

## 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 can mitigate neo-LVOTO risk. We report a case of sequential alcohol septal ablation 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%.

### PAST MEDICAL HISTORY

The patient's medical history included surgical aortic valve replacement in 2011 (21-mm Perimount Bio-prosthesis), 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.

### 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 alcohol septal ablation of 2 adjacent septal branches to resolve neo-LVOTO post-TMVR.

### INVESTIGATIONS

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

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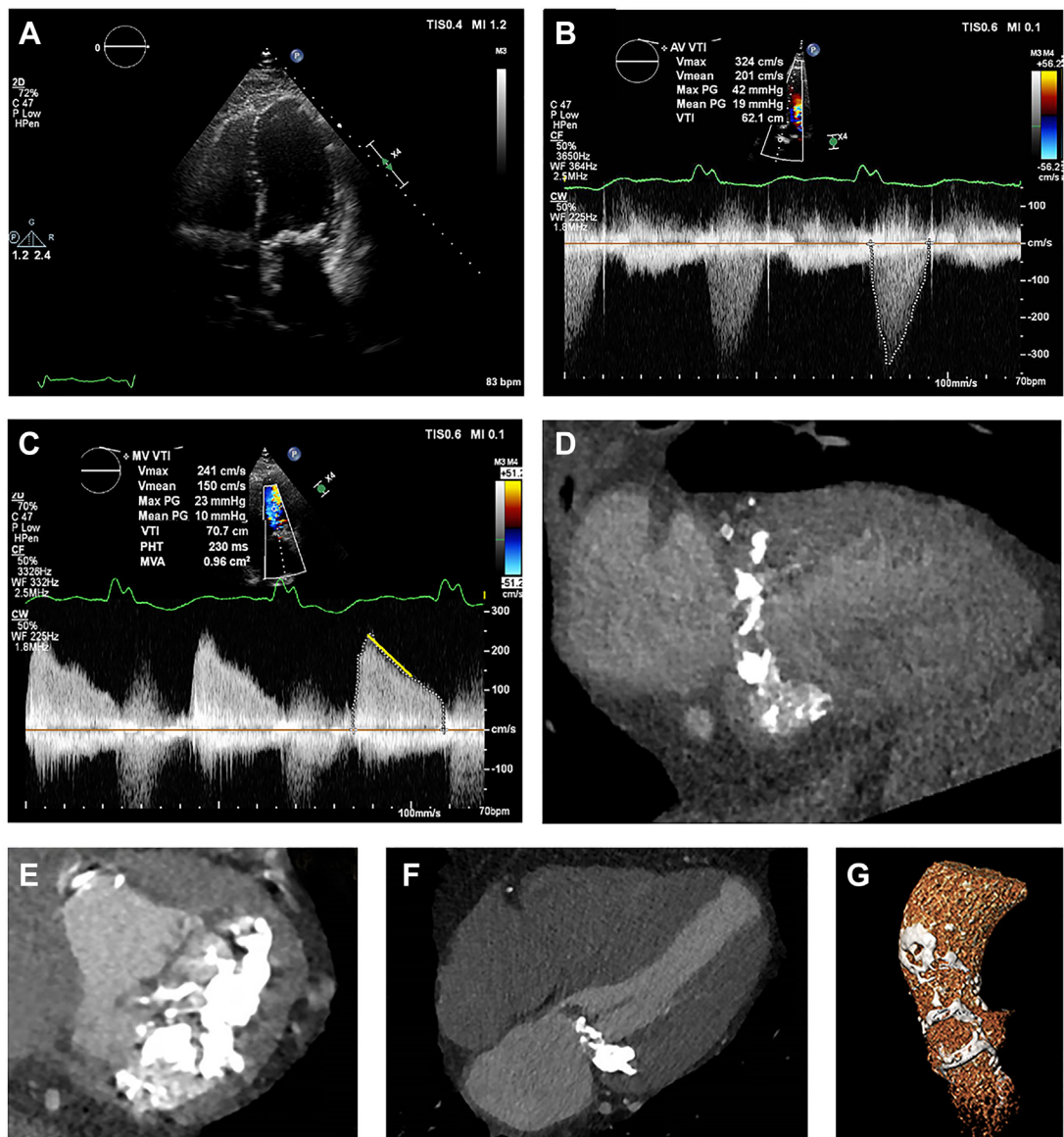
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**ABBREVIATIONS  
AND ACRONYMS**

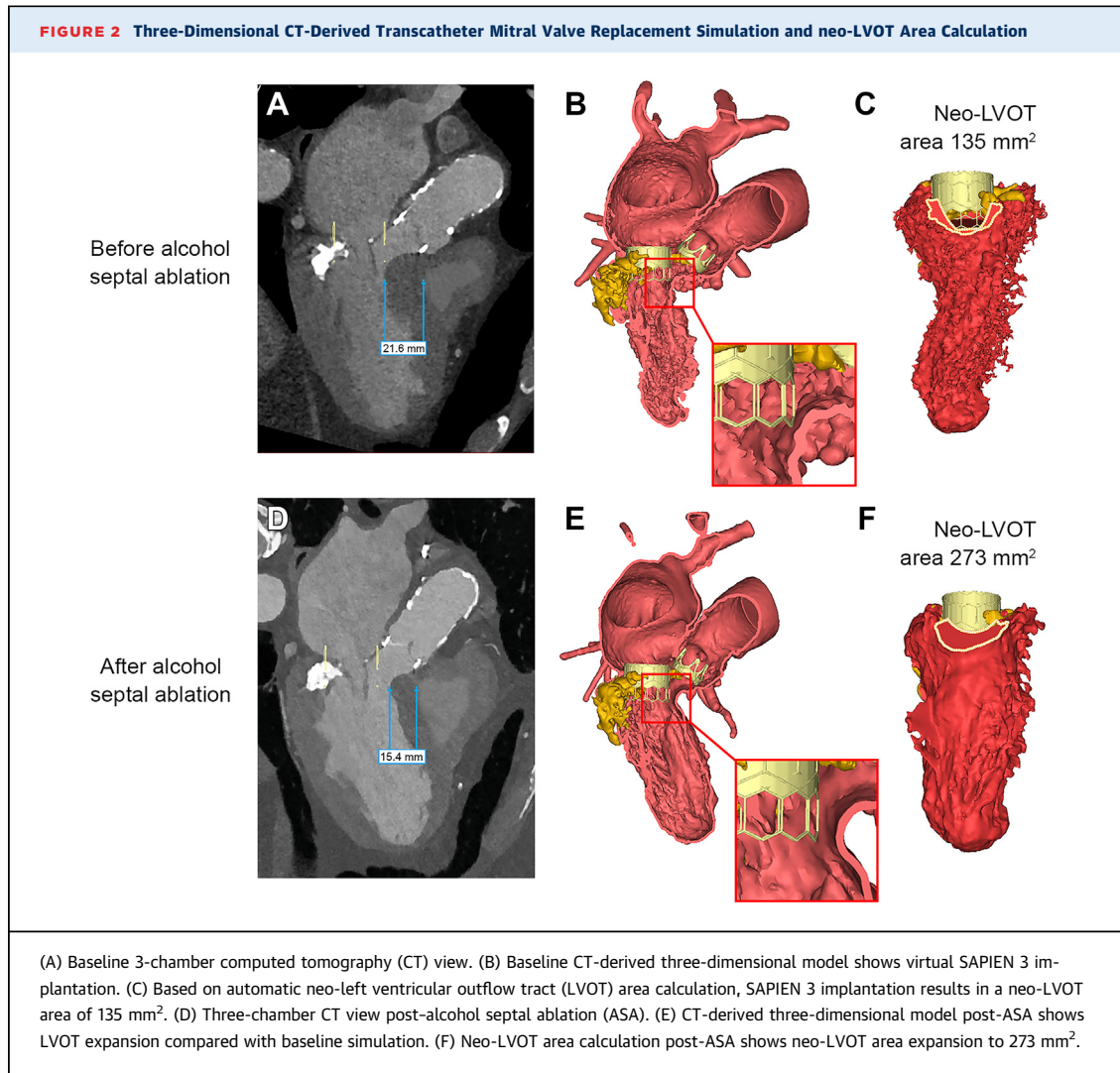
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valve degeneration, including leaflet thickening, calcification, and a gradually increasing mean gradient (from 8 to 19 mm Hg) over the past year (Figures 1A and 1B). Furthermore, a mitral mean gradient of 10 mm Hg and estimated mitral valve area of 0.96 cm<sup>2</sup> 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<sup>2</sup>). 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.



## MANAGEMENT

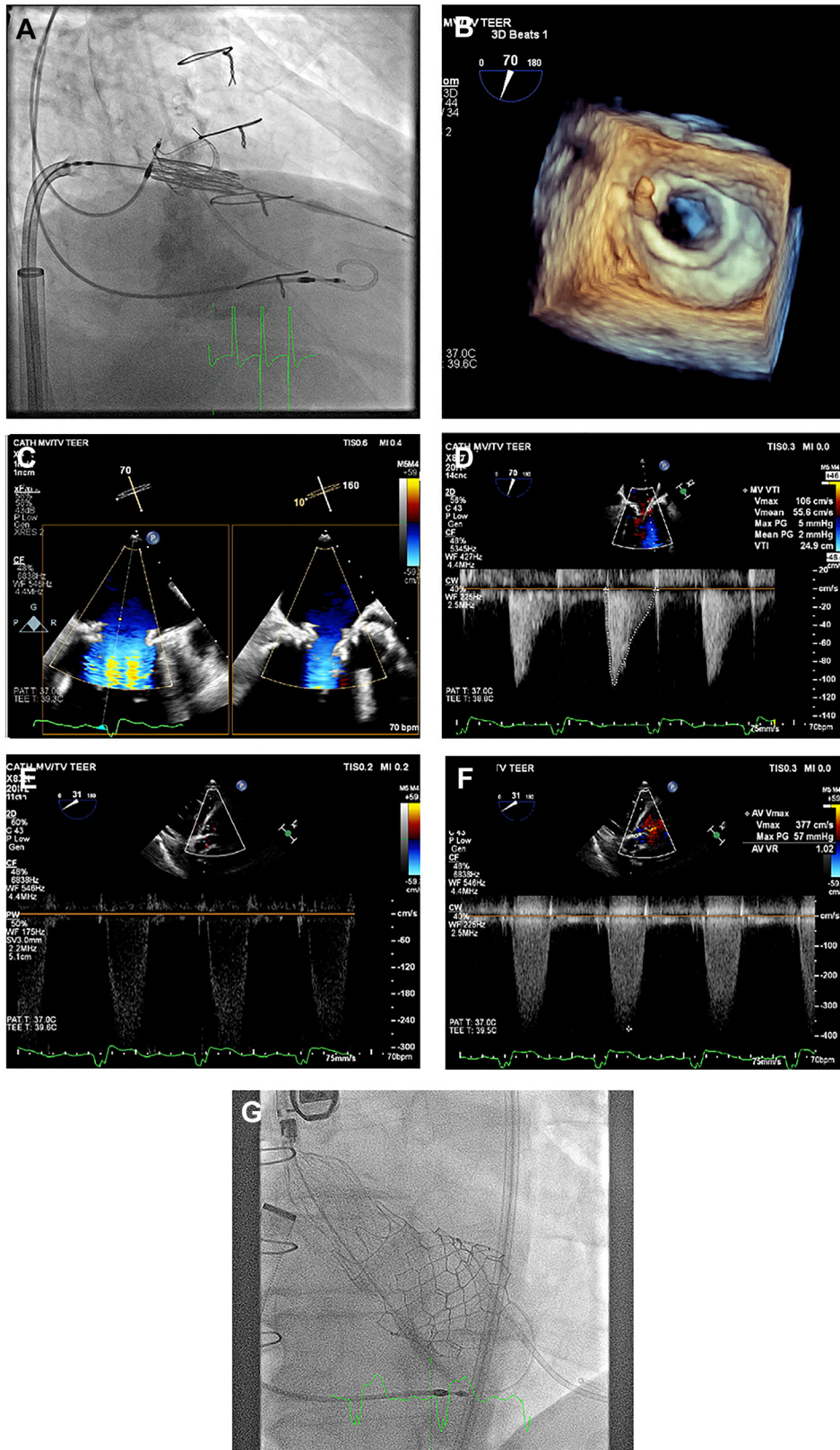
In the work-up for transcatheter mitral valve replacement (TMVR), CT-derived procedure simulation suggested a high likelihood for neo-left ventricular outflow tract obstruction (LVOTO) with an estimated neo-LVOT area of 135 mm<sup>2</sup> (Figures 2A to 2C).<sup>1</sup> Pre-emptive alcohol septal ablation (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<sup>2</sup> (Figure 2F).

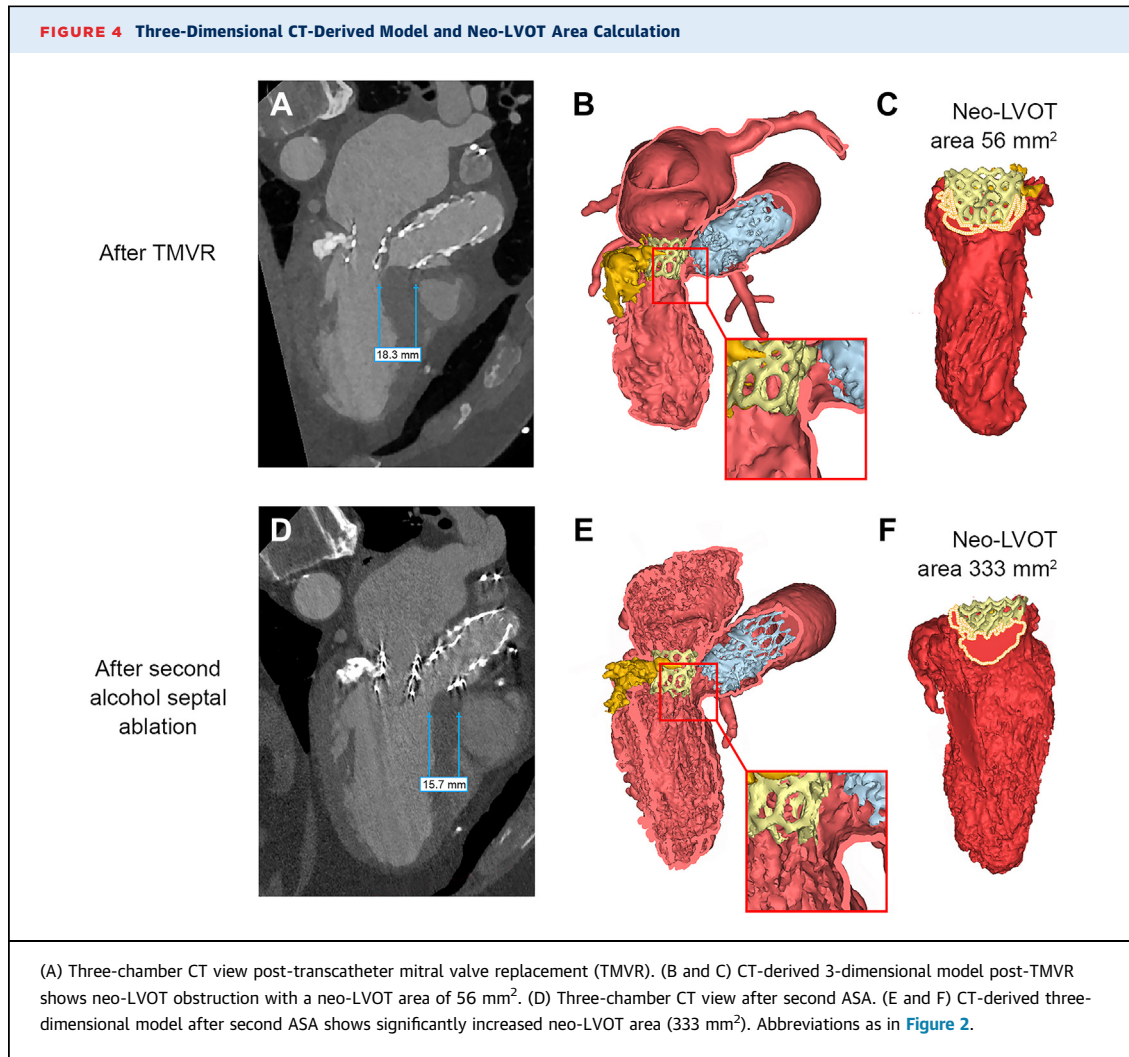
TMVR was now deemed suitable. Four months after the ASA procedure, a 29-mm SAPIEN 3 balloon-expandable valve (Edwards Lifesciences) was deployed in the mitral annulus, with a trace of

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

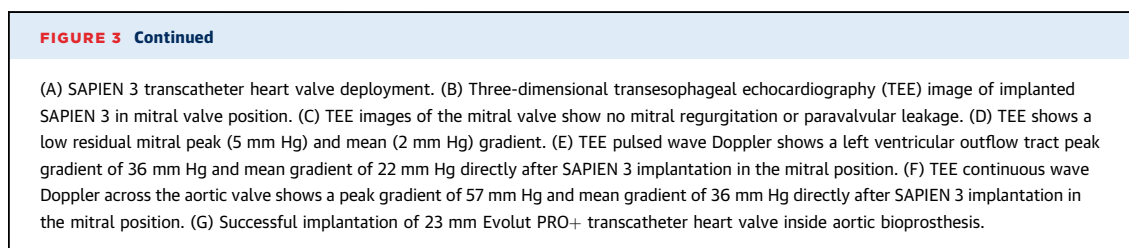


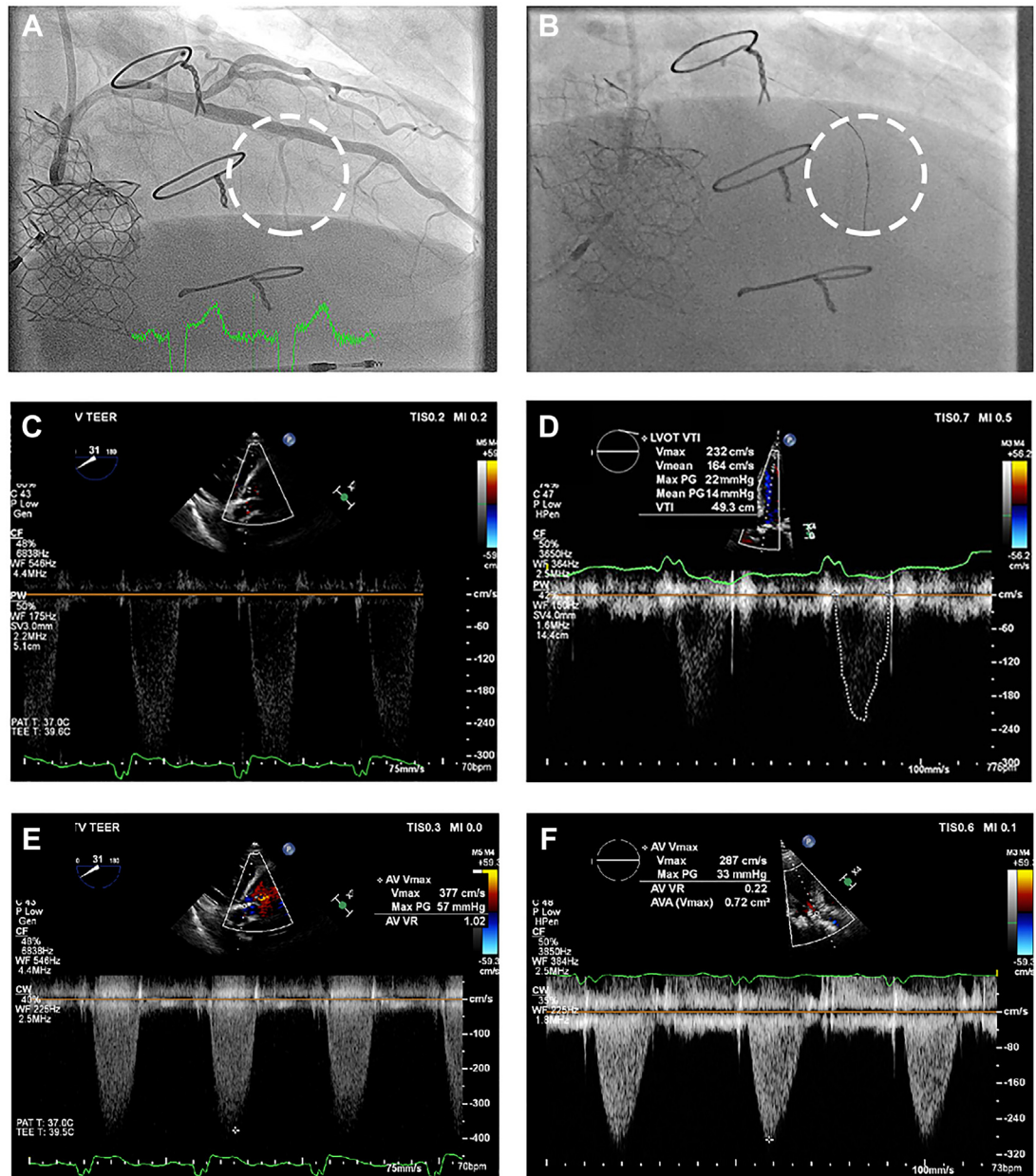


gradient was thus entirely generated by the neo-LVOT. A CTA after TMVR and TAVR revealed substantial increase in basal septum thickness compared with a CTA before the procedure, displacement of the anterior mitral valve leaflet (AMVL) toward the LVOT, and a neo-LVOT area of 56 mm<sup>2</sup> ([Figures 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<sup>2</sup> 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 5** Second ASA Procedure and LVOT Gradients (Before and After)

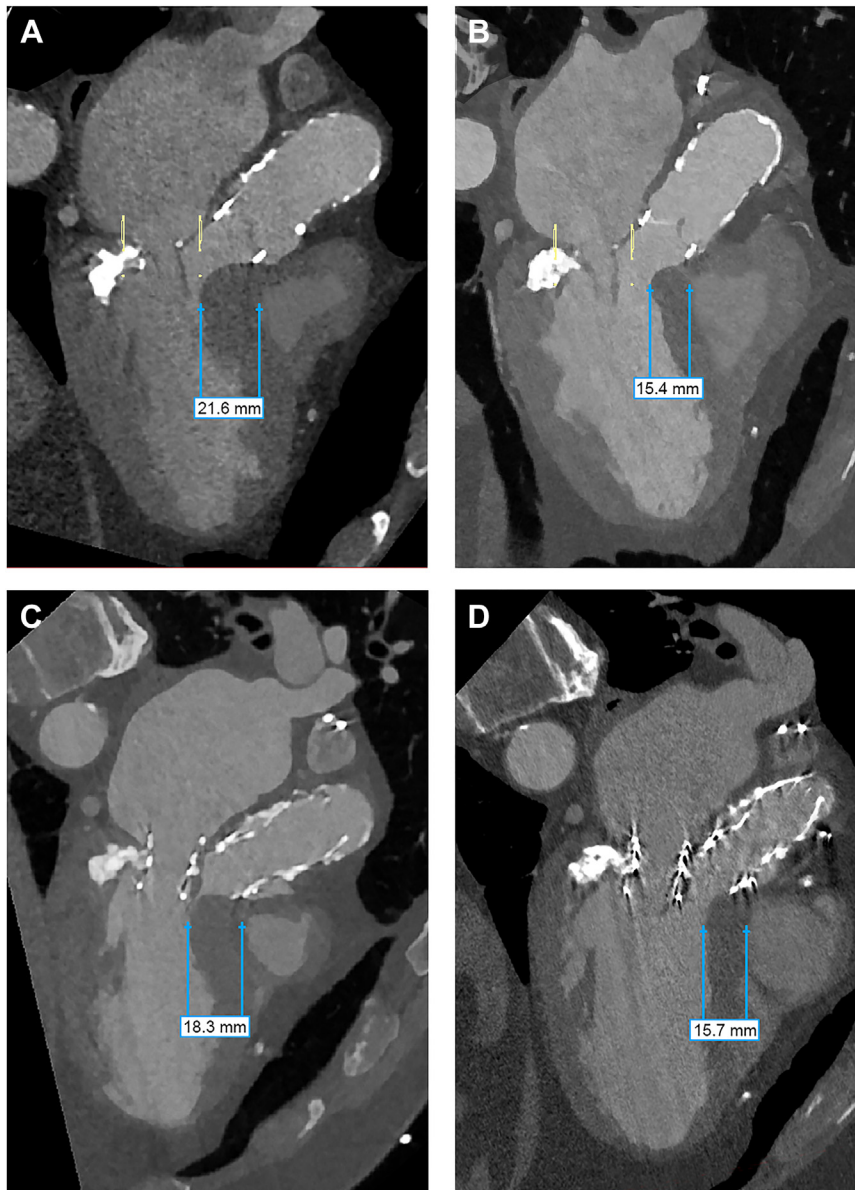
(A and B) ASA of the second septal perforator (indicated by dashed white circle). (C and D) Echocardiography 6 weeks after second ASA shows a significant decrease in LVOT peak and mean gradient (22 mm Hg and 14 mm Hg, respectively) compared with the LVOT gradient during TMVR (peak 36 mm Hg; mean 22 mm 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

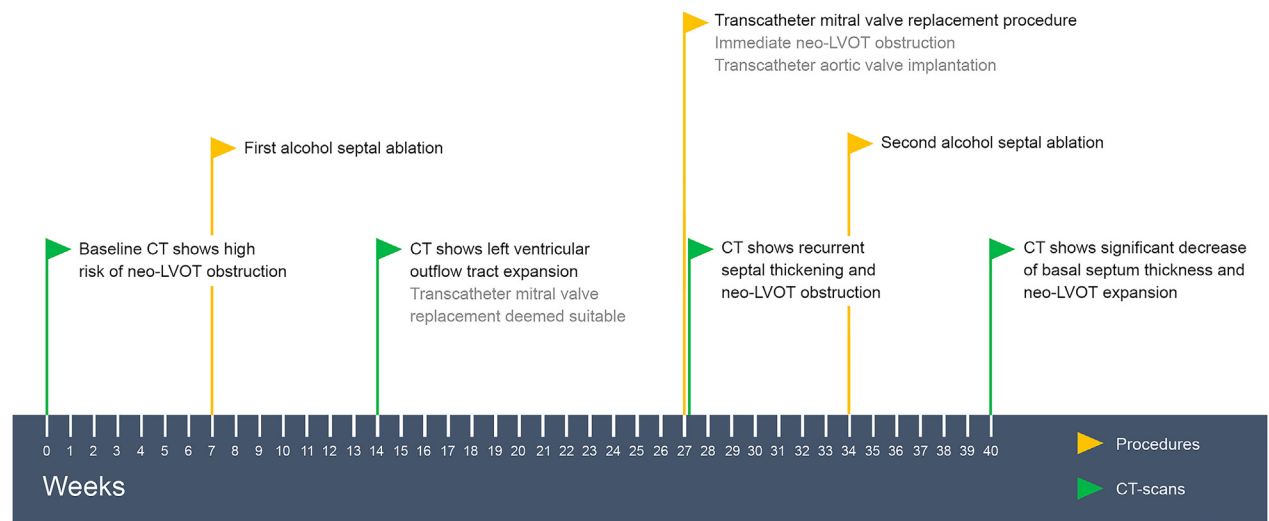
**FIGURE 6** Computed Tomography Angiography 3-Chamber View at Different Time Points



(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 Bernoulli forces may attract the AMVL further toward the basal portions of the (hypertrophic) muscular interventricular septum.<sup>2,3</sup> LVOTO

after TMVR is associated with higher short-term mortality, and a small estimated neo-LVOT area (<170 mm<sup>2</sup>) is currently the strongest predictor for LVOTO.<sup>1</sup> In our case, CTA-derived computer simulation initially suggested a narrow neo-LVOT and therefore triggered the decision for ASA of the

**FIGURE 7** Timeline of Clinical EventsAbbreviations as in [Figure 2](#).

first septal perforator. Various reports showed successful LVOT enlargement with pre-emptive ASA.<sup>4,5</sup>

### 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.<sup>6-8</sup>

### 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

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## REFERENCES

1. Yoon SH, Bleiziffer S, Latib A, et al. Predictors of left ventricular outflow tract obstruction after transcatheter mitral valve replacement. *J Am Coll Cardiol Interv.* 2019;12(2):182-193.
2. Sticchi A, Reineke D, Praz F, et al. Transcatheter mitral valve replacement for mitral valve-in-valve, valve-in-ring, and valve-in-MAC using balloon-expandable transcatheter heart valves. *J Am Coll Cardiol Interv.* 2021;14(8):873-878.
3. Blanke P, Naoum C, Dvir D, et al. Predicting LVOT obstruction in transcatheter mitral valve implantation: concept of the neo-LVOT. *J Am Coll Cardiol Img.* 2017;10(4):482-485.
4. Guerrero M, Wang DD, Eleid MF, et al. Prospective study of TMVR using balloon-expandable aortic transcatheter valves in MAC: MITRAL trial 1-year outcomes. *J Am Coll Cardiol Interv.* 2021;14(8):830-845.
5. Wang DD, Guerrero M, Eng MH, et al. Alcohol septal ablation to prevent left ventricular outflow tract obstruction during transcatheter mitral valve replacement: first-in-man study. *J Am Coll Cardiol Interv.* 2019;12(13):1268-1279.
6. Greenbaum AB, Khan JM, Bruce CG, et al. Transcatheter myotomy to treat hypertrophic cardiomyopathy and enable transcatheter mitral valve replacement: first-in-human report of septal scoring along the midline endocardium. *Circ Cardiovasc Interv.* 2022;15(6):e012106.
7. Khan JM, Babaliaros VC, Greenbaum AB, et al. Anterior leaflet laceration to prevent ventricular outflow tract obstruction during transcatheter mitral valve replacement. *J Am Coll Cardiol.* 2019;73(20):2521-2534.
8. John L, Norihiko K, Mikhael El C, et al. Septal Correction to Prevent Iatrogenic Left Ventricular Outflow Tract Obstruction (SCORPION) prior to transcatheter mitral valve replacement. *J Am Coll Cardiol.* 2019;74(suppl 13):B447.

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