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Case Report

Chordal Entanglement following MitraClip™ Implantation Necessitating Open Heart Surgery

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Abstract

MitraClip implantation has become an alternative technique to reduce the severity of mitral regurgitation for patients with prohibitive surgical risk. It can, however, lead to either procedure-related or device-related complications. Here, we describe a patient in which the MitraClip™ arms were entangled to the chordae tendinae and papillary muscles, and the device could neither be deployed nor removed. The patient required open heart surgery for the removal of the clips and emergent mitral valve replacement. The remaining perioperative course and follow-up of the patient was unremarkable.

Keywords: transcatheter intervention; MitraClip, implantation; chordal entanglement; open heart surgery

Introduction

For the last two decades, mitral valve (MV) edge-to-edge repair by MitraClip implantation has become the most popular, alternative technique to alter the mitral valve morphology, annular diameter, and reduce the severity of mitral regurgitation (MR) for patients with prohibitive surgical risk.1 Since the first MitraClip implantation in 2003, over 200,000 patients have undergone this procedure worldwide.2 The MitraClip implantation is a transcatheter method that is similar to the Alfieri technique in that it connects the middle scallops of the anterior (A2) and the posterior (P2) leaflet of a regurgitant MV. Echocardiography is an essential imaging modality for patient selection, guidance of the procedure, the identification of periprocedural complication/s, and the evaluation of the final result after clip implantation. The MitraClip implantation can cause procedure-related or device-related complications.3 The procedure-related complications include cardiac perforation, cardiac tamponade, vascular trauma/dissection, cardiac arrhythmias, myocardial infarction, stroke, bleeding, thrombosis, and infective endocarditis. The device-related complications include leaflet perforation, leaflet tear, dislodgement of the device, single leaflet device attachment, and chordal entanglement/ entrapment/rupture. We report a case in which the MitraClip™ arms were entangled to the chordae tendinae and papillary muscles, and the device could neither be deployed nor removed. The patient required open heart surgery for the removal of the clips and emergent MV replacement.

Case Report

A 72-year-old man was admitted to our institution for worsening dyspnea (New York Heart Association functional class III) for the last two months. Clinical evaluation and investigations including echocardiography revealed degenerative MV disease causing severe MR. The specific signs of severe MR included a vena contracta width of 0.8 cm, a large central regurgitant jet occupying >40% of the left atrium, systolic flow reversal in the pulmonary veins, a dense continuous-wave Doppler MR jet with a peak velocity of 5.1 cm/s, effective regurgitant orifice area of > 0.4 cm2 **(Figure 1),** dilated left atrium (5.7 cm), and enlarged left ventricle (end-diastolic dimension 6.0 cm). The MV leaflets were thickened with prolapse of the anterior mitral leaflet and tethered posterior leaflet (**Figure 2**). The left ventricular ejection fraction (LVEF) was 30%. The co-morbid conditions included systemic hypertension, type II diabetes mellitus, chronic obstructive pulmonary disease, and chronic kidney disease (serum creatinine 2.7 mg/dl). The calculated EuroSCORE II for MV repair/replacement was 7.2%. Given the symptoms, echocardiography findings, and co-morbid conditions, the 'Heart-team' advised percutaneous MitraClip™ edge-to-edge repair and informed consent was obtained.

Under standard cardiac monitoring including three-dimensional transesophageal echocardiography (TEE, X7-2t probe, Philips), general anesthesia was induced in the hybrid operating room. The cardiac surgical team and cardiopulmonary bypass (CPB) machine were kept on standby. Using fluoroscopy and TEE guidance, the MitraClip™ G4 XTW (Abbott Laboratories, Abbott Park, IL, USA) implantation procedure was started.

The standard procedural guidelines were followed which included trans-septal puncture in the superior and posterior part of the interatrial septum **(Figure 3)**, introduction of the steerable guide catheter and clip delivery system into the left atrium, positioning of the MitraClip™ perpendicular to the MV plane and coaptation line of MV leaflets, and advancing it into the left ventricle (**Figure 4**). After grasping the leaflets (A2 and P2) between the clip arms and the grippers, the clip was closed, but there was a residual lateral jet causing 3+ MR (**Figure 5**). The second clip was deployed as parallel as possible and lateral to the first one, but still, there was 3+ MR. We attempted to implant a third device but grasping was suboptimal and an entrapment of the device in the subvalvular apparatus was suspected on TEE. All possible maneuvers to release the device failed, and the decision to remove it by open heart surgery was taken. During surgery, the MitraClip™ arms entangled with chordae and papillary muscles were removed (**Figure 6**) and the MV was replaced by using a 25 mm SJM Epic mitral tissue valve. Follow-up visits at three and six months showed normal functioning of the bioprosthetic MV.

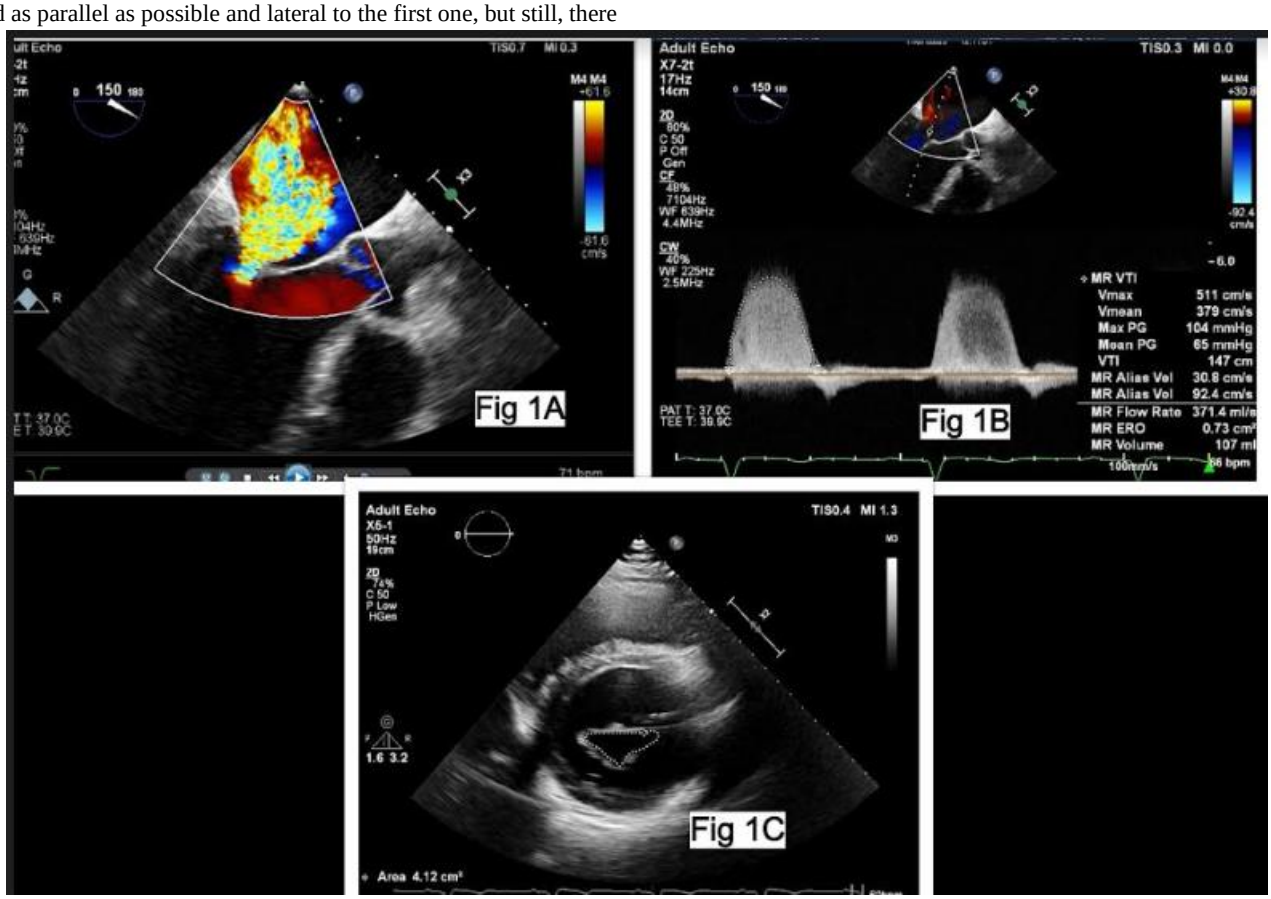

Figure 1: Transesophageal echocardiography long-axis view showing severe mitral regurgitation (Figure 1A), effective regurgitation orifice area >0.7 cm2 (Fig 1B), and mitral valve area > 4 cm2 on planimetry (Figure 1C)

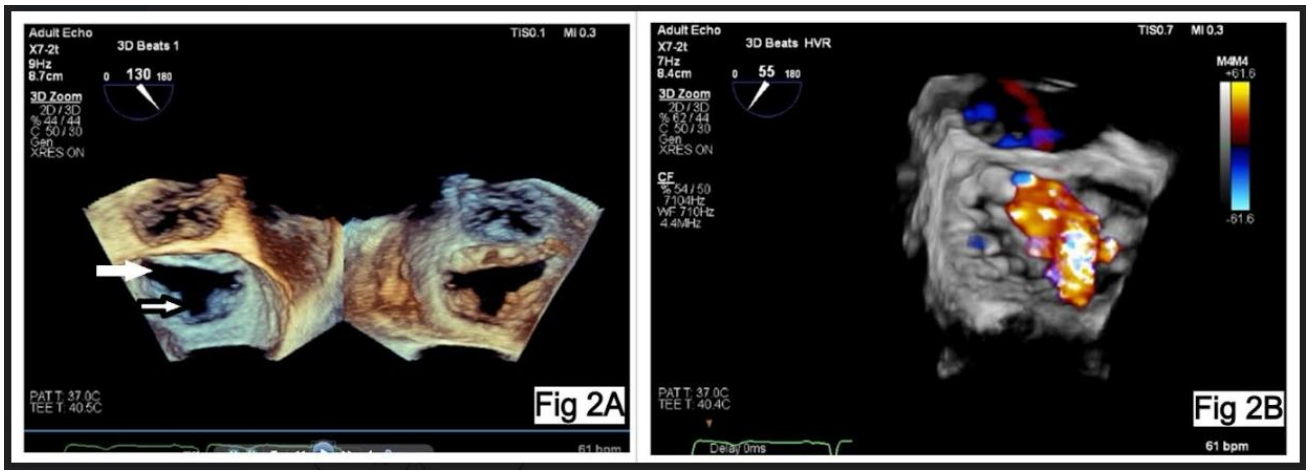

Figure 2: Three-dimensional en-face view of the mitral valve showing prolapse of the anterior mitral leaflet (white arrow), tethered posterior leaflet (black arrow, Figure 2A), and a central jet of severe mitral regurgitation (Figure 2B)

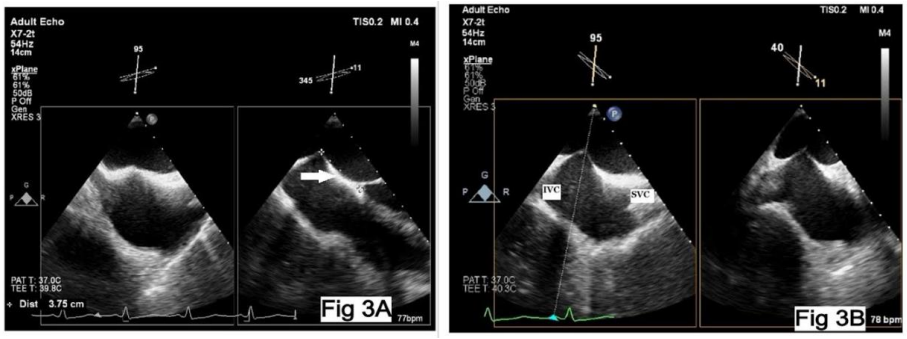

Figure 3: X-plane view of the interatrial septum depicting the site of trans-septal puncture (Fig 3A) at the superior and posterior part (Figure 3B). SVC: superior vena cava, IVC: inferior vena cava

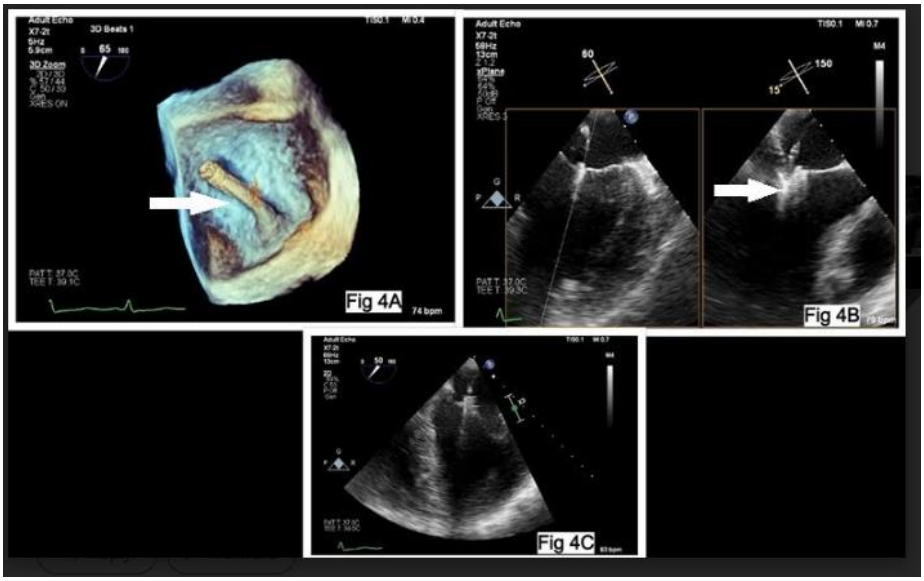

Figure 4: Introduction of the steerable guide catheter (arrow, Figure 4A) and clip delivery system into the left atrium (Fig 4B), and positioning of the MitraClip™ into the left ventricle (Figure 4C)

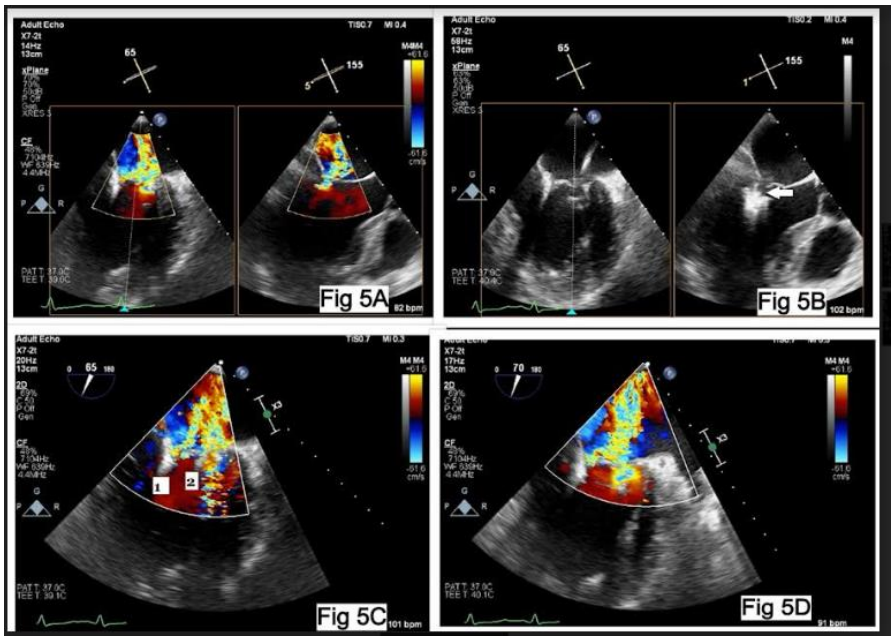

Figure 5: Residual mitral regurgitation after implantation of first clip (Figure 5A) due to non-coaptation of leaflets (arrow, Figure 5B). Residual mitral regurgitation after implantation of clip 1 and 2 (Fig 5C) and final result showing severe mitral regurgitation (Figure 5D)

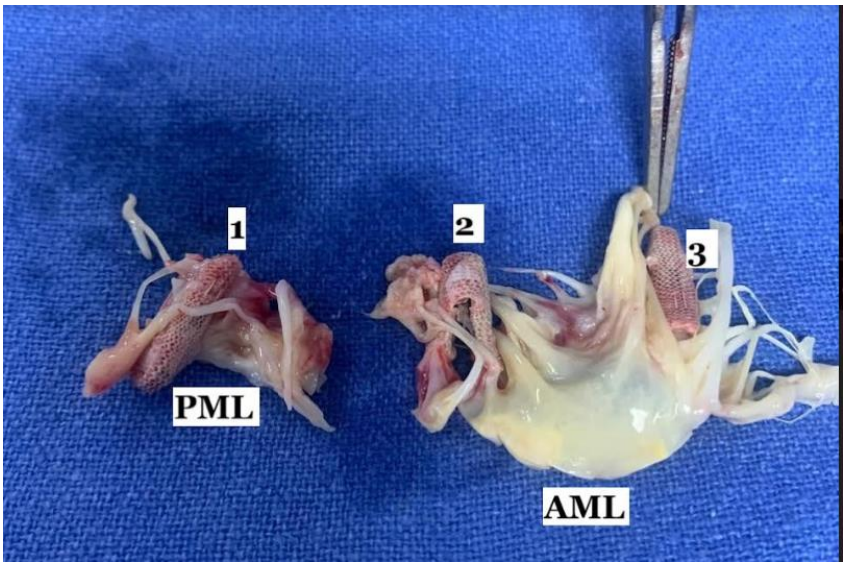

Figure 6: MitraClip™ arms (1, 2, and 3) entangled with chordae of the posterior mitral leaflet (PML) and anterior mitral leaflet (AML) removed during surgery

Discussion

The most plausible explanation for the entrapment of chordae and papillary muscles in this patient is the inappropriate positioning of the MitraClip™. There is also a possibility that the clip might have rotated during translation from the left atrium to the left ventricle. The first step to extract the entangled clip includes the reversal of the most recent maneuvers to the MitraClip™. On the contrary, a considerable adjustment in clip arm orientation in the left ventricle can itself result in clip-entanglement in the subvalvular apparatus. If the clip position is not satisfactory, raising the grippers and inverting the clip-arms, followed by retracting the inverted clip-arms into the left atrium may be helpful. Entanglement of the device in the subvalvular apparatus prevented raising the grippers and inverting the clip-arms in this patient. If the clip cannot be removed despite exhaustive attempts, an option is to deploy the clip onto the entangled subchordal mitral apparatus and remove it surgically, rather than tearing chords.

The MitraClip™ procedure is preferably performed in the hybrid operating room, a location capable of handling CPB and open-heart surgery.4 The advantages of a hybrid room include the immediate availability of critical personnel and resources, such as additional anesthesiologists, perfusionists, and CPB equipment. Severely impaired LVEF and comorbidities make MitraClip™ candidates less suitable for surgery. Franzen et al5 demonstrated that MitraClip™ implantation can be safely performed with promising results in patients with very reduced LVEF as 34% of their patients had an LVEF <20%. Moreover, the MitraClip™ procedure has shown beneficial effects on hemodynamics in the form of an increase in stroke volume and cardiac output as well as a decrease in left-sided filling pressures. The second, and sometimes third MitraClip™ placement immediately adjacent to the first MitraClip™ is required to stabilize and reduce the leaflet tension of the prior MitraClip™ and minimize the risk of subsequent leaflet detachment.

In a recent study performed by Chhatriwalla et al, the complication rate of MitraClip™ implantation was 8.5%.6 They assessed the relationship between operator experience and procedural results of the MitraClip™ in a cohort of 14,923 patients and found that 1,266 developed complications related to the procedure. The complications that arose due to the clip implantation itself, included: single leaflet device attachment, partial clip detachment, isolated leaflet damage, clip embolization, conversion to open heart surgery, and lack of procedural success. Mid-term results of the EVEREST trial have reported a conversion rate of 1.8% for open heart surgery and a procedural failure rate of 26%.7 With the development of technology and the availability of 'extended clip-arms' the risk of partial clip detachment has reduced from 11% to 0.2%. Another complication that requires urgent conversion to open heart surgery is clip embolization. Fortunately, it is extremely rare and constitutes only 0.1% of the cases.3 An anatomic variant, the intermediate accessory papillary muscle, and central chordae tendineae originating from it can impede the smooth handling of the clip and increase the risk of clip entanglement during the procedure.8

Compared to other transcatheter therapies such as transcatheter aortic valve implantation, periprocedural complication rates of MitraClip™ implantation are relatively low. Nevertheless, complications such as entanglement of the device in the subvalvular apparatus necessitating open heart surgery can happen.

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