Masters of Cardiothoracic Surgery

Transcatheter mitral repair: MitraClip technique

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Submitted Oct 02, 2018. Accepted for publication Oct 23, 2018.
doi: 10.21037/acs.2018.10.14
View this article at: http://dx.doi.org/10.21037/acs.2018.10.14

Introduction

Surgical mitral valve (MV) repair remains the gold-standard for organic primary MV pathology. Patients with myxomatous degeneration with prolapsing or flail mitral leaflets are usually amenable to sternotomy or minimally invasive mitral repair strategies that yield excellent short and long-term clinical outcomes with durable repair.

Transcatheter mitral repair with the MitraClip System (Abbott Vascular, Santa Clara, CA) has been shown to be viable alternative to surgical mitral repair in patients with significant symptomatic degenerative mitral regurgitation (MR) with prohibitive surgical risk (1,2). By approximating the anterior and posterior leaflets together, the MitraClip mimics the 'Alifieri stitch' and achieves a double-orifice MV which reduces MR severity.

Clinical vignette

An 84-year-old lady with severe symptomatic organic mitral regurgitation presents with increasing exertional dyspnea. Symptoms have progressed to New York Heart Association (NYHA) III classification which have limited her mobility and quality of life. Comorbidities include significant frailty, chronic renal failure (stage 3), prior non-ST elevation myocardial infarct (NSTEMI), diabetes, moderate chronic obstructive pulmonary disease, significant pulmonary hypertension and non-obstructive coronary artery disease (previous percutaneous coronary intervention).

Echocardiography reveals slightly reduced ejection fraction (50%) with moderate right ventricular dysfunction. MR was severe with P2 prolapse, moderate annular dilatation and annular calcification (no mitral stenosis).

While patient was amenable to surgical MV repair technically, her comorbidities and elevated STS mortality risk was 15.8% and morbidity was 66%. Patient was offered a MitraClip transcatheter mitral repair procedure as a viable alternative leading to decreased morbidity.

Procedure technique

Patient was positioned supine in the hybrid operating room then general anesthesia was induced with endotracheal intubation. Invasive arterial monitoring was achieved via radial artery and large-bore venous access was inserted into right internal jugular vein. Swan-Ganz catheter is not used. Patient is then prepped and draped in the usual fashion with exposure both groins. Preoperative prophylaxis antibiotics are administered per usual protocol.

The MitraClip procedure at this point is usually divided into five separate procedural steps: (I) baseline imaging, (II) trans-septal puncture, (III) steering and positioning the MitraClip device, (IV) leaflet grasping, insertion assessment and deployment, and (V) post-release assessment, additional MitraClip placement and system removal (3). Unlike transcatheter aortic valve replacement (TAVR) or surgical MV repair, the MitraClip [along with other transcatheter mitral valve repair (TMVR) techniques] procedures require a team approach between echocardiographic guidance and proceduralist to achieve a successful result. Specifically, the "valve-team" should have a uniform terminology to discuss the navigation of the MitraClip hardware based on navigational echocardiography with 2D transesophageal (TEE) and 3D live TEE with X-plane and 3D en-face views being the most common. Unique features of the MitraClip allow for each mitral leaflet to be unilaterally engaged by a separate gripper and clip arm through a multi-step deployment sequence controlled by handles at the steerable guide, steerable sleeve or delivery handle. Each

of these handles allows for steering and directing the clip into separate direction (e.g., anterior, medial etc.) to allow for accurate positioning and clip delivery under TEE and fluoroscopy assessment.

Procedure

Baseline procedural imaging is important for accurate MV assessment and delineation of MR etiology and MitraClip placement strategy. More importantly, it is critical for excluding patients in whom MitraClip generally leads to inadequate results such as leaflet perforation, leaflet calcification, tethering or more than mild mitral stenosis.

The transseptal puncture (TSP) is first step of procedure through right femoral venous puncture and insertion of large bore sheath. This can be performed through the Baylis radiofrequency transseptal needle or the Brockenbrough needle and Mullins sheath approach. Whichever approach preferred by the operator, TSP is usually performed through a pull-back technique with slow steady retraction from superior vena cava (SVC) to mid-fossa ovalis under TEE guidance using bi-caval and 4/5 chamber views with X-plane along with fluoroscopic confirmation of catheter and needle location. Once an indentation is observed mid-fossa (i.e., tenting), the puncture is made at the superior and posterior aspect of fossa to allow for optimal insertion of guide catheter for easy maneuverability in the left atrium (LA) and delivery of MitraClip. The puncture also needs to be positioned 4 to 5 cm above the MV annulus in organic disease and around 3.5 cm in patients with functional disease since the line of coaptation is usually below the annular plane. Many sites often prefer to insert a pigtail catheter into the aortic root as an extra anatomic landmark to further delineate aortic anatomy during TSP. Once the puncture is made with a small needle, confirmation of the LA pressure is important to confirm anatomic location before further dilatation is carried out. Once confirmed, a small 0.018" wire is inserted into the LA then interatrial hole is dilated and Mullins sheath is advanced into the LA. Heparin is administered with ACT goal of 250. Pre-curved 260 cm stiff 0.035" wire is then inserted into the LA. A LA angiogram can be performed at this point to further confirm size and anatomy. Next, we remove the large bore sheath and insert the steerable guide catheter with cone-shaped dilator under fluoroscopic and 2D/3D TEE monitoring. The dilator and wire are removed with guide catheter placed at 3 cm into the LA across the septum.

The clip delivery system (CDS) is then advanced carefully into the LA until CDS tip ring marker is centered between sleeve alignment markers with fluoroscopic confirmation (i.e., straddling). Once this is achieved, the delivery guide and CDS are maneuvered within the LA carefully using TEE guidance to clear the LA wall, coumadin ridge and position the MitraClip centrally over the valve. This is achieved using minor, repetitive adjustments using torque and knob adjustments. With TEE observation in 3D short axis en-face view, the clip is unlocked, grippers are raised and the clip arms are opened to 180° with fluoroscopic confirmation. TEE is used to confirm perpendicularity at 12 and 6 o'clock positions with respect to the A2 and P2 leaflets. The Clip is then advanced through MV annulus in a location that splits the MR jet under TEE guidance in intercommissural 2D view with x-plane. Appropriate orientation of the Clip with alignment perpendicular to line of coaptation and freely moving leaflets above Clip arms is essential to ensure effective grasping of MV leaflets. Once in good position to maximize likelihood of firm grasp of both leaflets, under 2D TEE LVOT view, the leaflets are grasped with grippers arms then Clip arms are closed fully. Insertion assessment is assessed thoroughly with TEE LVOT as well as four-chamber views to confirm adequate 'tissue-bridge' between anterior and posterior leaflets. The amount of residual MR and mitral gradient are assessed. A useful hemodynamic adjunct can be assessment of the LA pressure v-wave compared to preoperative pressure (4). If the Clip position is not acceptable, the grippers are raised, Clip arms are inverted, Clip retracted into LA and repositioned for repeat attempt at crossing MV annulus and re-grasping. If the Clip position is acceptable, the Clip is then released through a series of maneuvers involving the DCS fastener, release pin, lock line, actuator knob and gripper lines. Care must be taken to ensure that the sharp end of DCS after Clip release does not cause leaflet or cardiac injury during the removal process.

Following release of the Clip, the team performs a repeat assessment of the residual result including achievement of a dual orifice MV with an effective 'tissue-bridge', residual MR and gradient. If second or more Clips are required, then this is performed in the same manner. The orientation and advancement of a second/third Clip into MV should be aligned parallel to initial Clip and in closed position to avoid entanglement with chordae tendineae. The subsequent Clips are reopened in the LV then subsequent leaflet grasp and MV assessment is performed in the same manner. Once procedure is concluded, DCS and steerable guide are withdrawn carefully under fluoroscopic monitoring,

heparin reversal is performed with protamine and groin pressure is applied for hemostasis. Aspirin is prescribed for 6–12 months often with clopidogrel for 1–3 months depending on treating team's recommendation.

Comments

Clinical outcome

The patient had a successful placement two MitraClip devices with significant reduction in MR from severe to mild and residual gradient of 3 mmHg. She was extubated in hybrid operating room and transferred to cardiovascular ICU overnight then moved to regular telemetry floor on first postoperative day. Pre-discharge TTE confirmed mild residual MR and she was discharge home on second day. Follow up visit at revealed improvement to NYHA II classification and more energy.

Advantages

MitraClip is the most commonly used TMVr procedure available to date. The MitraClip's most definite advantage has been its very good safety profile in high risk and frail non-surgical patients. In well-selected patients, this procedure offers a very good alternative to surgical mitral repair in high-risk or non-surgical organic MR patients. Favorable anatomic characteristics include a leaflet coaptation depth of less than 11 mm, coaptation length more than 2 mm, flail gap less than 10 mm and flail width less than 15 mm. Furthermore, recent data from the COAPT trial has shown favorable outcomes which may increase MitraClip (and TMVR procedures in general) within functional MR patients (5).

Caveats

The MitraClip procedure has a steep learning curve and requires the implanter to be intimately familiar with all associated knobs and maneuvers before achieving optimal MR-reduction outcomes and minimizing procedure time. Also, certain anatomic features make MitraClip procedure very difficult or not possible such as inter-atrial septal abnormalities, small atrial size (acute MR), leaflet tethering, large/small MV annulus, calcification or large flail gap or length. Moreover, surgical repair remains the gold-standard for primary organic MR in patients deemed operable due to improved short-term and long-term freedom from recurrent MR. Since residual MR is a predictor of recurrent progression of MR severity and adverse outcomes, MitraClip usually limits any future repair attempts and is best reserved for patients at high risk for surgical repair.

Cite this article as: Ramlawi B, Skiles J, Myers D, Ali O, Viens C. Transcatheter mitral repair: MitraClip technique. Ann Cardiothorac Surg 2018;7(6):824-826. doi: 10.21037/acs.2018.10.14

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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