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IMAGES IN INTERVENTION

Software Modeling to Predict Paravalvular Leak Following Transcatheter Mitral Valve Replacement

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An 83-year-old woman with New York Heart Association stage III heart failure, severe mitral stenosis, and severe mitral annular calcification was referred for transcatheter mitral valve replacement (TMVR). Pre-procedural computed tomography angiography (CTA) analyzed using TMVR planning software (CircleCVI, Calgary, Alberta, Canada) showed a mitral annular area of 547 mm^2. Placing a virtual 29-mm Edwards Sapien S3 valve in the center of the mitral annulus demonstrated a favorable neo-left ventricular outflow tract area; however, a 9 × 4.7-mm gap between the virtual valve and the lateral mitral annulus raised concern for paravalvular leak (PVL) (**Figure 1A**).

Using a transseptal approach, a 29-mm Sapien S3 (Edwards Lifesciences, Irvine, California) was successfully deployed in the mitral position. The patient's hemodynamics rapidly deteriorated (**Figure 1B**), necessitating aggressive pressor support. Three-dimensional transesophageal echocardiography (3D-TEE) demonstrated a normally functioning prosthesis with severe PVL between the Sapien valve and lateral mitral annulus (**Figures 1C and 1D**, Online Video 1). A 10-mm Amplatzer ventriculoseptal defect (VSD) occluder (St. Jude Medical, St. Paul, Minnesota) was used to plug the PVL because of its small disc-to-waist ratio, with the goal of maximizing sealing while minimizing interaction between the disc and mitral prosthesis (**Figure 1E**). Follow-up 3D-TEE showed mild PVL (**Figure 1F**, Online Video 2), and the patient's hemodynamics significantly improved (**Figure 1G**). She was ultimately discharged home uneventfully, with persistent mild PVL on 30-day follow-up transthoracic echocardiography.

Severe PVL is uncommon following TMVR in selected patients with mitral annular calcification (1). Three-dimensional-printed models derived from CTA have been used to estimate the risk of PVL before TMVR (2); however, this technique is time-consuming, requires specialized equipment, and is not widely available.

In this patient, software modeling based on the CTA predicted PVL size and location, with excellent agreement to the post-deployment 3D-TEE. Informing the interventional team of the PVL risk allowed them to prepare for percutaneous closure and facilitated early recognition of severe PVL as the cause of hemodynamic compromise after valve deployment, resulting in a favorable patient outcome. Future studies should investigate the use of software-based modeling to predict PVL after TMVR.

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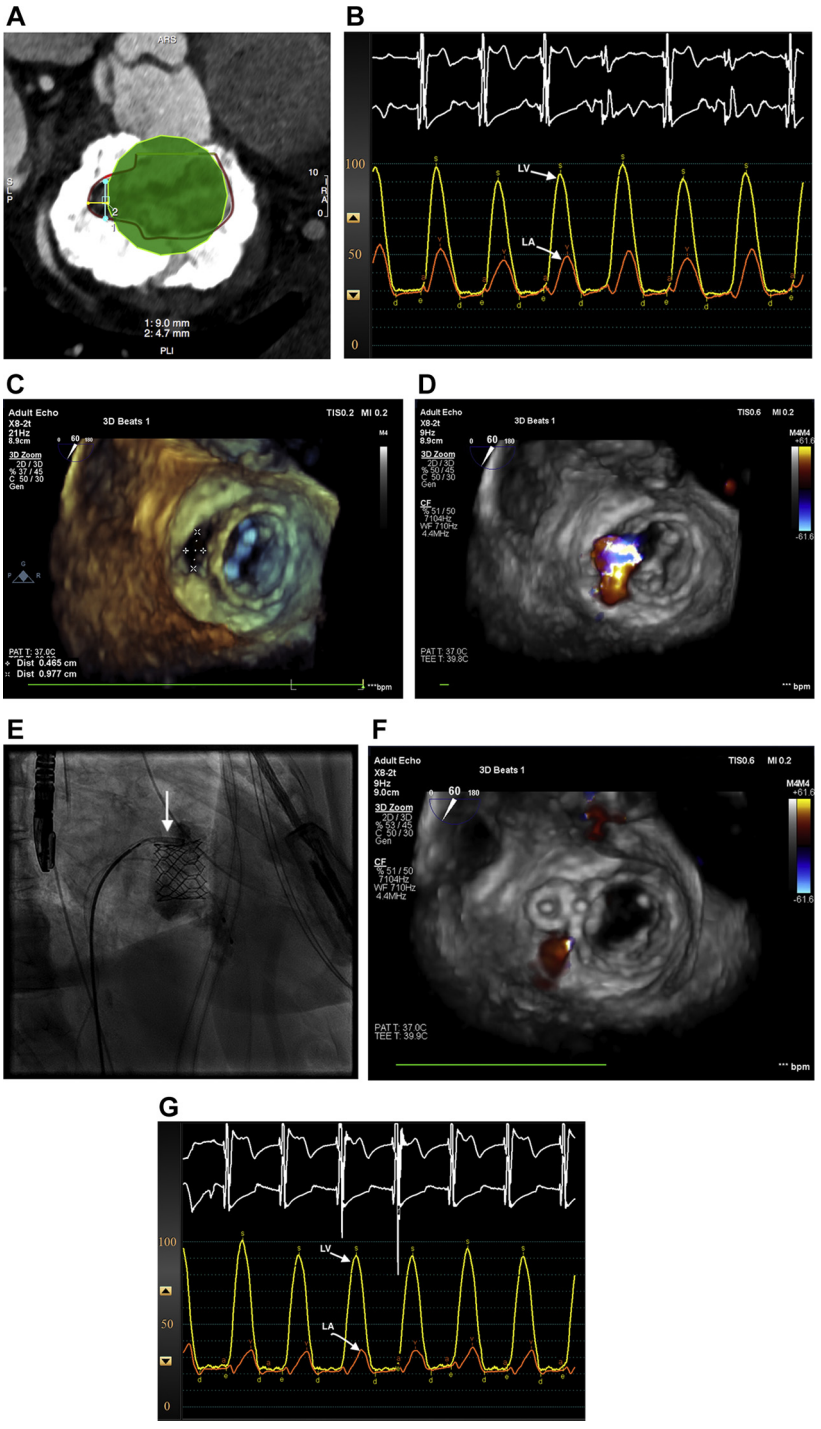
FIGURE 1 **Imaging and Hemodynamic Findings Before, During, and After TMVR**



(A) Pre-procedural CTA with a virtual 29-mm Sapien S3 in the mitral position. There is a 9 × 4.7-mm gap between the virtual valve **(green)** and lateral mitral annulus **(red)**, concerning for paravalvular leak. **(B)** Simultaneous left atrial–left ventricular pressure after deployment of the 29-mm Sapien S3. Severe mitral regurgitation and mean left atrial pressure 37 mm Hg. **(C)** 3D-TEE post TMVR demonstrating a 9.8 × 4.7-mm gap between the prosthetic valve and lateral mitral annulus. **(D)** 3D-TEE with color Doppler post TMVR, with severe paravalvular leak between the prosthetic valve and lateral mitral annulus (Online Video 1). **(E)** Angiogram during placement of a 10-mm Amplatzer VSD occluder **(arrow)**. **(F)** 3D-TEE with color Doppler post-deployment of a 10-mm Amplatzer VSD occluder. There is mild PVL (Online Video 2). **(G)** Simultaneous left atrial-left ventricular pressure post-deployment of a 10-mm Amplatzer VSD occluder. Mean left atrial pressure 24 mm Hg, and no significant diastolic gradient. 3D-TEE = 3-dimensional transesophageal echocardiography; CTA = computed tomography angiography; LA = left atrium; LV = left ventricle; PVL = paravalvular leak; TMVR = transcatheter mitral valve replacement; VSD = ventriculoseptal defect.

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