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Case Reports

Navigating the Complexities of Mitral Valve Clipping: Early Severe Mitral Valve Stenosis After Mitral Valve Clipping

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Abstract

This case study explores the journey of an 80-year-old male patient with a history of hypertension, diabetes, coronary artery disease after coronary artery bypass grafting, atrial fibrillation, and heart failure. Nine months before he presented to the emergency department, he had undergone mitral valve clipping for severe mitral valve regurgitation. Despite initial improvement, the patient experienced return of symptoms, including dyspnea at rest and lower limb edema. The results of this case—discovery of the need for mitral valve replacement—provides insights into the management of complications from mitral valve clipping and emphasizes that management requires a nuanced, meticulous approach.

Keywords: Heart valve prosthesis implantation; cardiac surgical procedures; mitral valve stenosis; heart valve diseases

Case Report

Presentation and Physical Examination

An 80-year-old man with a history of coronary artery disease presented to the emergency department (ED) experiencing ongoing dyspnea at rest and lower limb edema, with orthopnea and paroxysmal nocturnal dyspnea that had been ongoing for the past 3 months. He had undergone coronary artery bypass graft 25 years earlier and had a history of atrial fibrillation; heart failure (HF) with reduced ejection fraction after implanted cardioverter-defibrillator (ICD; St Jude/Abbott) placement; and mitral valve regurgitation, for which he had undergone mitral valve clipping 9 months before presentation. According to the patient, his symptoms started 3 months after mitral valve clip placement and had become increasingly severe.

In the year before he presented at the ED, the patient had had multiple admissions for acute decompensated HF. Echocardiography during those admissions showed a left ventricular ejection fraction (LVEF) estimated at 35%, with bilateral atrial enlargement; severe mitral valve regurgitation, with the larger of 2 jets exiting medial to the A2/P2 region and the smaller jet exiting laterally at the A1/P2 region; an estimated mitral valve area (MVA) of 3.9 cm^2; a mean mitral valve gradient of 1 mm Hg; no evidence of mitral valve stenosis; and mild to moderate tricuspid valve regurgitation. Although the MVA was below the recommended guideline for mitral valve clipping (4 cm^2), clipping was pursued in light of recurrent admissions for HF exacerbation, despite the maximum tolerated guideline-directed medical therapy and because of persistent shortness of breath believed to be related to mitral valve regurgitation. An Abbott MitraClip G4 System XTW clip was placed at the A2/P2 region, and a MitraClip G4 XT

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clip was placed adjacent to the XTW clip; the patient had a postplacement mitral valve gradient of 4 mm Hg at a heart rate of 70/min. His clinical condition improved after the procedure, and follow-up echocardiography 2 months after the intervention showed well-seated mitral valve clips with good grip. The patient had trace mitral valve regurgitation, with a mitral valve E-wave/A-wave ratio of 1:2, with a mean mitral valve gradient of 5 mm Hg and improvement of LVEF to approximately 60%. The patient continued on optimized medical therapy.

Two months after placement of the mitral valve clips, however, the patient experienced dyspnea, orthopnea, and bilateral lower limb edema. Transthoracic echocardiography after the index ED visit showed an elevated mitral valve gradient of 10 mm Hg. The patient was started on an optimized trial of HF guideline-directed medical therapy consisting of sacubitril plus valsartan 24 mg/26 mg, metoprolol succinate 50 mg, empagliflozin 10 mg, furosemide 60 mg daily, and spironolactone 25 mg, with continuation of anticoagulation therapy with apixaban 5 mg for atrial fibrillation. Despite the patient's adherence to medical therapy, he experienced no symptom improvement.

The patient's vital signs on the current admission were as follows: blood pressure, 110/67 mm Hg; heart rate, 73/min; respiratory rate, 18/min; oxygen saturation, 98% on room air; and afebrile body temperature. Physical examination was positive for jugular venous distention, hepatojugular reflux, bilateral fine basal crepitations, and severe bilateral lower limb edema.

Medical History

The patient's medical history included hypertension, hyperlipidemia, type 2 diabetes, coronary artery disease (having undergone coronary artery bypass graft 25 years previously), atrial fibrillation, HF with reduced ejection fraction (with subsequent ICD placement), mitral valve regurgitation (status post mitral valve clip placement), stage 3A chronic kidney disease, and benign prostatic hyperplasia.

Differential Diagnosis

During the index ED admittance, the patient's differential diagnosis included

- systolic HF exacerbation;
- mitral valve clip dislodgement or failure;
- mitral valve stenosis (after clipping);
- ischemic heart disease;
- tricuspid valve regurgitation;
- pulmonary hypertension;
- pulmonary edema; and
- acute kidney injury or chronic kidney disease progression.

Key Points

- Mitral valve stenosis is a rare but serious complication following TEER with the MitraClip device.
- Careful patient selection and preprocedural assessment of MVA and leaflet anatomy are critical to minimize the risk of mitral valve stenosis after valve clipping.
- Recurrent or worsening HF symptoms after MitraClip device placement should prompt early evaluation for mitral valve stenosis, including with echocardiography and hemodynamic assessment.
- Surgical mitral valve replacement remains the definitive therapy for severe mitral valve stenosis after failed TEER, especially in symptomatic patients.

Abbreviations

ED, emergency department
HF, heart failure
ICD, implantable cardioverter-defibrillator
LVEF, left ventricular ejection fraction
MVA, mitral valve area
TEE, transesophageal echocardiogram
TEER, transcatheter edge-to-edge repair

Technique

The patient's initial electrocardiogram showed a ventricular paced rhythm, with a heart rate of 74/min (Fig. 1). A chest radiograph showed bilateral mild pleural effusions and mild pulmonary congestion as well as the dual-chamber ICD (Fig. 2). Laboratory tests showed an elevation in brain-type natriuretic peptide (3465 g/mol [595 pg/mL]); negative high-sensitivity cardiac troponin values measuring 0.053 µg/L (53 ng/L), 0.028 µg/L (28 ng/L), and 0.025 µg/L (25 ng/L), respectively; a baseline creatinine value of 159 µmol/L (1.8 mg/dL); and a serum urea nitrogen level of 11.4 mmol/L (32 mg/dL).

Interrogation of the ICD showed appropriate biventricular pacing with acceptable measured parameters and battery voltage. The right ventricle measured 0.75 V at 0.4 milliseconds, and the left ventricle measured 3 V at 1 milliseconds. The patient was in chronic atrial fibrillation, with a burden of 100% and 100% ventricular pacing. No high-ventricular-rate events were detected.

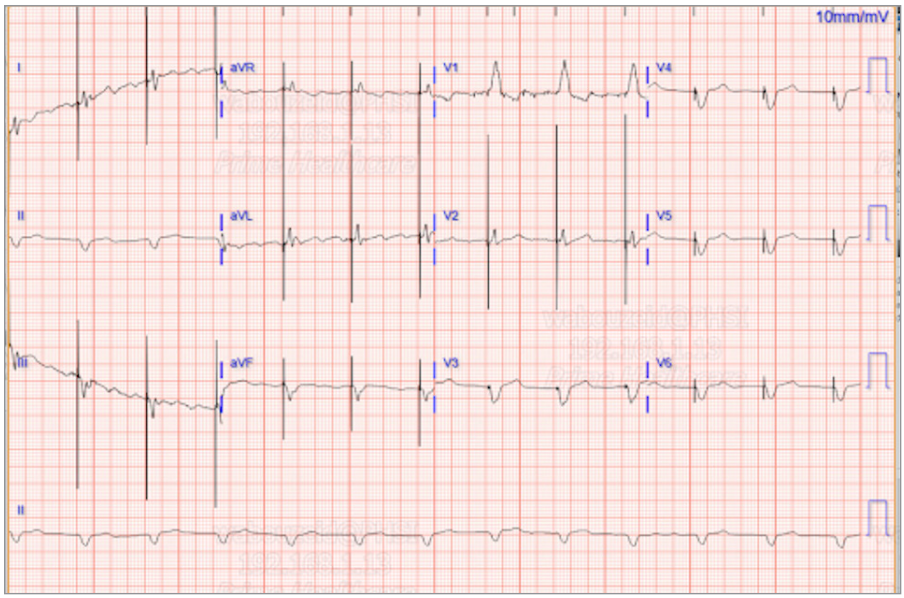

Fig. 1 Electrocardiogram on admission shows ventricular pacing rhythm and a heart rate of 74/min.

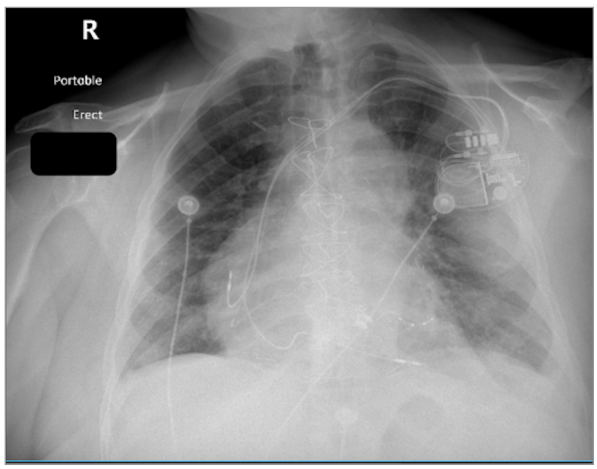

Fig. 2 Chest x-ray on admission shows cardiomegaly and pulmonary congestion.

Furosemide 120 mg was administered initially, and guideline-directed medical therapy was restarted. The patient reported some clinical improvement in his symptoms, and reapeat transthoracic echocardiography showed an LVEF of 50% to 55%; a dilated left atrium measuring 48 mm; and severe mitral valve stenosis, with an MVA of 0.8 cm^2 and a mean pressure gradient of 21 mm Hg. The patient had a normal left ventricle size and normal left ventricular diastolic function, with severe pulmonary hypertension, right ventricular systolic pressure measuring 62.15 mm Hg, and severe tricuspid valve regurgitation (Figs. 3-6). Transesophageal echocardiography (TEE) was performed to confirm these findings (Fig. 7).

Following optimization of the patient's cardiac volume status, it was determined that the deployment of 2 clips, despite a preintervention MVA of only 3.9 cm^2, had likely contributed to the development of severe mitral valve stenosis, with the rapid progression of severe fibrosis involving the mitral valve leaflets as a contributing factor. A decision was made to proceed with mitral valve replacement. In preparation for the procedure, TEE and right and left heart catheterizations were conducted. The TEE confirmed the transthoracic echocardiography finding of 2 mitral clips in the A2 and P2 segments of the heart, with severe mitral valve stenosis of the same gradient noted in the transthoracic echocardiograph, along with trace mitral valve regurgitation and moderate tricuspid valve regurgitation. During right heart catheterization, elevated right atrial pressure, pulmonary arterial pressure, and pulmonary capillary wedge pressure were noted (Table I).

During left heart catheterization, the patient was noted to have a chronic total occlusion of the left main, left anterior descending, left circumflex, and right coronary arteries. He did, however, have a patent left internal mammary arterial graft to the left anterior descending artery as well as patent saphenous venous grafts to the right coronary artery and the sequential diagonal and oblique marginal arteries.

Potential risks and benefits were discussed in detail with the patient, and he decided to proceed with valve replacement surgery.

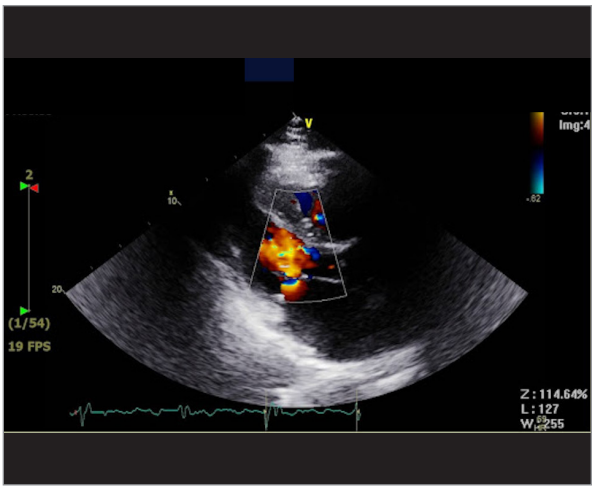

Fig. 3 A transthoracic echocardiogram with a parasternal long-axis view and a large flow convergence noted on color Doppler suggests severe mitral valve stenosis after mitral valve clipping.
FPS, frames per second; V, ventricle.

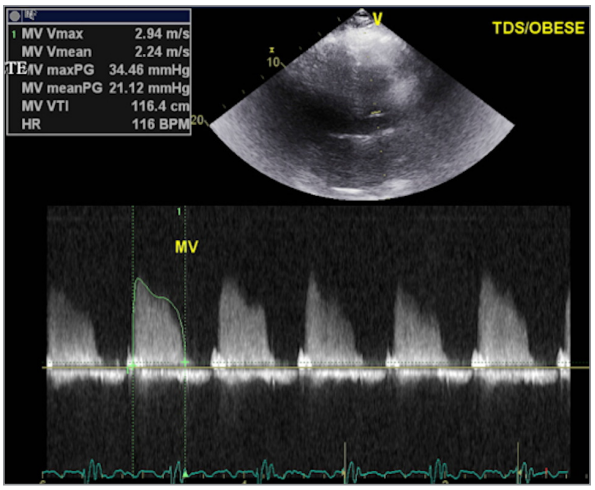

Fig. 4 A transthoracic echocardiogram with a 4-chamber view demonstrates a mean mitral valve pressure gradient of 21 mm Hg.
SI conversion factor: To convert mm Hg to kPa, multiply by 0.133.
BPM, beats per minute; HR, heart rate; maxPG, maximum pressure gradient; meanPG, mean pressure gradient; MV, mitral valve; TDS, total defect score; V, ventricle; Vmax, maximum velocity; Vmean, mean velocity; VTI, velocity-time integral.

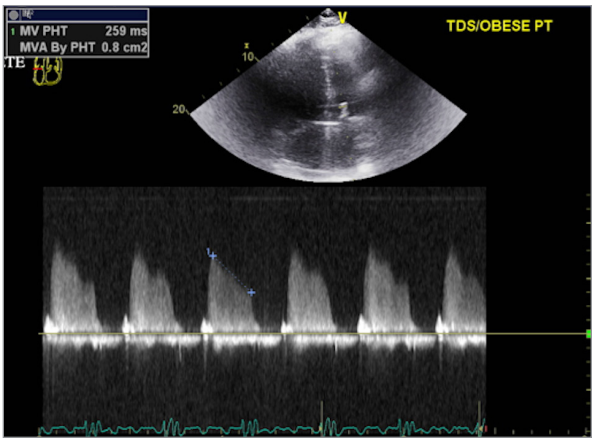

Fig. 5 A transthoracic echocardiogram with a 4-chamber view demonstrates a mitral valve pressure half-time of 259 milliseconds with an MVA of 0.8 cm^2.
MV, mitral valve; MVA, mitral valve area; PHT, pressure half-time; PT, patient; TDS, total defect score; V, ventricle.

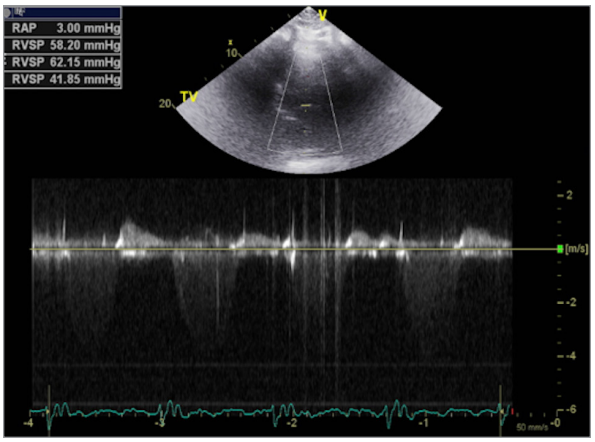

Fig. 6 Transthoracic echocardiogram shows elevated right ventricular systolic pressure secondary to severe mitral valve stenosis.
RAP, right atrial pressure; RVSP, right ventricular systolic pressure; TV, tricuspid valve; V, ventricle.

During the repeat sternotomy, the sternum was dissected off the heart and the mediastinum. The heart was then dissected. The patient was given heparin, and cannulas were placed in the ascending aorta for arterial inflow and bicavally for venous return. He was placed on cardiopulmonary bypass and his body temperature allowed to drift. Cross-clamping was applied, and a right atriotomy was performed. The interatrial septum was then incised, and the mitral valve accessed using a transeptal approach. A valve analysis showed

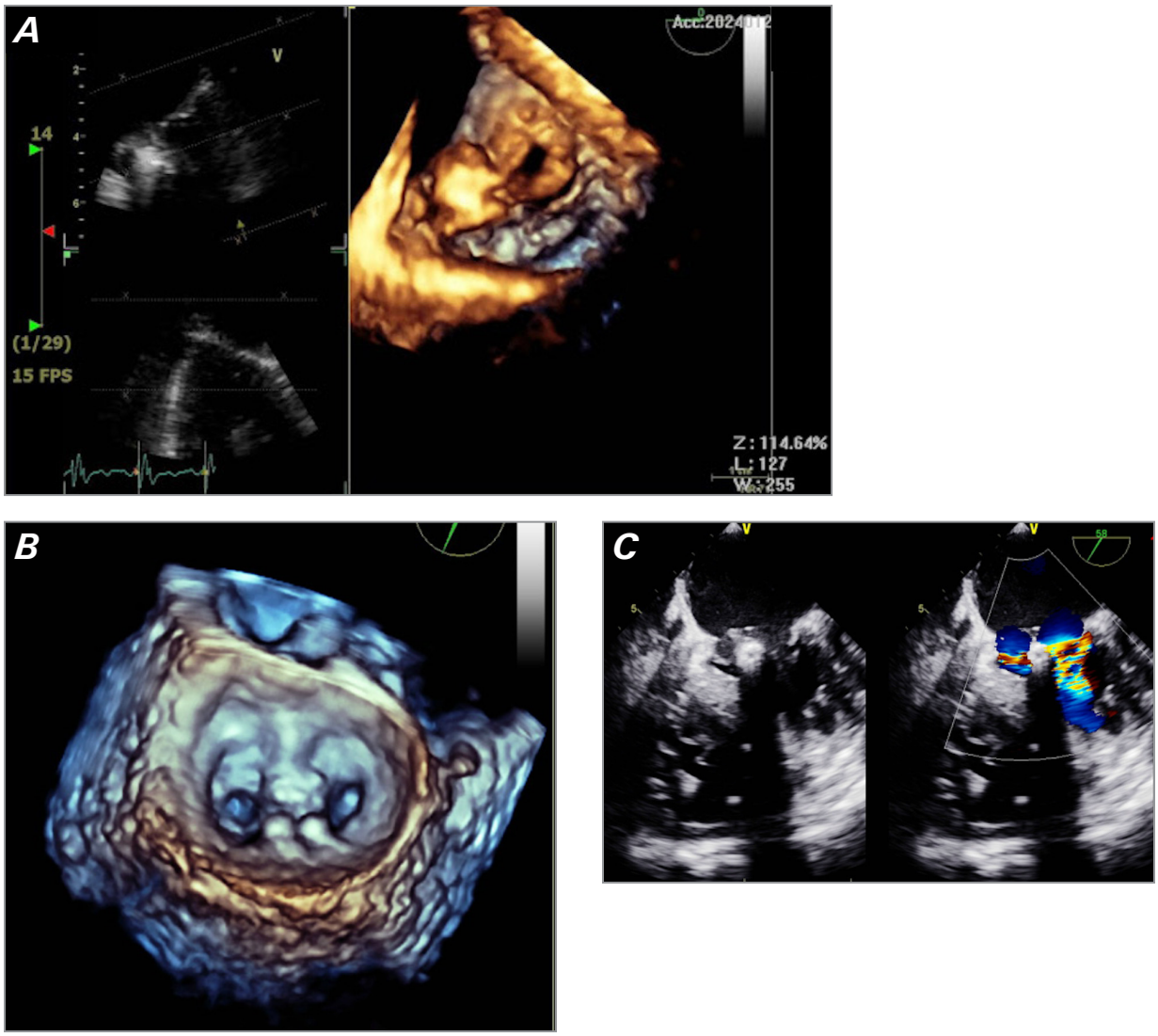

Fig. 7 Transesophageal echocardiogram shows (**A**) a 3-dimensional view of the lateral valve orifice after mitral valve clipping from the ventricular side; (**B**) a 3-dimensional reconstruction of the mitral valve with 2 MitraClip devices in the A2/P2 region causing severe stenosis; and (**C**) a commissural view of the mitral valve demonstrating a large flow convergence from both orifices after MitraClip device placement, suggesting severe stenosis.
FPS, frames per second; V, ventricle.

a diminutive opening on either side of the MitraClip clip, with severe fibrosis and stenosis of the valve. The anterior leaflet was then resected en bloc with a clip attachment, and portions of the posterior leaflet, en bloc to where the clip was attached, were removed. Portions of the P1 and P3 segments with ventricular annular continuity were preserved. A 29-mm bioprosthetic valve was placed and secured to the annulus with a Cor-Knot Device (LSI Solutions). Upon examination, the tricuspid valve was found to be substantially dilated, with mild fibrosis of the anterior leaflet margin. Annular sutures were placed, and a 28-mm Tri-Ad Adams 2.0 tricuspid band was implanted and tied securely to the annulus. After a total of 175 minutes of cardiopulmonary bypass time and 113 minutes of aortic clamp time, the patient was transferred to the intensive care unit for monitoring and hemodynamic stabilization. He was extubated after 3 days and weaned from pressors. Five days after surgery, the patient was downgraded to the medical floor for continued medical care. Postprocedural echocardiography showed an LVEF of 55%, with no evidence of mitral valve regurgitation and an estimated mean mitral valve gradient of 4 mm Hg at a heart rate of 84/min. There was no evidence of tricuspid valve regurgitation,

and the patient had an estimated tricuspid valve gradient of 2 mm Hg (Fig. 8).

Outcome

After the procedure, the patient's symptoms improved. He was discharged to a subacute rehabilitation center on optimized medical therapy.

Last Follow-Up

At his 2-week follow-up appointments in the cardiology and cardiothoracic surgery outpatient clinics upon discharge, the patient reported improved breathing and energy levels, with no dyspnea. He was able to perform basic daily activities independently and expressed satisfaction with his overall recovery and quality of life.

Discussion

Transcatheter edge-to-edge repair (TEER) with the MitraClip device is a less invasive therapeutic option for people with mitral valve regurgitation. The most recent American Heart Association/American College of Cardiology guidelines provide a class IIa recommendation for percutaneous mitral valve repair in patients with degenerative mitral valve regurgitation, stating that the procedure can be considered for extremely symptomatic patients (New York Heart Association class III or IV) with primary severe mitral valve regurgitation and a high or prohibitive surgical risk. Transcatheter edge-to-edge repair is appropriate if the mitral valve architecture is favorable for the repair surgery and the patient's life expectancy is at least 1 year.[1,2]

The MitraClip G4 System achieves TEER by deploying a clip that grasps and coapts the anterior and posterior mitral valve leaflets, lowering or eliminating regurgitation at the region of the prolapsed or flail leaflets. To achieve satisfactory mitral valve regurgitation reduction without valvular stenosis, TEE and hemodynamic measurements are used to assess leaflet insertion, degree of mitral valve regurgitation reduction, and pressure gradients before MitraClip clip deployment.[2]

MitraClip G4 System outcomes have been described in studies starting with EVEREST[3]; a series of trials; and, most recently, from the multicenter Global EXPAND[4] and COAPT[5] studies and the expanded EVEREST II REALISM study.[6] Recent studies[7,8] have shown that the MitraClip device reduces mitral valve regurgitation to moderate or lower severity in more than 90% of patients. Improvements in clinical expertise, 3-dimensional intraprocedural echocardiography, and the MitraClip device have led to better results over time.

According to the EVEREST II trial, the following complications occurred during the first and second phases of the study: bleeding that required transfusion of more

TABLE I. Right Heart Catheterization Findings

Measurement	Value
Right arterial pressure, mm Hg	11
Right ventricular pressure, mm Hg	56/14
Pulmonary artery pressure, mm Hg	58/26/39
Pulmonary capillary wedge pressure, mm Hg	29
Cardiac index, L/min/m^2	3.49
Left ventricular end diastolic pressure, mm Hg	11

SI conversion factor: To convert mm Hg to kPa, multiply by 0.133.

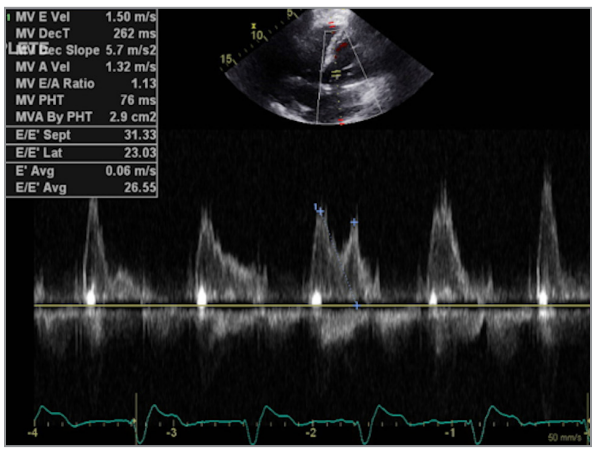

Fig. 8 Transthoracic echocardiogram shows mitral valve measurements.
A Vel, A-wave velocity; Avg, average; DecT, deceleration time; E Vel, E-wave velocity; Lat, lateral; MV, mitral valve; MVA, mitral valve area; PHT, pressure half-time; Sept, septal.

than 2 units (5.5%), transseptal complications (3.8%), mechanical ventilation for more than 48 hours (1.8%), partial clip detachment (9.0%), cardiac surgery after a failed clip deployment (26%), and recurrent mitral valve regurgitation (19.7%).[9] Surgery is the sole choice in the event of severe symptomatic mitral valve stenosis. Thirty-seven of 178 patients who received a MitraClip device in the EVEREST II study underwent mitral valve surgery.[9] In 54% of these patients, the mitral valve was repaired. The primary causes for replacement were bileaflet and anterior diseases as well as leaflet harm from the clip.[9]

Another rarely described complication is mitral valve stenosis, a serious complication of TEER that may result from a substantial reduction in the anteroposterior diameter, especially in the A2-P2 position. Current American College of Cardiology/American Heart Association/American Society of Echocardiography recommendations encourage appropriate patient selection to identify the valve morphology best suited to TEER. As with all new percutaneous valve procedures, choosing the right procedure for the patient is essential to prevent serious side effects and to achieve a positive long-term result. The guidelines and selection criteria for candidates undergoing percutaneous mitral valve repair with the MitraClip G4 System are primarily based on echocardiographic criteria, which include moderate to severe or severe mitral valve regurgitation on 2-dimensional and 3-dimensional echocardiography. In terms of anatomical suitability, the mitral valve must have enough leaflet tissue for mechanical coaptation, a resting valvular orifice of 4 cm^2, a flail gap less than 10 mm, a flail width less than 15 mm (in the case of degenerative mitral valve disease), and a minimum coaptation length of 2 mm (in the case of ischemic functional mitral valve regurgitation).[10] Repair of damaged mitral valves resulting from rheumatic heart disease is still not recommended, especially if the valve leaflets have calcified.[10]

In the COAPT trial, after 30 days, there were no device-specific problems from MitraClip G4 System use, and the device was deemed safe.[11] After TEER, there were greater pressure gradients across the mitral valve; however, these gradients did not reduce the prognostic advantages of therapy in this population,[12] and no patient underwent surgery for severe mitral valve stenosis.

Concern has also been raised that when TEER fails, surgical replacement rather than repair of the mitral valve is typically necessary.[13] Mitral valve replacement is recommended when surgery is necessary for secondary mitral valve regurgitation.[1,14] In the COAPT study, however, the frequency of mitral valve surgery, including valve replacement, was lower in the device group than in the control group throughout the 5-year follow-up period.

Conclusion

This case highlights the complexities and potential complications associated with mitral valve clipping, especially in patients aged 75 years and older with multiple comorbidities. Despite initial postprocedural improvement, the patient's symptoms recurred, necessitating further diagnostic evaluation and, ultimately, mitral valve replacement. Meticulous procedural planning and close postprocedural follow-up are crucial to identifying and managing complications early. A multidisciplinary approach involving cardiologists, cardiac surgeons, and other specialists is essential for optimizing patient outcomes.

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