MINIMALLY INVASIVE MITRAL VALVE REPLACEMENT (MIMVR) THROUGH RIGHT MINITHORACOTOMY: A SINGLE-CENTER EXPERIENCE FROM CENTRAL INDIA

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Abstract

Background: Minimally invasive mitral valve replacement surgery (MIMVR) is gaining popularity for its multifold advantages. Here we report our single-institution experience with MIMVR through the right minithoracotomy over two years.

Materials and Methods: This study was a retrospective analytical study. Forty-two patients undergoing MIMVR between August 2019 and July 2021 were included. Recorded perioperative data were collected and evaluated retrospectively.

Results: A total of 42 patients were included in the study, of which 29 were females (69%). The mean age was 43.2 $\pm$ 8.2 years. Overall 30-day mortality was 2.38% (n = 1). Mean operating time, cardiopulmonary bypass, and aortic cross-clamp times were 264.9 $\pm$ 48.7, 151.5 $\pm$ 39.8, and 89.8 $\pm$ 25.6 minutes, respectively. Tricuspid valve annuloplasty was performed in 8 patients (19%). One patient (2.38%) required conversion to median sternotomy, and three patients (7.1%) underwent re-explorations due to bleeding. The median postoperative hospital stay was 5 days.

Conclusions: MIMVR through right minithoracotomy is feasible, safe, and reproducible with low mortality and morbidity. Mitral valve surgery through a small anterior thoracotomy is a good alternative to conventional thoracotomy.

Keywords: minimally invasive, minithoracotomy, mitral valve replacement

Introduction

Minimally invasive cardiac surgery is gaining popularity, and various techniques for minimally invasive mitral valve replacement (MIMVR) have been developed recently. The use of MIMVR through the right minithoracotomy has been facilitated by advancements in the management of cardiopulmonary bypass (CPB) and the advent of special surgical instruments.

Compared with conventional sternotomy, the advantages of MIMVR are multi-folds. It has been shown to reduce postoperative pain and morbidity, enable faster recovery, return to complete activities, improve lung functions, and decrease ICU and hospital stay.[1] Although initiated as early as 2013, MIMVR was started to be done frequently towards the later part of the last decade at our center. The purpose of this study was to review early outcomes of MIMVR at our center and to examine the feasibility, safety, and effectiveness of MIMVR.

Materials and Methods

Patients

Forty-two patients, who underwent MIMVR through right minithoracotomy at our center from August 2019 to July 2021, were included in this study. Being a retrospective study, consent could not be obtained; however, written

informed consent was obtained from all the patients before surgery. Patients with the dilated ascending aorta (>40 mm), aortic regurgitation >grade 1, severe peripheral vascular disease, ascending aorta calcifications, and severe right pleural adhesions were excluded from the study.

Surgical Technique

Patients were intubated with a single lumen endotracheal tube. After general anesthesia was instituted, the right femoral vessels were exposed. Right minithoracotomy (5–7 cm) was performed through the 4th intercostal space, and the pericardium was opened. An additional small incision was made in the midaxillary line in the 2nd intercostal space for transthoracic aortic chitwood clamp placement: femoral arterial and venous cannulation done after systemic heparinisation. Correct positioning of the venous cannula was achieved under transesophageal echocardiographic guidance. The ascending aorta was clamped with a Chitwood clamp. A needle vent catheter delivered an antegrade cold crystalloid cardioplegia directly into the ascending aorta. The mitral valve was approached with a traditional left paraseptal atriotomy and exposed using an atrial retractor. The procedure was performed under direct vision.

Statistical analysis

Data are expressed as mean $\pm$ standard deviation (median, interquartile range [IQR]), and categorical data are expressed as frequencies or ratios. Testing of variables was compared by paired t-test. A p-value <0.05 was considered significant. Statistical analysis was performed with NCSS 11 Statistical Software 2016 (NCSS, LLC, Kaysville, UT, USA).

Results

From August 2019 to July 2021, a total of 42 MIMVR surgeries were performed at our center. Baseline patient characteristics are summarized in table 1. The mean age was 43.2 ± 8.2 years, and 69% were females ($n = 29$). 25 (59.6%) patients were in New York Heart Association (NYHA) functional class III and IV. Predominant valvular pathology was rheumatic, comprising 38 (90.4%) cases.

Table 1: Preoperative patient characteristics

Variables	Patients (n=42)
Age (years)	43.2 $\pm$ 8.2
Female gender	29 (69%)
BMI (kg/m ²)	23.1 $\pm$ 4.3
LVEF (%)	53.2 $\pm$ 12.8
T2DM	1 (2.4%)
COPD	3 (7.1%)
Arterial hypertension	4 (9.5%)
NYHA class	
i) and ii)	17 (40.1%)
iii) and iv)	25 (59.6%)
Mitral valve pathology	
-Rheumatic	38 (90.4%)
-Degenerative	4 (9.2%)

T2DM: Type 2 diabetes mellitus; COPD: Chronic Obstructive Pulmonary Disease; BMI: body mass index; LVEF: left ventricular ejection fraction.

Mean operating time, cardiopulmonary bypass, and aortic cross-clamp times were 264.9 ± 48.7 , 151.5 ± 39.8 , and 89.8 ± 25.6 minutes, respectively. Tricuspid valve annuloplasty was performed in 8 patients (19%).

Early outcomes

Overall 30-day mortality was 2.38% ($n = 1$). That patient manifested with low cardiac output syndrome in the early postoperative period due to low LVEF. Mean postoperative ventilation time was 6.7 ± 8.2 hours (median 7.0; IQR, 1.0–13.1); duration of intensive care unit stay was 42.0 ± 39.8 hours (median 35; IQR, 22.0–60.7), and total postoperative hospital stay was 4.2 ± 6.2 days (median 5; IQR, 4.0–9.0).

One patient (2.38%) required conversion to median sternotomy because of the main pulmonary artery (MPA) injury while manipulating the Chitwood clamp. After repair of MPA, further surgery was completed uneventfully. Re-exploration was performed in three patients (7.1%) with bleeding. In all cases, the revision was possible through the same minithoracotomy incision. Bleeding sources included intercostal artery in two and cardioplegic cannulation site in one patient. All patients had uneventful thoracic and groin wound healing. None of our patients suffered or required acute renal replacement therapy. One patient developed acute limb ischemia due to

thrombosis of the femoral artery. The patient underwent emergent femoral thromboembolectomy and recovered fully.

Discussion

Over the years, with advancements in surgical techniques and management of CPB, minimally invasive cardiac surgeries have refined considerably. Minimally invasive approaches have been used with increasing frequency for heart valve surgery in the recent past, and MIMVR is associated with comparable efficacy and excellent long-term results. [2] Overall 30-day mortality in our study was 2.38%, consistent with results reported in the Society of Thoracic Surgeons Database (STS) and various groups for conventional approach through the sternotomy. Gammie et al. reported results from the STS database. Operative mortality was 1.4% in the mitral valve repair group. [3] Perier et al. reported operative mortality of 2.9% for the mitral valve repair of posterior leaflet prolapse.[4] Our results were comparable to previously published studies on MIMVR. Glauber et al. reported in-hospital mortality of 1.1%.[2] Seeburger et al. from Leipzig group published 2.4% 30-day mortality. [5] Assessment of our patient cohort demonstrated that MIMVS is a safe procedure with excellent early outcomes and a low incidence of intra-operative complications.

The results of a meta-analysis conducted by the International Society of Minimally Invasive Cardiothoracic

Surgery (ISMICS) were published in 2010.[6,7] This study evaluated the effects of mitral valve surgery performed via a minithoracotomy versus results obtained using conventional sternotomy. The most important finding from this meta-analysis was a statistically comparable 30-day perioperative mortality confirming the safety of MIMVR. The meta-analysis concluded that MIMVR is a viable alternative to conventional mitral valve replacement, given the comparable short- and long-term mortality, comparable risk of postoperative complications (renal, pulmonary, cardiac, gastrointestinal), comparable reoperation rate, decreased sternal complications and blood transfusions, lower incidence of postoperative atrial fibrillation, shorter intensive care unit (ICU) stay, and shorter length of postoperative hospital stay.

We excluded those patients from the study who had undergone a previous right thoracotomy, as adhesions of the lung make dissection of the mediastinum a challenging proposition. Also, severe aortic or peripheral vascular disease in the form of an atherosclerotic process of the ascending aorta or severe atherosclerotic involvement of the pelvic and femoral arteries compromises the procedure's safety. Hence, it is recommended to perform CT-angiography of the aorta and femoral arteries in all patients. Where atherosclerosis is evident, some authors advocate using an alternative approach for cannulation, that is, central cannulation of the ascending aorta or axillary artery.[2] One of our patients developed thrombosis of the femoral artery at the cannulation site, hence taken up for emergent femoral thromboembolectomy, and her further postoperative course was uneventful.

There are concerns about the potential increased risk of stroke associated with MIMVR because of the perceived difficulty in deairing heart chambers, the retrograde blood flow in the descending aorta, or the longer duration of cardiopulmonary bypass. However, in propensity-matched comparisons published by Svensson and colleagues, by Holzhey and associates, and recently by Lange *et al.*, no differences in the incidence of thromboembolic events were seen.[8,9] In our study, too, there was no incidence of stroke.

Several previous studies have shown the significant clinical benefits of minimally invasive approaches. Santana *et al.* conducted a retrospective study of minimally invasive surgery in patients with COPD.[10] Patients treated with a minimally invasive procedure had lower hospital-related mortality than patients undergoing conventional sternotomy (1% versus 5%) and a significantly lower incidence of all postoperative complications (30% versus 54%, $p = 0.002$). The shorter length of stay in the intensive care unit (47 versus 73 hours, $p < 0.001$) and the shorter length of postoperative hospitalization (6 versus 9 days, $p < 0.001$) emphasize the benefit of the minimally invasive approach. In another study, Santana and colleagues

investigated the benefit of a less invasive approach versus sternotomy in obese patients (body mass index [BMI] >30 kg/m²).[11] More postoperative complications were noted in the sternotomy group, with a higher incidence of acute kidney failure, prolonged intubation, higher reintubation rate, higher mortality, and higher incidence of deep sternal wound infections.

Conversion from minithoracotomy to sternotomy was sometimes necessitated during MIMVR. Vollroth *et al.*[12] a study, which evaluated data from MIMVR in 3125 patients, demonstrated that it was necessary to proceed to conversion in only 1% of cases. In our study, only one patient (2.38%) required conversion to sternotomy. There was an injury to MPA during placement of chitwood aortic clamp across the aorta. As a visualization of MPA is not good from right minithoracotomy, we proceeded with conversion to sternotomy. Adequate control was obtained, and further surgery was completed uneventfully.

The experience with MIMVR in patients after previous cardiac surgery, in reoperations, was described by Seeburger *et al.*, who demonstrated a 30-day mortality rate of 6.6% (in 77% of patients, ventricular fibrillation was used).[13] These data suggest that right minithoracotomy is not only feasible in cases requiring reoperation but can be associated with lower-than-predicted mortality. Finally, Holzhey *et al.*, in a study, analyze the results of propensity-matched comparison of a less invasive approach in elderly patients >70 years of age.[14] No differences were observed between 30-day mortality (7.7% versus 6.3%, $p = 0.82$) and combined cardiac and cerebrovascular complications (11.2% versus 12.6%, $p = 0.86$).

Limitations

This study was retrospective with its associated shortfalls. Also, it was a single-center study, and only data of early outcomes were analyzed. A study with more extended periods of follow-up is necessary.

Conclusion

MIMVR is a feasible, safe, and reproducible approach with low mortality and morbidity. However, a prospective multicenter randomized study with longer follow-up is required to substantiate our research findings.

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