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Transcatheter Valve-in-Valve Mitral Valve Replacement Using 4D Intracardiac Echocardiogram and Conscious Sedation

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The use of intracardiac echocardiography (ICE) has emerged as a promising imaging modality for intraprocedural guidance of various structural procedures, primarily related to its ease of use, moderate sedation, and in some cases, better image quality.[1,2] The newer ICE catheters are equipped with the capability of acquiring three-dimensional volumetric images and real-time cine videos (four-dimensional [4D]).[1,2] We hereby report a case of valve-in-valve transcatheter mitral valve replacement (TMVR) using the novel NuVision (NuVera Medical, Los Gatos, California) ICE catheter.

An 83-year-old male with a prior mitral valve replacement with 27-mm Biocor (St. Jude Medical, Inc, St Paul, Minnesota) placed for acute mitral regurgitation (MR) secondary to papillary muscle rupture 13 years ago presented to the hospital with a 3-day history of worsening shortness of breath. Transthoracic echocardiogram demonstrated a normal ejection fraction and severe MR. A transesophageal echocardiogram (TEE) performed subsequently showed severe MR, due to a degenerated bioprosthetic valve with a flail posterolateral leaflet. Systolic flow reversal was noted in the pulmonary veins consistent with severe MR. Additional workup did not reveal any significant angiographic coronary stenosis. A computerized tomography scan demonstrated an adequate neo-left ventricular outflow tract of >400 mm^2. After multidisciplinary discussion, valve-in-valve TMVR with a 26-mm, S3 Sapien valve (Edwards Lifesciences, Irvine, California) was recommended to the patient. The procedure was planned to be performed under moderate sedation with the use of the NuVision (NuVera Medical, Los Gatos, California) ICE catheter consisting of a 90-cm 10 Fr deflectable shaft and a handle that allows for the independent transducer tip rotation for fine-tuning the image quality. Bilateral femoral venous access was obtained. A 12 Fr, 45-cm long sheath was placed in the left common femoral vein, and an ICE catheter was advanced to the right atrium. The ICE catheter was used for image guidance of the transseptal puncture (Figure 1a and b, Supplemental Videos 1 and 2) which was performed through right femoral venous access. After obtaining access to the left atrium, the ICE catheter was advanced to the left atrium through the same transseptal through the Oscor Destino Twist 12 Fr through the right femoral vein (Oscor Inc, Palm Harbor, Florida) to assess the mitral prosthesis (Figure 2a and b, Supplemental Videos 3 and 4). A Safari wire (Boston Scientific, Marlborough, Massachusetts) was then placed in the left ventricular apex, and a 14 Fr Edwards E-sheath was introduced through the right femoral vein. The septum was predilated with a 12 $\times$ 40–mm balloon. Thereafter, a 26-mm S3 valve was advanced through the transseptal straddling across the prior mitral valve prosthesis. The valve was deployed under rapid pacing. At the end of the procedure, trivial central intravalvular leak was seen on the ICE imaging with the mean transmitral gradients of 3.7-mm Hg at a heart rate of 69 beats per minute in Figures 3a and b and 4a and b and Supplemental Videos 5-7. The follow-up transthoracic echocardiogram did not show any elevated left ventricular outflow tract gradients and the transmitral gradient of 5-mm Hg at the heart rate of 80 beats per minute.

Our case demonstrates the utility and effectiveness of ICE in a select patient population undergoing valve-in-valve TMVR for periprocedural

Abbreviations: 4D, 4-dimensional; ICE, intracardiac echocardiography; MR, mitral regurgitation; TEE, transesophageal echocardiogram; TMVR, transcatheter mitral valve replacement.

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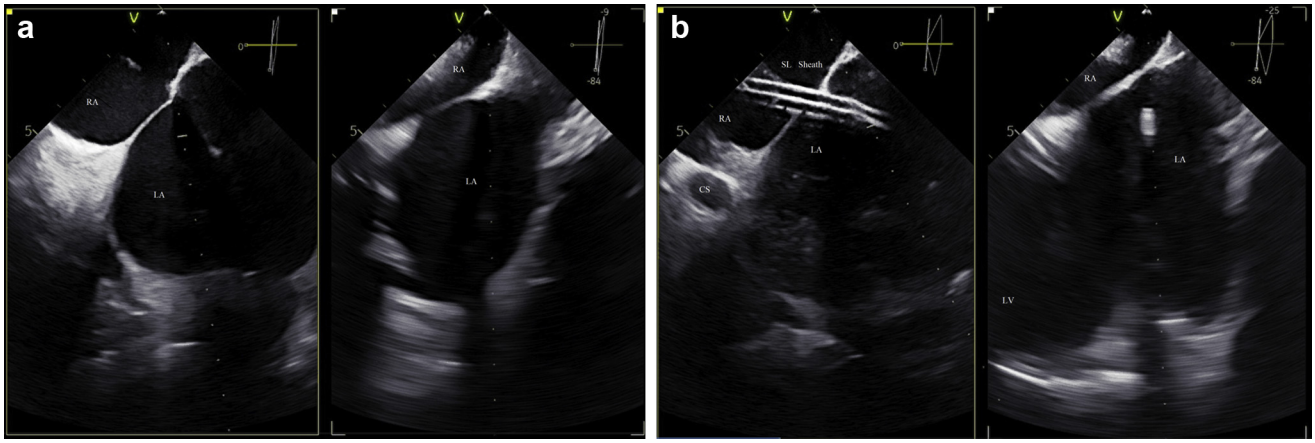

Figure 1. (a) Intracardiac echocardiogram picture of the interatrial septum showing crossing with the Brockenbrough curved needle at the time of transseptal puncture. (b) Intracardiac echocardiogram picture showing the SL0 sheath (Swartz Braided Transseptal Guiding Introducers SL Series) across the interatrial septum.

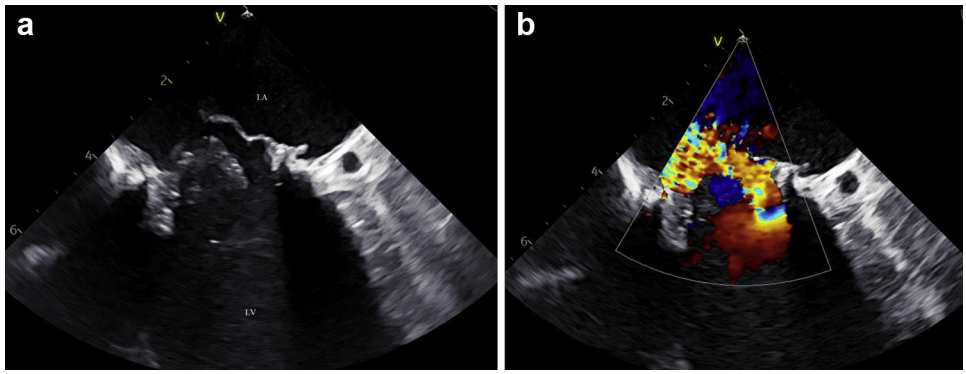

Figure 2. (a) Intracardiac echocardiogram picture of the mitral bioprosthetic valve showing the lateral flail leaflet. (b) Intracardiac echocardiogram picture of the mitral bioprosthetic valve showing the lateral flail leaflet with medially directed color Doppler jet.

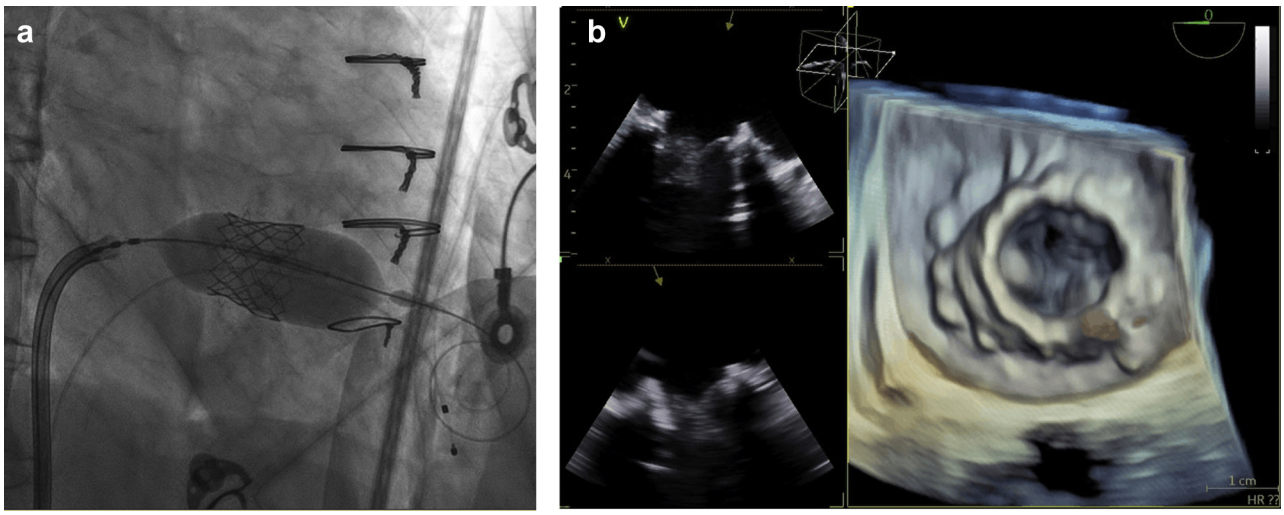

Figure 3. (a) Fluoroscopic image of the valve-in-valve transcatheter mitral valve replacement. (b) Postdeployment of the 26-mm S3 Sapien valve within the dysfunctional 27-mm Biocor prosthesis, 3-dimensional multiplanar reconstruction by intracardiac echocardiogram.

guidance of transseptal access, pre-TMVR imaging, and finally post-procedural paravalvular leak assessment. Newer ICE catheters like NuVision offer several advantages; first, use of ICE imaging for structural procedures is another step toward a minimalistic approach to take care of this complex patient subset. Second, the risks of general anesthesia in elderly patients with comorbidities can be avoided by using ICE with moderate sedation along with mitigating any risk of injury to the gastrointestinal tract with the TEE probe.[3] Third, in select structural in-

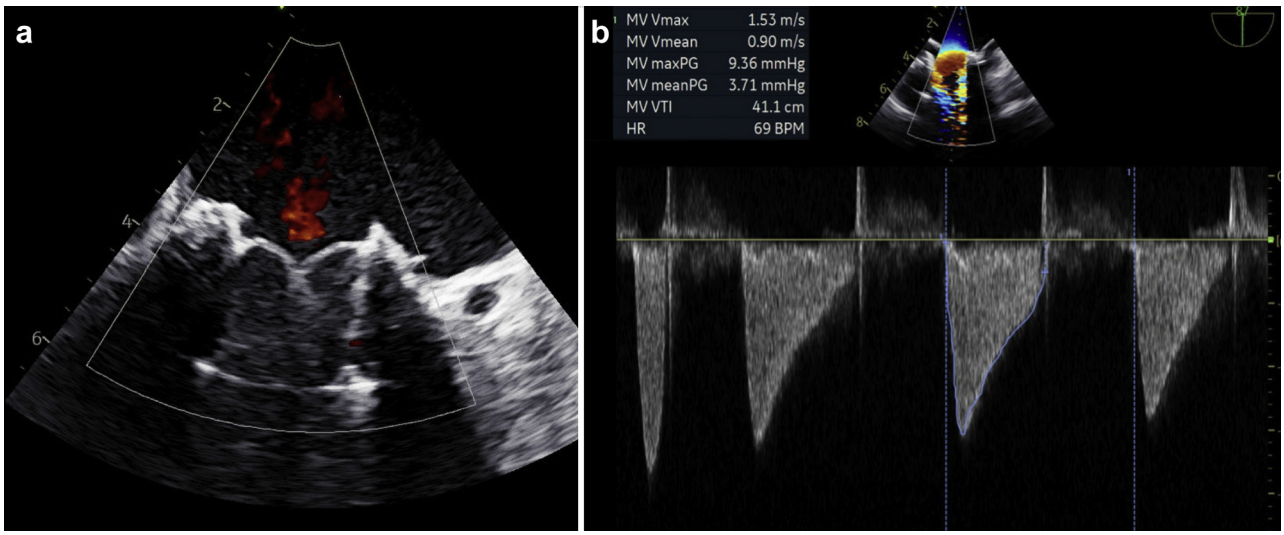

Figure 4. (a) Postdeployment of the 26-mm S3 Sapien valve within the dysfunctional 27-mm Biocor prosthesis, 2-dimensional reconstruction by the intracardiac echocardiogram image. (b) Continuous wave Doppler by intracardiac echocardiogram across the S3 valve within the Biocor postdeployment.

terventions, novel ICE devices like NuVision may overcome the limitations of 2-dimensional ICE by providing 90° × 90° field of view and real-time high-resolution 3-dimensional image rendering which may provide better imaging resolution and additive information to TEE for enhancing procedural success.

In conclusion, in our report, we describe our initial experience of the use of 4D ICE for periprocedural guidance of valve-in-valve TMVR. The use of 4D ICE as an imaging modality for transcatheter structural interventions is increasingly being recognized as a safe and effective option. Further larger studies are needed for consideration of widespread use of 4D ICE for transcatheter structural interventions.

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Disclosure statement

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Supplementary Material

Supplemental data for this article can be accessed on the publisher's website.

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