

## MINI-FOCUS ISSUE: PROCEDURAL COMPLICATIONS

ADVANCED

## CASE REPORT: CLINICAL CASE

# Surgical Removal of a Detached Mitral Valve Repair Clip to Resolve Cardiogenic Shock



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## ABSTRACT

Transcatheter edge-to-edge mitral valve repair (TEER) with a clip device relieves symptoms and improves outcomes in patients not suitable for open heart surgery. Here, we present a patient in whom ventricular arrhythmias developed as a result of clip embolization shortly after TEER. He underwent successful emergent surgical clip removal and mitral valve replacement. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:658–662) © 2022 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/>).

## HISTORY OF PRESENTATION

An 82-year-old man was continuously followed up by the outpatient heart failure clinic and regularly monitored for a mild to moderate mitral regurgitation (MR). After a hospital admission for decompensated heart failure, where transthoracic echocardiography (TTE) showed severe MR due to a P1-segment

prolapse with elevated systolic artery pulmonary pressures (55 mm Hg), a heart team discussion was held. On the basis of his age and comorbidities, the patient was denied surgery and instead was accepted for a transcatheter edge-to-edge mitral valve repair (TEER). His calculated EuroSCORE II before elective mitral valve intervention was 11.77%. The TEER was performed with the patient under general anesthesia through TEE guidance. After the origin of the regurgitant jet was identified, a clip device was deployed, with satisfactory results (**Figure 1**). The patient was feeling well, but routine postoperative TTE 2 days after the procedure raised suspicion of a partially detached clip (**Figure 2, Video 1**). A couple of hours after the routine TTE, the patient suddenly experienced nonsustained ventricular tachycardia with interspersed episodes of severe bradycardia (<30 beats/min). His condition began to deteriorate

## LEARNING OBJECTIVES

- To illustrate potential consequences of complete transcatheter edge-to-edge mitral valve repair clip detachment.
- To highlight a potentially growing ethical issue whereby patients denied open heart surgery may become surgical candidates.

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hemodynamically, with intermittent episodes of systolic bradyarrhythmias blood pressure <60 mm Hg, with subsequent decompensation and pulmonary edema with peripheral oxygen saturation of 75%.

### MEDICAL HISTORY

The patient's medical history was notable for hypertension, stage III chronic kidney disease, persistent atrial fibrillation, mitral valve regurgitation, previous deep vein thrombosis, and pulmonary embolism. He had continuous anticoagulant treatment with edoxaban.

### DIFFERENTIAL DIAGNOSIS

The general differential diagnoses to ventricular bradyarrhythmias and tachyarrhythmias include coronary ischemia, congenital and acquired cardiomyopathies, conduction disturbances, ion channel diseases, electrolyte disturbances, drugs, and others.

Specifically, ventricular arrhythmias after a transcatheter cardiovascular procedure raise suspicion of a surgical complication such as cardiac tamponade, myocardial ischemia, pulmonary embolism, severe hemorrhage, mechanical damage to the cardiac conduction system, or others. Because of to the previous finding of partial clip detachment, this was suspected as a mechanism behind the ventricular arrhythmias with resulting hemodynamic instability and cardiac decompensation.

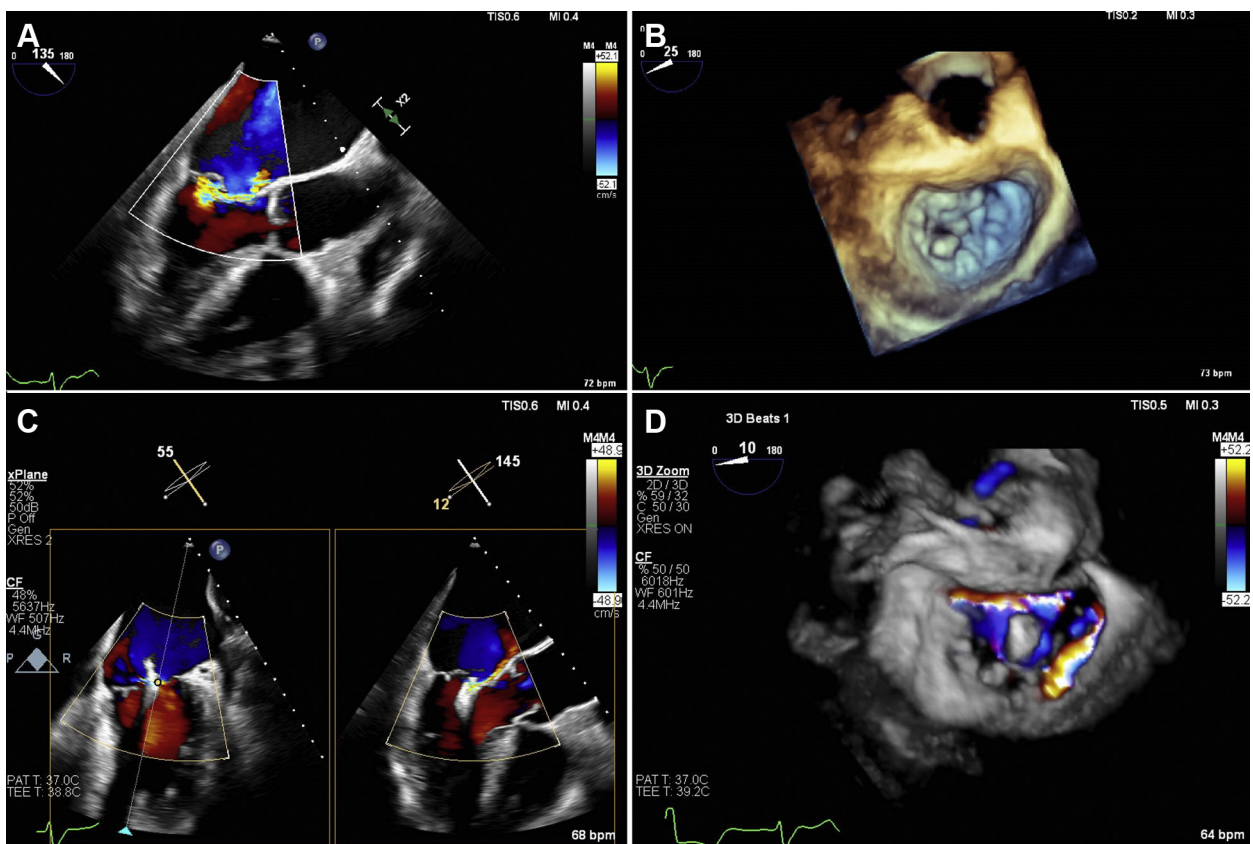
### INVESTIGATIONS

A bedside TTE showed that the TEER clip had detached totally and was suspected to be located alongside the anterolateral papillary muscle (Figure 3, Video 2). Additionally, a severe MR was seen (Video 3). The left ventricular ejection fraction was

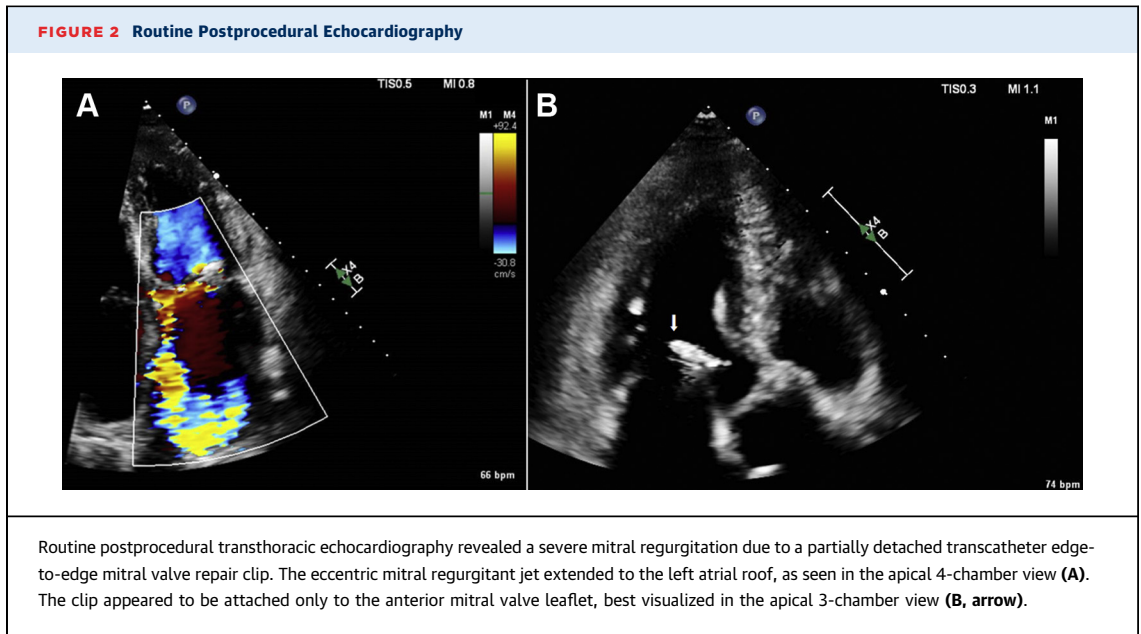
### ABBREVIATIONS AND ACRONYMS

- MR = mitral regurgitation
- TEE = transesophageal echocardiography
- TEER = transcatheter edge-to-edge mitral valve repair
- TTE = transthoracic echocardiography

FIGURE 1 Transcatheter Edge-to-Edge Mitral Valve Repair Through Echocardiographic Guidance



The mechanism of severe mitral regurgitation was a P1 prolapse (A, B), which was resolved with the placement of a transcatheter edge-to-edge mitral valve repair clip device (C, D).



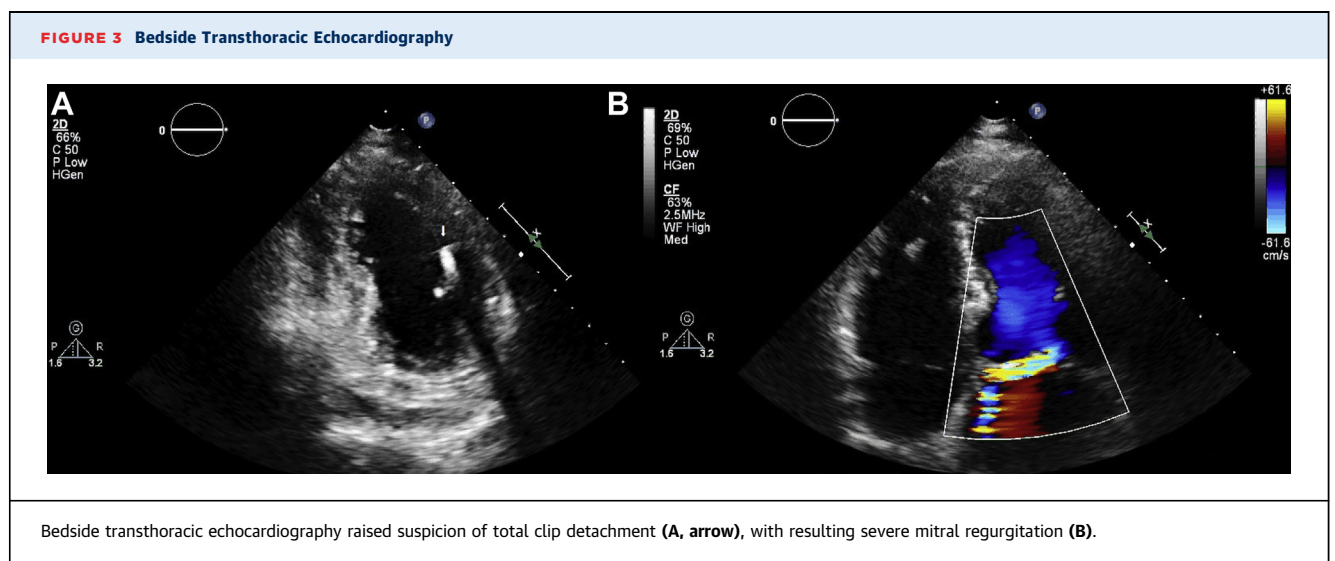
normal, and there was no evidence of significant pericardial fluid that could explain the symptoms.

### MANAGEMENT

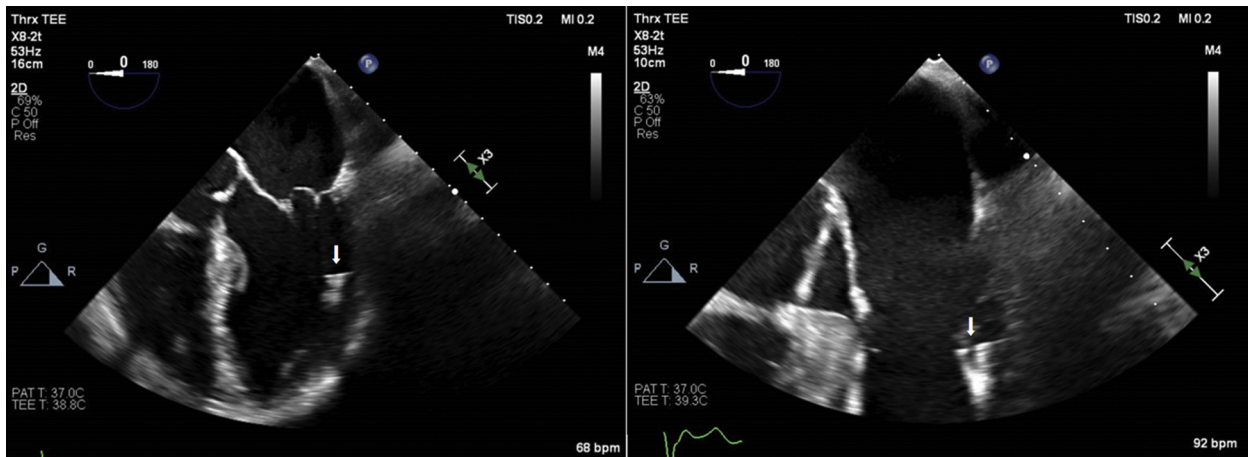
The cardiothoracic surgeon was consulted to judge whether the patient was suitable for emergent surgical clip removal and concomitant repair or replacement of the mitral valve. A quick discussion was held between the cardiothoracic surgeon, the cardiologist, and the interventionist to review potential treatment options. An interventional approach with catheter-

based removal (through snaring) through the aortic valve was deemed too risky because of the size of the clip, together with the heavily calcified aortic arch and descending aorta. It was determined that surgical removal was the best option to resolve the cardiogenic shock and to prevent clip embolization. The patient's calculated EuroSCORE II before emergency open heart surgery was 44.42%. The patient was informed about the risks, and he was motivated to undergo the procedure.

The patient was immediately transferred to the cardiothoracic operating room. He remained in a



**FIGURE 4** Perioperative Transesophageal Echocardiography



Perioperative transesophageal echocardiography showed that the clip was in proximity to the anterolateral papillary muscle (arrows).

hemodynamically stable condition through the induction of general anesthesia. Perioperative TEE revealed a foreign body in proximity to the anterolateral papillary muscle, as previously suggested (Figure 4). A median sternotomy was performed, and upon opening of the pericardial sac, heparin was administered, and the activated clotting time was kept >480 s. Subsequently, bicaval cannulation and aortic cannulation were performed before antegrade cardioplegia was delivered to induce asystole. Retrograde cardioplegia was subsequently iterated every 20 minutes. The mitral valve was visualized through a left atriotomy. The clip had embolized to the left ventricle, where it was completely loose, and it was extracted with the forceps (Figure 5). It was not possible to proceed with a mitral valve repair because both the anterior and the posterior mitral leaflets had been damaged by the clip. The mechanism of complete clip detachment was probably tearing. A mitral valve replacement to a 29-mm biological prosthesis was therefore performed. After the aorta was declamped, the heart began a ventricular fibrillation, which was managed with amiodarone and defibrillation. Weaning from extracorporeal circulation was uncomplicated, and after administration of protamine and prothrombin complex concentrate to reverse the effect of heparin and edoxaban, respectively, the sternotomy was closed.

The patient was extubated 1 hour after arrival in the thoracic intensive care unit and remained in circulatory and respiratory stable condition throughout his hospital stay. Inotropic drugs were ceased during the

first postoperative day, and the patient was transferred to the surgical ward on the third postoperative day. Routine postoperative pulmonary x-ray produced ordinary findings. The routine postoperative TTE showed a well-functioning biological mitral valve prosthesis with minimal transvalvular regurgitation, a preserved left ventricular ejection fraction, and no evidence of pericardial effusion. He was discharged to his home on the sixth postoperative day.

**FIGURE 5** Surgically Removed Transcatheter Edge-to-Edge Mitral Valve Repair Clip



The detached transcatheter edge-to-edge mitral valve repair clip after removal.

## DISCUSSION

Partial TEER clip detachment remains a known complication, although its incidence is decreasing with technical enhancements.<sup>1</sup> Total detachment with clip embolization is rare, with only a few reported cases to date. Some cases of clip embolization have been resolved by an interventional approach with transcatheter retrieval,<sup>2</sup> whereas fewer cases describe urgent surgical clip removal with concomitant mitral valve repair or replacement.<sup>3</sup> In these cases, open heart surgery has been performed primarily to intervene against the symptomatic severe MR.<sup>4,5</sup> To our knowledge, emergent surgery to resolve ventricular arrhythmias and hemodynamic instability caused by complete clip detachment and embolization has not been reported previously.

We believe that the mechanism of pulmonary edema was ventricular arrhythmias rather than the sudden-onset severe MR. The patient previously had a longstanding MR with compensatory mechanisms such as left ventricular and left atrial dilatation. It is thus unlikely that the sudden severe MR upon complete clip detachment caused the pulmonary edema. The ventricular arrhythmias were likely caused by direct left ventricular mechanical stimulation by the embolized clip. In the choice between an interventional and a surgical approach, the hemodynamic status of the patient should be considered. Quick establishment of extracorporeal circulation for mechanical circulatory assist can be lifesaving, which argues in favor of a surgical approach for patients in cardiogenic shock. Surgical removal also provides an opportunity for concomitant intervention against a significant MR, which otherwise may further deteriorate the clinical status of the patient.

This case illustrates the ethical difficulties when high-risk patients, previously denied conventional surgical options, become surgical candidates in emergency settings when in poor clinical status. This case report emphasizes that in critical situations, a

life-saving open heart operation should always be considered, and patients should not automatically be disqualified from surgical therapy based only on the previous decision from the heart team. The appropriate strategy should be determined from case to case, with involvement of the patient's own desire. This case also shows the benefit of having a cardiothoracic surgical department at the site of a transcatheter cardiovascular center. This patient would probably not have survived transportation to an external referral center.

## FOLLOW-UP

At the 1-month follow-up visit the patient described having shortness of breath and therefore underwent computed tomography, which revealed a moderate amount of pericardial fluid around the posterior left ventricular wall. This was managed conservatively, and the symptoms were relieved. The patient received a pacemaker 2 months after surgery and has recovered fully.

## CONCLUSIONS

This case highlights a potentially growing ethical issue in the expanding transcatheter era whereby high-risk patients may become candidates for open heart surgery. Emergency open heart surgery can be successfully performed in high-risk patients in critical preoperative condition.

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Dr Grinnemo is a co-founder of the company Avolution AB. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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**KEY WORDS** cardiogenic shock, complications, embolization, mitral regurgitation, transcatheter edge-to-edge repair, ventricular arrhythmias

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