

Late mitral leaflet tear after transcatheter edge-to-edge repair for acute ischaemic mitral regurgitation: a case report

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Received 9 May 2024; revised 8 July 2024; accepted 20 September 2024; online publish-ahead-of-print 25 September 2024

Background

Acute mitral regurgitation due to papillary muscle rupture is a severe complication of acute myocardial infarction. Transcatheter edge-to-edge repair is emerging as an effective alternative to surgical treatment, with encouraging outcomes. Leaflet adverse events are rare and are associated with relapse of significant mitral regurgitation.

Case summary

A 54-year-old man arrived at our hospital with a late presentation of ST-elevation myocardial infarction. During primary percutaneous coronary intervention of the circumflex coronary artery, a partial papillary muscle rupture occurred with acute severe mitral regurgitation and cardiogenic shock. Due to the severe haemodynamic instability, the patient underwent an emergent transcatheter edge-to-edge repair with MitraClip device during Impella support with mitral regurgitation resolution and haemodynamic stabilization. At 2-month follow-up, an interclip leaflet tear occurred with relapse of severe mitral regurgitation, requiring a mitral valve replacement surgery.

Discussion

Acute mitral regurgitation due to papillary muscle rupture is a serious complication of acute myocardial infarction. Management is based on haemodynamic stabilization and surgery. The transcatheter edge-to-edge repair is emerging as a therapeutic alternative in high-risk cases. Leaflet adverse events rarely occur during the transcatheter edge-to-edge repair procedure or before patient discharge. Our case is the first to report a late leaflet adverse event, occurring two months after the procedure and, interestingly, after an acute myocardial infarction conditioning an ischaemic mitral regurgitation. This event may be the result of the progressive adverse remodelling of left ventricular inferolateral akinetic wall, with consequent increase of tethering forces on the posterior leaflet, tensioned in the opposite direction by the clip.

Keywords

3D-echocardiograph • Papillary muscle rupture • Mitral regurgitation • Leaflet tear • Transcatheter edge-to-edge repair • Heart team • Case report

ESC curriculum

2.2 Echocardiography • 3.2 Acute coronary syndrome • 4.3 Mitral regurgitation • 6.4 Acute heart failure

Learning points

- To understand the potential role of transcatheter edge-to-edge repair procedure as a salvage therapy for ischaemic mitral regurgitation.
- To suspect a leaflet adverse event after transcatheter edge-to-edge repair and to learn the role of trans-thoracic and trans-oesophageal echocardiography in the differential diagnosis.

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Handling Editor: Christoph Sinning

Peer-reviewers: Masahiko Asami; Andrew Harris; Aiste Monika Jakstaite

Compliance Editor: Nikesh Jathanna

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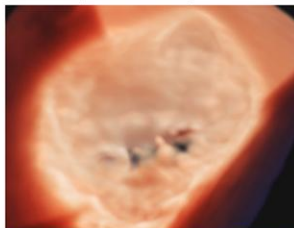
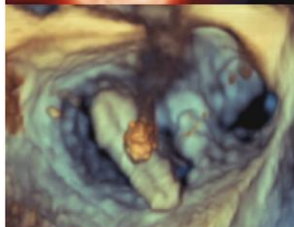
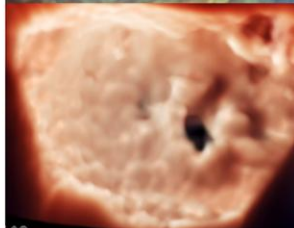

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Introduction

Acute mitral regurgitation due to papillary muscle rupture (PMR) occurs in 1%–3% of patients with acute myocardial infarction, carrying a poor prognosis.¹ While surgery remains the preferred treatment for PMR,² the transcatheter edge-to-edge repair (TEER) procedure has been emerging as an effective salvage therapy for high-risk patients.^{3–5} The safety of TEER has been extensively demonstrated, showing a low incidence of leaflet adverse events, typically occurring during the index procedure or before discharge.⁶ Herein, we present the case of a 54-year-old man who experienced a late failure of TEER performed for acute ischaemic mitral regurgitation due to PMR.

myocardial infarction (STEMI), and bedside trans-thoracic echocardiography (TTE) showed an inferolateral akinesia with mildly reduced left ventricular ejection fraction [left ventricular ejection fraction (LVEF) 45%]. Physical examination was unremarkable. The patient was treated with acetylsalicylic acid 250 mg, prasugrel 60 mg, unfractionated heparin 7000 IU, and atorvastatin 80 mg. Urgent coronary angiography showed a thrombotic occlusion of mid circumflex coronary artery (*Figure 1*). Thrombus aspiration was performed, and one drug-eluting stent was implanted (*Figure 1*). During the procedure, the patient was intubated due to flash pulmonary oedema. Post-procedural TTE and trans-oesophageal echocardiography (TOE) showed a posterior leaflet prolapse resulting in acute severe eccentric mitral regurgitation (MR) due to partial anterolateral papillary muscle rupture (*Figure 2*; [Supplementary material online, Videos S1–S3](#)) and a false normalization of LVEF (55%) due to reduced afterload.

Summary figure

<u>Date</u>	<u>Event</u>	<u>Figure</u>
June 2022	STEMI and ischemic MR	
	Urgent TEER procedure	
August 2022	Inter-clip leaflet tear diagnosis	
September 2022	Mitral valve replacement surgery	

Case presentation

A 54-year-old man presented to our emergency department for chest pain lasting for 9 h. He had a high cardiovascular risk profile (dyslipidaemia, active smoking, overweight), with no major comorbidities and no chronic therapy. The ECG revealed an inferolateral ST-elevation

In Cardiac Intensive Care Unit, due to severe haemodynamic compromise with a refractory cardiogenic shock (pulmonary congestion, anuria, acidosis, hypotension, and hypoperfusion with hepatic and renal damage requiring continuous renal replacement therapy, increasing inotropic and vasopressor support; lactates rising and persistently > 2 mmol/L, creatinine values increasing up to 2.2 mg/dL from the

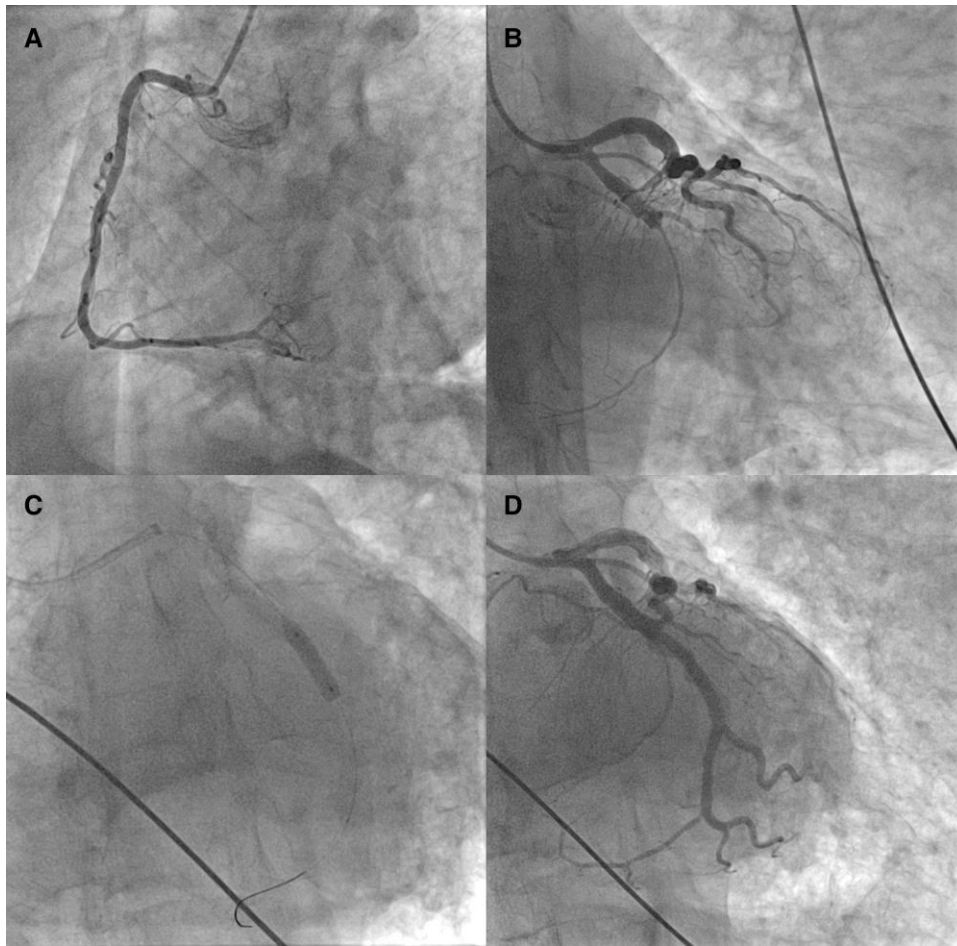


Figure 1 Coronary angiography and primary percutaneous coronary intervention: (A) normal right coronary artery; (B) normal left anterior descending coronary artery and thrombotic occlusion of mid circumflex artery; (C) drug-eluting stent implantation in circumflex artery; (D) final result.

baseline values of 0.8 mg/dL, bilirubin 2.5 mg/dL, transaminases $\times 3$ upper limit normal) and the underlying STEMI disease treated with stent implantation and antithrombotic drugs (with consequent risk of both haemorrhagic and thrombotic complications), the patient was deemed at very-high surgical risk by the Heart Team composed by intensivist, clinical cardiologist, interventionalist, imager, and cardiac surgeon. Hence, in order to primarily solve the cardiogenic shock, the patient underwent a salvage TEER procedure with Impella haemodynamic support. The TEER procedure was successfully performed with positioning of two XTW Mitraclip (Abbott, Abbott Park, IL) devices, after a few grasping attempts, and a residual mild MR and normal transvalvular mean gradients (4 mmHg; pre-operative mitral valve area 5 cm²) (Figure 3; Supplementary material online, Videos S4 and S5). The patient's haemodynamics improved, and he was successfully weaned off Impella, mechanical ventilation, and pharmacological support. Pre-discharge TTE confirmed the good results of TEER procedure with mild MR and mildly reduced left ventricular ejection fraction (LVEF 49%). Mitral valve surgery was no longer deemed necessary anymore due to the effectiveness of the TEER procedure, and the patient was discharged with the following medications: aspirin 100 mg, prasugrel 10 mg, atorvastatin 80 mg, pantoprazole 20 mg, furosemide 25 mg, bisoprolol 5 mg, ramipril 2.5 mg, and spironolactone 25 mg.

At the 2-month follow-up evaluation, the patient complained about effort dyspnoea (NYHA class III) lasting for few days. Trans-thoracic echocardiography showed a severe MR with an eccentric interclip jet, with normal position and stability of the clips. The TTE raised the suspicion of an interclip leaflet tear, subsequently confirmed by 3D TOE (Figure 4; Supplementary material online, Videos S6–S8).

The patient underwent an uncomplicated mitral valve replacement surgery with a St. Jude 33 mm mechanical valve, shown as well functioning at the intraoperative TOE (Figure 5). Noteworthy, the intraoperative inspection of the mitral valve confirmed the echocardiographic suspicion of an interclip leaflet tear with an exceptional correspondence of echocardiographic and surgical images (Figure 4). The patient's post-operative recovery was uncomplicated, and he was discharged on the eighth post-procedural day with a normally functioning mechanical prosthesis and a mildly reduced left ventricular ejection fraction, with the following therapy: coumadin 5 mg, clopidogrel 75 mg, atorvastatin 40 mg, ezetimibe 10 mg, furosemide 25 mg, bisoprolol 5 mg, ramipril 2.5 mg, and spironolactone 25 mg. At one-year follow-up, the patient was asymptomatic, had no recurrent cardiovascular events, and the subsequent TTE confirmed a well-functioning mechanical mitral prosthesis.

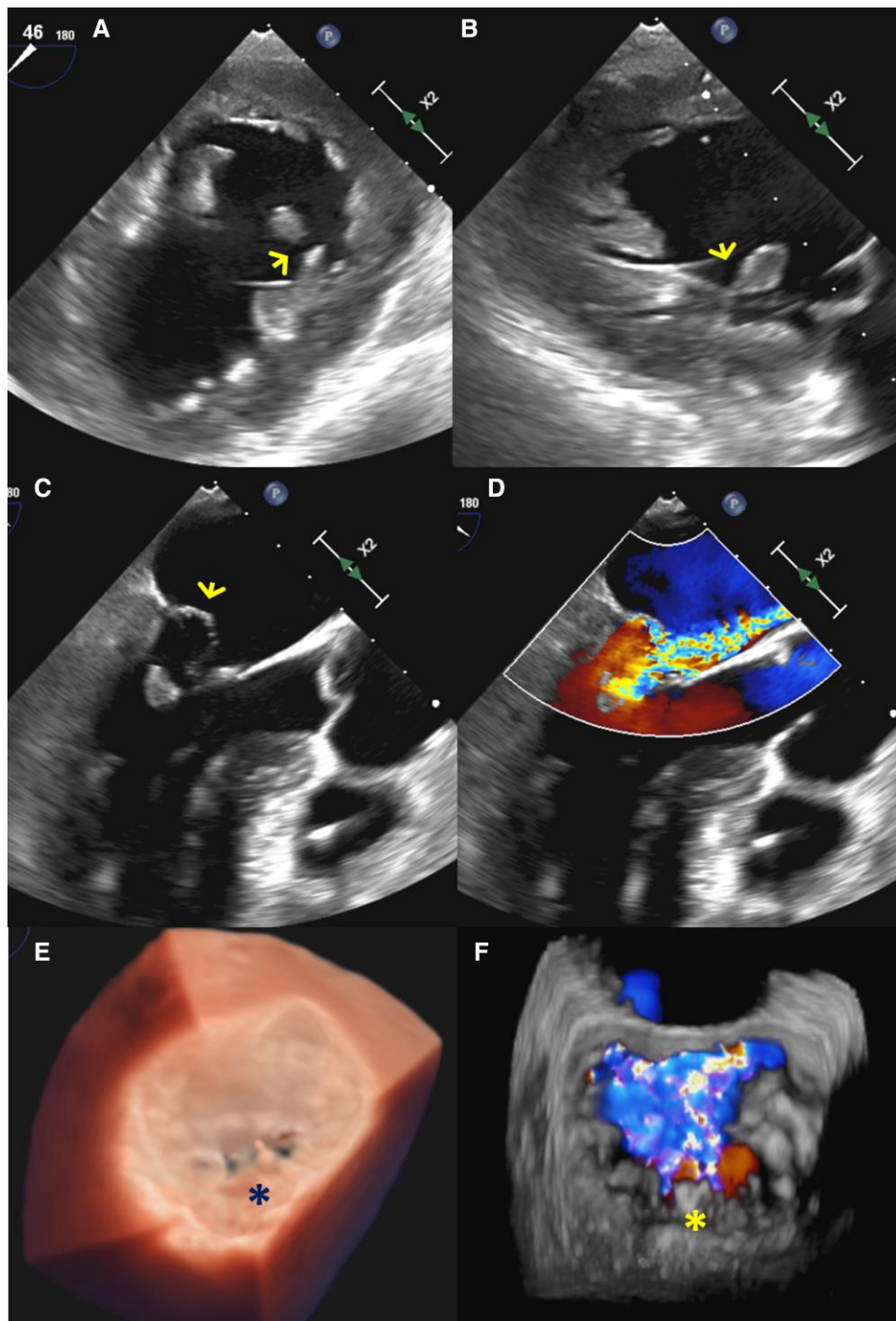


Figure 2 Trans-oesophageal echocardiogram: (A, B) transgastric views showing the partial anterolateral papillary muscle rupture (arrowhead); (C, D) mid-oesophageal three-chamber views with and without colour Doppler showing the posterior leaflet prolapse (arrowhead) conditioning an acute severe eccentric mitral regurgitation; (E, F) 3D with and without colour Doppler of the mitral valve showing the posterior leaflet prolapse and the severe mitral regurgitation (asterisk).

Discussion

Acute MR due to PMR is a rare and devastating complication of acute myocardial infarction. While the medical therapy aims to stabilize

patients' haemodynamics, urgent mitral valve intervention is essential.⁴ Conservative treatment yields an 80% mortality rate, whereas surgical intervention reduces it to 50%.⁷ Moreover, after surgery, the incidence of acute kidney injury, transfusions, prolonged mechanical ventilation,

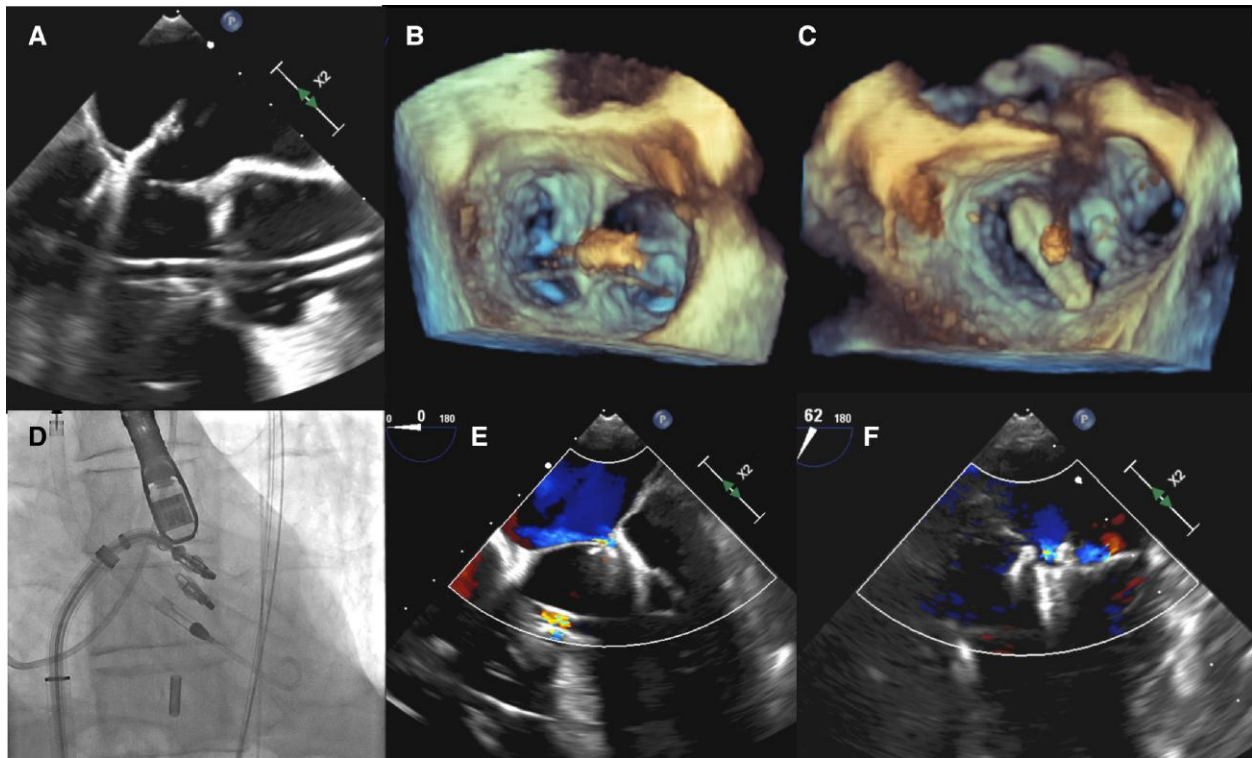


Figure 3 Intraoperative imaging during transcatheter edge-to-edge repair with MitraClip device: (A) mid-oesophageal three-chamber view showing the positioning of the first XTW clip during Impella support; (B) 3D of the mitral valve after the positioning of the first XTW clip; (C) 3D of the mitral valve during the positioning of the second XTW clip; (D) intraoperative fluoroscopy during the positioning of the second XTW clip; (E, F) mid-oesophageal four- and two-chamber views showing the final result.

and post-operative clinical deterioration is still significant. The current guidelines of the European Society of Cardiology recommend prompt surgery in the case of refractory cardiogenic shock due to ischaemic papillary muscle rupture.² In this high-risk setting, TEER is nowadays emerging as an effective salvage procedure, either as a definitive therapeutic alternative or as a bridge therapy for patient stabilization and subsequent definitive mitral valve surgery. As recently shown in a large series of acute MR due to PMR treated with TEER, the in-hospital mortality was 30%.^{1,8} It is noteworthy that 22% of these patients, after haemodynamic stabilization with TEER, received an elective surgical mitral valve replacement with a favourable operative risk and optimal surgical outcomes.^{1,8} Of note, mitral valve surgical repair after a TEER procedure is highly challenging in most cases due to the fibrotic and sclerotic effects of the clips on leaflets, and carries a high risk of operative adverse outcomes.^{9,10} Indeed, surgical repair after failed TEER requires great surgical expertise and advanced reconstructive techniques. On this basis, in cases of acute MR due to PMR, a multifaceted assessment taking into account the patient's haemodynamics, age and comorbidities, the surgical risk, the short- and long-term prognoses, and the specific local interventional expertise is needed for a wise therapeutic pathway definition. Despite the young age of our patient, our Heart Team opted for the transcatheter approach due to the failing haemodynamics, the high surgical risk and our interventionalists' expertise in urgent TEERs. The primary goal of the TEER was haemodynamic stabilization and patient's recovery.

Though generally safe, TEER carries a risk of leaflet adverse events, occurring only in a minority of cases, generally at the time of the index procedure, and resulting in severe MR with an unfavourable prognosis.^{6,9,11,12} To the best of our knowledge, our case is the first report of a late leaflet adverse event, occurring two months post-TEER and resulting in recurring severe MR. We hypothesize that this event is the result of the progressive adverse remodelling of left ventricular inferolateral akinetic wall (Table 1), with consequent increase of tethering forces on the posterior leaflet. The tension on the tissue due to the opposition between the tethering forces and the device may have caused the leaflet tear in a mitral valve with fragile interclip leaflet tissue due to the TEER grasping attempts.⁹ Unlike functional MR with asymmetrical tethering of posterior leaflet due to a longstanding inferolateral scar, an ischaemic MR due to a recently infarcted inferolateral wall (either functional with asymmetrical tethering or organic with PMR) is prone to more rapid and more extensive changes of tethering forces because of the ongoing remodelling of the injured wall.¹³

Finally, the diagnosis of leaflet injury is a real challenge for the echocardiographer.^{9,14} A differential diagnosis including single leaflet device attachments and residual anatomic lesion with lack of coaptation is necessary and requires a multiplanar and 3D evaluation of the leaflets and the implanted clips. In our case, the single leaflet device attachment was excluded due to the clear stability of the implanted clips, while a residual anatomic lesion was not possible due to the timing of MR recurrence. Moreover, the possibility of an evolution from a partial PMR to a complete one with a bouncing papillary muscle head was excluded due to

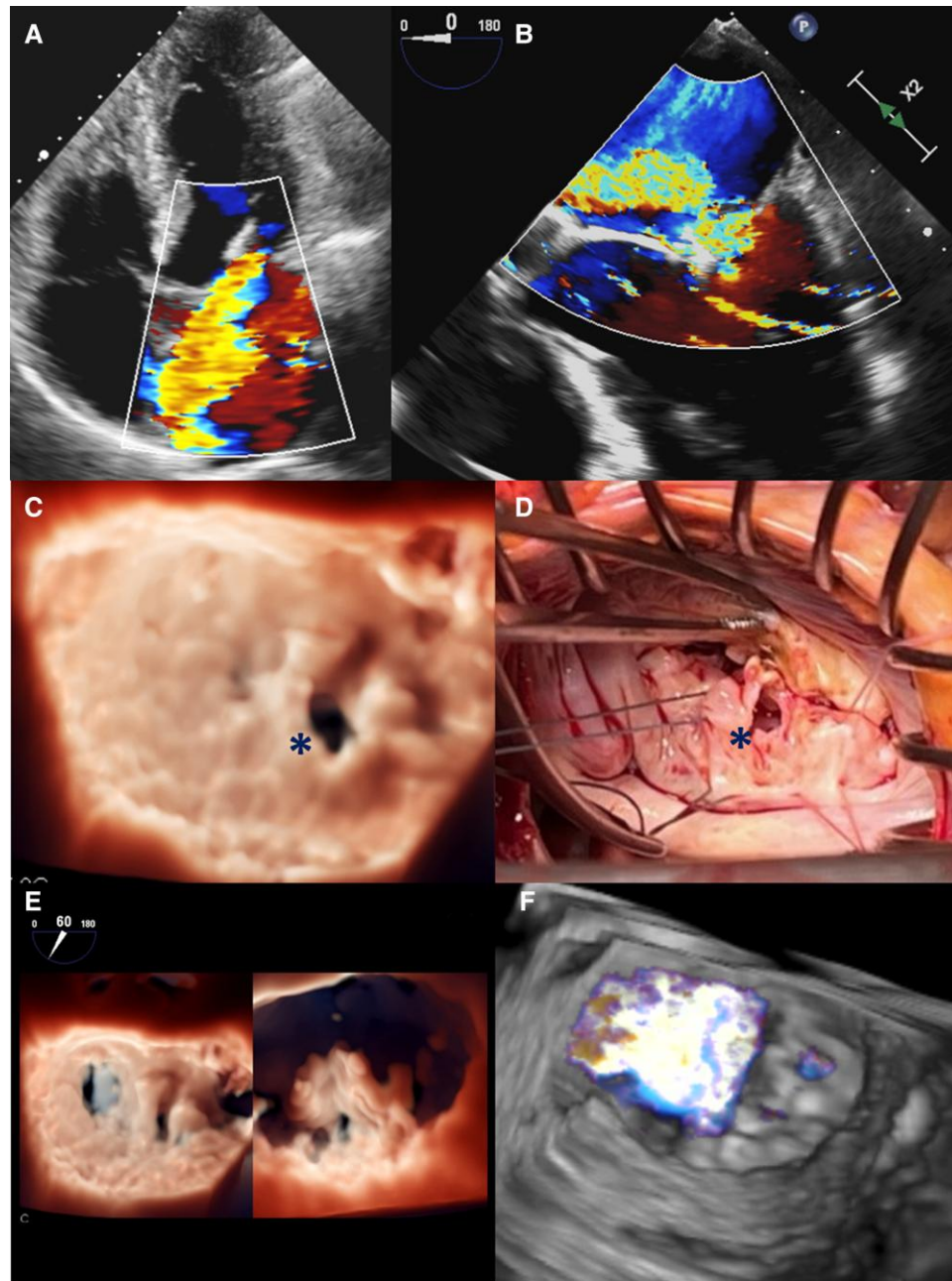


Figure 4 Interclip leaflet tear: (A, B) trans-thoracic and trans-oesophageal echocardiograms with four-chamber views showing a severe MR with an eccentric interclip jet; (C) trans-oesophageal 3D of the mitral valve showing the interclip leaflet tear (asterisk); (D) intraoperative inspection of the mitral valve showing the interclip leaflet tear (asterisk); (E) trans-oesophageal 3D of the mitral valve from both the atrial and ventricular views; (F) trans-oesophageal 3D of the mitral valve with colour Doppler.

the absence of moving masses into the left ventricle. The use of TTE was able to raise the suspicion of a leaflet tear, then confirmed by the 3D TOE with a perfect correspondence of echocardiographic and surgical images. Hence, our case contributes to shed light on the

use of TEER as salvage/bridge therapy in acute ischaemic MR and underscores the central role of echocardiography in emergency diagnostics, intraoperative guidance, and follow-up assessment of complex structural cases.

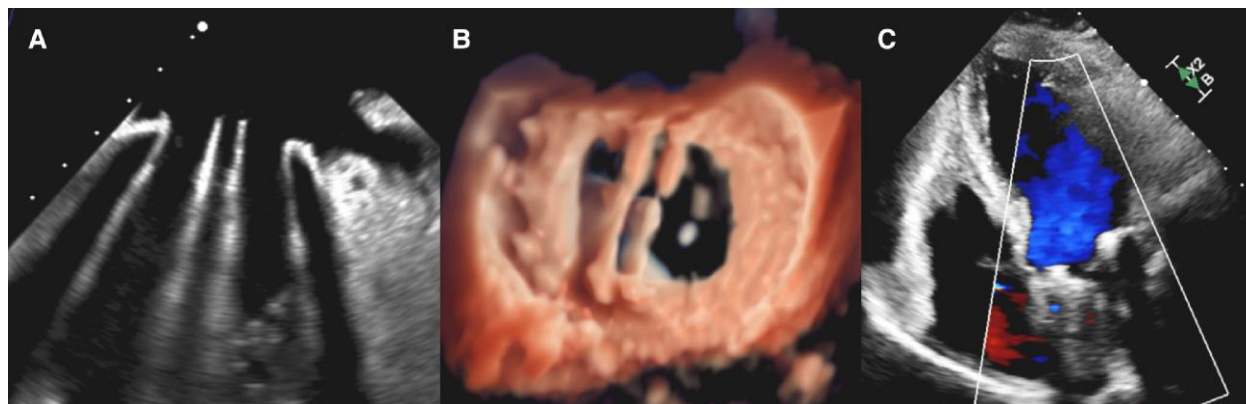


Figure 5 Mitral valve replacement: (A) intraoperative mid-oesophageal two-chamber view showing the well-functioning mechanical mitral valve; (B) intraoperative trans-oesophageal 3D view of the mechanical mitral valve; post-operative trans-thoracic four-chamber view of the mechanical mitral valve.

Table 1 Left ventricular remodelling

	Pre-TEER	Post-TEER	Two-month follow-up
LV end-diastolic diameter (mm)	46	53	60
LV end-systolic diameter (mm)	38	43	44
LV end-diastolic volume (mL)	120	135	175
LV end-systolic volume (mL)	54	69	88
LV ejection fraction (%)	55	49	50

LV, left ventricular; TEER, transcatheter edge-to-edge repair.

Conclusions

Acute ischaemic MR due to PMR is a surgical emergency. However, due to the high mortality rates associated with surgery, TEER has emerged as a safe alternative, representing either a definitive treatment or a temporary bridge to patient's recovery and subsequent surgical correction. In our case, the TEER became a temporary bridge to mitral valve replacement due to a latecomer leaflet tear. The use of advanced echocardiography was essential in all the phases of this patient's management, and particularly useful in the diagnosis of this unique leaflet adverse event.

Lead author biography



Dr Francesco Cannata is a cardiologist trained at the Humanitas University and Università Vita Salute San Raffaele in Milan, Italy. He completed his PhD at the Humanitas University and is now working at the Cardiovascular Imaging Department of Centro Cardiologico Monzino in Milan.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

Consent: The authors confirm that the written consent for submission and publication of this case report, including images and associated text, has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

Funding: This research was supported by the Italian Ministry of Health—Ricerca Corrente to Centro Cardiologico Monzino IRCCS.

Data availability

The data underlying this article are available in the article and in its [Supplementary material](#) online.

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