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CASE REPORT

INTERMEDIATE

CLINICAL CASE: TECHNICAL CORNER

Retrograde Retrieval of a Novel Large Mitral Clip After Embolization Into the Left Ventricle

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ABSTRACT

We describe the successful retrieval of a novel large mitral clip, which embolized in a patient with severe secondary mitral regurgitation and left ventricular dysfunction, dilated left ventricle, and severely tethered mitral valve leaflets in the setting of a challenging anatomy for transcatheter edge-to-edge repair. The description highlights planning, technical issues, and possible adverse events of this bailout procedure. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2021;3:1561–1568) © 2021 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/).

Patients with complex mitral valve anatomy, in particular short, retracted, or calcified leaflets, or severe tethering caused by left ventricle (LV) dilatation are at risk of various leaflet adverse events such as leaflet tear, single leaflet device attachment (SLDA), or clip embolization (1,2). The technical evolution achieved with the newer-generation transcatheter edge-to-edge repair (TEER) system has expanded the treatment to challenging anatomies owing to the availability of different implant sizes, as well as the ability of independent gripper actuation (1,3). The initial learning curve with these new devices has been favorable (1,2). However, the use of larger implants may result in new difficulties related to bailout procedures in a case of rarely occurring device embolization.

LEARNING OBJECTIVES

- To recognize features of mitral valve anatomies that may be challenging for TEER and evaluate alternative treatment options in those patients.
- To describe the factors to be considered for procedural planning of clip retrieval and the choice of the access route.
- To highlight limitations and appreciate difficulties encountered during clip retrieval.

HISTORY OF PRESENTATION

A 69-year-old woman with severe LV dysfunction (left ventricular ejection fraction [LVEF] 20%) was

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ABBREVIATIONS AND ACRONYMS

DCM = dilated cardiomyopathy

LV = left ventricle

LVAD = left ventricular assist device

LVEF = left ventricular ejection fraction

SLDA = single leaflet device attachment

SMR = secondary mitral regurgitation

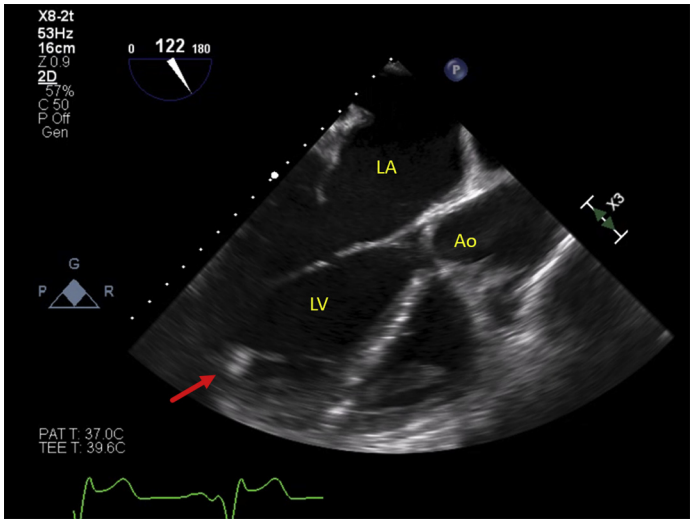
TEER = transcatheter edge-to-edge repair

referred for treatment of secondary mitral regurgitation (SMR).

MEDICAL HISTORY

The patient was known to have dilated cardiomyopathy (DCM) accompanied by severe SMR (effective regurgitant orifice area 0.31 m^2, and regurgitant volume of 55 ml with asymmetrical orifice) and had undergone cardiac resynchronization therapy defibrillator implantation in 2014 following sustained ventricular arrhythmias. Despite optimized medical treatment and successful resynchronization, her heart failure symptoms progressed (NYHA functional class III), resulting in repeated hospitalizations. The patient was deemed at extreme risk for open-heart surgery by the Heart Team because of advanced heart failure and severe LV remodeling without need for surgical revascularization, and she refused left ventricular assist device (LVAD) implantation as a destination therapy.

FIGURE 1 Transesophageal Left Ventricular Outflow Tract View Showing the Embolized Clip



Transesophageal echocardiogram showing the embolized clip **(red arrow)** adherent to the inferolateral wall of the left ventricle (LV). Ao = aorta; LA = left atrial.

Although formally not fulfilling the COAPT criteria because of low LVEF and severely dilated LV, the patient was offered mitral TEER with the aim to alleviate symptoms and decrease the occurrence of rehospitalizations.

Severe tethering with elevated chordal tension, low coaptation (tenting height 18 mm, tenting area 5.7 cm^2), cardiac rotation resulting from severe LV dilation, and impaired imaging quality imposed procedural challenges. After implantation of a MitraClip XTW Gen 4, SLDA was observed despite confirmation of sufficient grasping by echocardiography. Attempts to stabilize the first clip with implantation of a second XTW device resulted in chordal rupture with increased motion of the partially detached clip from the ventricle into the atrium. Lateral interaction with the highly mobile clip prevented implantation of a second device close enough to the first one to achieve its stabilization. Echocardiographic control the day after the procedure revealed embolization of the clip into the posterolateral wall of the LV (Figure 1), with unchanged SMR severity.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis of TEER failure without reduction of mitral regurgitation includes post-procedural SLDA, leaflet damage, or less frequently complete device detachment with subsequent embolization.

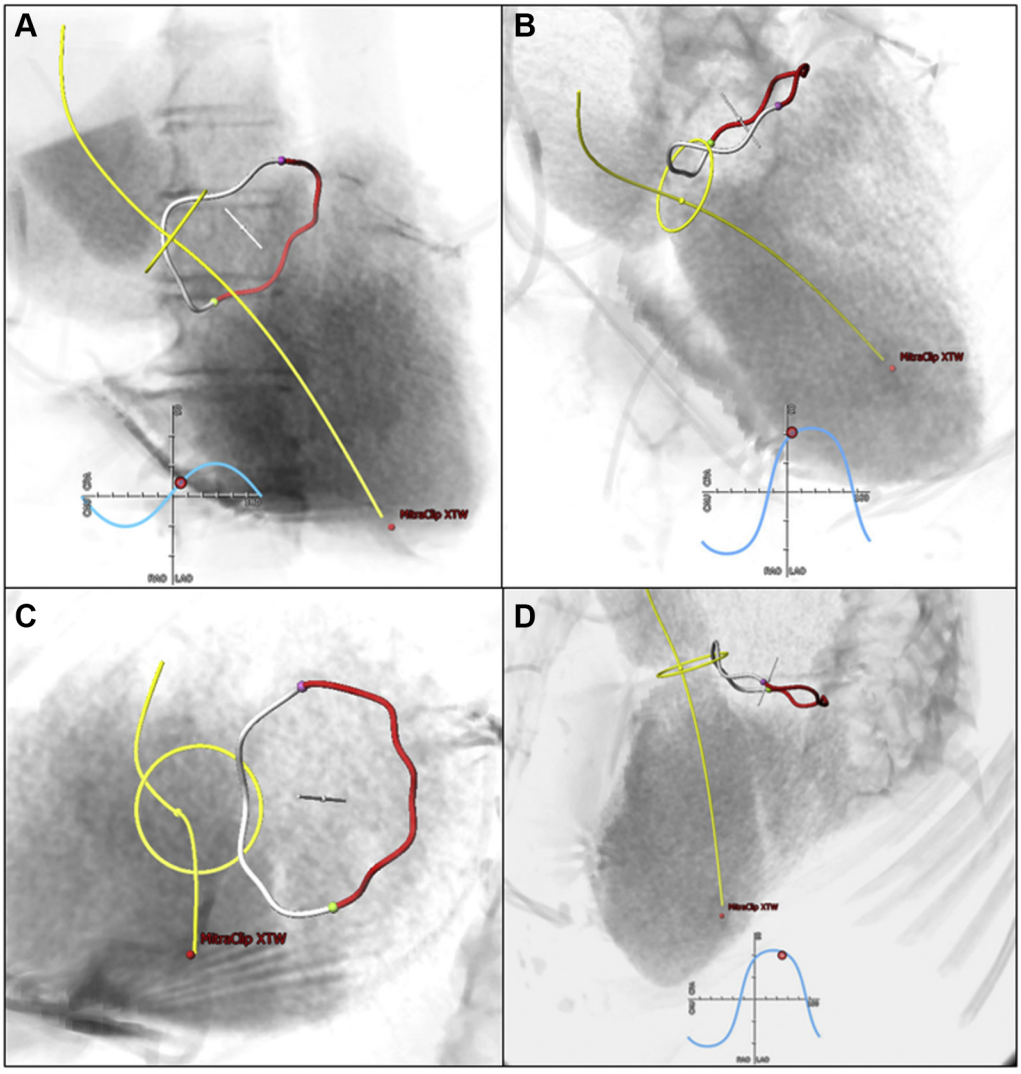
INVESTIGATIONS

For precise localization of the device and planning of a bailout procedure, fluoroscopy and electrocardiogram-gated cardiac computed tomography were performed. The clip was found to be immobilized in immediate proximity to the posterior papillary muscle. Direct retrograde access from the aortic route was therefore preferred over a transseptal approach for clip retrieval (Figure 2).

MANAGEMENT

The bailout procedure was performed on post-operative day 2 via right femoral arterial access. After positioning of 2 Proglide closure devices, a 20-F sheath was introduced (Figure 3). Following aortic

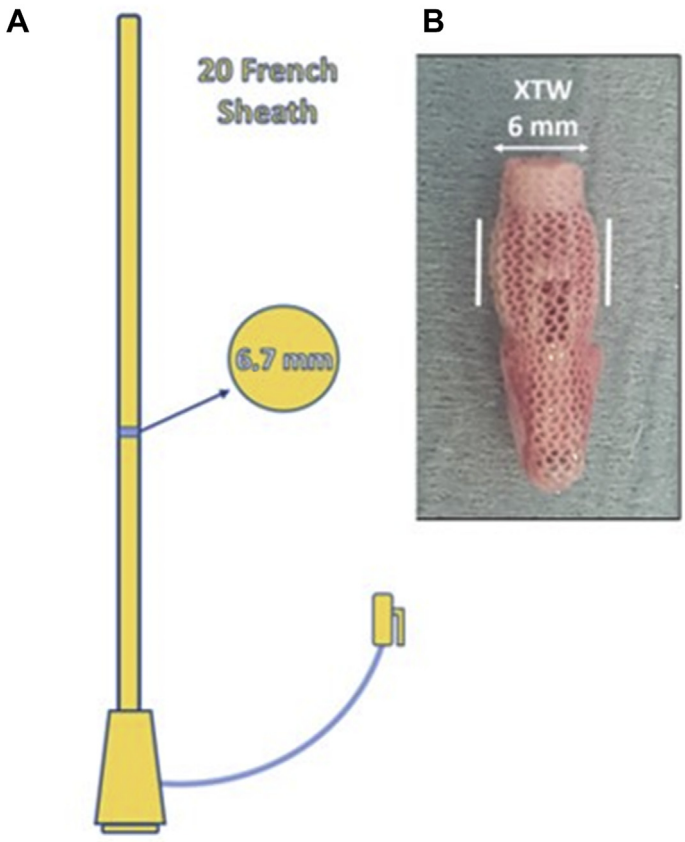
FIGURE 2 **Preprocedural Planning Using Computed Tomogram Analysis**



CT planning of the access route showing straight-line retrograde trajectory from the aortic root in several projections (**red dot**, embolized XTW clip) (**yellow ring**, aortic annulus) (**yellow line**, trajectory to reach the clip). The mitral annulus is represented by the **red** (region of the posterior leaflet) and **white ellipse** (region of the anterior leaflet). **(A)** Frontal plane. **(B)** Right anterior oblique view. **(C)** Cranial view. **(D)** Left anterior oblique caudal view.

valve crossing, the clip was captured with a ONE Snare (Merit Medical) (**Figure 4A**, Video 1) and retrieved through the valve (**Figure 4B**, Video 2), easily passing the arch and the descending aorta until the iliac bifurcation, where the tip of the sheath was located (**Figure 4C**, Video 3). Despite several attempts using different angles (**Figure 4**), the clip could not be introduced into the 20-F sheath and finally embolized into the left common iliac artery (**Figure 4**, Video 4). A new attempt using a second snare from the contralateral side was also unsuccessful (**Figure 4F**), and the device embolized into the left internal iliac artery. Inasmuch as mobilization from the bifurcation toward the aorta was complicated by the tortuosity of the common iliac artery (**Figure 4G**, Video 5), distal displacement of the clip to the superficial femoral artery to allow for easy surgical removal was preferred and was performed using the second snare from the left femoral access (**Figure 4H**, Video 6). Surgical removal of the device from the femoral

FIGURE 3 Sheath and Mitral Clip Dimensions



A 20-F sheath **(A)** was used to attempt to externalize the clip. The inner diameter of 6.7 mm is compatible with the 6 mm of the XTW **(B)**. Upper clip after surgical bailout **(B)**.

bifurcation was performed uneventfully. The patient was discharged home after 3 days and refused further intervention.

DISCUSSION

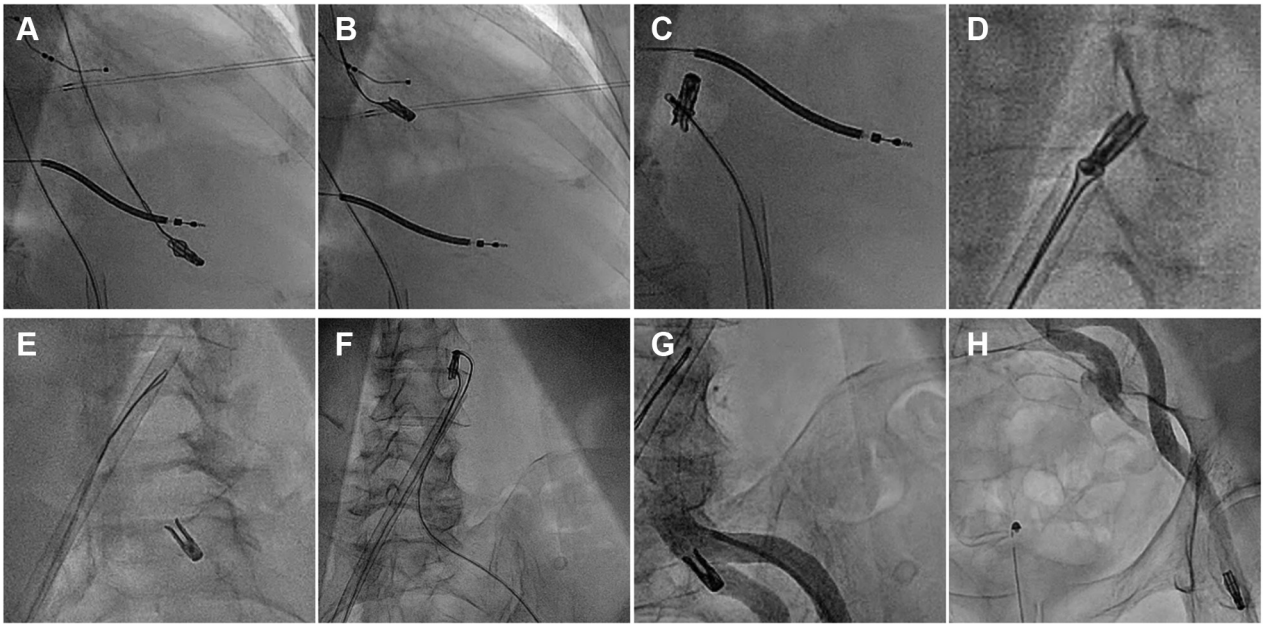
This case report describes the embolization of a novel larger mitral clip with successful retrieval from the LV using a retrograde transaortic approach (**Central Illustration**).

Although the rate of SLDA is decreasing, it remains a concern during and after TEER (3). This adverse event may be explained by several factors, such as low-quality imaging with suboptimal delineation of leaflet anatomy, friable leaflet tissue, insufficient grasping, suboptimal angulation of the implant catheter resulting from cardiac rotation in patients with DCM, severe leaflet tethering, and overall expansion of the procedure to more challenging anatomies (1,3,4).

Clip embolization is a rare adverse event during TEER. In the preliminary experience with the MitraClip Gen 4, only one SLDA and no clip embolization was reported (1,3). In the TVT registry, the rate of embolization was 0.1% (12/12,334), and complete detachment occurred in 0.2% of the patients (20/12,334) (5).

Few successfully resolved embolization cases with the use of previous device generations have been reported and are summarized in **Table 1** (6–10). Two of them occurred acutely with the gripper line still connected to the clip (8,9). Detachment or

FIGURE 4 Procedural Steps Shown on Fluoroscopy



(A) The embolized clip in the LV has been fixated using the One snare (Video 1). **(B)** The immobilized clip is removed from the LV through the aortic valve (Video 2). **(C)** Clip in the abdominal aorta at the height of the aortic bifurcation. **(D)** Repositioning of the clip towards the sheath orifice. **(E)** Incomplete alignment of the clip and the sheath preventing removal. **(E)** Embolization of the clip to the left common iliac artery. **(F)** A second snare is introduced from the left femoral artery to facilitate reorientation of the clip. **(G)** Embolization of the clip to the left internal iliac artery. **(H)** Displacement of the clip into the superficial femoral artery to facilitate surgical removal.

embolization is generally preceded by SLDA, in some cases even when satisfactory grasping is confirmed by transesophageal echocardiography. Most of the cases occurred in patients with primary mitral regurgitation (6–10). and clip removal was usually performed with snaring via the transseptal access, in particular in cases where the clip was still attached to the gripper lines.

Our case demonstrates that patients with SMR may also be at risk for this rare complication, in particular when severe tethering with high tension on the valve leaflets is present. In this context, it is therefore essential to consider other therapy approaches in patients with advanced heart failure, including LVAD implantation as a destination therapy. Removal of large clip models (NTW and XTW) is challenging and requires the use of large-bore sheaths (≥20-F). In addition to snares, the use of forceps as an alternative may be considered. Surgical cutdown should be anticipated. Preprocedural planning with CT was useful to determine the most direct access route and to calculate fluoroscopic projections.

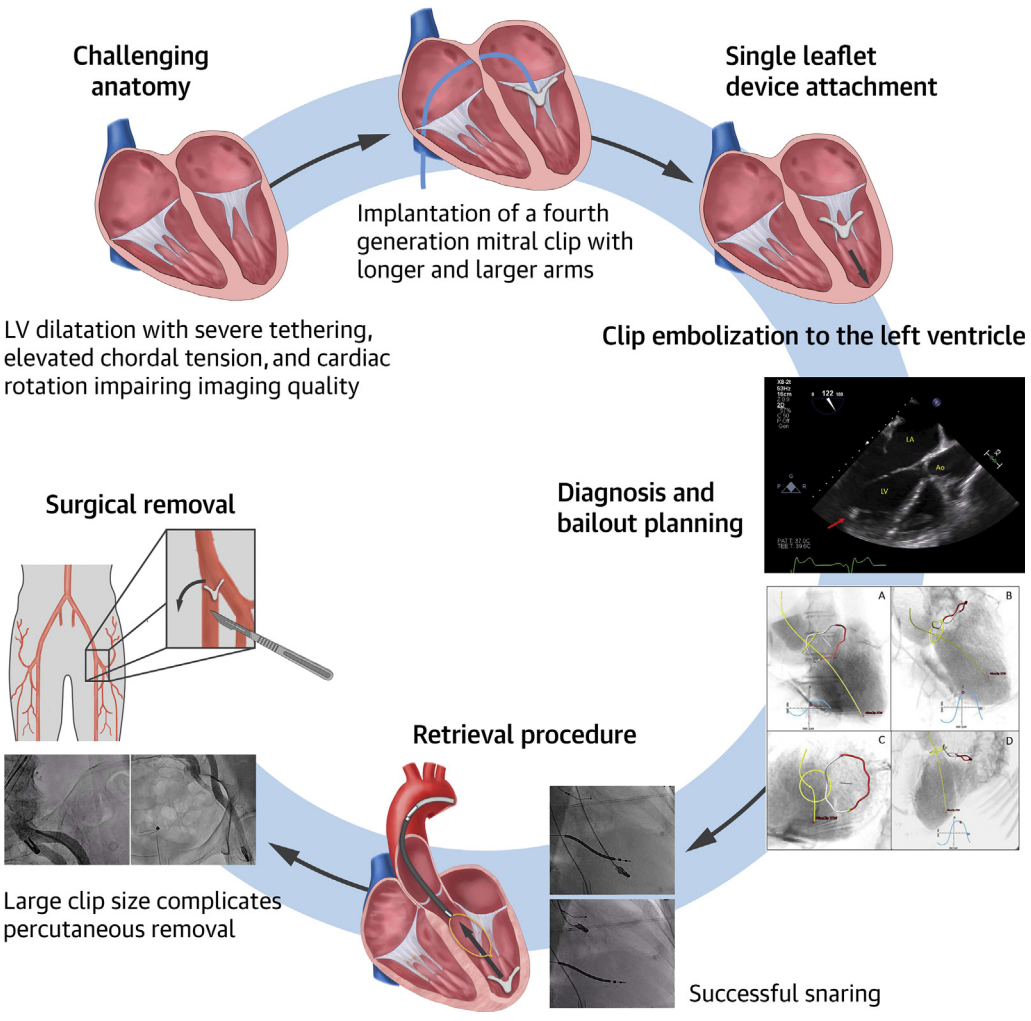
FOLLOW-UP

The patient continued to be followed up in our outpatient heart failure clinic. At 6 months, no rehospitalizations had occurred, and transthoracic echocardiography still showed severe SMR.

CONCLUSIONS

This case report describes the embolization of a large mitral clip with successful retrieval from the dilated LV by use of a retrograde transaortic approach. It underlines the anatomical challenges of TEER, the

CENTRAL ILLUSTRATION **Retrieval of a Novel Large Mitral Clip After Embolization Into the Left Ventricle**



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importance of preprocedural bailout planning, and the difficulties faced during removal of larger clip dimensions.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

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TABLE 1 MitraClip Embolization and Retrieval: A Review of the Literature

	Caussin et al. (6)	Pasala et al. (7)	Millan-Iturbe et al. (8)	Stripe et al. (9)	Chitsaz et al. (10)	Sticchi et al.
Year	2015	2018	2019	2019	2021	2021
MR mechanism	Severe mitral regurgitation No additional information	Severe primary MR: large mitral valve prolapse involving the P2 and P3 segments	Severe secondary MR: catastrophic antiphospholipid syndrome with stroke, acute renal failure, and liver failure developed impaired LV function and global thickening of the mitral leaflets	Severe primary MR: P1 flail	Severe mixed MR: moderately reduced LV function combined with posterior flail leaflet	Severe secondary MR: severely dilated LV with severe tethering
Total number of clips implanted	2	2	1	2 plus 1 as bailout strategy	3	1
Timing of event	Day 2	Acute	Acute	Acute	6 weeks after the procedure	Day 2
Postulated cause	Diffuse hematoma on the anterior leaflet, and tear of the initial clip grasping zone	-	Severe inflammation and friability of the mitral leaflets due to antiphospholipid syndrome	-	Difficult grasping of the posterior leaflet due to significant flail, resulting in acute SLDA of the first 2 clips	Severe tethering with high chordal tension and poor imaging quality due to cardiac rotation
Embolization location	Right ostial renal vein after backward migration through the septum	Freely mobile between the left atrium and the left ventricle	No embolization (still attached to the gripper lines)	No embolization (still attached to the gripper lines)	Right coronary cusp with inferior STEMI	Left ventricle
Access for bailout	Transseptal	Transseptal	Transseptal	Transseptal	Transfemoral aortic	Transfemoral aortic
Percutaneous bailout technique	Double snare and 18-F sheath	Through CDS and 6-F JR 4 guide catheter with an 18-30 mm En Snare 3-loop (Merit Medical)	EN Snare 3-loop (Merit Medical), the clip was brought back to the inferior vena cava. Then, using a second EN Snare 3-loop, the clip was retrieved through the right femoral sheath	8-F Pinnacle side-arm sheath (Terumo Medical Systems) placed over the gripper lines A second CDS was inserted over a second transseptal puncture, 2 30-mm gooseneck snare. (Medtronic) in JR 4 and through a 26-F DrySeal sheath (W.L. Gore & Associates) the detached clip was removed	Forceps 25-mm Amplatz goose neck snare (Medtronic) Surgical cutdown at the femoral arteriotomy site	Double snare from right and left femoral access with 20-F sheath for the percutaneous retrieval. Bailout surgical retrieval at the left superficial femoral access
TEER result	Severe eccentric MR at TEE	Unknown	Unknown	Mild-to-moderate MR	Hemodynamic instability due severe MR despite IABP	Unchanged severe MR
Following interventions/ outcome	Surgery	Implantation of a third clip for stabilizing during a second procedure with MR reduction to 2+	Surgery	Implantation of a second clip and ASDs (30 mm Cribriform Occlude) closure during the same procedure	Death	Medical treatment No further interventions

ASD = atrial septal defect; CDS = clip delivery system; CRT-D = cardiac resynchronization therapy defibrillator; IABP = intra-aortic balloon pump; JR = Judkins Right guide catheter; LV = left ventricular; MR = mitral regurgitation; SLDA = single leaflet device attachment; STEMI = ST-segment elevation myocardial infarction; TEE = transesophageal echocardiography.

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KEY WORDS **clip retrieval, complications, embolization, MitraClip G4, single leaflet device attachment, transcatheter edge-to-edge repair**

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