettina, Milan 21032, Italy. E-mail: saccocci.matteo@hsr.it.

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KEY WORDS **LVOT obstruction, mitral repair failure, mitral surgery, mitral valve, TMVR, valve in ring**