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ANAESTHESIA CHALLENGES IN MINIMAL ACCESS MITRAL VALVE REPLACEMENT – CASE REPORT

Anaesthesiology

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ABSTRACT

Minimal Access Cardiac Surgery has evolved since the 21st century with major advances in techniques and technology. Scepticism regarding the safety of MACS has precluded universal adoption of MACS. 25/Male with RHD posted for Minimal access mitral valve replacement with h/o BMV in 2007. After placing basic ASA monitors and invasive lines, Patient was induced, SVC cannulation done through right IJV, IVC and Aortic cannulation through right femoral vein and artery respectively, all under TEE supervision. MVR was done through 6 cm right mini-thoracotomy incision. Post CPB, Patient was shifted to ICU, extubated within 2 hrs, discharged within 4 days.

Glossary of terms with abbreviations/acronyms

1. **Activated clotting time (ACT) -** test of coagulation that can be used to monitor anticoagulation effects, such as from high-dose heparin
2. **American society of Anaesthesiology (ASA) -** Educational, research and scientific association of physicians organized to raise the standards of the medical practice of anaesthesiology and to improve patient care
3. **Balloon mitral valvuloplasty (BMV) –** an inflatable balloon is used to increase the opening of a narrowed (stenotic) valve. It is used for select patients who have mitral valve stenosis with symptoms
4. **Cardiopulmonary bypass (CPB) -** is a technique in which a machine temporarily takes over the function of the heart and lungs during surgery, maintaining the circulation of blood and the oxygen content of the patient's body
5. **End tidal carbon dioxide (ETCO2) -** is the level of carbon dioxide that is released at the end of an exhaled breath
6. **Minimal access cardiac surgery / Minimally invasive mitral valve surgery (MACS/MIMVS) -** heart surgery performed through several small incisions instead of the traditional open-heart surgery that requires a median sternotomy approach
7. **Nil by mouth (NBM) -** a medical instruction meaning to withhold food and fluids
8. **Pulmonary artery systolic pressure (PASP) –** systolic blood pressure in the pulmonary artery estimated on 2D Echocardiography
9. **Rheumatic Heart Disease (RHD) -** a life-threatening heart condition which results from damage to heart valves caused by one or several episodes of rheumatic fever, an autoimmune inflammatory reaction to infection with streptococcal bacteria
10. **Trans-oesophageal Echocardiography (TEE) -** done by inserting a probe with a transducer down the oesophagus

KEYWORDS

INTRODUCTION

Minimal Access Cardiac Surgery has evolved since the start of 21st century with major advances in techniques and technology. Minimally invasive incisions measure about 2 to 3 inches compared to 8-to-10-inch sternotomy incisions. As a result, Minimal access cardiac surgeries are associated with significantly less postoperative pain requiring less analgesics, less morbidity and faster recovery.

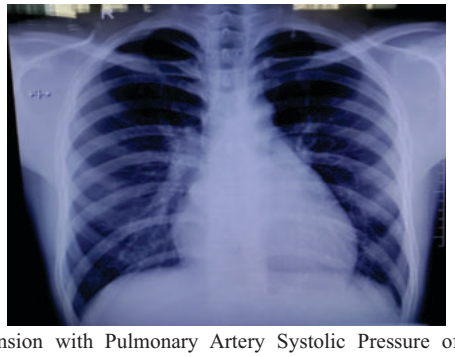
Concerns over reduced surgical exposure in highly complex operations, potential for prolonged operative times, difficulty to deal with technical complications through limited exposure, and a steep learning curve, has precluded universal adoption of MACS.

Anaesthesia for MACS is equally challenging. Apart from the safe conduct of anaesthesia for complex cardiac lesions, the anaesthesiologist confirms the diagnosis, placement of cannula and cardioplegia delivery. A patient-centric approach and clear communication between the surgeon, anaesthesiologist and perfusionist are vital for the success of MACS. Written and informed consent has been obtained from the patient for the publication of this Case Report.

Case summary

A 25-year-old male presented for Mitral valve replacement for mitral stenosis and regurgitation. The patient reported a history of mitral valve disease which was secondary to Rheumatic Fever in childhood. He had undergone Balloon Mitral Valvuloplasty in 2007. He was asymptomatic until past few months when he started experiencing easy fatigability, dyspnoea on exertion and orthopnoea.

On evaluation, his Chest x ray showed pulmonary congestion with mild cardiomegaly.ECG showed normal sinus rhythm. He was treated with Diuretics. His 2D-echocardiography revealed severe Mitral stenosis with mild to moderate Mitral regurgitation, severe Pulmonary



hypertension with Pulmonary Artery Systolic Pressure of 50-55 mmHg, LV ejection fraction of 60% and good RV systolic function.

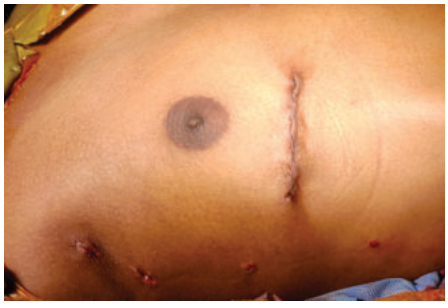
His medical history was unremarkable. His Preoperative examination revealed well-nourished male with no known allergies and no acute distress. His Height 171 cm and weight 59 kg. His vital signs were recorded. His airway examination was normal. His preoperative laboratory values were unremarkable. He was classified as American Society of Anaesthesiology class 4. Consent was obtained for Mitral valve replacement, invasive monitoring, transoesophageal echocardiography, blood products and General Anaesthesia and NBM status confirmed.

After shifting to the operating room, non-invasive monitors and 2 External Defibrillator pads were attached patient preoxygenated with O_2 supplementation via facemask. Patient was premedicated with 0.5 mg Intravenous Midazolam and 30 microgram Buprenorphine followed by placement of invasive lines, which included a right radial artery 3 Fr catheter and a left IJV 7 Fr triple lumen central venous catheter.

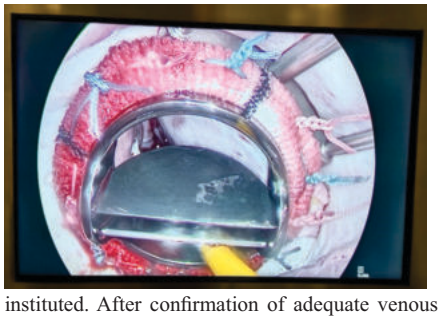
After preoxygenation with 100% FiO_2, Induction was achieved with 2 mg Intravenous Midazolam, 90 micrograms of Intravenous Buprenorphine and 14 mg of Intravenous Etomidate taking utmost care to avoid systemic hypotension. Any hypotension was treated with small boluses of Phenylephrine to prevent the fall in BP below the pulmonary pressures. Endotracheal intubation was facilitated with 60 mg Intravenous Rocuronium and 8.0 mm cuffed portex tube, placement confirmed with ETCO2 measurement and auscultation for bilateral air entry. A TEE probe was placed, and preoperative Echo findings confirmed.

Antibiotic prophylaxis was given 30 min before skin incision. Maintenance of anaesthesia was done with Isoflurane in a O2-Air mixture, intermittent boluses of Buprenorphine and Atracurium infusion @ 5 mcg/kg/min. 400 units/kg of Intravenous Heparin was administered for anticoagulation, anticoagulation confirmed on ACT. Superior Vena Cava cannulation for Cardiopulmonary Bypass, done through right Internal Jugular Vein with USG guided access and serial dilatation with the tip of the cannula close to the junction of SVC and right atrium was done by the anaesthesia team, confirmed on TEE using the mid-oesophageal bi-caval view. Inferior Vena Cava cannulation achieved through the right femoral vein with tip of the cannula close to junction of IVC and right atrium was done by the surgeon, confirmed on TEE. Arterial cannula was placed in the right femoral artery.

The procedure was carried out through a 6 cm incision in the 3rd intercostal space.



The middle part of the right mini-thoracotomy incision was positioned in the anterior axillary line. Two auxiliary working ports were established. One 5.5 mm working port placed in the same intercostal space, in the mid-axillary line was used for video assistance and for passing the pericardial stay sutures. Another 10.5 mm port was placed two intercostal spaces lower in the mid-axillary line. This port was used for the cardiotomy vent, CO_2 insufflation, and for other pericardial stay sutures.

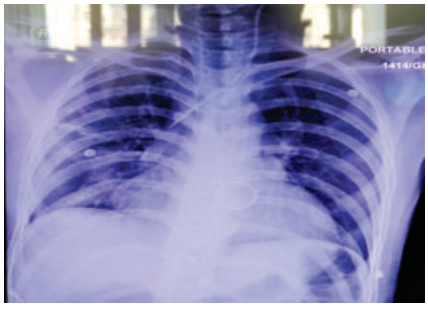


CPB was instituted. After confirmation of adequate venous return, Aorta was clamped directly through the thoracoscope, Cardioplegia was administered through a small cardioplegia cannula, and Cardiac arrest was achieved.

Midazolam 5 mg and Buprenorphine 300 mcg were given to maintain sedation and analgesia during CPB. Urine output was adequate during CPB. After rewarming, an Adrenaline infusion @ 0.05 mcg/kg/min and Noradrenaline infusion @ 0.02 mcg/kg/min were started. After adequate rest time,

Cardiopulmonary bypass was discontinued. Aortic cross-clamp time was 1 hr 17 min. TEE showed a prosthetic mitral valve with both leaflets opening adequately, no gradient across mitral valve and no paravalvular leak. Heparin reversal achieved with 250 mg IV Protamine after a test dose. Haemostasis was confirmed with an ACT value of 120 sec.

The patient was transferred to Intensive care unit, intubated, on Adrenaline and Noradrenaline infusions and full monitoring. He was extubated after 4 hrs postoperatively, Drains and invasive lines were removed on Post-operative Day 2 [SM-10], Mobilised on POD2, shifted to room on POD3 and discharged on POD4.



DISCUSSION

The Mitral valvular complex consists of the anterior and posterior leaflets, together with the annulus, chordae tendinae, papillary muscles and left ventricle. Rheumatic heart disease results in thickening and deformation of the mitral leaflets with subsequent insufficient coaptation and restricted mobility leading to Mitral valvular dysfunction.

Several important goals should guide the anaesthetic management of patients with mixed Mitral valvular lesions.

1. Prevent tachycardia - treat it promptly
2. Maintain sinus rhythm
3. Maintenance of LV preload without exacerbation of pulmonary vascular congestion
4. Avoid factors that aggravate pulmonary hypertension
5. Maintain afterload – avoid sudden changes
6. Maintain myocardial contractility

TEE is crucial.[1,2] The most important use of TEE in MACS is guiding proper positioning of SVC and IVC cpb cannula in mid-oesophageal bicaval view [SM-5, SM-6]. Evaluation of the mitral valve for anatomy, annulus size, area and quantification of lesion requires interrogation at mid-oesophageal four chamber (0º), mitral commissural (60º), two chamber (90º) and long axis (120º) views as well as Trans-gastric two chamber view (90º) for sub-valvular apparatus. It helps to evaluate the prosthetic valve for function, gradient and paravalvular leaks [SM-3, SM-4, Sm7].

TEE can help ensure that myocardial protection is adequate by visualization of cardioplegia flow in the left and right coronary arteries. Left ventricular distension during administration of cardioplegia can also be identified. We used a single lumen ET tube after taking surgeon's preference into consideration. A double lumen endotracheal tube can be used for single (left) lung ventilation if some difficulties during preparation are expected. Pleural adhesions, chest profile, and unfavourable intrathoracic working plane that can cause poor visualisation of the ascending aortic cannulation site could be reasons for double lumen tube insertion.[2]

Loulmet and Carpentier classified these levels of minimally invasive cardiac surgery into 4 types.[3,5,8]

Levels of ascent in minimally invasive cardiac surgery

Level 1	Direct vision	Limited (10–12cm) incisions
Level 2	Direct vision/video assisted	Mini (4–6cm) incisions
Level 3	Video directed and robot assisted	Micro (1.2–4cm) incisions
Level 4	Robotic (computer telemanipulation)	Port (<1.2cm) incisions

Potential Benefits of Minimally Invasive Surgery include [4]

- Avoids full sternotomy
- Small, right-sided, 4 cm mini-thoracotomy incision
- Shorter ventilation time
- Lower incidence of post-operative atrial fibrillation
- Reduced transfusion rate and reduced post-operative bleeding
- Shorter ICU stays
- Shorter hospitalizations stay
- Eliminates risk of sternal wound complication

- Reduction in post-operative pain
- Faster return to active life
- Lower risk of complications

One of the disadvantages of the right mini-thoracotomy approach is that it needs a learning curve for the surgeon and team to be able to perform the procedure through a smaller incision.[1] As several parts of the procedure are highly dependent on TEE, any contraindication to TEE should be considered a contraindication to MIMVS. Circumflex artery occlusion is a rare but serious complication of mitral valve surgery, and there may be an increased risk in MIMVS. Patency of the circumflex artery can be demonstrated by TEE.[2]

Unsuitable candidates:[3,6]

- Highly calcified mitral annulus
- Severe pulmonary hypertension, especially with a small right coronary artery
- Significant untreated coronary artery disease
- Severe peripheral atherosclerosis
- Prior right chest surgery
- Concomitant aortic or aortic valve pathology
- Reoperation

Cardiac surgeons worldwide have reported their MIMVS data. Most of these results suggest that MIMVS provide excellent, safe, and familiar exposure of the mitral valve with results comparable to those with conventional approaches. Studies reviewed do not show a significant difference in operative mortality between minimally invasive and conventional approaches.[7]Moreover, the long-term outcomes of these procedures appear to be as durable as the conventional approaches.[7] Increasing awareness of the actual and potential benefits of MACS is likely to result in greater demand by patients for MACS approaches in the future.

As for the future, minimally invasive cardiac surgery is likely to become more widely adopted as growth in this niche market and cardiac surgery is often patient driven, much in the same way that percutaneous intervention for multivessel disease has been.

Conflicts of interest: None

Figure Legends

SM 3 - TEE Mid-oesophageal two chamber view showing a functioning prosthetic valve at Mitral position.

SM 4 - TEE Mid-oesophageal two chamber view with colour doppler interrogation of prosthetic Mitral valve with central washing jets but no paravalvular leak.

SM 5 - TEE Mid-oesophageal Bicaval view. A guidewire is seen passing through the SVC into the Right Atrium.

SM 6 - TEE Mid-oesophageal Bicaval view. A cannula is seen in the SVC with the tip close to the SVC-Right Atrium junction.

SM 7 - TEE Mid-oesophageal long axis view with colour doppler interrogation of Prosthetic Mitral valve confirming the above findings as in SM 4.

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