JACC: CASE REPORTS VOL. 29, 2024

INTERVENTIONS

CASE REPORT: CLINICAL CASE

Sequential Alcohol Septal Ablation to Resolve LV Outflow Tract Obstruction After Transcatheter Mitral Valve Replacement

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ABSTRACT

Left ventricular outflow tract obstruction (LVOTO) is a notorious complication of transcatheter mitral valve replacement (TMVR). Computed tomography–derived simulations can predict neo-LVOTO post-TMVR, whereas alcohol septal ablation (ASA) can mitigate neo-LVOTO risk. We report a case of sequential ASA of 2 adjacent septal branches to resolve unexpected neo-LVOTO post-TMVR. (J Am Coll Cardiol Case Rep 2024;29:102193) © 2024 The Authors. 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/).

HISTORY OF PRESENTATION

A 71-year-old male patient had symptomatic severe calcific mitral valve stenosis but was deemed inoperable because of a porcelain aorta and excessive mitral annular calcifications. The Society of Thoracic Surgeons Predicted Risk of Operative Mortality score was 9.8%.

LEARNING OBJECTIVES

- To understand the challenges involved with neo-LVOT calculation in TMVR.
- To review transcatheter treatment options of neo-LVOTO post-TMVR.
- To show the potential of sequential ASA of 2 adjacent septal branches to resolve neo-LVOTO post-TMVR.

PAST MEDICAL HISTORY

The patient's medical history included surgical aortic valve replacement in 2011 (21-mm Perimount Bioprosthesis), chronic obstructive pulmonary disease classification stage 2 of the Global Initiative for Chronic Obstructive Lung Disease system, peripheral arterial disease, atrial fibrillation, hypertension, and type 2 diabetes mellitus.

INVESTIGATIONS

Preprocedural echocardiography showed a preserved left ventricular ejection fraction and moderate aortic

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received September 4, 2023; accepted October 17, 2023.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2023.102193

JACC: CASE REPORTS, VOL. 29, 2024
FEBRUARY 7, 2024:102193

ABBREVIATIONS AND ACRONYMS

AMVL = anterior mitral valve leaflet

ASA = alcohol septal ablation

CTA = computed tomography angiography

LV = left ventricular

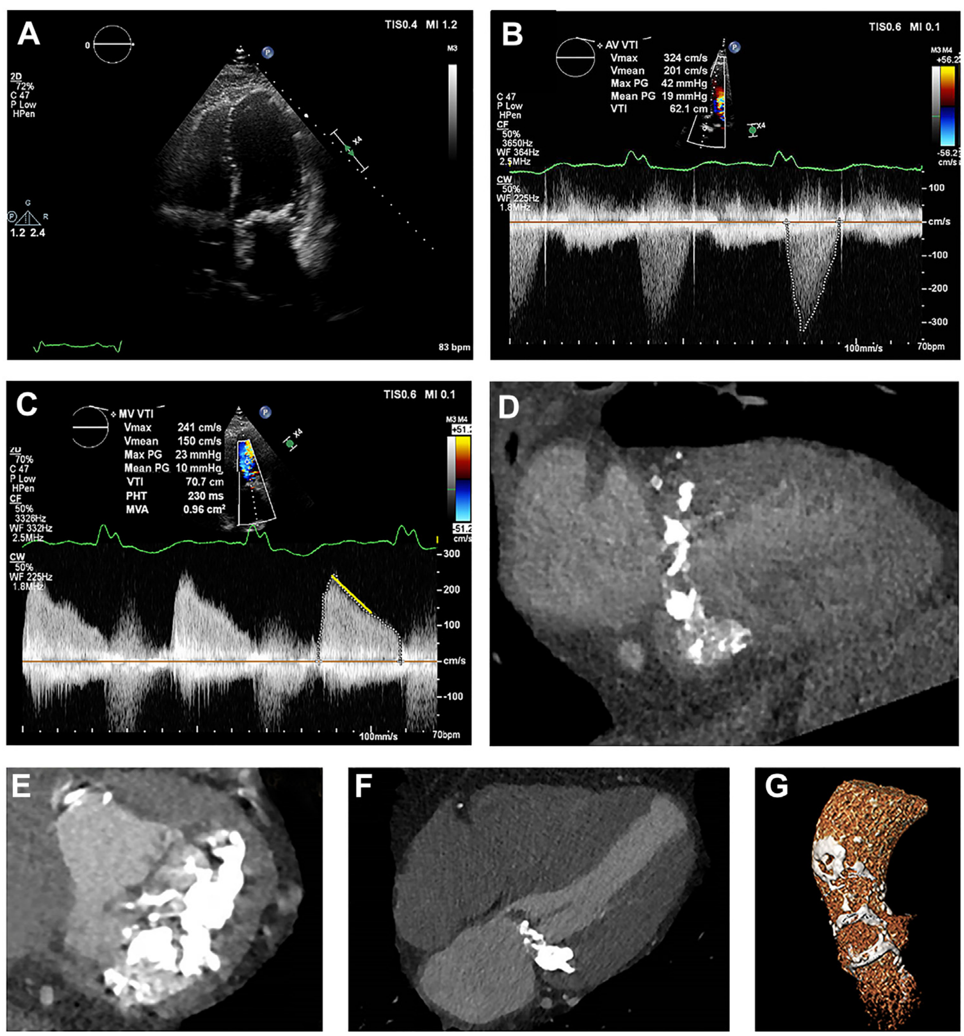
LVOT = left ventricular outflow tract

LVOTO = left ventricular outflow tract obstruction

TMVR = transcatheter mitral valve replacement

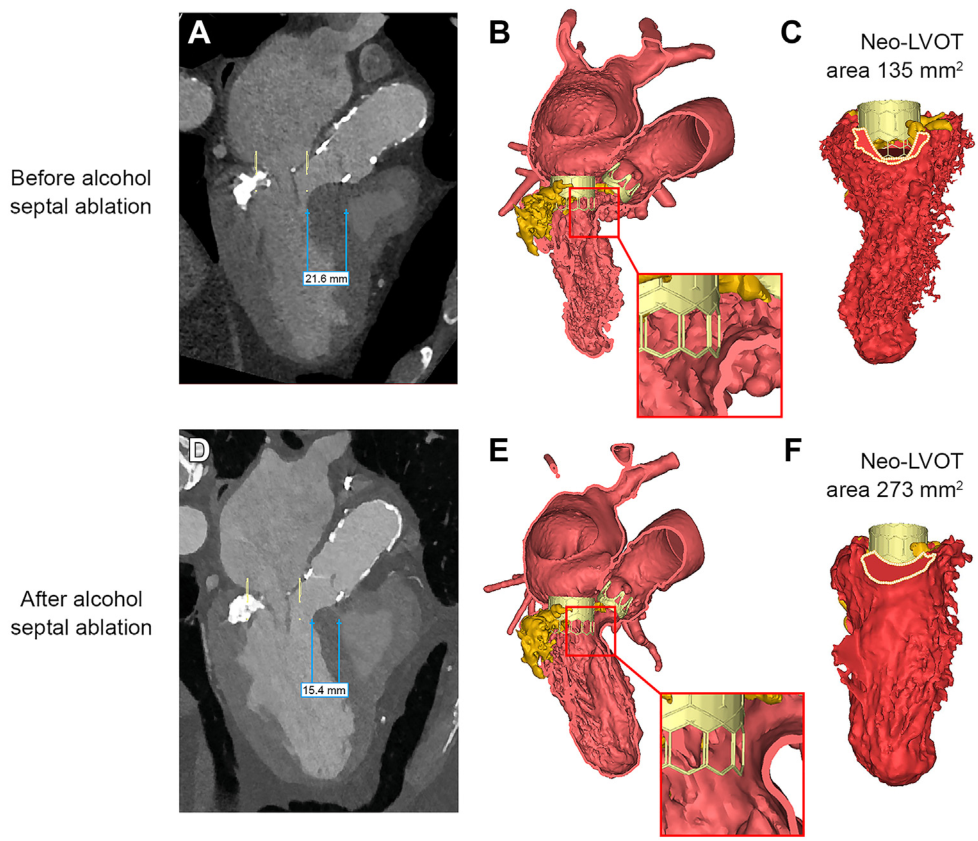
valve degeneration, including leaflet thickening, calcification, and a gradually increasing mean gradient (from 8 to 19 mm Hg) over the past year (Figures 1A and 1B). Furthermore, a mitral mean gradient of 10 mm Hg and estimated mitral valve area of 0.96 cm^2 indicated severe mitral valve stenosis (Figure 1C). Computed tomography angiography (CTA) confirmed severe mitral annulus calcifications, protruding into the basal anterior, lateral, and inferior wall of the left ventricle (Figures 1D to 1F) and multiple calcifications in the ascending aorta (Figure 1G). The anterior mitral leaflet length was 29 mm.

FIGURE 1 **Baseline TTE and Computed Tomography Angiography**



(A) Transthoracic echocardiography (TTE) showing a nondilated left ventricle. (B) TTE showing a mean aortic bioprosthesis gradient of 19 mm Hg. (C) TTE showing a mitral valve mean gradient of 10 mm Hg and pressure half-time of 230 milliseconds (estimated mitral valve area 0.96 cm^2). Computed tomography angiography 2-chamber (D), short-axis (E), and 4-chamber (F) views showing severe mitral annulus calcification, protruding into the basal anterior, lateral, and inferior wall. (G) Three-dimensional modeling of the ascending aorta showing multiple calcifications.

FIGURE 2 3-Dimensional CT-Derived Transcatheter Mitral Valve Replacement Simulation and Neo-LVOT Area Calculation



(A) Baseline 3-chamber computed tomography (CT) view. (B) Baseline CT-derived 3-dimensional model shows virtual SAPIEN 3 implantation. (C) Based on automatic neo-left ventricular outflow tract (LVOT) area calculation, SAPIEN 3 implantation results in a neo-LVOT area of 135 mm^2. (D) Three-chamber CT view post–alcohol septal ablation (ASA). (E) CT-derived 3-dimensional model post-ASA shows LVOT expansion compared with baseline simulation. (F) Neo-LVOT area calculation post-ASA shows neo-LVOT area expansion to 273 mm^2.

MANAGEMENT

In the work-up for transcatheter mitral valve replacement (TMVR), CT-derived procedure simulation suggested a high likelihood for neo-left ventricular outflow tract obstruction (LVOTO) with an estimated neo-LVOT area of 135 mm^2 (Figures 2A to 2C).[1] Pre-emptive alcohol septal ablation (ASA) was performed by administration of 2 cc of alcohol in the first septal perforator branch. The patient developed a total atrioventricular block and received a permanent pacemaker. Seven weeks later, a CTA confirmed a thinner basal septum and a neo-LVOT area of 273 mm^2 (Figure 2F).

TMVR was now deemed suitable. Four months after the ASA procedure, a 29-mm SAPIEN 3 balloon-expandable valve (Edwards Lifesciences) was deployed in the mitral annulus, with a trace of residual mitral regurgitation and a mean transvalvular gradient of 2 mm Hg (Figures 3A to 3D).

Immediately after TMVR, neo-LVOTO was observed with a LVOT peak velocity (V_{max}) of 3.0 m/s and an LVOT peak gradient of 36 mm Hg (Figure 3E). Because it was difficult to see the exact level where the obstruction was located, the continuous wave Doppler signal also exhibited a substantially increased gradient (peak 57 mm Hg; mean 36 mm Hg), and the aortic bioprosthesis already had degenerative features, the idea was to eliminate any contribution of the stenotic aortic prosthesis (Figure 3F). Therefore, transcatheter aortic valve replacement (TAVR) with a supra-annular functioning self-expanding valve (23 mm, Evolut PRO+, Medtronic) inside the Perimount Bioprosthesis and subsequent bioprosthetic valve fracturing were performed (Figure 3G). Neo-LVOTO remained unchanged. The

FIGURE 3 Transcatheter Mitral Valve Replacement Procedure

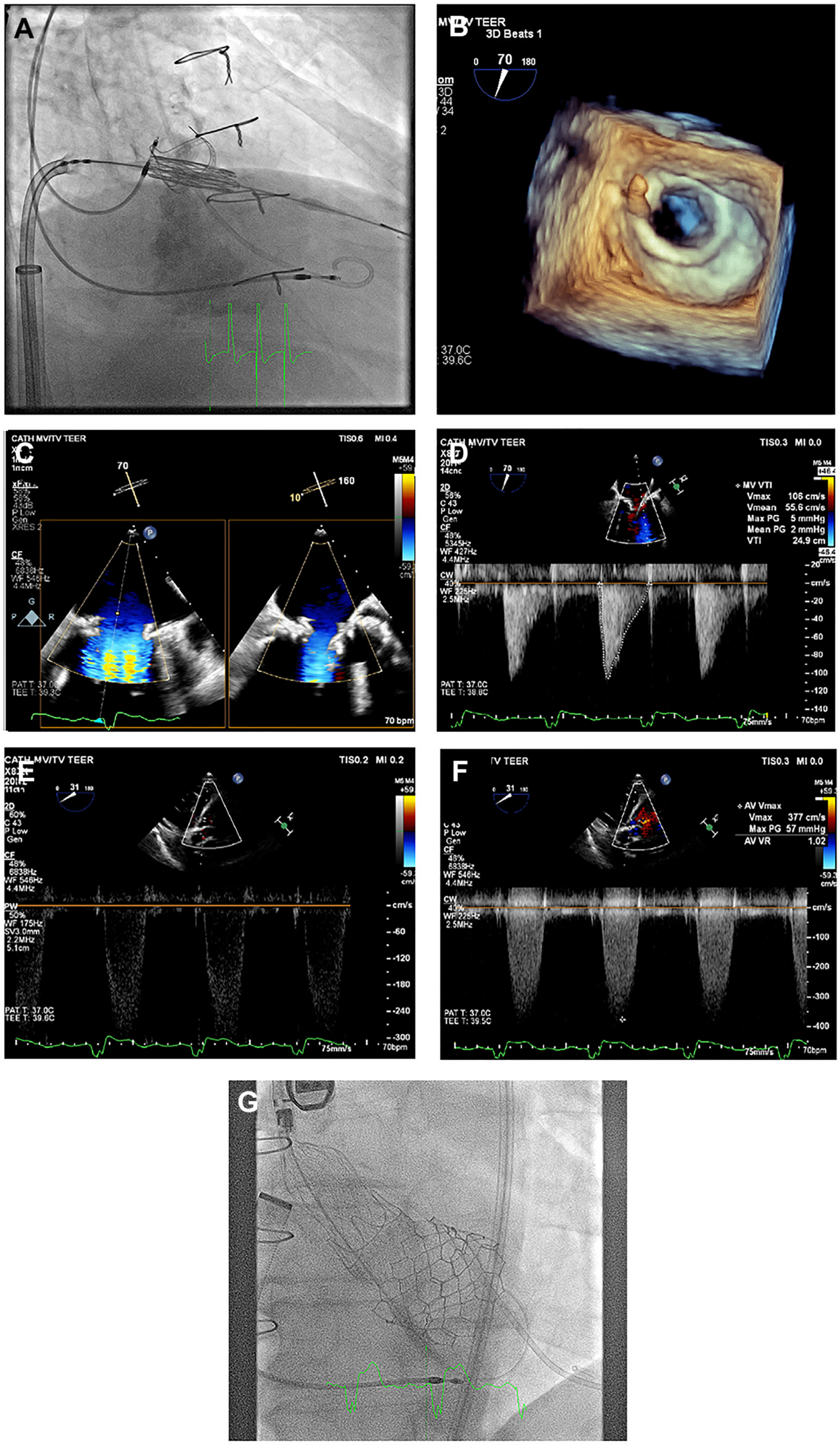


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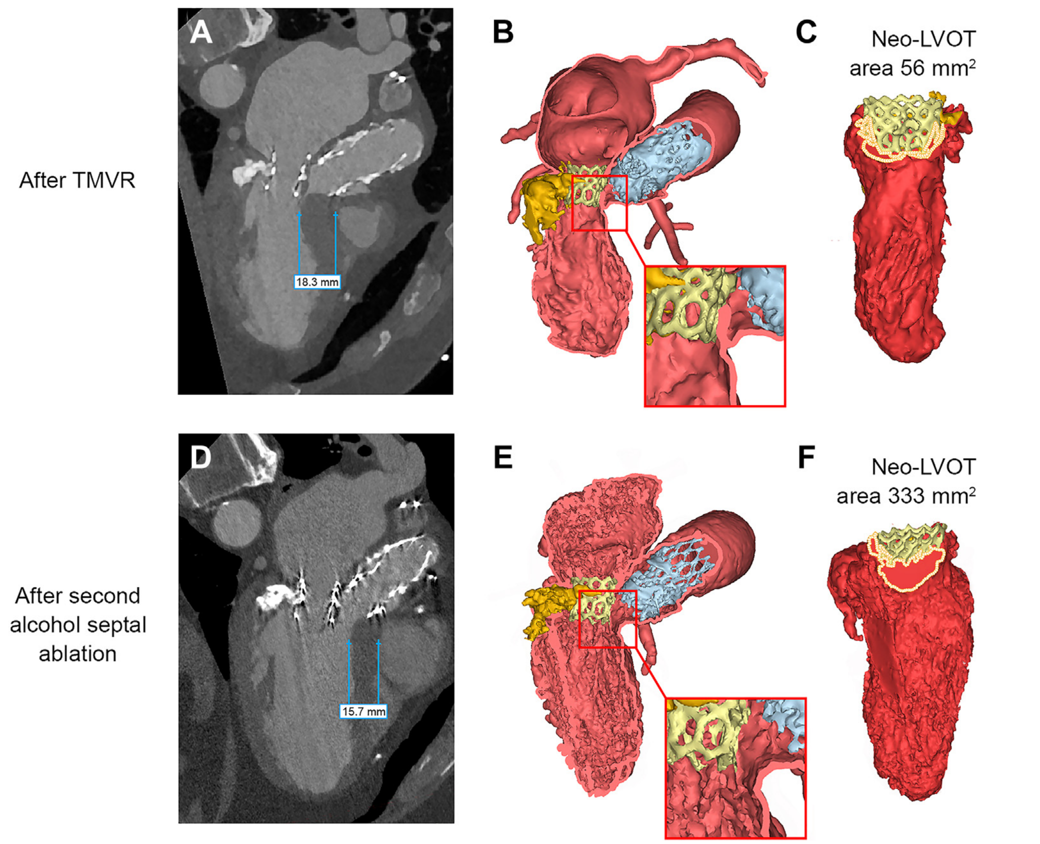
FIGURE 4 3-Dimensional CT-Derived Model and Neo-LVOT Area Calculation



(A) Three-chamber CT view post-transcatheter mitral valve replacement (TMVR). (B and C) CT-derived 3-dimensional model post-TMVR shows neo-LVOT obstruction with a neo-LVOT area of 56 mm^2. (D) Three-chamber CT view after second ASA. (E and F) CT-derived three-dimensional model after second ASA shows significantly increased neo-LVOT area (333 mm^2). Abbreviations as in Figure 2.

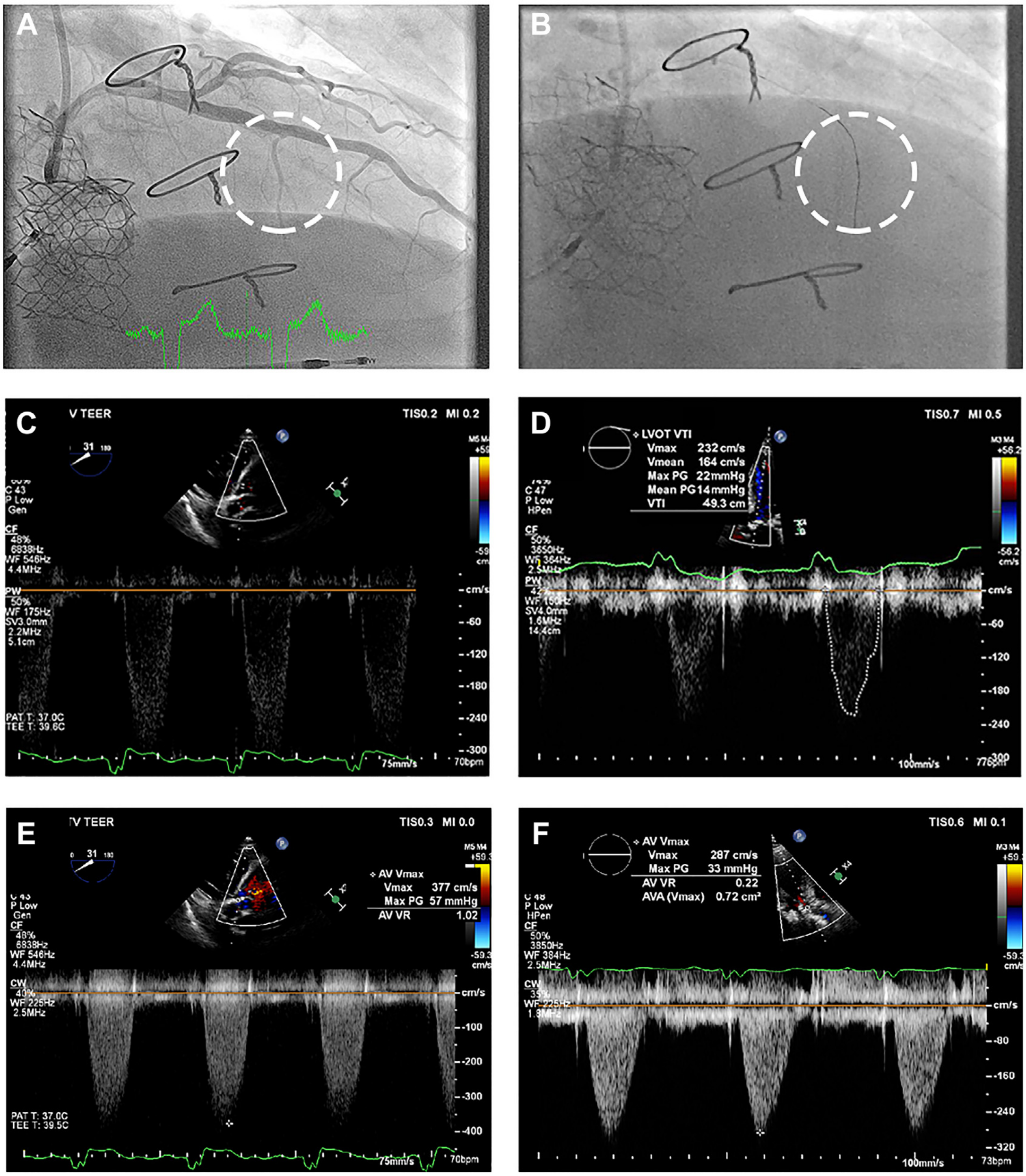
gradient was thus entirely generated by the neo-LVOT. A CTA after TMVR and TAVR revealed substantial increase in basal septum thickness compared with a CTA before the procedure, displacement of the anterior mitral valve leaflet (AMVL) toward the LVOT, and a neo-LVOT area of 56 mm^2 (Figures 4A to 4C).

The patient remained symptomatic (NYHA functional class III). Echocardiography confirmed good valve performances of the mitral and aortic bioprostheses but also a residual LVOT obstruction (V_{max} of 3.0 m/s and a peak gradient of 36 mm Hg). A second ASA of the adjacent second septal perforator with 2.5 cc of alcohol was performed (Figures 5A and 5B). CTA 6 weeks after this second ASA (13 weeks after TMVR and TAVR) revealed an incremental neo-LVOT area of 333 mm^2 and no more neo-LVOTO (Figures 4D to 4F), whereas echocardiography showed a reduced peak LVOT gradient at rest of 22 mmHg, with a mean

FIGURE 3 Continued

(A) SAPIEN 3 transcatheter heart valve deployment. (B) Three-dimensional transesophageal echocardiography (TEE) image of implanted SAPIEN 3 in mitral valve position. (C) TEE images of the mitral valve show no mitral regurgitation or paravalvular leakage. (D) TEE shows a low residual mitral peak (5 mm Hg) and mean (2 mm Hg) gradient. (E) TEE pulsed wave Doppler shows a left ventricular outflow tract peak gradient of 36 mm Hg and mean gradient of 22 mm Hg directly after SAPIEN 3 implantation in the mitral position. (F) TEE continuous wave Doppler across the aortic valve shows a peak gradient of 57 mm Hg and mean gradient of 36 mm Hg directly after SAPIEN 3 implantation in the mitral position. (G) Successful implantation of 23 mm Evolut PRO+ transcatheter heart valve inside aortic bioprosthesis.

FIGURE 5 Second ASA Procedure and LVOT Gradients (Before and After)



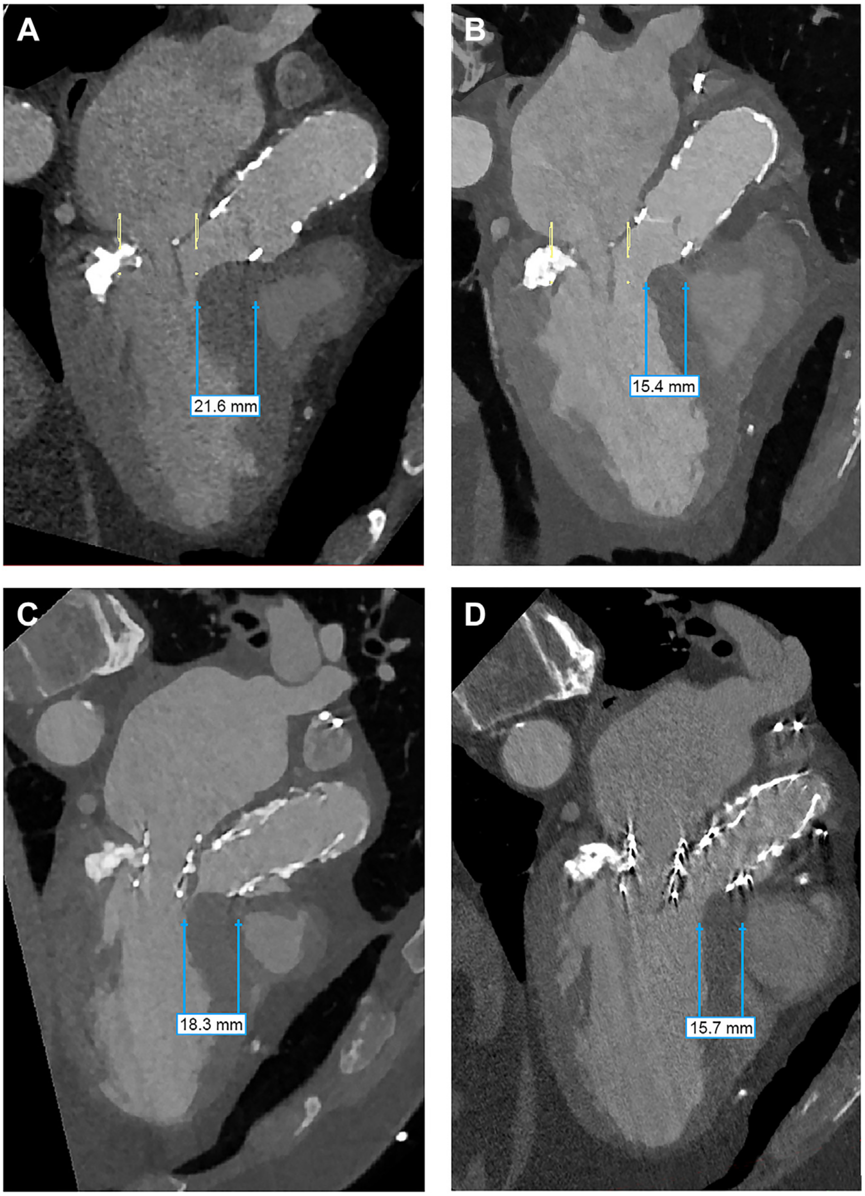
(A and B) ASA of the second septal perforator (indicated by dashed white circle). (C and D) Echocardiography 6 weeks after second ASA shows a significant decrease in LVOT peak and mean gradient (22 mm Hg and 14 mm Hg, respectively) compared with the LVOT gradient during TMVR (peak 36 mm Hg; mean 22 mm Hg). (E and F) Echocardiography 6 weeks after second ASA shows a significant decrease in aortic valve peak and mean gradient (33 mm Hg and 21 mm Hg) compared with the aortic valve gradient during TMVR (peak 57 mm Hg; mean 36 mm Hg). Abbreviations as in Figure 2 and 4.

gradient of 14 mm Hg (Figure 5D). Peak aortic valve gradient was reduced to 33 mmHg, with a mean gradient of 21 mm Hg (Figure 5F). The patient was no longer symptomatic (NYHA functional class I) and resumed his active lifestyle.

DISCUSSION

TMVR may (partially) obstruct the LVOT. Smaller left ventricular (LV) dimensions, LV hypertrophy, extended and/or thickened mitral leaflets, and acute

FIGURE 6 **Computed Tomography Angiography 3-Chamber View at Different Time Points**

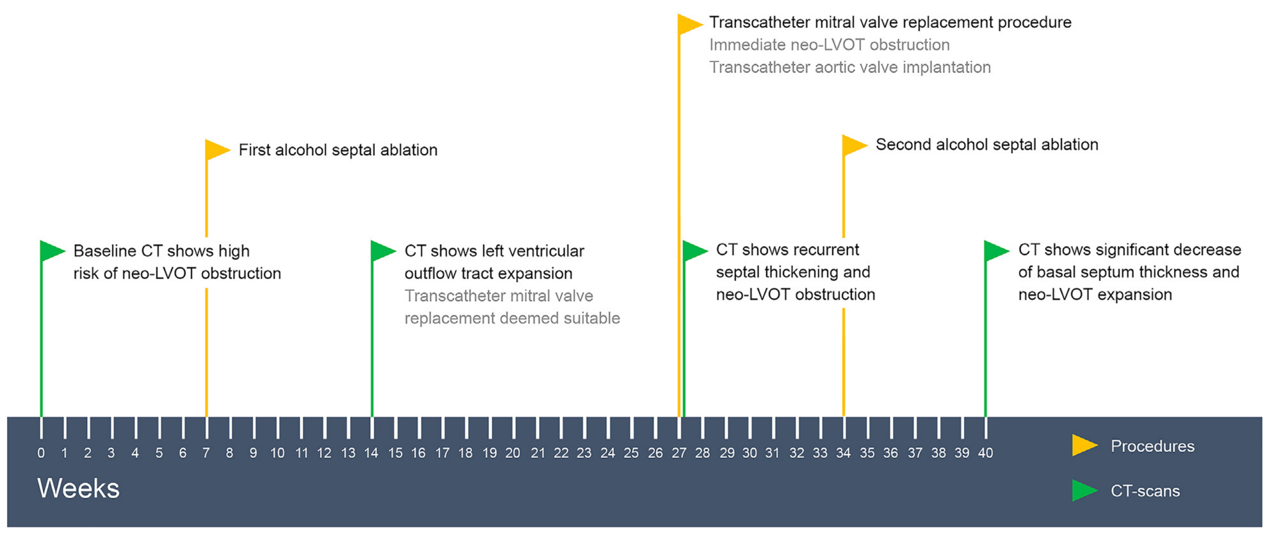


(A) Baseline situation. Virtual TMVR implantation (indicated by yellow lines) results in LVOT obstruction. Basal septum thickness is 21.6 mm. (B) Post first ASA. Basal septum thickness has decreased (now 15.4 mm). Virtual TMVR implantation exhibits a suitable neo-LVOT. (C) Post-TMVR. Unanticipated, recurrent thickening of the basal septum (18.3 mm) is observed. Displacement of the anterior mitral valve leaflet toward the LVOT further compromises the neo-LVOT. (D) Post second ASA. A significant decrease of the basal septum thickness and neo-LVOT expansion is observed. Basal septum thickness is 15.7 mm. Abbreviations as in Figure 2 and 4.

aortic mitral angulation may predispose to LVOTO post-TMVR. TMVR may also push the native AMVL into the LVOT, and systolic anterior movement of the AMVL by Bernouilli forces may attract the AMVL further toward the basal portions of the (hypertrophic) muscular interventricular septum.[2,3] LVOTO after TMVR is associated with higher short-term mortality, and a small estimated neo-LVOT area (<170 mm^2) is currently the strongest predictor for LVOTO.[1] In our case, CTA-derived computer simulation initially suggested a narrow neo-LVOT and therefore triggered the decision for ASA of the

JACC: CASE REPORTS, VOL. 29, 2024
FEBRUARY 7, 2024:102193

FIGURE 7 **Timeline of Clinical Events**



Abbreviations as in Figure 2.

first septal perforator. Various reports showed successful LVOT enlargement with pre-emptive ASA.[4,5]

FOLLOW-UP

Follow-up CTA after ASA in our patient confirmed a larger and reassuring neo-LVOT. TMVR 4 months later nonetheless resulted in LVOTO. We speculate that septal collaterals toward the target septal area resulted in the recurrence of the septal thickness. An alternative explanation is the emergence of transient stunning after ASA, with gradual recovery of LV contractility. An inflammatory response after the initial ASA seems a less likely explanation for recurrent septal thickening because this would occur early after the ablation rather than after several months. A second ASA targeted at the second septal perforator resulted in significant neo-LVOT enlargement and LVOTO resolution. Other LVOT modification techniques may be possible to prevent or resolve LVOTO; these include the SESAME (Septal Scoring Along the Midline Endocardium, the LAMPOON (Laceration of the Anterior Mitral leaflet to Prevent Outflow Obstruction), or the SCORPION (Septal Correction to Prevent Iatrogenic Left Ventricular Outflow Tract Obstruction) procedure.[6-8]

CONCLUSIONS

Using the serial CTA studies (Figures 6 and 7), this case illustrated the following: 1) how the initial favorable ASA effect on LVOT area got reversed and resulted in unexpected LVOTO post TMVR; and 2) how a second ASA of an adjacent septal perforator could resolve (recurring) neo-LVOTO post-TMVR.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Van Mieghem has received grants or contracts from Abbott, Boston Scientific, Biotronik, Edwards Lifesciences, Medtronic, PulseCath BV, Abiomed, and Daiichi Sankyo; consulting fees from JenaValve, Daiichi Sankyo, Abbott, Boston Scientific, and Medtronic; payment or honoraria for lectures, presentations, speakers, manuscripts, and educational events from Abiomed and Amgen; and support for attending meetings and/or travel from JenaValve. Dr Daemen has received grants or contracts from AstraZeneca, Abbott Vascular, Boston Scientific, ACIST Medical, Medtronic, MicroPort, Pie Medical, and ReCor Medical; and consultancy and speaker fees from Abbott Vascular, Abiomed, ACIST Medical Systems, Boston Scientific, Cardialysis BV, CardiacBooster, Kaminari Medical, ReCor Medical, PulseCath, Pie Medical, Sanofi, Siemens, and Medtronic. Dr Hirsch has received grants and consultancy fees from GE Healthcare; speaker fees from GE Healthcare and Bayer; and is a member of the medical advisory board of Medis Medical Imaging Systems. Dr de Sá Marchi is supported by a PhD Scholarship for International Research from "Conselho Nacional de Desenvolvimento Científico e Tecnológico-Brasil (CNPq)" under grant 88887.716769/2022-00. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS alcohol septal ablation, left ventricular outflow tract obstruction, transcatheter mitral valve replacement