Percutaneous Repair of Severe Eccentric Mitral Regurgitation Due to Medial Commissural Flail: Challenges for Imaging and Intervention

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INTRODUCTION

Percutaneous repair of severe mitral regurgitation (MR) is an important treatment option for patients deemed to be at high risk for surgical intervention.[1,2] The presence of a central regurgitant lesion is generally considered an important anatomic criterion to achieve optimal results.[2] We present a case of severe eccentric MR successfully treated with a MitraClip device (Abbott Vascular, Santa Clara, CA) and discuss the uniqueness of the procedure and the role of intraprocedural guidance by two-dimensional (2D) and three-dimensional (3D) transesophageal echocardiography (TEE).

CASE PRESENTATION

An 86-year-old man with a medical history of heart failure, chronic atrial fibrillation, hyperlipidemia, hypertension, and chronic anemia was referred to our valve center for severe MR. He reported worsening dyspnea (New York Heart Association functional class III) and progressive functional decline. On cardiac catheterization, coronary artery disease was documented (diffuse calcification and 75% stenosis of the mid left anterior descending coronary artery). Transthoracic echocardiography revealed a hyperdynamic left ventricle with normal right ventricular function, severe biatrial enlargement, and severe eccentric MR, with possible prolapse of the anterior mitral valve leaflet.

To better define the valve pathology and to enable procedural planning, TEE was performed with 3D image acquisition. On 3D TEE, the mechanism of the MR was noted to be a flail medial commissural scallop with evident ruptured chordae. Neither the mechanism of MR nor the eccentric regurgitant jet was visualized in the guideline-recommended[3] standard long-axis view (multiplane angle 120°–130°). The eccentric lesion required a modified imaging approach to visualize the nature of the anatomic pathology as well as the regurgitant jet (Figure 1, Videos 1 and 2).

Although the MR was originating from a commissural flail, the patient's surgical risk prompted the valve team to favor a catheter-based intervention over surgical correction of the MR.

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The patient underwent a MitraClip procedure under general anesthesia and with transesophageal echocardiographic guidance. The 3D imaging was pivotal in identifying the anatomic target for the MitraClip position.

A Preface sheath (Biosense Webster, Diamond Bar, CA) was placed in the right femoral artery using a modified Seldinger technique and guided to the right atrium. The left atrium was then accessed through a transseptal puncture. The positioning of such access is critical, as it governs the available range of motion of the MitraClip delivery catheter. For primary MR, the standard site for the transseptal puncture lies approximately 4.5 cm above the mitral valvular plane, but higher or lower puncture sites may be advantageous for medial or lateral commissural targets, respectively. Two-dimensional visualization of the interatrial septum and mitral annulus allowed identification of such a target. Tenting of the septum by the catheter was visualized using X-plane to confirm an appropriate location (Figure 2A). The transseptal puncture was performed under 3D transesophageal echocardiographic guidance with a Baylis radiofrequency needle (Baylis Medical, Montreal, QC, Canada). Upon accessing the left atrium, heparin was given for full anticoagulation. The Preface sheath was exchanged for the MitraClip delivery guiding catheter and the MitraClip delivery system. The MitraClip was advanced across the atrial septum along the guiding wire (Figure 2B). To target the medial commissural flail lesion, the MitraClip's arms were open and oriented in the "clock-face" plane (aortic valve at 12 o'clock) to be approximately aligned in a 10–4 o'clock position (Figure 2C) and then moved medially within the left atrium. The MitraClip was partially closed to create an "arrowhead" configuration (Figure 2D) before being guided across the mitral valve into the left ventricle. Once below the mitral leaflet, its arms were fully open again; because the crossing might cause rotation and translation of the device itself, the position had to be reconfirmed. Careful manipulation of the imaging settings, with progressive 3D gain reduction, allowed the visualization of the highly echogenic MitraClip arms below the thin mitral leaflets (Figure 2E, Video 3). A modified imaging plane, as discussed earlier, allowed ideal views of the valvular structures and the device arms for procedural guidance.

After multiple manipulations in the medial position, the medial commissural flail was secured within the MitraClip graspers, and the device was secured in place. Hemodynamic impact and grasp stability were evaluated before the device was released. Left atrial pressure measurement showed significant improvement of both the V wave and left atrial mean pressure (from 24 to 12 mm Hg and from 18 to 8 mm Hg, respectively). Mean Doppler-derived diastolic gradient was not significant (2 mm Hg). Final MR was assessed as mild (1+ using the Mitral Valve Academic Research Consortium classification[4]), confirming procedural success. The MitraClip device was thus

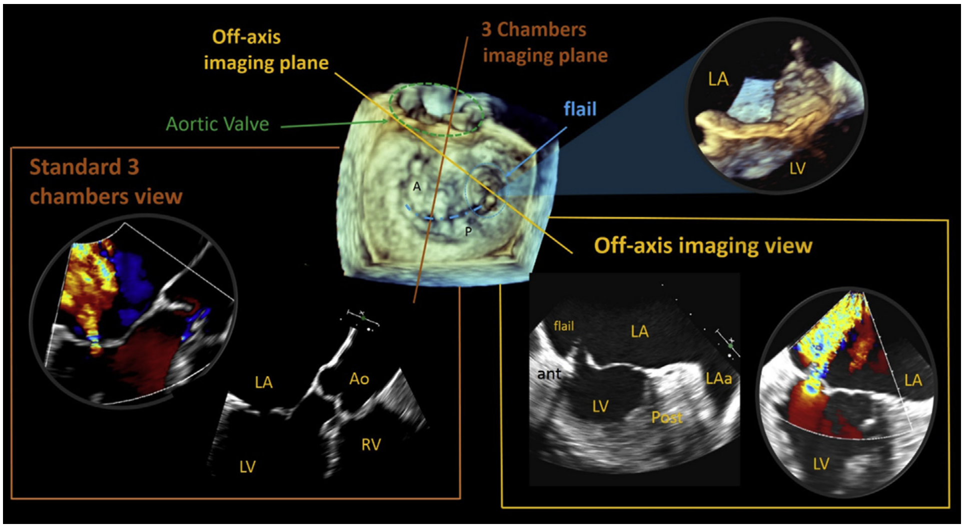

Figure 1 Standard LVOT long-axis imaging plane (currently recommended by guidelines for echo-guidance of the MitraClip procedure *[3]*) versus off-axis imaging plane: the MR severity and its mechanism could be fully appreciated only using a nonstandard imaging plane. *Ant*, anterior; *Ao*, aortic valve; *LA*, left atrium; *LAa*, left atrial appendage; *LV*, left ventricle; *RV*, right ventricle.

completely released from its guiding catheter, and the decision was made that no further MitraClips were required. Catheters and wires were removed.

At the end of the procedure, a clear tissue bridge between the lateral aspects of the two mitral leaflets was demonstrated from 3D en face visualization of the mitral valve, as well as effective repair of the flail leaflet tissue (Figure 3, *right*, Video 4).

The patient was discharged home the day after the procedure and was doing well at his 30-day follow-up clinic visit.

DISCUSSION

Percutaneous repair of severe MR has proved to be a valuable option for patients deemed at too great a risk for a surgical approach. In trials leading to the device approval,[1,2] only patients with "central" MR (i.e., originating from structural alteration involving the central scallops [A2/P2 lesions]) were included. This selection criterion was specified because of concerns of device interference with the subvalvular apparatus and difficulties in image guidance, potentially jeopardizing the success and safety of the procedure itself should a noncentral lesion be the target.

The mitral valve apparatus is a complex anatomic structure that performs because of the coordinated action of its key functional elements. The anterior and posterior leaflets are in continuity with the cardiac fibrous skeleton and the aortic valve and are connected to the contracting papillary muscles by a large number of chordae tendineae. These elastic structures are arranged in a complex network between the papillary muscles and the leaflets, either attaching to their free margin or just beyond it, in the ventricular aspect of the leaflets' "rough zone," with a predilection for the peripheral area. The central portion of the mitral valve, at the apposition of the middle anterior and posterior scallops (A2/P2 area), is thus characterized by a unique lack of chordae insertion. This chordae-free zone is an ideal space for MitraClip deployment and was thus defined as the preferred target for device implantation during the early experience with the device. With more lateral or more medial defects, the available space for MitraClip maneuvering becomes more limited, with added challenges both from an imaging and a procedural standpoint.

From an interventional perspective, navigating the delivery catheter in the lateral or medial position brings in the risk for device entanglement within the subvalvular apparatus and potential chordae rupture. Despite initial restricted trial indication for central mitral pathology,[1] >20% of the cases in the Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy Registry[5] dealt with noncentral lesions, indicating a significant potential new niche for the device. The final US Food and Drug Administration approval did not explicitly exclude non-A2/P2 lesions, but published data on the outcomes of the MitraClip procedure in this anatomic setting remain scant. In a small series of patients, Estevez-Loureiro *et al.*[6] reported similar procedural success rates and clinical outcomes for central versus noncentral MR and no entanglement (defined as manipulation of the system for >120 sec to free the MitraClip) or chordal rupture for the patients with noncentral MR. As in our case, operator experience played an important role in the procedure outcome.[7]

Extensive use of 3D echocardiographic technology was also of pivotal importance to the outcome achieved. The 3D views allowed us to gain a better understanding of the valve pathology and to monitor the reciprocal positioning of the target structures and devices, as these can be all depicted in a single view within the interventional space. Moreover, a case-tailored approach was used to optimize visualization with 2D imaging. Current guidelines[3] suggest the use of a standard long-axis 2D left ventricular outflow tract view on TEE to monitor the grasping of the leaflets by the device grippers, the pivotal step in MitraClip positioning. This approach (multiplane angle 100°–160°) traditionally grants visualization of the MitraClip arms in their long axis and of the most significant regurgitant leaflet pathology. However, this standard imaging plane primarily evaluates the