

MINI-FOCUS ISSUE: PROCEDURAL COMPLICATIONS

ADVANCED

CASE REPORT: CLINICAL CASE

Hemolytic Anemia After Surgical Mitral Valve Repair Treated With Transcatheter Edge-to-Edge Device



Adrià Ruiz-López, MD,^a Chi-Hion Pedro Li, MD,^a Pilar Valdovinos, MD,^b Álvaro Rodríguez, MD,^a Ana Bonet, MD,^a Manel Tauron, MD,^c Carmen Ligeró, MD,^b Xavier Millan, MD, PhD,^a Josep M. Alegret, MD, PhD,^b David Viladés, MD,^b Dabit Arzamendi, MD, PhD^a

ABSTRACT

An 80-year-old woman with mitral valve repair failure was admitted with hemolytic anemia secondary to the impact of a regurgitant jet on the annuloplasty ring. Transcatheter repair to treat both mitral regurgitation and hemolysis was favored because of surgical risk. Transcatheter edge-to-edge repair represents an alternative for treating hemolysis associated with mitral regurgitation. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:727-731)
© 2022 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 80-year-old woman was admitted to the emergency department with intense asthenia and choloria 2 months after surgical mitral valve repair (MVRe). Physical examination revealed jaundice, a new systolic heart murmur at the lower left sternal border

(grade 4 intensity) and bibasal crackles, arterial blood pressure of 112/57 mm Hg, heart rate of 95 beats/min, and arterial oxygen saturation of 94%. Blood analysis showed new onset hemolytic anemia (hemoglobin, 75 g/L; mean cell volume, 100 fL; lactate dehydrogenase, 3,470 U/L; haptoglobin, <0.06 g/L; bilirubin, 3.14 mg/dL; and 3% of schistocytes in the peripheral blood smear), with a negative Coombs test result (Figure 1). Transthoracic echocardiography revealed prolapse of the posterior mitral leaflet that led to severe mitral regurgitation (MR) secondary to an eccentric jet. Under the diagnosis of nonimmune hemolytic anemia, she was admitted to the cardiology department for further studies.

LEARNING OBJECTIVES

- To recognize hemolytic anemia as a rare but relevant complication after surgical MVRe.
- To demonstrate that hemolysis secondary to surgical MVRe can be corrected with TEER.
- To highlight the importance of understanding the physiologic and echocardiographic mechanisms that lead to hemolysis after MVRe to ensure the best correction of this complication.

PAST MEDICAL HISTORY

The patient had severe kyphoscoliosis and hypertension. She had a first admission for iron deficiency

From the ^aDepartment of Cardiology, Hospital de la Santa Creu i Sant Pau, Autonomous University of Barcelona, Barcelona, Spain; ^bDepartment of Cardiology, Sant Joan de Reus University Hospital, University of Rovira i Virgili, Reus, Spain; and the ^cDepartment of Cardiac Surgery, Hospital de la Santa Creu i Sant Pau, Autonomous University of Barcelona, Barcelona, Spain.

Marco Barbanti, MD, served as the Guest Associate Editor for this paper.

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 December 13, 2021; revised manuscript received March 23, 2022, accepted March 23, 2022.

**ABBREVIATIONS
AND ACRONYMS**

MR = mitral regurgitation
MVRe = [surgical] mitral valve repair
TEER = transcatheter-edge-to-edge repair

anemia requiring red blood cell transfusion and iron therapy. Endoscopic examinations showed a hiatal hernia and diverticulosis with no signs of active bleeding. Congestive heart failure developed and was diagnosed by echocardiography showing severe MR resulting from prolapse of the posterior mitral leaflet, moderate tricuspid regurgitation, and a preserved left ventricular ejection fraction. Preoperative coronary angiography showed no coronary artery disease. She underwent MVRe with triangular P2 resection, mitral annuloplasty with a Memo 3D ReChord 34-mm ring (LivaNova Group), implantation of 2 neochoords, and tricuspid valve repair with a Contour 3D 34-mm ring (Medtronic). Intraoperative transesophageal echocardiography showed a good surgical result with mild residual MR (Figures 2A to 2E). The patient had an episode of paroxysmal atrial fibrillation, but her postoperative course was otherwise uneventful, and she was able to be discharged on day 8 after surgery. Trans-thoracic echocardiography performed before hospital discharge showed moderate MR with an eccentric jet directed toward the anterior and septal wall of the left atrium and no mitral stenosis (mean gradient, 2.3 mm Hg).

anemia requiring red blood cell transfusion and iron therapy. Endoscopic examinations showed a hiatal hernia and diverticulosis with no signs of active bleeding. Congestive heart failure developed and was diagnosed by echocardiography showing severe MR resulting from prolapse of the posterior mitral leaflet, moderate tricuspid regurgitation, and a preserved left ventricular ejection fraction. Preoperative coronary angiography showed no coronary artery disease. She underwent MVRe with triangular P2 resection, mitral annuloplasty with a Memo 3D ReChord 34-mm ring (LivaNova Group), implantation of 2 neochoords, and tricuspid valve repair with a Contour 3D 34-mm ring (Medtronic). Intraoperative transesophageal echocardiography showed a good surgical result with mild residual MR (Figures 2A to 2E). The patient had an episode of paroxysmal atrial fibrillation, but her postoperative course was otherwise uneventful, and she was able to be discharged on day 8 after surgery. Trans-thoracic echocardiography performed before hospital discharge showed moderate MR with an eccentric jet directed toward the anterior and septal wall of the left atrium and no mitral stenosis (mean gradient, 2.3 mm Hg).

DIFFERENTIAL DIAGNOSIS

The differential diagnosis included autoimmune hemolytic anemia and hemolytic anemia related to dysfunction of MVRe.

INVESTIGATIONS

Different causes of hemolytic anemia were ruled out: pharmacologic treatment was revised, and no association with hemolysis was found; the result of a direct Coombs test was negative; and physical examination and abdominal ultrasound examination excluded splenomegaly. Transesophageal echocardiography revealed residual mitral P1-P2 prolapse by neochoord rupture and a severe eccentric MR jet toward the annuloplasty ring (Figures 3A to 3D, Videos 1 and 2), without significant stenosis (mean gradient of 3.9 mm Hg and Doppler pressure half-time mitral valve area of 3.5 cm²) (Figure 4), with mild to moderate residual tricuspid regurgitation and an estimated pulmonary artery systolic pressure of 60 mm Hg.

MANAGEMENT

The patient required several blood transfusions and diuretic therapy to relieve congestive symptoms. The patient had a high surgical risk (Society of Thoracic Surgeons [STS] score, 2.75% risk of mortality; European System for Cardiac Operative Risk Evaluation [EuroSCORE] II, 8.74% risk of in-hospital mortality). The case was discussed by the heart team, and transcatheter repair was favored to avoid surgical reintervention. Within the percutaneous options, we prioritized repair over valve replacement (although the mitral ring would have been favorable for a percutaneous valve-in-ring procedure), and a transcatheter edge-to-edge repair (TEER) therapy was chosen on the basis of our experience.

We hypothesized that hemolysis originated from the mechanical impact of blood moving toward the surgical ring. For TEER intervention, the smallest MitraClip device (MitraClip NTR, Abbott Vascular) was chosen to avoid mitral stenosis. The risk of stenosis that we suspected was confirmed. When the clip was placed in a central A2-P2 position with “aggressive” leaflet capture, the transmitral mean gradient increased up to 12 mm Hg. We had to move the device more in a more ventricular direction to reduce tissue capture, and we were able to achieve a transvalvular mean gradient of 6 mm Hg (with a mitral valve area of 2.6 cm²) and resolve the eccentric jet (Figures 5A to 5E, Videos 3 and 4).

Immediately after the procedure, hemoglobinuria disappeared and hemolysis parameters improved (hemoglobin, 92 g/L; lactate dehydrogenase, 990 U/L; haptoglobin, 0.72 g/L; bilirubin, 0.97 mg/dL) (Figure 1). No additional blood transfusions were needed, and she was discharged 4 days later.

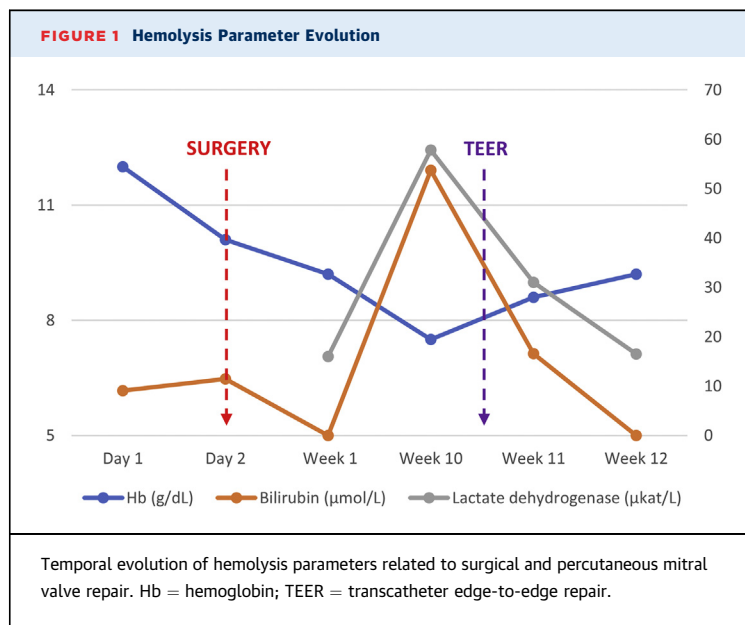
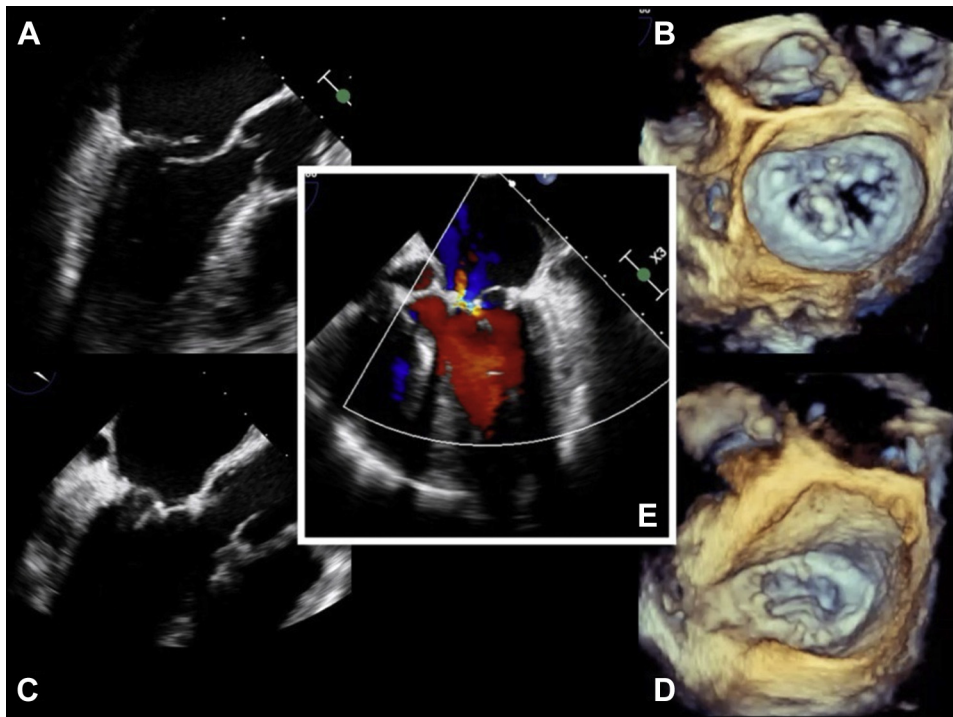


FIGURE 2 Mitral Valve Before and After Surgical Repair



Transesophageal echocardiographic view of posterior leaflet flail with (A) 2-dimensional and (B) 3-dimensional images before surgery. (C to E) The same perspectives after surgery repair achieving mild mitral regurgitation (E) at the end of the intervention.

Transthoracic echocardiography showed mild MR and mild mitral stenosis (mean gradient, 5 mm Hg; mitral valve area, 2.38 cm²).

DISCUSSION: ASSOCIATION WITH CURRENT GUIDELINES, POSITION PAPERS, AND CURRENT PRACTICE

MVRe is recommended over mitral valve replacement for patients with degenerative MR. Hemolysis is a well-recognized complication after prosthetic valve replacement, especially associated with paravalvular leaks, but it is a rare complication after MVRe (<1%), and it generally occurs early, within the first 3 months of MVRe.¹

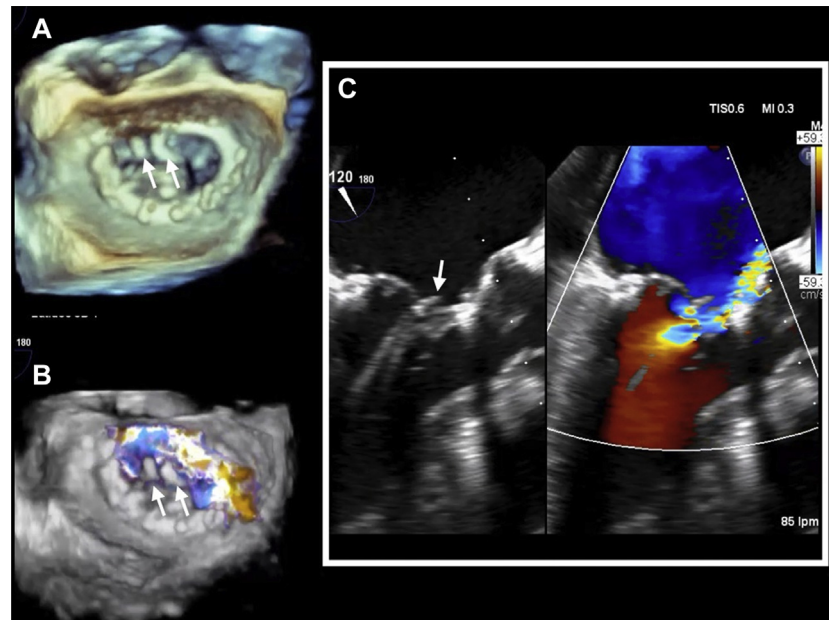
Rapid acceleration, fragmentation, and collision jets against different materials, as well as disrupted sutures and dehisced annuloplasty rings, are associated with erythrocyte high shear stress and hemolysis. Echocardiographic features of residual MR may help predict the origin of hemolysis. However, the definitive diagnosis is established when correction of

collision jets is associated with improvement of hemolysis parameters.

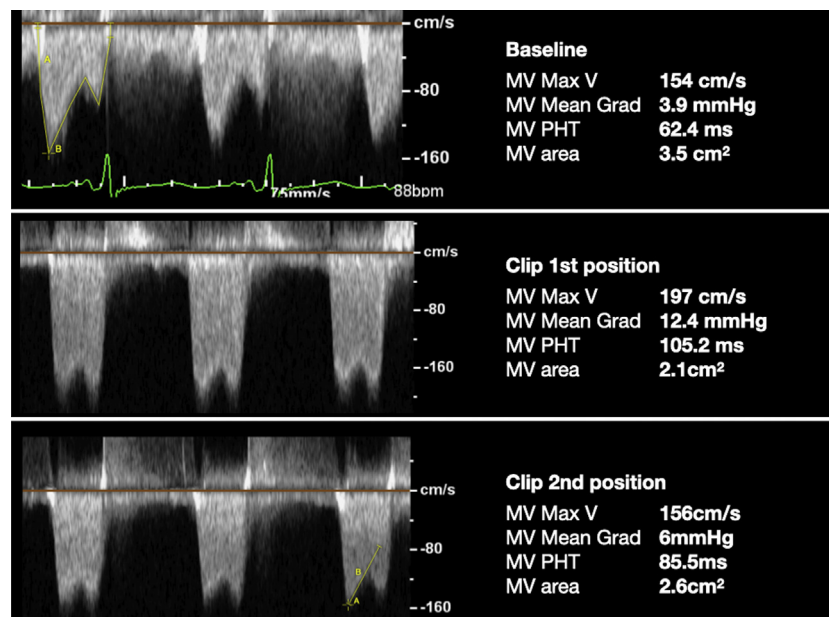
Therapies for symptoms associated with hemolysis include blood transfusions, urine alkalization, hemodialysis, or β -blockers. However, up to 90% of patients require a new surgical correction. Transcatheter techniques using different occluders and plugs have been used in selected cases to repair paravalvular leaks. TEER is an accepted strategy for patients with severe degenerative MR who are at high surgical risk.² However, the use of mitral valve TEER for treating hemolysis after MVRe has been reported only once.³ TEER of the mitral valve constitutes an appealing and effective alternative therapy to avoid redo surgery in patients with early failure of MVRe and hemolytic anemia.

FOLLOW-UP

At 4-month follow-up, the patient remains free of readmission and has no hemolysis or heart failure

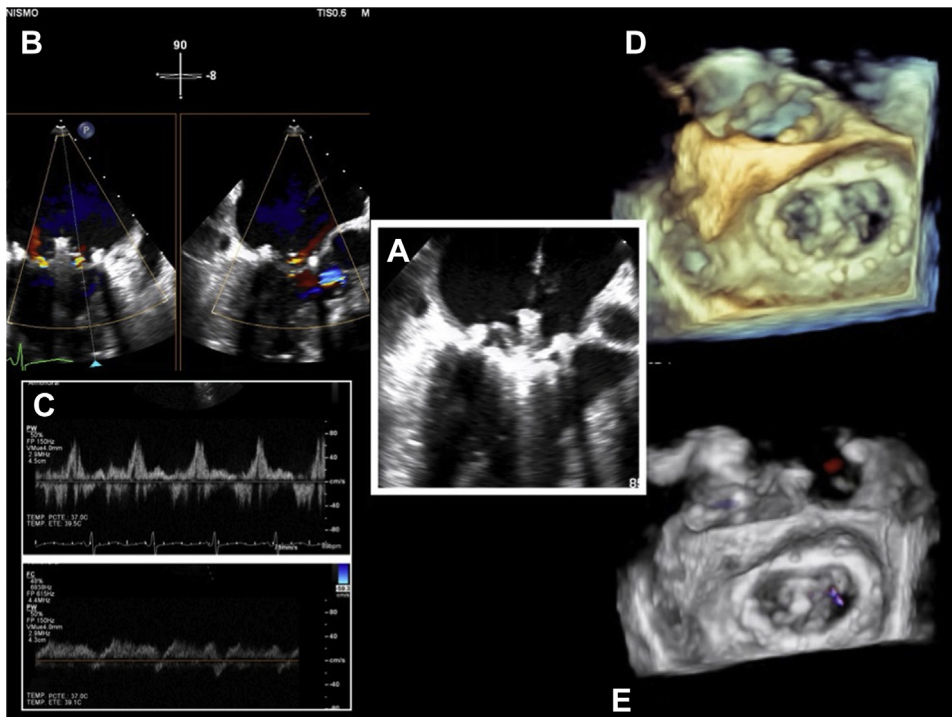
FIGURE 3 Mitral Regurgitation Causing Hemolysis

Mitral regurgitation on admission for hemolysis. Note the broken neochords (**arrows**) prolapsing into the left atrium in the 3-dimensional mitral valve view with and without color (**A, B**), as well as in the 2-dimensional image (**C**) and the eccentric jet directed toward the surgical mitral ring.

FIGURE 4 Mitral Valve Gradients Before and During TEER Intervention

bpm = beats per minute; grad = gradient; max V = maximum velocity; MV = mitral valve; PHT = pressure half-time; TEER = transcatheter edge-to-edge repair.

FIGURE 5 Transcatheter Mitral Valve Repair



The transcatheter edge-to-edge repair procedure, (A) starting with the transcatheter edge-to-edge repair “grasping view” and the capture or residual mitral prolapse, (B) with final mild regurgitation and (C) significant improvement of pulmonary vein hemodynamics (top, an inverted S-wave; bottom, a recovered profile). (D and E) 3-dimensional imaging showing the final result.

signs. Control transthoracic echocardiography was performed and showed mild MR and mild mitral stenosis (mean gradient, 4 mm Hg; mitral valve area, 2.34 cm²).

CONCLUSIONS

Hemolytic anemia secondary to MVRe failure is a rare complication. Echocardiography plays an important role in the suspicion of pathophysiologic cause, and TEER of the mitral valve can be successfully used for treating hemolytic anemia caused by residual eccentric MR.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Drs Li, Millan, and Arzamendi have reported received proctoring and speaker fees from Abbott. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Chi-Hion Pedro Li, Department of Cardiology, Hospital de la Santa Creu i Sant Pau, C/ Mas Casanova 90, 08041 Barcelona, Spain. E-mail: ch.pedroli@gmail.com. Twitter: @CHPedroLi.

REFERENCES

1. Abourjaili G, Torbey E, Alsaghir T, Olkovski Y, Costantino T. Hemolytic anemia following mitral valve repair: a case presentation and literature review. *Exp Clin Cardiol*. 2012;17(4):248-250.
2. Davidson LJ, Davidson CJ. Transcatheter treatment of valvular heart disease: a review. *JAMA*. 2021;325(24):2480-2494.

3. Sanchis L, Jorda P, Pereda D, et al. MitraClip implantation for hemolytic anemia treatment after surgical mitral valve repair. *J Am Coll Cardiol Intv*. 2020;13(9):e85-e86.

KEY WORDS hemolysis, mitral regurgitation, mitral valve

repair, transcatheter-edge-to-edge repair

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