Tip-to-base LAMPOON to prevent left ventricular outflow tract obstruction in a valve-in-ring transcatheter mitral valve replacement: First LAMPOON procedure in Turkey and first LAMPOON case for transseptal Myval™ implantation

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Introduction

Transcatheter mitral valve replacement (TMVR) using aortic transcatheter heart valves is an emerging alternative treatment modality to reoperation among high-risk patients with failed mitral bioprosthetic valves and failed annuloplasty rings (1-4). Compared with mitral valve-in-bioprosthetic valve (TMVIV) procedures, transcatheter mitral valve-in-ring (TMVIR) implantations are associated with more frequent adverse events, including left ventricular outflow tract obstruction (LVOTO), device embolization, and residual mitral regurgitation (3, 4). TMVIR may also cause acute LVOTO, which is an important cardiac emergency as the native anterior mitral leaflet is displaced toward the interventricular septum throughout the cardiac cycle. Intentional laceration of anterior mitral leaflet to prevent outflow obstruction (LAMPOON) by percutaneous electrosurgery is a novel technique and a life-saving therapy among patients undergoing TMVR (5). However, the technique has not been used worldwide. To date, only one case has been published outside of the United States, where it was performed using the old retrograde base-to-tip LAMPOON approach (5, 6). Herein, we present implementation of a newly discovered technique: Tip-to-base LAMPOON procedure before a TMVIR with Myval™ valve (Meril Life Sciences Pvt. Ltd., Vapi, Gujarat, India) (7, 8).

Case Report

On March 2, 2021, a 78-year-old woman with a history of a 30-mm Medtronic Profile 3D complete rigid ring (Medtronic, Minneapolis, Minnesota, USA) replacement presented with heart failure to our clinic (Fig. 1a, Video 1). Past medical history revealed hypertension and chronic obstructive lung disease. Transesophageal echocardiography (TEE) demonstrated severe central regurgitation, restricted movement of the posterior leaflet, a small left ventricle (LV) cavity and a long anterior leaflet extending to the left ventricular outflow tract, and a grade I-II paravalvular leak (PVL) at the posterior region outside the ring (Fig. 1b, Video 1). The anterior mitral leaflet length measured from the tip of the leaflet to the base of the annuloplasty ring was 30-31.5 mm. This was confirmed at different TEE angles (Fig. 1c, 1d, and Video 1). Logistic EuroSCORE of the patient was calculated as 46.25%. The patient's central mitral regurgitation was very severe. Thus, TMVIR was recommended as a first procedure by our Heart Team.

However, gated computed tomography (CT) revealed a very unfavorable aortico-mitral angle (AMA) and a large septal bulge, which increase the risk of LVOTO (Fig. 2a). The valve deployment was modeled at a 10% to 20% atrial position and at an 80% to 90% ventricular position (Fig. 2b) (8). Predicted neo-LVOT area using virtual 26-mm Myval was calculated and found to be 169 mm^2 (Fig. 2c) (9-12). According to TEE and CT findings, the patient was deemed at very high and prohibitive risk during standard TMVIR owing to the risk of LVOTO; therefore, LAMPOON procedure was discussed and strongly recommended by our Heart Team before performing TMVIR on the patient.

The procedure was performed under general anesthesia guided by fluoroscopy and TEE. After a successful inferoposterior transseptal puncture, a left atrial steerable sheath (Agilis NxT Steerable Introducer; St. Jude Medical, Inc, St. Paul, Minnesota, USA) was placed into left atrium (LA). A balloon wedge end-hole catheter was floated through the mitral ring and the LV. A 0.035 Terumo guidewire (Terumo Medical Corp.) was advanced through the balloon catheter, snared in the aorta, and the first venoarterial loop was created (Video 2). A 6F guiding catheter was inserted through the femoral artery over the wire loop and advanced into the Agilis sheath. The mid segment of a 0.014-inch Astato XS20 wire (Asahi-Intecc, Tokyo, Japan) was kinked and focally denuded outside to form a flying V (5, 8, 13, 14). The Astato guidewire was inserted from the venous side into the Agilis sheath and then advanced into the 6F guiding catheter inside the Agilis sheath and the second venoarterial loop was created (Video 2). Terumo guidewire was then removed. The denuded and kinked mid segment of the Astato XS20 guidewire (Flying V) was positioned at the anterior leaflet's tip and aligned with the midline of the leaflet and with the aortic root (Fig. 3a) (5, 8, 13, 14). An intraaortic balloon pump (IABP) was placed through a braided 8F Super Arrow-Flex sheath (Teleflex, Morrisville, NC, USA). The outside end of the Astato XS wire was connected via forceps to a monopolar electrosurgery pencil and a standard electrosurgery generator (such as Valley Lab Force FX/A, Medtronic). The Flying V segment of the Astato guidewire was pulled toward the ring and electrified at 70 W with continuous 5% dextrose flush until it reached the base. TEE confirmed tip-to-base laceration of the mitral leaflet and new severe mitral regurgitation (Fig. 3b, 3c, and Video 3). The IABP support was immediately started. The lacerating system was removed from the patient. Balloon

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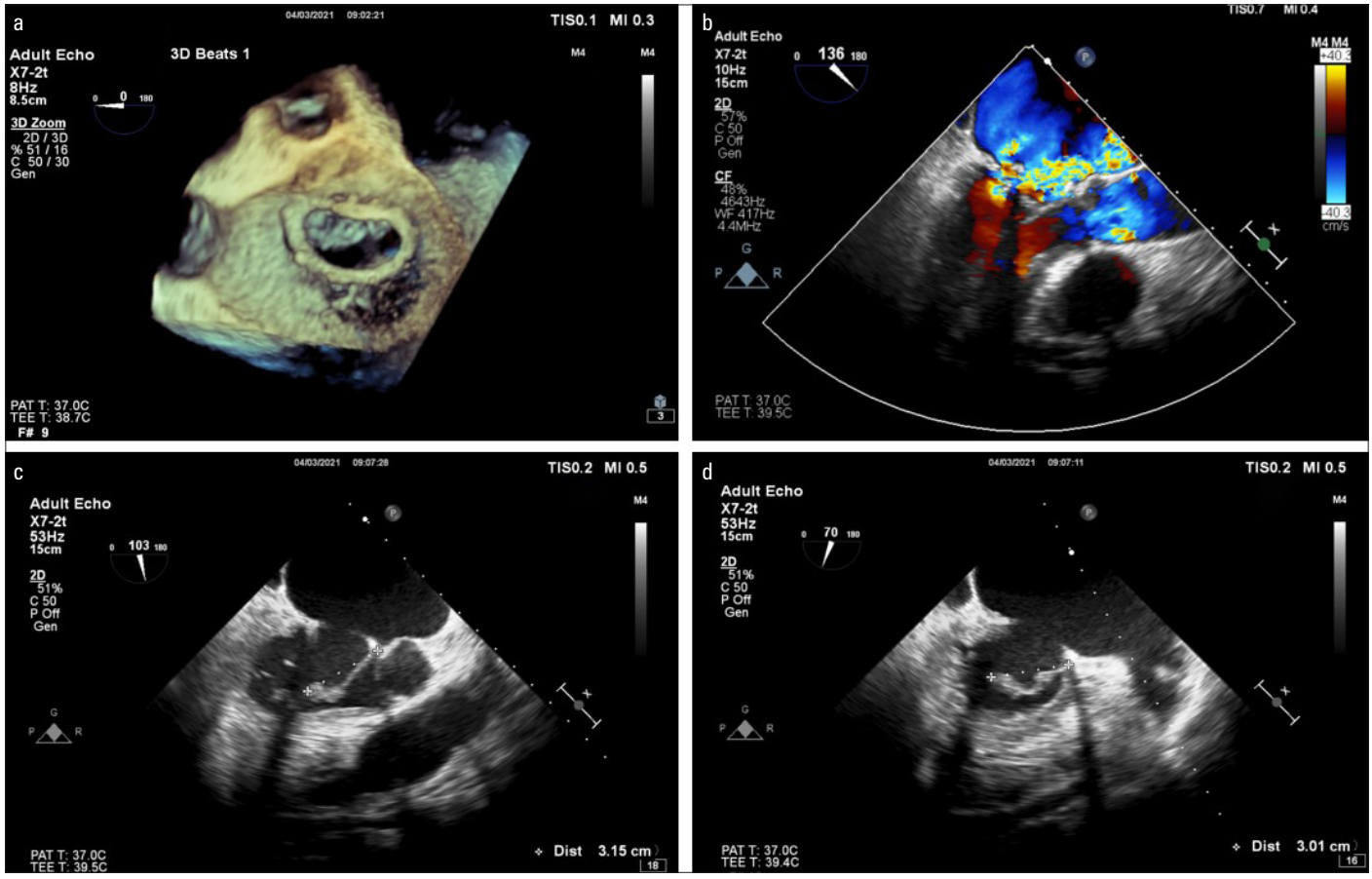

Figure 1. a. 3D Transesophageal echocardiography (TEE) image of Medtronic Profile 3D complete rigid ring and a crescentic paravalvular defect outside the ring at posterior region. b. Color Doppler TEE image showing severe central regurgitation and paravalvular leak outside the ring. c. TEE showing the anterior mitral leaflet length measured from the tip of the leaflet to the base of the annuloplasty ring. d. TEE showing the anterior mitral leaflet length measured from a different TEE angle

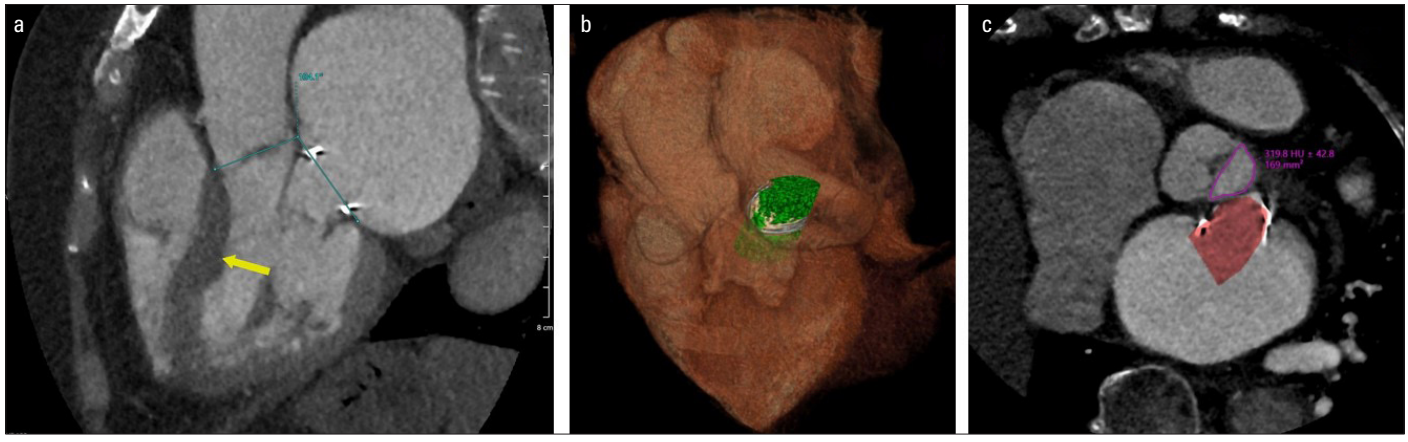

Figure 2. a. Gated computed tomography (CT) revealed a very unfavorable AMA and a large septal bulge, which increase the risk of LVOTO. b. CT showing virtual modeling of the 26-mm Myval valve deployment. c. CT showing predicted neo-LVOT area using virtual 26-mm Myval to be 169 mm^2

wedge end-hole catheter was again floated inside through the Agilis sheath, the mitral ring, and the LV. A manually shaped Amplatz stiff guidewire (Boston Scientific, Malborough, MA, USA) was positioned in the LV cavity at apex. Interatrial septal puncture site was dilated with a 20 mm Z-med balloon (B. Braun Interventional Systems, Inc.). TMVIR was then successfully performed using a 26-mm Myval™ transcatheter heart valve under rapid pacing at 180 bpm (Fig. 3d, 3e, and Video 4). Final assessment demonstrated no evidence of LVOT obstruction and no PVL between the valve and the ring. Gated CT after TMVIR showed that the valve was settled properly, neo-LVOT was significantly increased, and the flow was across the lacerated

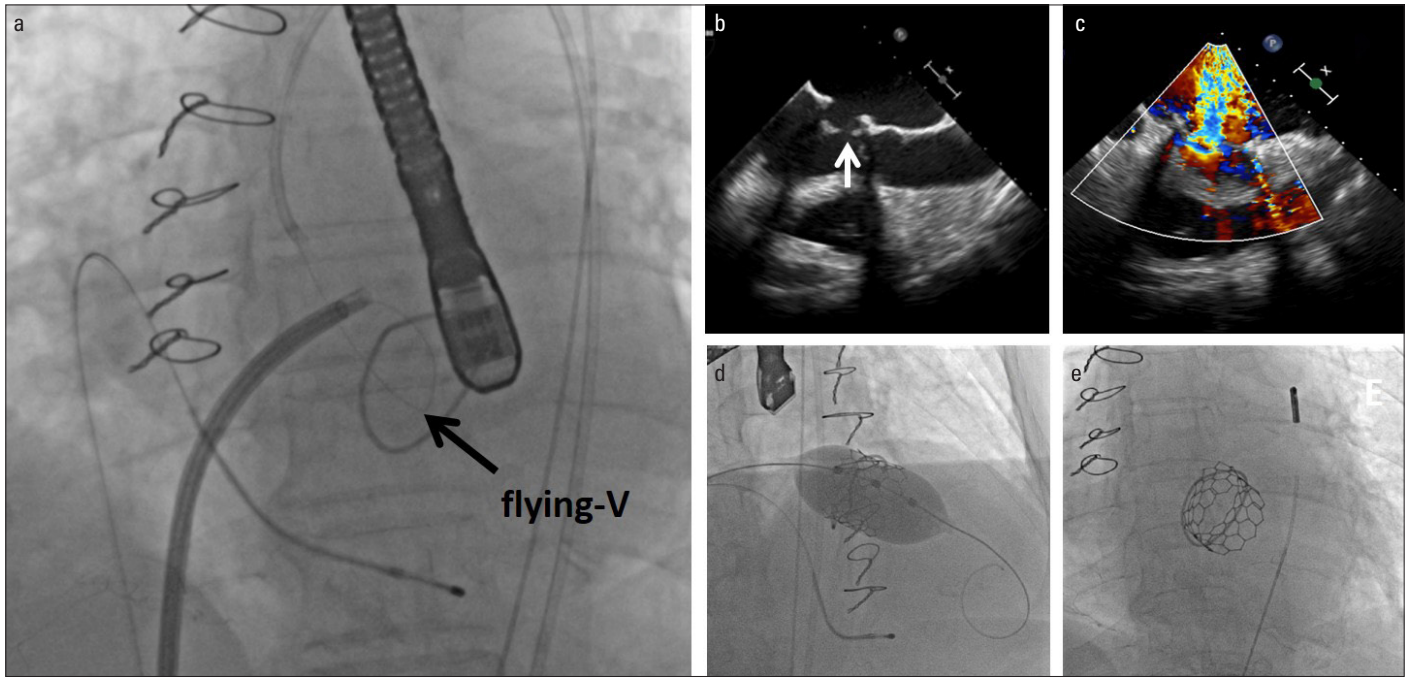

Figure 3. a. Fluoroscopy of the tip-to-base LAMPOON using the flying-V (black arrow) guidewire straddling the anterior mitral leaflet. b. TEE showing lacerated anterior mitral leaflet (white arrow). c. TEE showing new severe mitral regurgitation. d. Fluoroscopy of the 26-mm Myval valve deployment. e. Fluoroscopy showing the final position of 26-mm Myval and intraaortic balloon pump

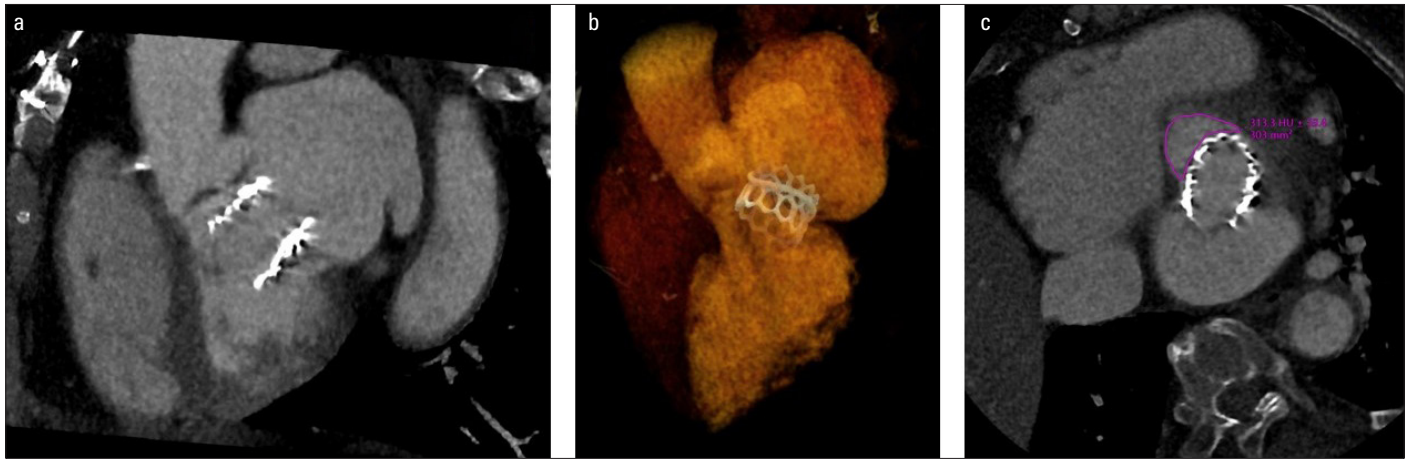

Figure 4. a. CT showing the proper settlement of Myval valve in the mitral ring. b. CT showing the exact position of Myval valve (15% atrial, 85% ventricular). c. CT showing the neo-LVOT area after 26-mm Myval valve deployment to be 303 mm^2

anterior mitral valve to LVOT (Fig. 4a, 4b, and 4c). Post procedural TEE one week after the procedure showed increased regurgitation in the paravalvular area outside the ring. Significant left to right shunt due to iatrogenic atrial septal defect (ASD) was also observed. Thus, antegrade transseptal closure of the posterior PVL outside the ring by creating a veno-arterial loop and by using 14x5 AVP III and 20 mm AVP II devices and transcatheter ASD closure with a 24-mm Amplatzer septal Occluder were performed one week after the procedure (Fig. 5a, Supplemental Video 1). Final TEE showed no mitral regurgitation (Fig. 5b, 5c, and Supplemental Video 2). The patient was discharged 2 weeks after her admission in an improved condition.

Discussion

To the best of our knowledge, this case is the first LAMPOON procedure in Turkey, the first tip-to-base LAMPOON procedure outside of the United States, and the first LAMPOON case before transcatheter Myval™ replacement in mitral position.

In this case, there were multiple anatomic risk factors for LVOTO during TMVIR, as the patient had a 30-mm elongated anterior leaflet (>20 mm), a small ventricular cavity, and a perpendicular AMA (15). Moreover, predicted neo-LVOT using virtual 26-mm Myval was found to be 169 mm^2, which indicates increased risk of LVOTO according to observational studies (<170-190 mm^2) (9, 13). Thus, we believed that the LAMPOON

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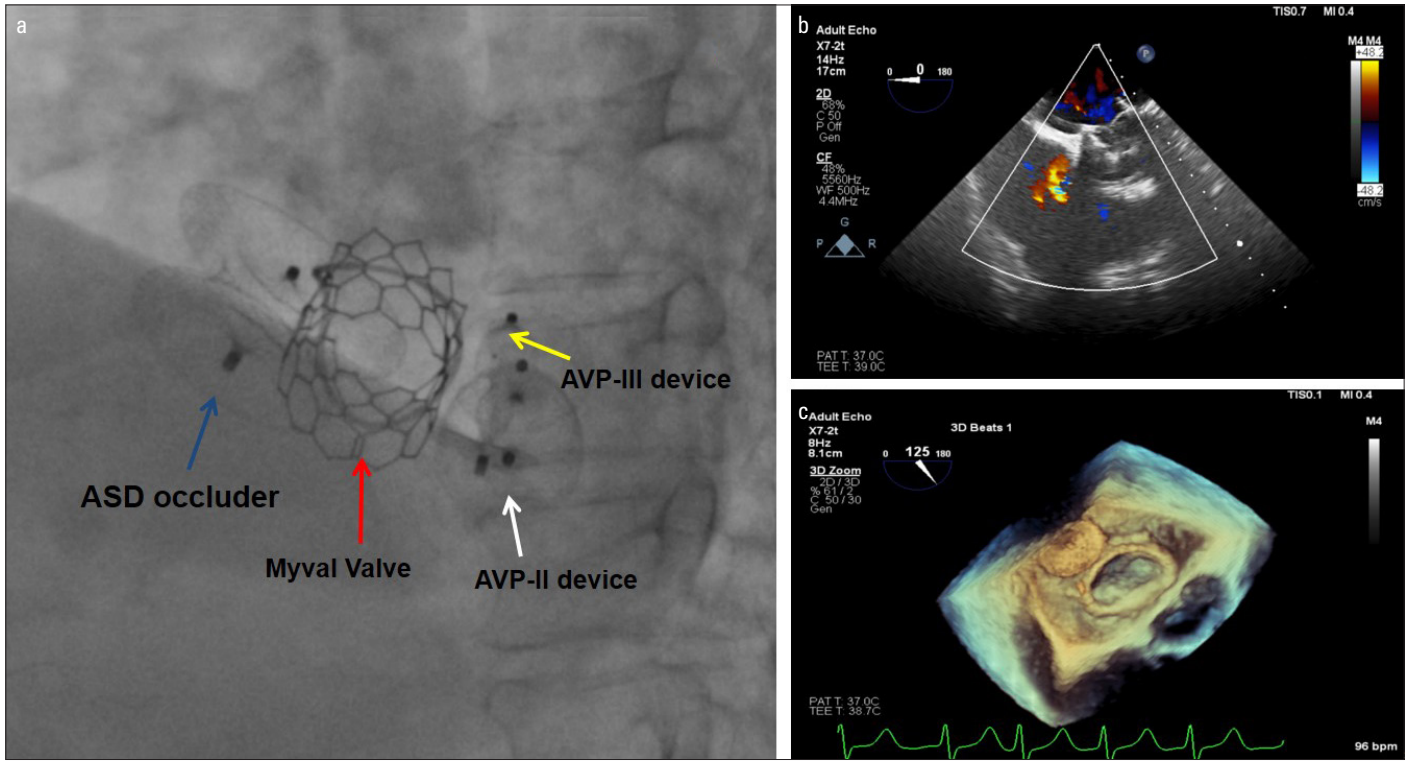

Figure 5. a. Fluoroscopy showing AVP-III (yellow arrow) and AVP-II devices (white arrow), atrial septal occluder device (blue arrow), and myval valve (red arrow). b. Final TEE showing no central or paravalvular regurgitation. c. 3D TEE showing complete closure of paravalvular leak with AVPII and AVP III devices

procedure before TMVIR would be a life-saving therapy for the patient. Post procedural CT data also confirmed our observation that actual neo-LVOT was significantly increased to 303 mm^2 after the procedure (Fig. 4c). Without LAMPOON, this patient would have been at high risk of LVOTO.

The LAMPOON technique has been originally described as a retrograde base-to-tip approach (5). Antegrade simple version of the original technique has recently been described (14). The main advantage of these base-to-tip techniques was that the vector of laceration aligns along the LVOT. Thus, these two "base-to-tip" approaches are essential for patients with native valves to avoid inadvertent laceration of the aortomitral continuity. However, both techniques have not been universally adopted because retrograde or antegrade traversal of the base of the A2 scallop can be technically challenging and time consuming (6). In contrast, the recently described tip-to-base LAMPOON for TMVIR or TMVIV procedures may be quickly adopted because lacerating the leaflet from tip to base is relatively easy, as the technique only requires a simple venoarterial rail (7). Our case also confirms a universal adaptation of the new technique. However, tip-to-base approach is only applicable in patients with protected annulus with a valve ring or an annuloplasty device (7, 8). Moreover, aortic injuries, which require emergent valve replacement, can also develop in some patients. This was clearly defined by Lisko et al. (8) in their recently published case series. Thus, operators must be careful and ensure to sufficiently telescope the guiding catheter which was sent through the aorta over the electrified guidewire and should refrain from making aggressive tractions (6, 8).

Conclusion

For patients with protected annulus and high-risk anatomy undergoing TMVIR, tip-to-base LAMPOON is a life-saving solution to prevent LVOTO. Nevertheless, it requires meticulous attention to insulate the lacerating surface to avoid serious injury to the aortic valve.

Informed consent: Written informed consent was obtained from the patient and patient's family for publication of this case report and any accompanying images.

Video 1. 2D and 3D TEE examination of the patient before the procedure

Video 2. Creation of the venoarterial loop; first with the Terumo wire and second with the Astato XS20 wire

Video 3. Tip-to-base Lampoon procedure using the flying V guidewire

Video 4. Balloon dilation of interatrial septum and transseptal antegrade deployment of 26-mm Myval valve

Supplemental Video 1. Percutaneous transcatheter closure of posterior PVL outside the ring and transcatheter closure of the iatrogenic atrial septal defect

Supplemental Video 2. 2D and 3D TEE examination after PVL closure procedure

References

1. Sekaran N, Horne BD, Doty JR, Reid BB, Miner EC, Harkness JR, et al. Transcatheter mitral valve in ring, hazards of long anterior mitral leaflet and 3-dimensional rings. Catheter Cardiovasc Interv 2021; 97: 353-8. [Crossref]
2. 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: 1932-42. [Crossref]
3. 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: e008425. [Crossref]
4. Yoon SH, Whisenant BK, Bleiziffer S, Delgado V, Dhoble A, Schofer N, et al. Outcomes of transcatheter mitral valve replacement for degenerated bioprostheses, failed annuloplasty rings, and mitral annular calcification. Eur Heart J 2019; 40: 441-51. [Crossref]
5. Khan JM, Rogers T, Schenke WH, Mazal JR, Faranesh AZ, Greenbaum AB, et al. Intentional Laceration of the Anterior Mitral Valve Leaflet to Prevent Left Ventricular Outflow Tract Obstruction During Transcatheter Mitral Valve Replacement: Pre-Clinical Findings. JACC Cardiovasc Interv 2016; 9: 1835-43. [Crossref]
6. Kasel AM, Rumpf M, Frangieh AH, Mayr P, Joner M, Xhepa E, et al. International LAMPOON: first European experience with laceration of the anterior mitral valve leaflet prior to transseptal transcatheter mitral valve implantation. EuroIntervention 2018; 14: 746-9. [Crossref]
7. Case BC, Khan JM, Satler LF, Ben-Dor I, Lederman RJ, Babaliaros VC, et al. Tip-to-Base LAMPOON to Prevent Left Ventricular Outflow Tract Obstruction in Valve-in-Valve Transcatheter Mitral Valve Replacement. JACC Cardiovasc Interv 2020; 13: 1126-8. [Crossref]
8. Lisko JC, Babaliaros VC, Khan JM, Kamioka N, Gleason PT, Paone G, et al. Tip-to-Base LAMPOON for Transcatheter Mitral Valve Replacement With a Protected Mitral Annulus. JACC Cardiovasc Interv. 2021; 14: 541-50. [Crossref]
9. Yoon SH, Bleiziffer S, Latib A, Eschenbach L, Ancona M, Vincent F, et al. Predictors of Left Ventricular Outflow Tract Obstruction After Transcatheter Mitral Valve Replacement. JACC Cardiovasc Interv 2019; 12: 182-93. [Crossref]
10. Wang DD, Eng MH, Greenbaum AB, Myers E, Forbes M, Karabon P, et al. Validating a prediction modeling tool for left ventricular outflow tract (LVOT) obstruction after transcatheter mitral valve replacement (TMVR). Catheter Cardiovasc Interv 2018; 92: 379-87. [Crossref]
11. Blanke P, Naoum C, Dvir D, Bapat V, Ong K, Muller D, et al. Predicting LVOT Obstruction in Transcatheter Mitral Valve Implantation: Concept of the Neo-LVOT. JACC Cardiovasc Imaging 2017; 10: 482-5. [Crossref]
12. Murphy DJ, Ge Y, Don CW, Keraliya A, Aghayev A, Morgan R, et al. Use of Cardiac Computerized Tomography to Predict Neo-Left Ventricular Outflow Tract Obstruction Before Transcatheter Mitral Valve Replacement. J Am Heart Assoc 2017; 6: e007353. [Crossref]
13. Case BC, Lisko JC, Babaliaros VC, Greenbaum AB, Satler L, Ben-Dor I, et al. LAMPOON techniques to prevent or manage left ventricular outflow tract obstruction in transcatheter mitral valve replacement. Ann Cardiothorac Surg 2021; 10: 172-9. [Crossref]
14. Lisko JC, Greenbaum AB, Khan JM, Kamioka N, Gleason PT, Byku I, et al. Antegrade Intentional Laceration of the Anterior Mitral Leaflet to Prevent Left Ventricular Outflow Tract Obstruction: A Simplified Technique From Bench to Bedside. Circ Cardiovasc Interv 2020; 13: e008903. [Crossref]
15. Urena M, Himbert D, Brochet E, Carrasco JL, Iung B, Nataf P, et al. Transseptal Transcatheter Mitral Valve Replacement Using Balloon-Expandable Transcatheter Heart Valves: A Step-by-Step Approach. JACC Cardiovasc Interv 2017; 10: 1905-19. [Crossref]

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