JACC: CASE REPORTS VOL. 30, NO. 8, 2025


CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

CLINICAL CASE

# Impromptu SVC Caval Implantation During Tricuspid Transcatheter Valve-in-Ring

Hussayn Alrayes, DO,[a] Eyas Chakfeh, MD,[b] Leo Kar Lok Lai, MD,[a] Georgi Fram, MD,[a] Brian Zweig, MD,[a] James C. Lee, MD,[a] Brian O'Neill, MD,[a] Tiberio Frisoli, MD,[a] William O'Neill, MD,[a] Pedro Villablanca, MD, MS,[a] Pedro Engel Gonzalez, MD[a]

## ABSTRACT

An 84-year-old man with a history of tricuspid valve regurgitation after repair with an incomplete annuloplasty band presented with worsening tricuspid regurgitation. He underwent a transcatheter valve-in-ring procedure, which was complicated by proximal valve embolization. The procedure was salvaged by performing an ad hoc caval implantation, followed by an additional valve implantation within the tricuspid band, with an excellent result. (JACC Case Rep. 2025;30:103237) © 2025 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/).

Tricuspid valve repair with the use of an annuloplasty band is associated with improved survival.[1] However, residual and recurrent tricuspid regurgitation (TR) after tricuspid valve repair over time is common, with low rates of reoperation despite progression of symptoms.[2] Thus, off-label transcatheter therapies such as a valve-in-ring (ViR) procedure using a SAPIEN 3 valve (Edwards Lifesciences) have been performed and have been effective in reducing TR.[3] However, tricuspid repair is often performed using a semirigid band, resulting in difficulties with sizing, anchoring, and avoiding paravalvular leak (PVL).[4] We report a case of ViR that was complicated by valve embolization requiring implantation of a second valve.

### TAKE-HOME MESSAGES

- Tricuspid TViR is a complex procedure, usually performed in unfavorable incomplete rings. Hence, the risk of complications is not trivial, and operators must be prepared to manage them and have the appropriate equipment.
- This case demonstrates that an ad hoc CAVI is an option to manage atrial embolization of a tricuspid valve.
- One of the known challenges is a tortuous SVC, which can result in tension within the delivery system leading to atrial underexpansion of the SAPIEN valve. Operators must be prepared to navigate this challenge.

## HISTORY OF PRESENTATION

An 84-year-old man with a history of severe aortic stenosis treated with transcatheter aortic valve replacement (2011), severe mitral regurgitation after bioprosthetic mitral valve replacement (2017) complicated by valve degeneration requiring valve-in-valve

From the [a]Center for Structural Heart Disease, Henry Ford Health System, Detroit, Michigan, USA; and the [b]Division of Hospitalist Medicine, Henry Ford Health System, Detroit, Michigan, USA.

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 October 16, 2024; revised manuscript received November 25, 2024, accepted December 3, 2024.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2025.103237

**ABBREVIATIONS AND ACRONYMS**

**CAVI** = caval valve implantation

**PVL** = paravalvular leak

**RA** = right atrium

**SVC** = superior vena cava

**TEE** = transesophageal echocardiography

**TR** = tricuspid regurgitation

**TViR** = transcatheter valve-in-ring

**ViR** = valve-in-ring

mitral valve replacement (2022), Complete heart block status (July 2024) post Micra pacemaker placement (Medtronic), and severe TR after repair (2017) with a 32-mm CG Future annuloplasty band (Medtronic) presented with right-sided heart failure symptoms, including significant lower extremity edema despite high doses of loop diuretic agents and severe dyspnea on exertion. He was found to have severe TR of the tricuspid band and was referred to our Center for Structural Heart Disease (Henry Ford Hospital, Detroit, Michigan, USA).

## MANAGEMENT

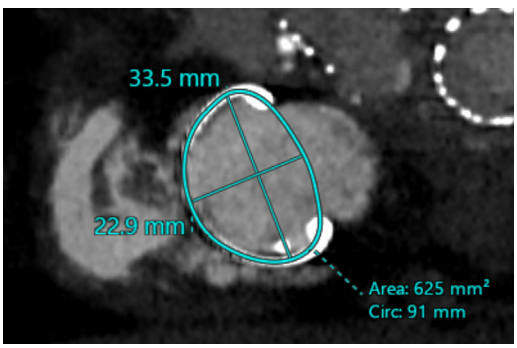
The patient was deemed a prohibitive risk for repeat surgical tricuspid valve repair or replacement because of his age, comorbidities, previous cardiac interventions, and functional status, with a calculated surgical mortality of 5.25% (The Society of Thoracic Surgeons Predicted Risk of Mortality). Thus, our dedicated structural heart team decided on a transcatheter valve-in-ring (TViR) procedure with a commercial 29-mm SAPIEN 3 Ultra prosthesis despite the unfavorable nature of the CG Future band given that there were no other suitable alternatives. The leaflets were too degenerated to perform tricuspid transcatheter edge-to-edge repair, and the dimensions of the band were too small to perform transcatheter valve replacement with an Evoque valve (Edwards Lifesciences).

The tricuspid annular area and dimensions are shown in **Figure 1**. The patient underwent general anesthesia, and the procedure was performed with transesophageal echocardiography (TEE) guidance. Right internal jugular access was obtained to bias the valve system toward the septum, thereby potentially mitigating the risk of PVL on valve deployment by promoting expansion of the valve along the septum. Over a pulmonary artery catheter, a single curve 0.035-inch Lunderquist Extra-Stiff Wire (Cook Aortic Interventions) was advanced to the distal right pulmonary artery. Over the Lunderquist wire, a 16-F eSheath was advanced to the tricuspid annulus. A 29-mm SAPIEN 3 Ultra Resilia valve was advanced to the band and was prepared. The valve was deployed, but it failed to expand completely along the atrial side and thus did not anchor appropriately. This issue was thought to be caused by tortuosity and tension in that delivery system that resulted in an asymmetric expansion of the Edwards delivery balloon with more expansion toward the ventricular than the atrial aspect. An additional inflation was performed with the same delivery balloon by using extra volume, but it resulted in balloon rupture because the balloon interacted with the Micra anchors (Video 1).

While the delivery balloon was being removed, the partially underexpanded valve continued to migrate partially more atrially, but it was still within the tricuspid band. We elected to use a second 29-mm SAPIEN 3 Ultra valve to anchor the first valve within the tricuspid band. However, as the second delivery system was being positioned, before deployment, the partially underexpanded (original) valve migrated proximally into the right atrium (RA) and completely outside the tricuspid band. The second valve was positioned across the tricuspid band and deployed with +4 cc, thus resulting in successful anchoring and very little residual TR. While maintaining wire position, the valve delivery system was withdrawn, and a 30-mm NuCLEUS balloon (NuMed) was advanced and inflated within the embolized valve (**Figure 2**).

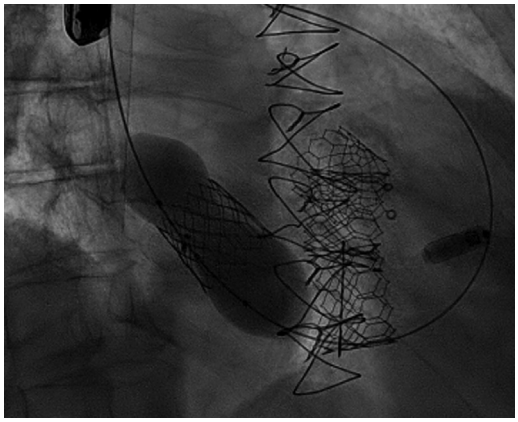
While maintaining inflation, the balloon was withdrawn, carrying with it the embolized valve into the superior vena cava (SVC). Measurements of the SVC were performed with TEE to ensure adequate oversizing in anticipation of anchoring the embolized valve. The valve was then dilated using a 28-mm TRUE Dilatation balloon (Bard Vascular), with excellent apposition in the SVC-RA junction, confirmed on both TEE and fluoroscopy (**Figure 3**). Notably, the orientation of the SAPIEN 3 valve in the SVC was the same that would be used in a heterotopic caval valve implantation (CAVI). TEE demonstrated mild central regurgitation, trivial PVL of the ViR, and appropriate

**FIGURE 1 Tricuspid Annular Area and Dimensions**




Circ = circumference.

**FIGURE 2** A 30-mm NuCLEUS Balloon (NuMed) Inflated Within the Embolized Valve and Withdrawn to the Superior Vena Cava



opening of the leaflets in the newly implanted caval valve. No pacing was performed throughout the procedure.

## DISCUSSION

Despite the high rate of recurrent TR after tricuspid repair, TViR remains limited in practice. In a large case series, 20 patients underwent TViR, and only 2 of these patients had reported complications, including valve embolization and severe PVL secondary to malposition.[3] However, variability in the different annuloplasty bands renders some of the bands much more unfavorable for ViR than others, and therefore larger studies are needed to characterize outcomes for this procedure more clearly. Our case was complicated by valve embolization caused by balloon rupture after interaction with the Micra anchors, a problem that has not been previously described. Although we had intended to deploy a new SAPIEN 3 valve to secure the previous valve in place, the original valve embolized proximally into the RA. Once valve embolization occurs, ensuring stable wire position is paramount because loss of wire traversal through the embolized valve could be catastrophic. In our case, the embolized valve was brought into the SVC and fully expanded, thus converting the original ViR into a functional CAVI.

**FIGURE 3** Placement of the Embolized Valve Into the Superior Vena Cava-Right Atrial Junction

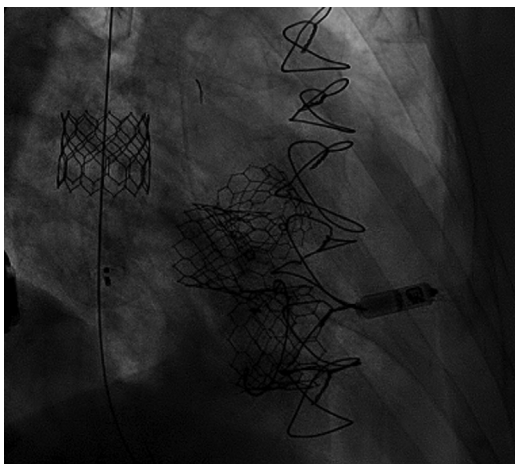
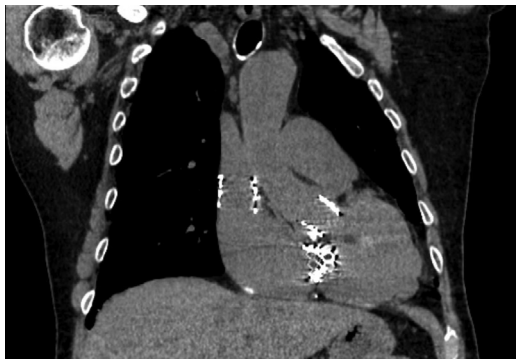


**FIGURE 4** Chest Computed Tomography 24 Hours Postprocedurally Demonstrating Stable Placement of the Embolized Valve Along the Course of the Superior Vena Cava



## FOLLOW UP

A follow-up transthoracic echocardiogram 24 hours later showed mild central regurgitation and a mean tricuspid gradient of 3.5 mm Hg of the ViR. Computed tomography of the chest without contrast, also performed 24 hours postprocedurally, demonstrated stable placement of the embolized valve along the course of the SVC (Figure 4). The patient was discharged the following day, with improvement in his dyspnea and lower extremity edema on a follow-up visit.

## CONCLUSIONS

Although TViR is performed infrequently, the rates of complications on smaller case series are uncommon. Our case report, however, highlights the potentially catastrophic event of valve embolization secondary to balloon rupture during deployment, triggered by balloon interaction with a Micra anchor. Although the procedure was complicated by

proximal valve embolization, it was salvaged by balloon apposition into the SVC without further complication.

## FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Lee has served as a consultant for Edwards Lifesciences; and has served as a proctor for Abbott Laboratories. Dr B.P. O'Neill has served as a consultant to Edwards Lifesciences; and has received research support from Edwards Lifesciences. Dr Frisoli has served as a proctor for Edwards Lifesciences, Abbott, Boston Scientific, and Medtronic. Dr Villablanca has served as a consultant for Edwards Lifesciences, Medtronic, Shockwave, Abiomed, and Angiodynamics. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

**ADDRESS FOR CORRESPONDENCE:** Dr Pedro Engel Gonzalez, Center for Structural Heart Disease, Henry Ford Hospital, 2799 West Grand Boulevard, Detroit, Michigan 48202, USA. E-mail: pengel1@hfhs.org. OR Dr Hussayn Alrayes, Center for Structural Heart Disease, Henry Ford Hospital, 2799 West Grand Boulevard, Detroit, Michigan 48202, USA. E-mail: halraye1@hfhs.org.

## REFERENCES

**1.** Tang GHL, David TE, Singh SK, Maganti MD, Armstrong S, Borger MA. Tricuspid valve repair with an annuloplasty ring results in improved long-term outcomes. *Circulation*. 2006;114(1 suppl):I577–I581.

**2.** McCarthy PM, Bhudia SK, Rajeswaran J, et al. Tricuspid valve repair: durability and risk factors for failure. *J Thorac Cardiovasc Surg*. 2004;127(3):674–685.

**3.** Aboulhosn J, Cabalka AK, Levi DS, et al. Transcatheter valve-in-ring implantation for the treatment of residual or recurrent tricuspid valve dysfunction after prior surgical repair. *JACC Cardiovasc Interv*. 2017;10(1):53–63.

**4.** Sharma H, Nadir MA, Steeds RP, Doshi SN. Transcatheter valve-in-ring and para-ring vascular plug implantation for severe tricuspid regurgitation following annuloplasty ring failure: a case report. *Eur Heart J Case Rep*. 2022;6(2):ytac041.

**KEY WORDS** complication, tricuspid valve, valve replacement

**APPENDIX** For a supplemental video, please see the online version of this paper.