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CASE REPORT

ADVANCED

CLINICAL CASE

Management of MitraClip Single-Leaflet Detachment with an Additional Clip and an Amplatzer Vascular Plug

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ABSTRACT

Single-leaflet detachment of the MitraClip is a mechanism of early failure, but management is challenging and often requires surgical repair. This case report describes a novel transcatheter approach to repairing severe mitral regurgitation after MitraClip single-leaflet detachment by placement of an additional clip and an Amplatzer vascular plug. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2019;1:755-60) © 2019 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/).

CASE

Transcatheter mitral valve repair using the MitraClip device (Abbott Laboratories, Rockville, Maryland) has been approved by the U.S. Food and Drug Administration for treatment of severe mitral regurgitation (MR). In patients with functional MR, treatment using the MitraClip is associated with absolute risk reductions of 32% for heart failure hospitalization and 17% for all-cause mortality at 2 years in the recent COAPT (Cardiovascular Outcomes Assessment of the MitraClip Percutaneous Therapy for Heart Failure Patients With Functional Mitral Regurgitation) trial (1). MitraClip procedures can be performed with low rates of procedural complications. However, MitraClip single-leaflet detachment (SLD) is a mechanism of failure which occurs in 1.0% to 1.5% of MitraClip procedures in the United States and typically results in severe MR (2,3). SLD may occur from loss of leaflet insertion within the clip or from torn leaflet tissue. Repeated use of the MitraClip in patients with prior SLD is associated with low rates of procedural success (4) and often requires surgery (5,6). This report presents a case in which MitraClip SLD was managed successfully with a novel transcatheter solution involving placement of an additional MitraClip and an Amplatzer vascular plug (AVP).

LEARNING OBJECTIVES

- To understand implications of MitraClip single-leaflet detachment and potential management strategies.
- To describe a novel approach using an Amplatzer vascular plug to repair mitral regurgitation between 2 MitraClips.

PRESENTATION. An 82-year-old man presented with dyspnea on exertion. The patient described his inability to complete light housework, whereas 6 months previously he was able to ride a bicycle at a modest pace. Cardiopulmonary examination was unremarkable.

MEDICAL HISTORY. Previous medical history was notable for atrial fibrillation, stroke, rheumatoid arthritis, ischemic cardiomyopathy, and coronary artery bypass grafting.

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Informed consent was obtained for this case.

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ABBREVIATIONS AND ACRONYMS

AVP = Amplatzer vascular plug

MR = mitral regurgitation

SLD = single-leaflet detachment

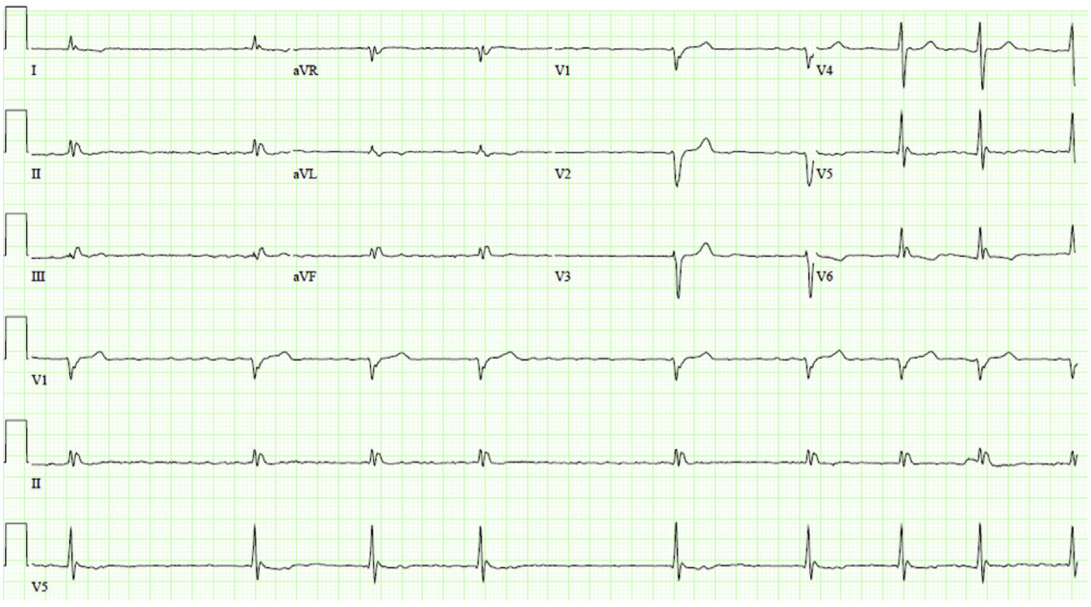
TEE = transesophageal echocardiogram

INVESTIGATIONS. Electrocardiography revealed atrial fibrillation at a rate of 48 beats/min (Figure 1). Coronary angiography revealed patent coronary bypass grafts with no need for coronary revascularization. Transthoracic echocardiography demonstrated previous inferolateral wall infarction with left ventricular ejection fraction of 50%. Transesophageal echocardiography (TEE) revealed restricted movement of the posterior mitral valve leaflet with a posteriorly directed MR jet of 3 to 4+ severity (Figure 2). The mitral valve pressure halftime was 88 ms with a calculated mitral valve area of 2.5 cm^2. The posterior mitral leaflet measured 17 mm in length.

DIFFERENTIAL DIAGNOSIS. Coronary ischemia and congestive heart failure related to MR were the most likely diagnoses. Given the findings of coronary angiography and the patient's continued symptoms despite optimal medical therapy, it was decided to proceed with treatment of the patient's MR.

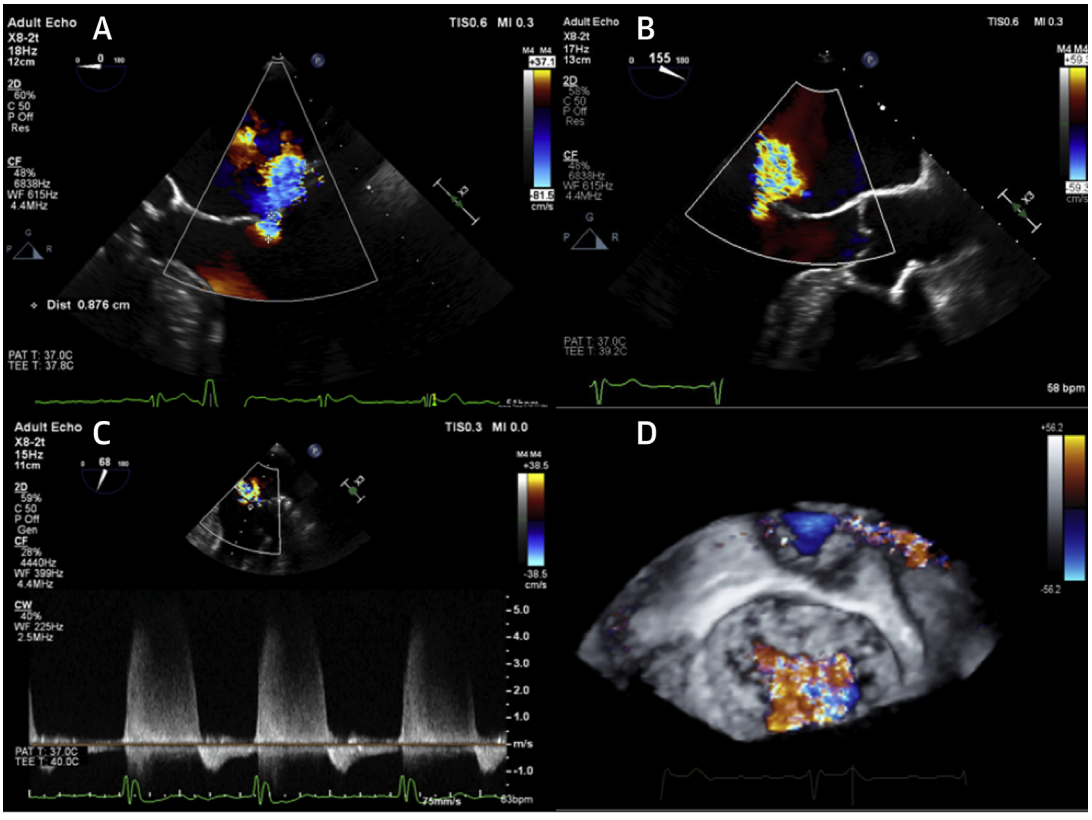
MANAGEMENT. The MitraClip procedure was performed with the patient under general anesthesia with TEE guidance. Trans-septal access was achieved using a Mullins sheath and Brockenbrough needle. Left atrial pressure was 30 mm Hg. A 0.032-inch Toray guide wire (Toray, New York, New York) was advanced into the left atrium, and the Mullins sheath was exchanged for the 24-F MitraClip delivery system. An NTr MitraClip device was used to grasp the medial aspect of the anterior and posterior mitral leaflets, and the clip arms fully grasped leaflet tissue with approximately 6 mm of posterior leaflet successfully contained. After leaflets were grasped, TEE demonstrated trivial MR. However, prior to final clip release, there was a sudden increase in MR to 4+ at the clip insertion site, and this was believed to be due to a tear in the posterior leaflet at the site of the clip insertion. The clip was removed, and the valve was re-evaluated by TEE, including 3D reconstruction, which confirmed a torn cleft-like appearance in the posterior leaflet. The clip was regrasped and released medially to the first grasp, but severe MR remained lateral to this clip (at the area of posterior leaflet tear). Mean transmitral gradient by TEE after 1 clip was 1 mm Hg. An attempt was made to repair the residual severe MR by placing a second NTr MitraClip laterally to the first clip and as close as possible, although the torn posterior leaflet segment posed a hindrance. Therefore, severe MR remained between the 2 clips through a circular orifice measuring 8 mm in diameter; the mean transmitral gradient was 3 mm Hg. Placement of a third clip between the 2 existing clips would not be technically feasible as

FIGURE 1 Baseline Electrocardiography



Electrocardiogram demonstrated atrial fibrillation.

FIGURE 2 Baseline TEE



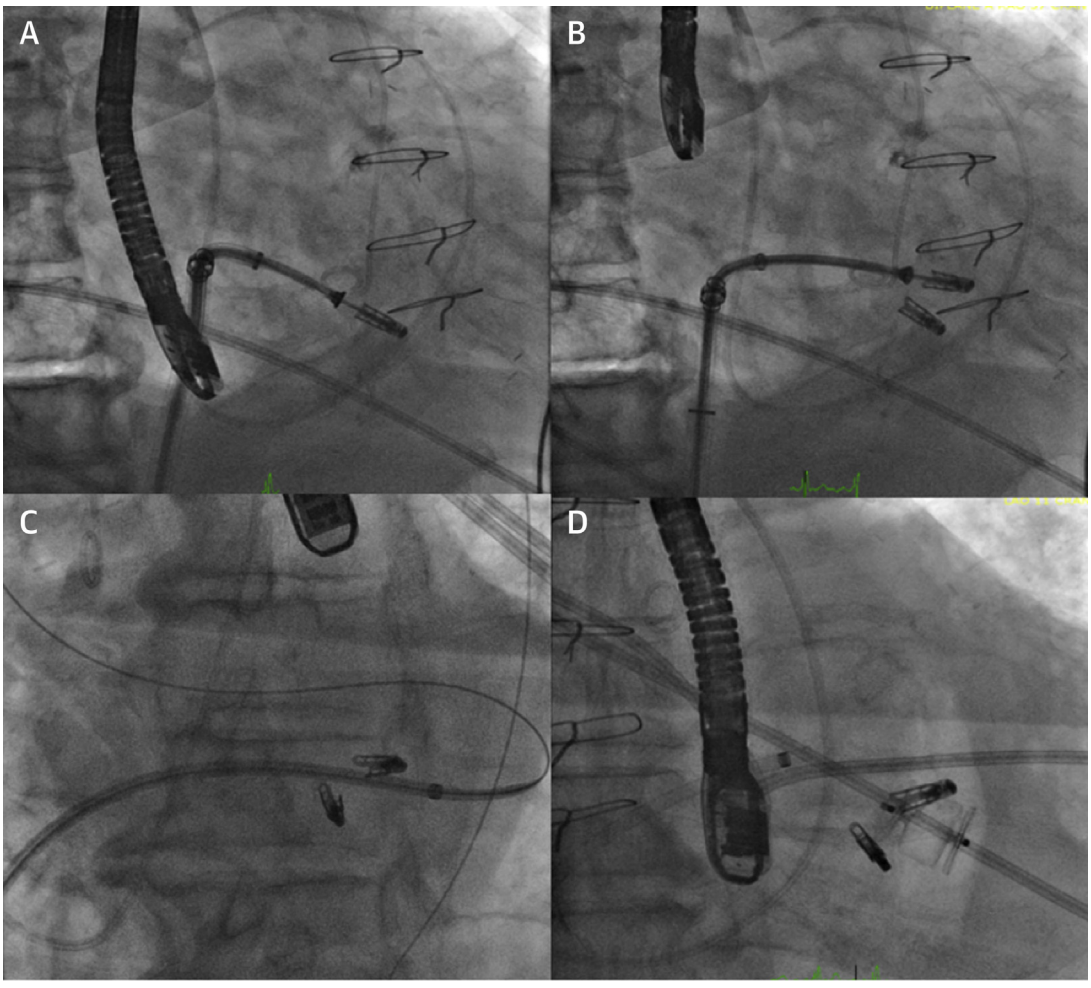
(A and B) Baseline TEE demonstrated left ventricular ejection fraction of 50% and MR of 3 to 4+ severity. Two-dimensional (2D) imaging of the mitral valve with color flow Doppler demonstrating proximal isovelocity surface area radius of 0.9 cm. **(C)** Continuous wave Doppler through the mitral valve reveals a dense holosystolic jet consistent with MR of 3 to 4+. **(D)** 3D reconstruction of the mitral valve with color flow mapping demonstrating severe MR spanning the coaptation zone with a posterior directed jet. MR = mitral regurgitation; TEE = transesophageal echocardiogram.

this area had a torn posterior leaflet with inadequate leaflet tissue to grasp. Therefore, it was decided to close the leak between the clips with a vascular plug. A list of key procedural equipment is provided in Table 1. The MitraClip delivery system was exchanged for a 20-F introducer sheath over the Toray wire. A medium curl 8.5-F steerable introducer was advanced (Agilis, Albert Lea, Minnesota) into the left atrium, through which a 4-F angled hydrophilic glide catheter was placed. Through this system the mitral valve was crossed between the 2 clips by using a stiff angled

TABLE 1 Key Procedural Equipment

Equipment	Function
20-F introducer sheath	Replaces MitraClip delivery system over stiff wire
8.5-F Agilis steerable introducer (Abbott)	Steerable introducer facilitates crossing leak with catheter/wire
4-F angled hydrophilic coated catheter	Low-profile catheter crosses leak over 0.035-inch guidewire
8-F TorqVue delivery system (St. Jude Medical)	Long introducer crosses leak and delivers 16-mm Amplatzer vascular plug II
16-mm Amplatzer vascular plug II	Self-expanding nitinol wire mesh plugs to close regurgitant orifice between the clips
260-cm 0.035-inch hydrophilic guidewire	Guidewire crosses the orifice between clips with length needed to exchange introducer sheaths while maintaining wire position

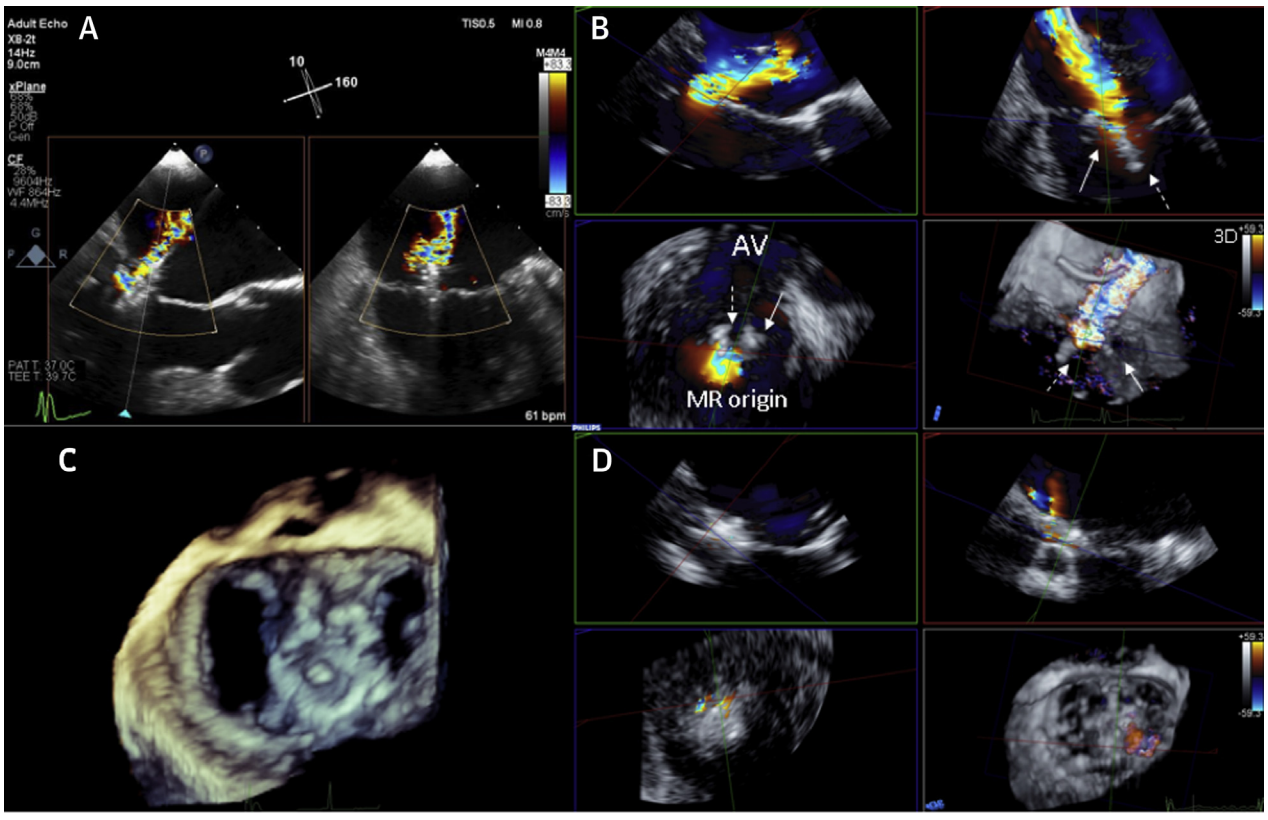
FIGURE 3 Procedural Fluoroscopy



(A) Deployment of the first clip resulted in trivial MR. Prior to clip release, there was a sudden increase to MR 4+ due to SLD. **(B)** The first clip was repositioned medially and a second clip was placed just lateral to the first clip, but substantial MR remained between the 2 clips. **(C)** The orifice between the 2 clips was crossed with a guidewire and an 8-F 180° TorqVue introducer was advanced between the 2 clips. **(D)** A 16-mm AVP II was deployed between the 2 clips, resulting in MR of 1+. AVP = Amplatzer vascular plug; SLD = single leaflet detachment; other abbreviations as in Figure 2.

hydrophilic 0.035-inch glidewire, which was advanced into the descending aorta. The Agilis introducer and the angled glide catheter were removed, and an 8-F TorqVue 180° delivery introducer (St. Jude Medical, St. Paul, Minnesota) was advanced into the left ventricle. Through the TorqVue introducer, a 16-mm AVP II was deployed between the 2 clips. A 16-mm AVP II device (100% oversizing) was selected to minimize the risk of device embolization. A single-lobed AVP I device might have increased the risk of embolization, and an AVP IV device would be too small. Prior to releasing the plug, the mitral valve function and anatomy were carefully assessed with TEE to assess transmitral gradients and to ensure there was no excessive tension on or distortion of the mitral leaflets and clips, which would result in iatrogenic MR. When the result was satisfactory, the plug was released. The MR severity was reduced from 4+ to 1+. Final left atrial pressure was 20 mm Hg. Final transmitral peak and mean gradients by TEE were 11 and 5 mm Hg, respectively (Figures 3 and 4). The patient was discharged 2 days later with a prescription for warfarin in the context of prior atrial fibrillation.

FIGURE 4 Procedural Echocardiography



(A) While placing the first MitraClip, an SLD from the posterior leaflet was observed due to a torn posterior leaflet with resultant MR of 4+ prior to deployment. **(B)** The first clip was repositioned more medially and a second clip was placed more laterally but significant MR was through a circular orifice was observed between the 2 clips. **(C)** A 1-6mm AVP II device was placed in the orifice between the 2 clips. **(D)** A final echocardiogram demonstrated MR of 1+ after the plug was deployed. Abbreviations as in Figures 2 and 3.

DISCUSSION

Although historical reports suggested rates of MitraClip SLD near 5% (7), the rate of SLD in contemporary U.S. practice appears to be 1.0% to 1.5% with an observed learning curve suggesting rates of <1.0% among more experienced centers (2,3). However, SLD remains a rare but potentially serious complication resulting in the potential need for surgery. Repeated MitraClip insertion after prior SLD is associated with particularly low success. Kreidel et al. (4) observed an 85% success of repeated MitraClip in patients without SLD versus 25% success in those with SLD, highlighting the challenges of managing SLD percutaneously (4). The present case highlights a novel technique using an AVP II to percutaneously repair severe MR after SLD.

Despite the successful result of the procedure described in this case report, operators should be cautious when attempting off-label and novel transcatheter interventions. Although the present authors do not recommend this approach as the standard of care per se in cases of MitraClip SLD, the strategy used in this case may be a viable option for experienced operators in highly selected cases, as the only other option for this patient would have been an extremely risky cardiac surgical MV replacement.

Reasons to avoid this approach include patients with unacceptable transmitral gradient (>5 mm Hg) after 2 clips, patients with mild residual MR, patients with multiple jets of residual MR, patients with difficult TEE images, and those with large orifice areas in between clips such that a plug device cannot be safely anchored. However, in patients with a solitary jet of at least moderate MR through a small orifice between 2 clips, this approach is an attractive option as it can be performed with equipment commonly used for percutaneous paravalvular leak

closure. The present authors have used a similar technique in some patients with very medial or lateral jets of MR by performing MitraClip close to the valve commissure and then closing residual jets of MR between the clip and commissure with a vascular plug. High-quality real-time TEE guidance is essential to facilitate novel transcatheter solutions such as the strategy described in this report.

FOLLOW-UP

The patient continues to do well 1-year post-procedure with mild MR.

CONCLUSIONS

MitraClip SLD is a potential mechanism of early MitraClip failure. High-quality procedural echocardiography guidance facilitates novel transcatheter solutions during MitraClip procedures. An AVP II can be successfully used to repair MR between 2 clips in highly selected patients.

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KEY WORDS echocardiography, mitral valve, valve repair