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IMAGES IN INTERVENTION

Transfemoral Implantation of a Balloon-Expandable Transcatheter Valve in a Rigid Mitral Annuloplasty Ring Optimized by Post-Dilatation

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Transcatheter mitral valve-in-ring (VIR) implantation is known to be a feasible treatment for recurrent mitral regurgitation (MR) after failing surgical annuloplasty in inoperable patients. The difficulties of this procedure are related to different shapes and material characteristics of the annuloplasty ring as well as sizing and positioning of the transcatheter heart valve (THV). These may lead to valve malposition and delayed embolization, post-procedural MR, elevated gradients, and left ventricular outflow tract (LVOT) obstruction (1). In this emerging field, a thorough understanding of the structural features of the failed ring is crucial to obtaining good outcomes (2).

We report on a 72-year-old man with a medical history of hypertension, non-insulin-dependent diabetes, dyslipidemia, previous smoking with chronic obstructive pulmonary disease, and paroxysmal atrial fibrillation. In 2014, because of severe left ventricular (LV) dysfunction with normal coronary arteries and severe MR, he underwent surgical mitral valve repair with the Medtronic Profile 3D 28 mm (Medtronic, Minneapolis, Minnesota), a saddle-shaped, fully rigid annuloplasty ring (with a titanium core). He was admitted with New York Heart Association functional class III after frequent episodes (>1 per month) of heart failure in 2016. Transesophageal echocardiography (TEE) revealed recurrence of severe MR due to residual severe leaflet tethering, severe LV systolic dysfunction (LV ejection fraction 25%), and moderate-to-severe pulmonary hypertension. After Heart-Team discussion, the patient was deemed inoperable due to his prohibitive surgical risk (Society of Thoracic Surgeons score for mortality was 13.2%); transcatheter VIR procedure was considered the therapy of choice: transseptal approach was chosen over transapical due to chronic obstructive pulmonary disease.

The main cause of concern was the rigid profile of the prosthetic ring, which may prevent the correct expansion of THV. The Valve-in-Valve Mitral App 2.2 (Dr. Bapat, supported by National Institute for Health Research and PCR) recommended a 23-mm Edwards valve (Edwards Lifesciences, Irvine, California) but we were concerned about the risk of residual paravalvular leak and high transmitral gradients. Thus we performed a bench test at first: a 22-mm balloon was inflated inside the "out-of-the-box" ring, resulting in an asymmetrical expansion of the balloon with a high risk of paravalvular regurgitation (**Figures 1A to 1C**);

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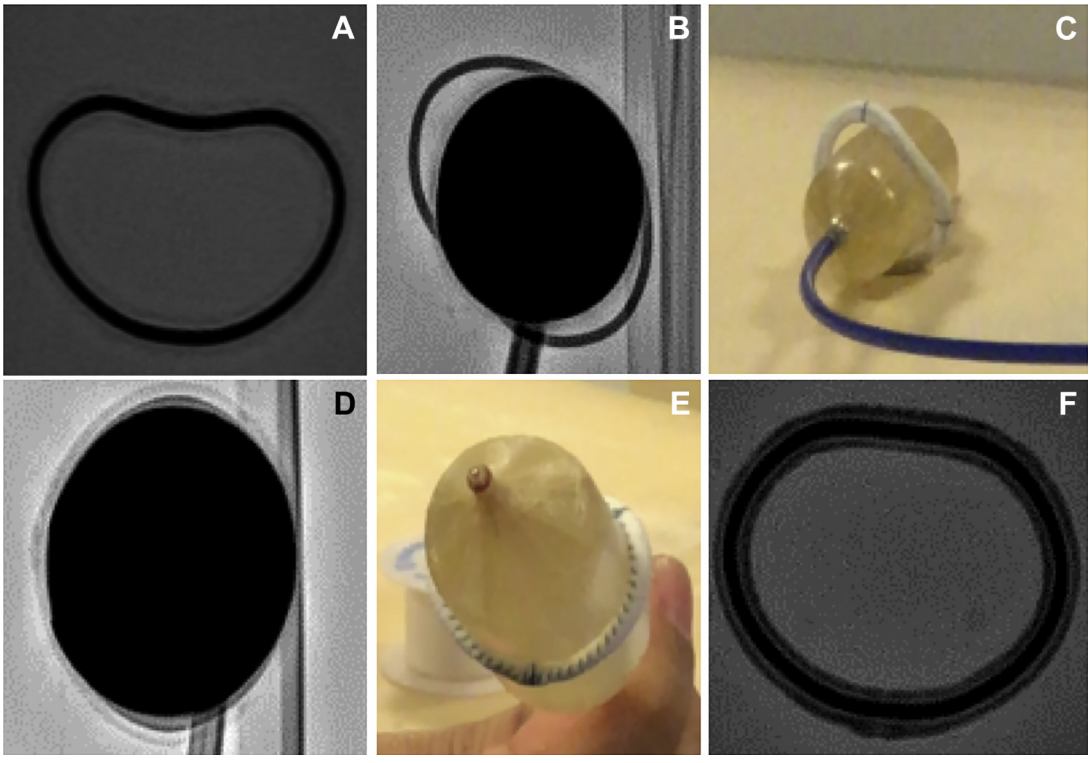
FIGURE 1 Bench Test

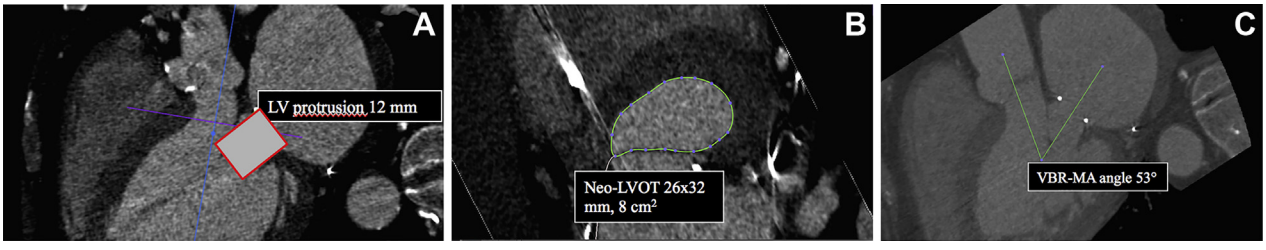


(A) Angiographic aspect of the rigid Medtronic Profile 3D 28-mm ring (Medtronic, Minneapolis, Minnesota). **(B,C)** The inflation of a 22-mm balloon inside the ring resulted in an asymmetrical expansion of the balloon, with a high risk of paravalvular regurgitation. **(D,E)** High-pressure inflation of a 26-mm balloon, with a complete expansion of the device and reduced risk for paravalvular leaks; **(F)** final rounder shape of the rigid ring.

a high-pressure (12 atm) inflation of a 26-mm balloon gave a round shape to the prosthetic ring, thus reducing the risk of THV underexpansion (Figures 1D to 1F). The cardiac computed tomography scan predicted that the derived neo-LVOT was sufficient for the implanting a 26-mm Sapien 3 protruding 10, 12, or 14 mm in the left ventricle (area 8 cm^2, axis 26 mm × 32 mm) (Figure 2).

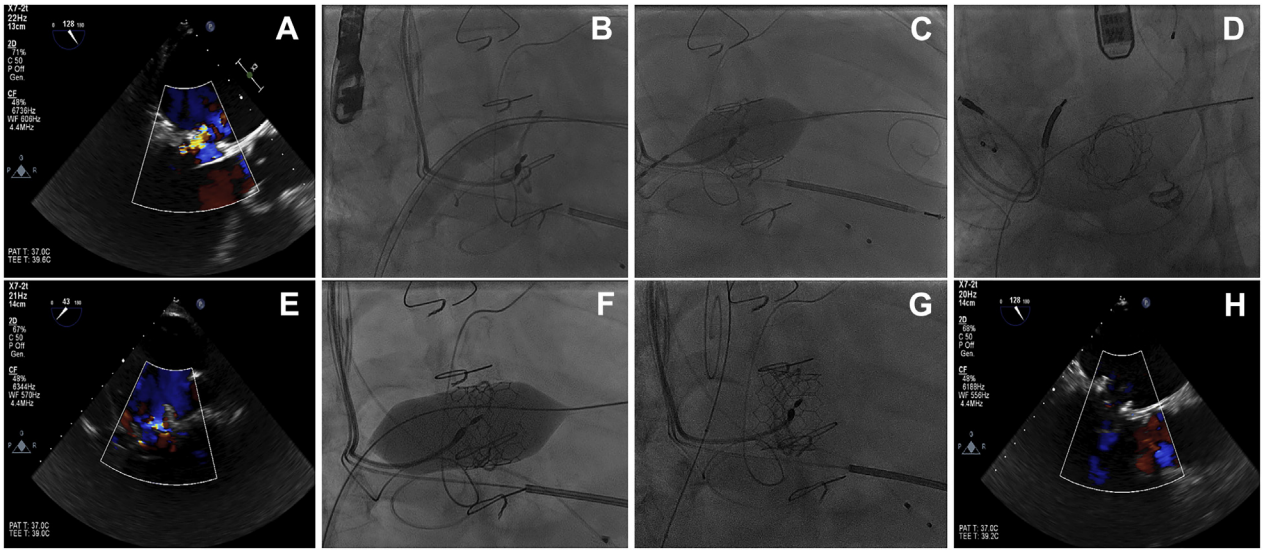
The transvenous-transseptal intervention was performed under fluoroscopic and TEE guidance: after transseptal puncture, a steerable Agilis (St. Jude Medical, St. Paul, Minnesota) catheter was used to

FIGURE 2 Cardiac Computed Tomography Scan



Pre-procedural computed tomography predicted no left ventricular outflow tract (LVOT) obstruction: **(A,B)** the neo-LVOT with a prosthetic protrusion of 12 to 14 mm in the left ventricle (LV). **(C)** The angle between the line passing through virtual basal ring (VBR) and mitral annulus (MA) is 53°.

FIGURE 3 Procedure



(A) Baseline transesophageal echocardiography showing severe mitral regurgitation (Online Videos 1 and 2). **(B)** After transseptal puncture, 2 supportive wires were placed in left ventricle and the interatrial septum (IAS) was dilated with a 14 mm peripheral balloon (Online Video 2). The 26-mm Sapien 3 valve (Edwards Lifesciences, Irvine, California) **(C)**, was advanced and inflated during rapid pacing (Online Videos 3 and 4), **(D)** with asymmetrical expansion (Online Video 4) and **(E)** residual paravalvular regurgitation (Online Video 4). The inflation **(F)** of a 26-mm noncompliant balloon (Online Video 5) resulted in **(G)** a better shape of the prosthetic valve (Online Video 6), **(H)** with only trivial residual intravalvular regurgitation (Online Video 6).

advance 2 supportive Safari guidewires (Boston Scientific, Marlborough, Massachusetts) into the LV. The use of this "buddy wire" technique facilitated the dilatation of interatrial septum with a 14-mm peripheral balloon and offered better support to facilitate valve delivery (**Figures 3A and 3B**, Online Videos 1 and 2). It also offers the option to reperform the interatrial septum dilatation or use a buddy balloon technique if there is difficulty in crossing the septum or surgical prosthesis with the transcatheter valve. Finally, the Sapien 3 was implanted during rapid pacing (**Figure 3C**, Online Videos 3 and 4). As expected, TEE showed an underexpanded valve with resulting moderate-to-severe paravalvular regurgitation (**Figures 3D and 3E**, Online Video 4). Therefore, we post-dilated the Sapien 3 with a 26-mm True Dilatation (Bard, Tempe, Arizona) noncompliant balloon at 12 atm during rapid pacing (**Figure 3F**, Online Video 5). High-pressure post-dilatation optimized the prosthesis shape and expansion with no paravalvular regurgitation, trivial residual intravalvular regurgitation, normal transmitral gradients (3 mm Hg), and no LVOT obstruction (**Figures 3G and 3H**, Online Video 6).

This case highlights the importance of carefully selecting valve size depending not only on the dimensions but also the rigidity of the ring. Because there are no data on which rigid annuloplasty rings are dilatable, we strongly recommend the importance of performing benchtop testing before attempting this in vivo. Post-dilatation may be useful in optimizing VIR procedures, especially when treating rigid rings. However, we cannot exclude that ring pre-dilatation with subsequent valve implantation would not have resulted in similar outcomes.

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KEY WORDS Edwards Sapien 3, post-dilatation, TMVI, transcatheter mitral valve interventions, valve-in-ring

APPENDIX For supplemental videos and their legends, please see the online version of this article.