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CASE REPORT

ADVANCED

CLINICAL CASE SERIES

Computed Tomography/Fluoroscopy Fusion and 3D Transesophageal Echocardiography-Guided Percutaneous Paravalvular Leak Closure

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ABSTRACT

Percutaneous paravalvular leak closure seems a safe alternative to surgery in frail patients. However, it is a challenging procedure that should be tailored to each patient with optimal imaging guidance. Transesophageal echocardiography during the procedure and computed tomography scan/fluoroscopy fusion provide guidance for critical steps, such as PVL localization and crossing. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2023;5:101690)

Severe paravalvular leaks (PVLs), although infrequent, need to be addressed quickly to avoid worsening heart failure. Percutaneous PVL closure appears to be a safe and often successful alternative to redo surgery in frail patients.[1-3] PVL localization and crossing remain critical and difficult steps poorly guided by transesophageal echography (TOE). Computed tomography (CT) scan fusion guidance can improve localization and crossing.[4]

LEARNING OBJECTIVES

- To show the benefits of cardiac CT scan work-up in the selection and sizing of the PVL closure device.
- To consider the use of CT scan/fluoroscopy fusion to guide PVL closure, especially PVL crossing, on top of TOE.

We recently performed 2 cases of aortic and mitral PVL closure using CT scan fusion in addition to TOE.

CASE 1

CLINICAL SETTING. A 66-year-old man was admitted to our hospital for increasing shortness of breath and limb edema for several months despite recent increase of his medical treatment for heart failure. He had undergone biological prosthesis implantation for mitral valve replacement 6 years before recent admission and had a history of persistent atrial fibrillation for 5 years. On physical examination, his blood pressure was 115/80 mm Hg with a heart rate of 78 beats/min, an oxygen saturation of 100% on room air, and a temperature of 36.4 °C. His heart rhythm was irregular with a systolic mitral murmur, and the auscultation revealed bilateral pulmonary crackles

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ABBREVIATIONS AND ACRONYMS

CT = computed tomography

PVL = paravalvular leak

TOE = transesophageal echocardiography

and lower limbs edema. The electrocardiogram displayed atrial fibrillation with no other abnormality.

Transthoracic echocardiography showed a left ventricular ejection fraction of 50% with a dilated left ventricle and a severe mitral PVL. TOE revealed a severe 5 × 11 mm PVL at 11 o'clock (**Figures 1 and 2**), a transprosthetic gradient of 5 mm Hg and no argument for endocarditis.

The CT scan confirmed the presence of an anterior and lateral paravalvular oval orifice with a mean diameter of 9 mm (**Figure 3**).

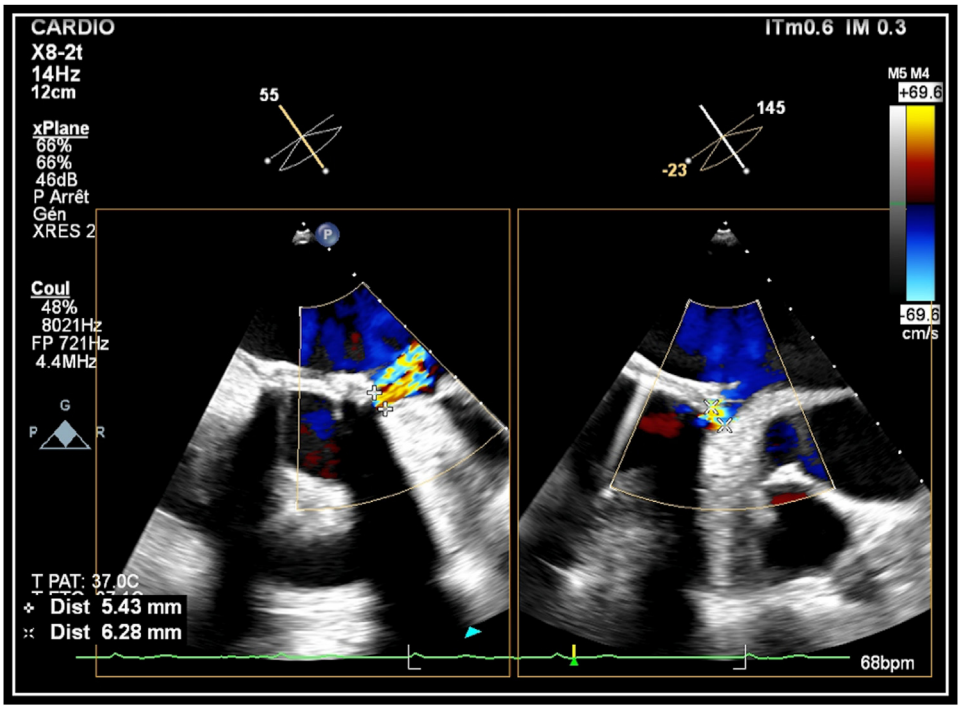
INTERVENTION. PVL percutaneous closure was performed under general anesthesia with a femoral venous access to allow anterograde closure through transseptal puncture. The device implantation was guided both with CT scan/fluoroscopy fusion (General Electric HealthCare) and 3-dimensional (3D) TOE. After TOE and CT scan/fluoroscopy fusion guided-transseptal puncture, a stiff guide wire was introduced with the delivery sheath into the PVL to cross, depicted as a fusion landmark on the screen (**Figure 4**). PVL measurements were confirmed with 3D-TOE to choose the device size. After guidewire removal, a 14 × 5 mm Amplatzer Valvular Plug III (Abbott Vascular) (**Figure 5**) device was implanted right on the fusion landmark on the second attempt, the first one leading to recapture caused by recoil of the device into the left atrium (Video 1).

The final TOE displayed a mild leak inside the device, with no residual PVL and a mean transprosthetic gradient of 3 mm Hg (**Figures 6 and 7**). The procedure was straightforward and no complication occurred.

CASE 2

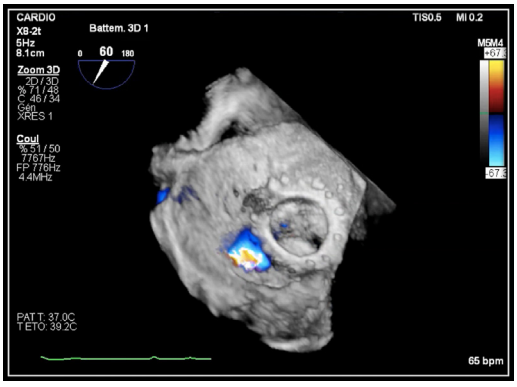
CLINICAL SETTING. The second patient was a 74-year-old man also experiencing increasing

FIGURE 1 Preprocedural X Plane Transesophageal Echocardiography



Severe anterior and lateral mitral paravalvular leak (diameter 6.3 × 5.4 mm)

FIGURE 2 **Preprocedural 3D Transesophageal Echocardiography**



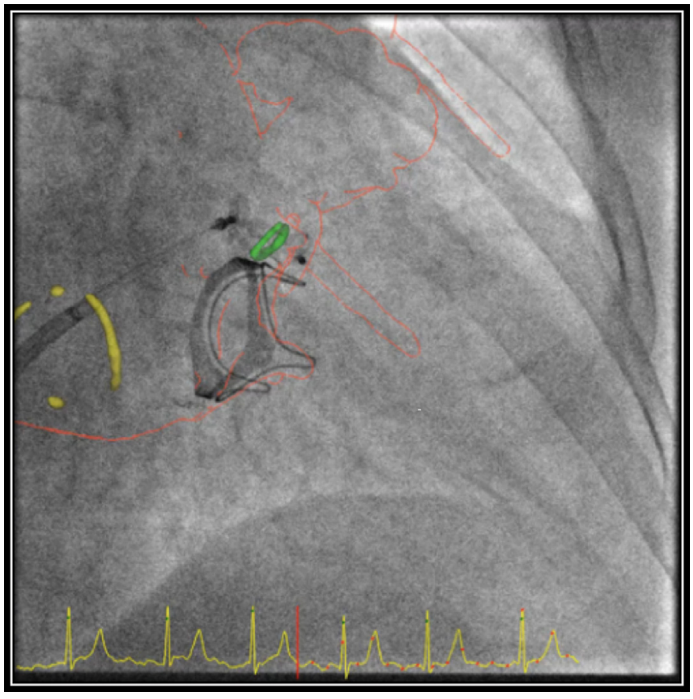
Severe anterior and lateral mitral paravalvular leak with higher dimensions after 3-dimensional (3D) transesophageal echocardiography assessment (diameter 6 × 11 mm).
2D = 2-dimensional.

shortness of breath because of heart failure. He had undergone biological aortic valve replacement surgery in 1998, redo surgery in 2007 and transcatheter aortic valve replacement in 2014 with a 26-mm CoreValve prosthesis (Medtronic). He also had liver cirrhosis with esophageal varices, chronic obstructive pulmonary disease, moderate kidney failure, and persistent atrial fibrillation with a pacemaker.

FIGURE 3 **Preprocedural Computed Tomography Scan**

Severe anterior and lateral mitral paravalvular leak.

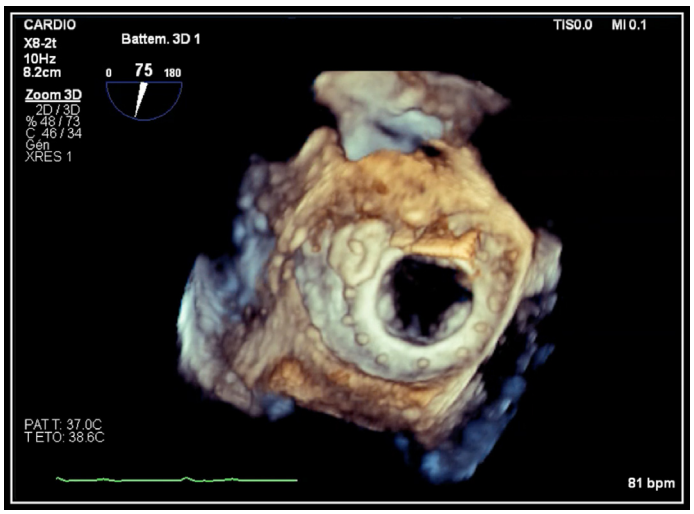
FIGURE 4 **Procedural Computed Tomography Scan/Fluoroscopy Fusion**



The plug is positioned inside the paravalvular leak orifice with computed tomography scan/fluoroscopy fusion (paravalvular leak orifice is represented in **green**; **yellow circle** represents the fossa ovalis).

FIGURE 5 **Plug Device Used in Both Procedures**

FIGURE 6 Final 3D Transesophageal Echocardiography



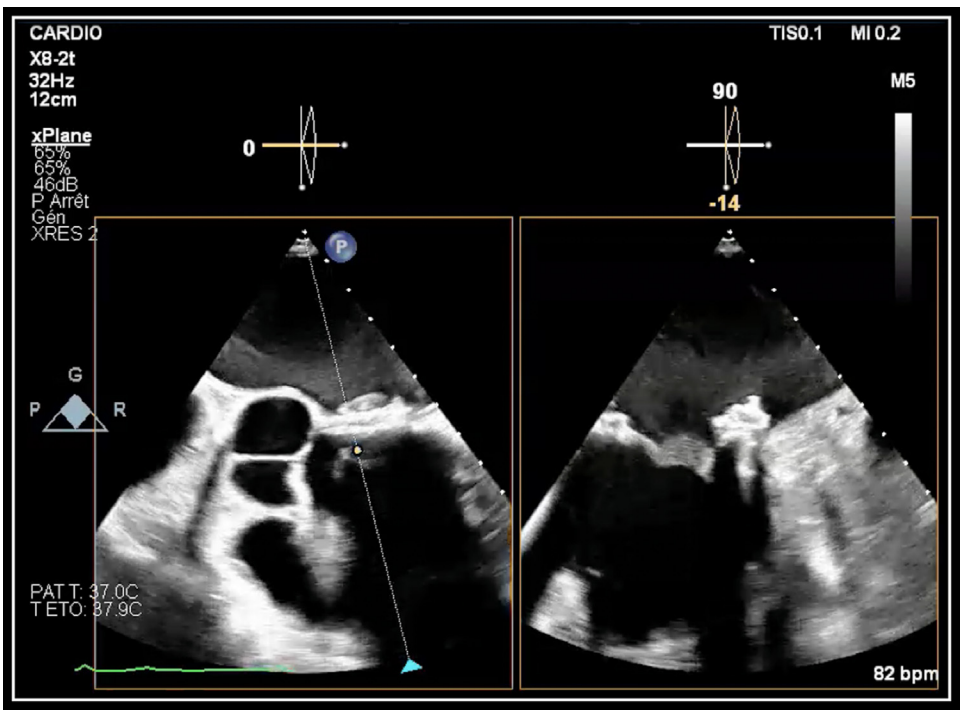
Correct occlusion of the paravalvular leak with the plug. 2D = 2-dimensional; 3D = 3-dimensional.

On physical examination, his blood pressure was 115/54 mm Hg with an irregular heart rate of 90 beats/min and an oxygen saturation of 95% on room air. The auscultation displayed bilateral crackles and discrete lower limbs edema.

Transthoracic echocardiography displayed normal left ventricular ejection fraction with an aortic grade 2/4 left anterior PVL, confirmed with TOE (Figure 8), and a pulmonary artery systolic pressure of 74 mm Hg. However, cardiac magnetic resonance displayed a more severe leak with a 41% regurgitated fraction. Cardiac CT scan confirmed an anterior dis-insertion of the surgical prosthesis on about one-third of the annulus circumference with a width of 5 mm (Figure 9).

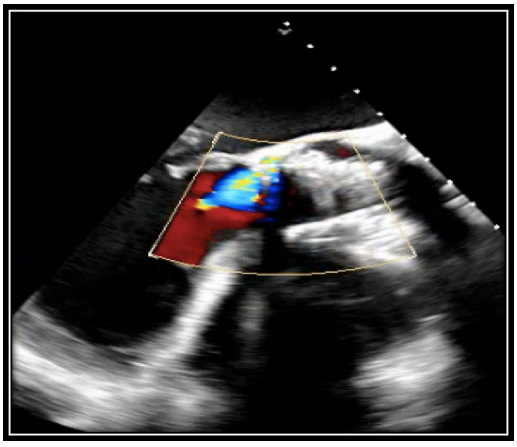
INTERVENTION. PVL closure was performed under general anesthesia with a femoral arterial puncture for retrograde access. Access to PVL was challenging because it required the intubation of transcatheter aortic valve replacement prosthesis mesh wide enough to insert a 6F Flexor Shuttle Guiding sheath (Cook Medical) with the right angle to access the

FIGURE 7 Final X Plane Transesophageal Echocardiography



Correct occlusion of the paravalvular leak with the plug.

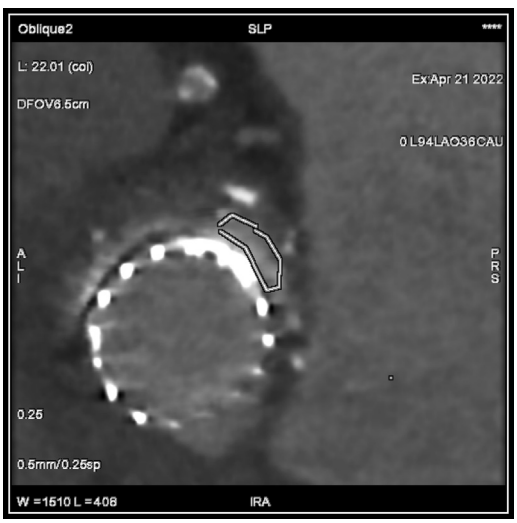
FIGURE 8 Preprocedural Transesophageal Echocardiography



Severe anterior paravalvular leak around the aortic biological prosthesis.

PVL around the surgical prosthesis. Moreover, top prosthesis meshes were too close to the aortic wall to insert a wire, whereas bottom meshes were too small to be crossed by the sheath. Therefore, we selected the right mesh and displayed it thanks to the CT scan/fluoroscopy fusion on screen to facilitate access (Figure 10). Other useful fusion landmarks were displayed on the screen to avoid complications, such as the left main artery (Figure 11). A guide wire was introduced into the PVL through this mesh to advance the delivery sheath. Meanwhile, the PVL dimensions were reassessed with 3D-TOE. After the guidewire removal, a 14 × 5 mm plug was deployed into the leak, which was sealed accurately (Video 2). Final TOE and control cardiac magnetic resonance showed a reduced PVL with an 8% regurgitated fraction (Figures 12 and 13).

FIGURE 9 Preprocedural Computed Tomography Scan

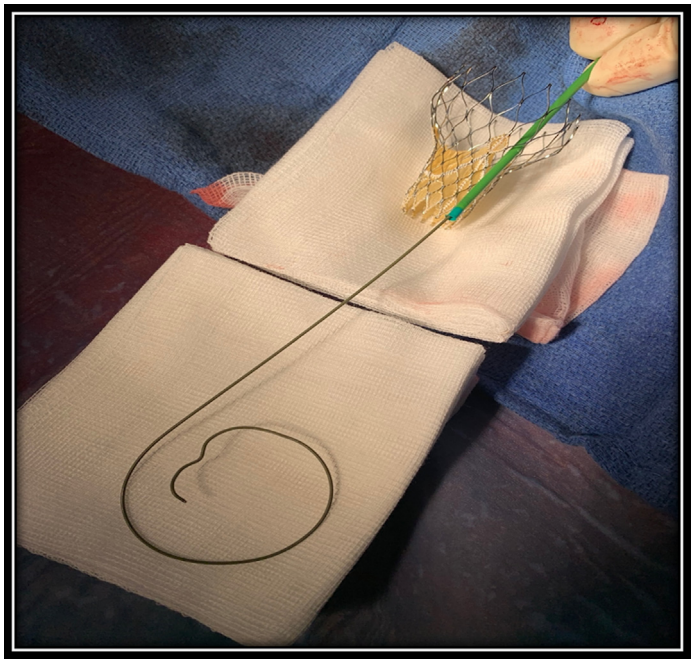


Anterior 5-mm-wide paravalvular leak around the aortic biological prosthesis.

DISCUSSION

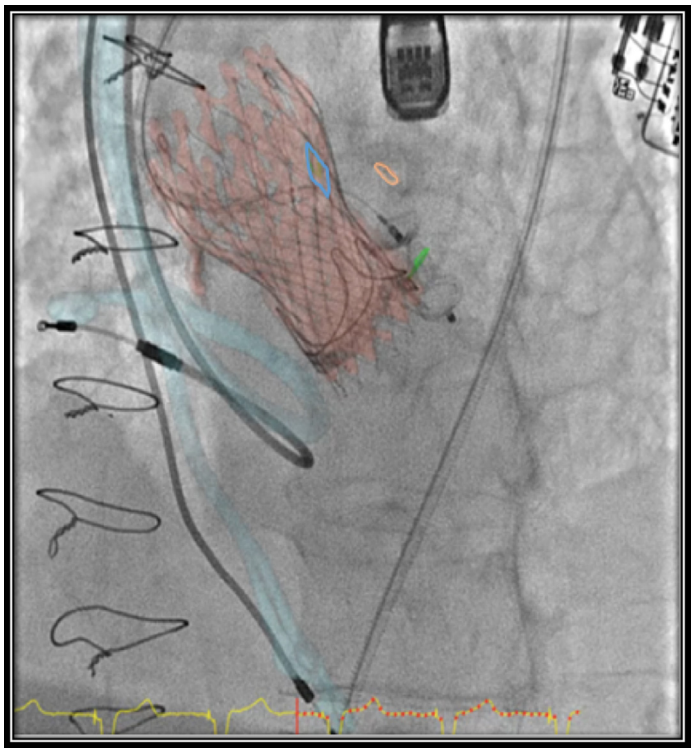
Procedural work-up is critical to ensure good sizing and allow total PVL occlusion. Although TOE remains mandatory for transseptal puncture and reassessing PVL measures during the procedure, CT scan/fluoroscopy fusion guidance is an interesting tool to facilitate PVL crossing because it enables accurate on-screen PVL visualization.[5] Indeed, especially for aortic PVL, TOE guidance alone for this critical step might provide insufficient insight. Even though TOE guidance usually enables correct visualization of mitral PVL, fusion guidance can still be useful in this case to guide the device implantation directly on the fluoroscopy screen. In the second case, this step appeared to be particularly challenging because it required crossing the right prosthesis mesh to aim for the PVL between the biological prosthesis and the aortic wall with the delivery sheath according to the right angle. The added value of CT scan/fluoroscopy fusion guidance in this setting was essential, providing the operators with direct PVL 3D localization on screen. CT scan/fluoroscopy fusion guidance might therefore improve the rates of procedural success and reduce procedural time and radiation exposure for patients and teams. In our center, since 2015, CT scan/fluoroscopy fusion guidance in left atrial appendage occlusion has proven useful and easily integrated in our clinical practice. The potential benefit of using it for PVL closure should be considered given the critical need for tailoring the procedure to each patient.

FIGURE 10 Prosthesis Mesh Crossing Demonstration



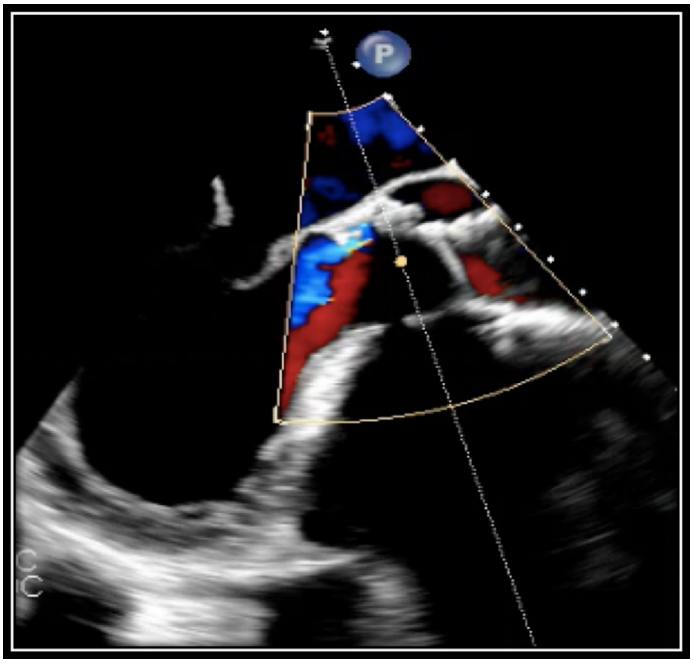
Selection of the right prosthesis mesh to cross with the delivery sheath to access the paravalvular leak around the biological prosthesis.

FIGURE 11 Procedural Computed Tomography Scan/Fluoroscopy Fusion



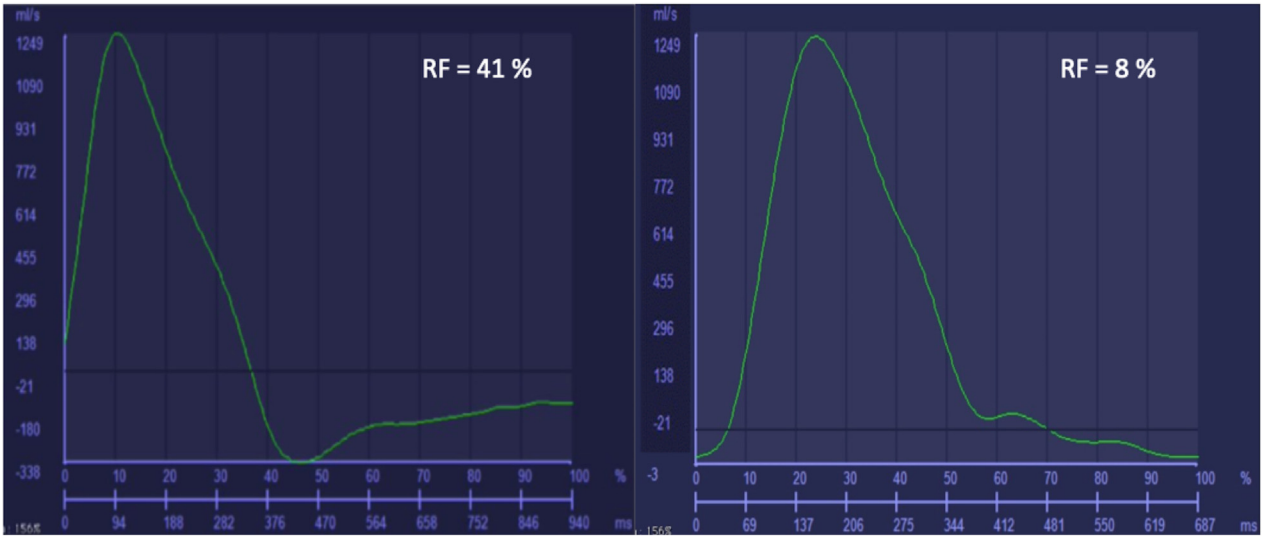
Paravalvular leak orifice **(green line)** and the targeted mesh **(blue line)** to cross to align the delivery sheath with the paravalvular leak. The left main mark **(pink line)** is useful to avoid conflict with the left main.

FIGURE 12 **Final Transesophageal Echocardiography**



Reduction of the aortic paravalvular leak.

FIGURE 13 **Preprocedural and Final Cardiac Magnetic Resonance Measured Paravalvular Leak Aortic Flow**



Reduction of the aortic paravalvular leak with a reduction of the regurgitated fraction (RF) from 41% to 8%.

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KEY WORDS closure, CT, fusion, percutaneous, PVL, TEE

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