Anesthetic Considerations & Management for MitraClip® Implantation

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Introduction

Mitral regurgitation (MR) is one of the most prevalent valvular heart diseases in the US, affecting more than 2.5 million adults in 2014, and is expected to double by 2030.[1] MR occurs when the mitral valve (MV) fails to close completely, resulting in retrograde blood flow from the left ventricle (LV) into the left atrium (LA). There are two types of MR: 1.) Primary (aka, Degenerative) MR, which occurs when the MV itself is dysfunctional, and 2.) Secondary (aka, Functional) MR, occurs when an abnormality outside of the MV, such as LV or LA dilation, causes the regurgitation.[2] Without surgical intervention, the prognosis for patients with moderate-to-severe MR is poor. However, nearly 50% of patients with severe MR are considered too high risk for traditional valve replacement surgery.[3,8] Fortunately, there are now minimally invasive options available to treat these patients.

Transcatheter Edge-to-Edge Repair of the mitral valve (mTEER) is a minimally invasive percutaneous treatment option for patients with moderate-to-severe MR. mTEER technology is based on the Alfieri stitch (aka "Bow-Tie Repair"), a surgical technique that involves placing a single suture between the middle segments of the anterior and posterior MV leaflets (A2-P2), resulting in the creation of two MV orifices and a considerable reduction in MR.[4,8] Currently, there are only two devices approved by the US Food and Drug Administration (FDA) for mTEER – PASCAL and MitraClip.

The MitraClip (Abbott Vascular) is an mTEER device used to treat MR in high-risk surgical patients. Since receiving FDA approval for primary and secondary MR in 2013 and 2019 respectively, MitraClip implantation volume has grown significantly, and MitraClip therapy has become a reliable treatment option for patients with MR.[4] As the prevalence of MR continues to rise, anesthesia providers will become more likely to encounter the MitraClip procedure and will increasingly be called upon to provide care for these high-risk patients. The intent of this presentation is to educate anesthetists on the MitraClip procedure and provide practical information to improve the anesthetic management of patients undergoing MitraClip implantation.

Figure 1.) Alfieri stitch[8]

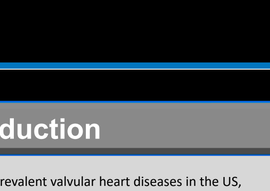


Figure 2.) MitraClip[8]

MitraClip Prevalence

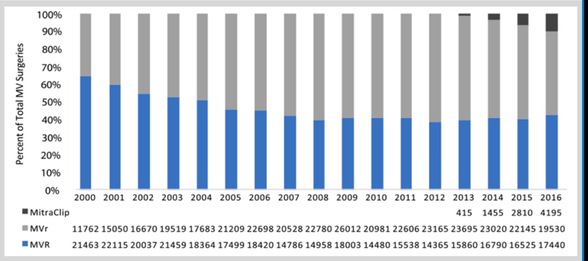


Figure 3.) Distribution of Mitral Valve Interventions[5]

Since receiving FDA approval for Degenerative MR, the number of MitraClip implantation procedures increased by ~80% annually from 2013 to 2016, while the total number of MV surgeries remained relatively consistent. Importantly, this data was collected prior to the FDA expansion approval of MitraClip for Functional MR in 2019. Therefore, it is reasonable to believe that MitraClip implantation now accounts for >20% of all MV surgeries in the US.

Anesthetic Considerations

Table 1.) Baseline Characteristics of Patients Who Underwent MV Intervention from 2000 – 2016 by Procedure Type[5]

	MVR (N = 298,102)	MVr (N = 349,053)	MitraClip (N = 8,875)
Average Age (years)	64.7	64.4	77.0
Comorbid Conditions (%)			
• Rheumatic Heart Disease	31.2	16.6	9.6
• Congestive Heart Failure	51	44.5	69.9
• Hypertension	48.8	51.3	66.3
• Peripheral Vascular Disease	7.1	7.1	12.5
• Chronic Lung Disease	21.3	17	26.3
• Diabetes Mellitus	24	17.4	33.5
• Diabetes Mellitus with Complication	14.4	14.3	17.6
• Obesity	3.3	3.3	6.8
• Liver Disease	7.9	7.6	8.8
• Chronic Kidney Disease	1.4	1.1	2.6
• Anemia	11.2	10.1	35.6
• Neurologic Disease	12.7	12.5	21.1
• Hypothyroidism	3.7	3.1	4.3
• Rheumatoid Arthritis	9.3	8.2	17.8
• Alcohol Abuse	2.5	1.9	4.2
• Drug Abuse	1.5	1.8	1.0
• Depression	1	0.9	0.6
Elixhauser Comorbidity Score, Median [IQR]	4.7	4.4	6.8
Severity of Illness (2002-2016)* (%)	6.8 [2.6-11.5]	6.2 [0.8-10.5]	10.1 [6.2-14.3]
• Minor	0	23.6	1.3
• Moderate	23.3	10.6	52.1
• Severe	76.7	65.8	46.7
Risk of Mortality (2002-2016)* (%)			
• Minor	0.1	17.8	7.4
• Moderate	47.2	37.9	46.3
• Severe	52.6	44.2	46.4
Observed Outcomes:			
• Length of Stay (Days), Median [IQR]	9.7 [6.4-15.9]	7.6 [5.0-12.9]	2.2 [0.9-5.0]
• Died During Hospitalization (%)	7.8	4.2	1.7

MVR = Mitral Valve Replacement; MVr = Mitral Valve repair
*Data was not available before 2002

Key Findings: MitraClip patients are considerably older and have more comorbidities yet demonstrate significantly better observed outcomes compared to patients who undergo traditional MV interventions (MVR + MVr).

The most common comorbidities in MitraClip patients are CHF, HTN, CKD, DM, and Chronic Lung Disease, which are present in >25% of all cases. These conditions must be considered when formulating and implementing a safe anesthetic plan.

Risk Stratification: Preoperative risk assessment is performed using MitraScore, a simple 8-item algorithm that reliably predicts postoperative mortality and supports clinical decision-making for patients treated with mTEER. The MitraScore assigns one point to each independent predictor, as shown below. With each point of the MitraScore, the relative risk of postoperative mortality increases by 55%.[3]

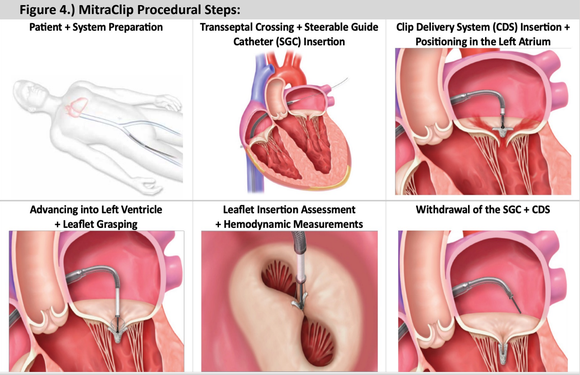
MitraScore	
Variable	**Points**
Age ≥ 75 years	1
LV EJ < 40%	1
Anemia	1
eGFR < 60 ml/min/1.73m^2	1
Peripheral Artery Disease	1
COPD	1
High Diuretic Dose	1
No therapy with RAS Inhibitors	1
Total:	8

Table 2.) MitraScore Preoperative Risk Assessment Algorithm

Anesthetic Management

MitraClip implantation is typically performed in cardiac catheterization laboratories under transesophageal echocardiographic (TEE) guidance. Due to the need for TEE guidance and careful device manipulation, the procedure is usually performed under general anesthesia with ETT placement, though several studies have demonstrated the feasibility of deep sedation as well.[6] Patients typically receive a pre/post-induction radial arterial line and defibrillator pads. Anesthetic induction strategies are patient-specific; however, the presence of severe MR and other comorbidities typically direct the hemodynamic goals. Optimization of anesthetic management is best achieved when providers understand the hemodynamic goals and potential complications associated with different steps in the procedural process.

Figure 4.) MitraClip Procedural Steps:



Patient + System Preparation: Defibrillator pads should be placed before induction of anesthesia. A cardio-stable induction technique utilizing high-dose opioids and low-dose propofol or etomidate is preferred for MitraClip patients due to their significant cardiac comorbidities. Arterial line placement is standard to allow for hemodynamic surveillance and activated clotting time (ACT) monitoring intraoperatively.[4,8]

Transseptal Crossing + SGC Insertion: Heparin is given to prevent clotting of the SGC and CDS. The procedural team will inform when to dose Heparin initially. An ACT goal of > 250 seconds should be maintained for the duration of the procedure. To minimize the risk associated with transeptal puncture (TSP), many anesthetists give ~3000 U of Heparin before TSP and wait to fully heparinize until access to the LA has been achieved without complication.[4,8]

CDS Insertion + Positioning in the LA: The primary anesthetic goal during this portion of the procedure is to optimize/maintain hemodynamics. Anesthetists should be aware that arterial hypotension may occur when the device crosses the MV (see below). Treatment should consist of IV crystalloids and vasopressors only if necessary.[4,8]

Advancing into the LV + Leaflet Grasping: As the clip is positioned and placed, it may occlude blood flow from the LA to the LV. Be prepared to treat the consequent hypotension but communicate with the procedural team as this phenomenon may be transient and you do not want to overtreat and cause hypertension. The procedural team may request a temporary suspension of mechanical ventilation to facilitate grasping of the mitral leaflets.[4,8]

Leaflet Insertion Assessment + Hemodynamic Measurements: Return the patient's vital signs to their baseline levels to allow for assessment of any residual MR and determination of the mean diastolic pressure gradient. If the clip requires repositioning, the previous steps will be repeated.[4,8] It is important to be aware that MR allows a systolic unloading effect by providing a low-resistance outlet for blood to travel back into the LA, presenting as a falsely elevated LV ejection fraction (EF) and potentially masking LV failure.[7] Therefore, patients may present postoperatively with a considerably reduced LVEF secondary to increased afterload from removing the low-resistance regurgitant pathway and may require inotropic support.

Withdrawal of the SGC + CDS: Protamine may be considered to reverse heparinization if required to facilitate hemostasis. If indicated, administer a test dose (1mg) and evaluate for signs of anaphylactoid reaction. Be cautious not to exceed an administration rate of 50 mg over 10 minutes. Before extubating, evaluate the patient's airway for possible bleeding from TEE probe manipulation.[4,8]

Case Report

An 82-year-old M with known 3v CAD, severe degenerative MR, pAF s/p Watchman, and recent GI bleed with NYHA Class II DOE considered too high risk for MVR/CABG and therefore presents for mTEER.

The procedure was performed under general anesthesia. The patient was intubated via direct laryngoscopy with a MAC 3 blade and 7mm oral, cuffed ETT. A post-induction radial arterial line was placed under ultrasound guidance for intraoperative hemodynamic monitoring. The procedural team instructed intraoperative ACT goals of > 250 seconds and HR goals of 80-100 bpm. Intraoperative TEE was performed to facilitate MitraClip placement and evaluate efficacy. The procedure was uncomplicated and lasted approximately 2.5 hours.

Induction:
Fentanyl: 200 mcg
Lidocaine: 100 mg
Propofol: 50 mg
Rocuronium: 100 mg

Maintenance:
Sevoflurane: 1.2% @ 2 L/min
Phenylephrine: 0.5 mcg/kg/min
Dobutamine: 1-2 mcg/kg/min
Dexamethasone: 4 mg
Vancomycin: 1g
Hydromorphone: 1 mg
Heparin per procedural team

Emergence:
Ondansetron: 4 mg
Sugammadex: 150 mg
Protamine: 20 mg

The next morning the patient received a TTE, which demonstrated a good position of the MitraClip and a stable ejection fraction. He was deemed stable for discharge and was sent home with recommendations to follow up in approximately one week, one month, and one year with echocardiograms.

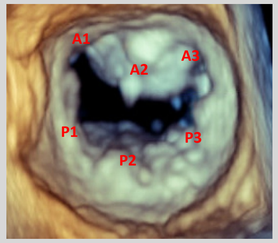


Figure 5.) Preoperative View of the MV

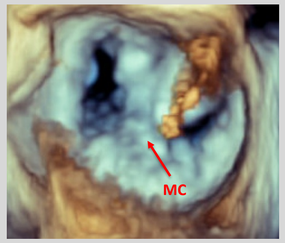


Figure 6.) Postoperative View of the MV

Preoperative TEE Interpretation: Severe, anteriorly directed mitral regurgitation due to flail P2 posterior leaflet. PISA = >10mm; consistent with Grade 4 mitral regurgitation.

Postoperative TEE Interpretation: Successful implantation of one clip along the A2-P2 scallops with mild residual mitral regurgitation. Mitral regurgitation is anteriorly directed and just lateral to the MitraClip. Mean diastolic gradient 3-4 mmHg.

Conclusions

MitraClip implantation is an increasingly popular mTEER procedure used to treat moderate-to-severe MR in high-risk surgical patients and anesthesia providers play a key role in caring for these patients. With a comprehensive understanding of common patient comorbidities, potential intraoperative complications, and opportunities to optimize perioperative care, anesthetists can help maximize procedural success and minimize the risk of procedural complications in this high-risk patient population.

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