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Original Article

Mitral Valve Surgery by Right Minithoracotomy Vs Traditional Median Full Sternotomy

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ABSTRACT

Objective: To compare the clinical outcomes of mitral valve surgery through right minithoracotomy versus median full sternotomy.

Study Design: It was a comparative cross-sectional study

Place and Duration of Study: Carried out at the Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/ NIHD), from Dec 2013 to Mar 2020.

Methodology: From December 2013 to March 2020, 721 patients with various mitral valve diseases were treated at our institute with isolated mitral valve surgery. 50 patients had (MIMVS). 670 patients, on the other hand, underwent conventional median full sternotomy (MFS) mitral valve surgery. We selected 50 MFS patients with similar age, gender, Euro Score, NYHA functional class, Left ventricular ejection fraction (LVEF), mitral valve disease grade, renal and liver function. The outcome variables chosen for this study were cross clamp time (CXT), cardio pulmonary bypass (CPB) time, intensive care unit (ICU) stay, postoperative pain, and Length of stay (LOS).

Results: The majority (n=42, 84%) of MIMVS group patients had CPB time between 122-201 minutes, whereas, majority (n=33, 66%) of MFS group had CPB time between 81-134 minutes. In MIMVS group maximum number of the patients (n=36,72%) had ICU stay of 50-70 hours duration, whereas, in MFS group, maximum number of patients (n=40,80%) stayed in ICU for 10-30 hours duration. The mean CX time for MFS approach was 72.08 minutes while that for MIMVS was 96.9 minutes. Similarly, the median and mode for MFS were 68.5 minutes and 47 minutes respectively. Pain after surgery plus subsequent overall hospital length of stay (LOS) were reduced in MIMVS group.

Conclusions: MIMVS is related with elevated CPB and CXT, which subsequently resulted in longer ICU stay while reduced post-operative pain lead to decrease in overall hospital length of stay.

Keywords: Minimally invasive, Minithoracotomy, Sternotomy.

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INTRODUCTION

MIMVS has proven to be an effective alternative to the traditional full sternotomy approach.[1] In 2008, the AHA issued a scientific statement defining minimally invasive cardiac surgery as, "cardiac surgery performed without the standard full sternotomy through a small chest wall incision."[2] MIMVS can be performed under direct vision either through a right minithoracotomy (rib spreading) or partial sternotomy. Another method is a parasternal approach in which a 10 cm parasternal incision is given and 3rd & 4th costal cartilages are removed.[3,4] MIMVS can also be performed under videoscopic visualisation through even less invasive port minithoracotomy (non rib spreading) without robot assistance (endoscopically) or with robotic telemanipulation (totally endoscopi-cally). Regardless of the surgical approach, the fundamental objective of all MIMVS procedures is to prevent the complication of full sternotomy which include infection, mediastinitis, and nerve injuries,[5] while still offering a safe and effective choice for mitral valve surgery,[6,7] with the benefit of minimally invasive surgery such as reduced postoperative pain and surgical trauma, resulting in improved postoperative recovery and cosmesis.[8,9]

Following Carpentier et al's initial description of MIMVS in 1996,[10] the number of cases performed using this method has increased dramatically.[8,11] However, performing MIMVS usually means that the surgeons limit themselves to a very narrow operative field, with relatively weaker exposure, which remarkably increases the learning difficulty and learning curve.[12] de Vaumas *et al,* showed us that both CPB time and (CXT) in MIMVS was significantly longer than that in mitral valve surgery done through median full sternotomy (MFS).[11] Furthermore, due to the lack of specific guidelines, surgeons' opinions on absolute and relative

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contraindications to performing MIMVS continue to differ.[13] As most of our target population suffer from rheumatic heart disease and for them valve replacement was the only long lasting and economical option, so we assume MIMVS equivalent to minimally invasive mitral valve replacement where mentioned .

The study's goal was to assess MIMVS's safety and efficacy, as well as to compare it to the conventional MFS group.

METHODOLOGY

It was a comparative cross-sectional study carried out at AFIC/NIHD, Rawalpindi from December 2013 to March 2020, after approval of Institutional ethical review board (IERB LTR#26/08/R&D/2022/75).

Sample Size: All (n=50) patients who underwent MIMVS at AFIC/NIHD from December 2013 to March 2020, were selected.

721 patients with various mitral valve diseases were treated with isolated Mitral valve surgery. 670 patients underwent conventional median full sternotomy (MFS) mitral valve surgery. We selected 50 MFS patients who matched the criteria with 50 patients of MIMVS.

Inclusion Criteria: MIMVS patients were selected by consecutive non-probability sampling on basis of availability of instruments, trained manpower and patient's characteristics.

After matching the patients by age, gender, Euro Score, NYHA functional class, LVEF, grade of mitral valve disease, renal and liver function, 50 patients were selected for MFS group.

Exclusion Criteria: Patients who underwent concomitant Coronary Artery Bypass Grafting (CABG), Aortic valve surgery, tricuspid valve surgery or Atrial Septal defect closure were excluded from the study.

Data on patient demographics, operating factors and both immediate and short-term morbidity and mortality were gathered from the AFIC/NIHD cardiac surgery database.

To perform MIMVS, the patient was put on supine with a small pillow beneath the right scapula to uplift the right hemithorax. A double lumen endotracheal tube was used to intubate the patient. The anesthetist performed, Superior Vena Caval (SVC) cannulation percutaneously, through the right internal jugular vein and also inserted a trans-esophageal echo (TEE) probe, before draping. A 3 cm transverse right groin incision was made and under TEE guidance, the right femoral artery and vein were cannulated, to set up Cardio pulmonary Bypass (CPB). In the right 4th intercostal space, 4–6 centimeter minithoracotomy skin incision was given and right pleural cavity was entered under single left lung ventilation. To protect the wound, a soft tissue retractor was put inside, intercostal space was gradually retracted with a minithoracotomy chest retractor. The left atrial vent and carbon dioxide insufflator were placed through a separate stab incision in the right maxillary line in the 5th or 6th intercostal space. Before opening the pericarpdium, vacuum-assisted cardiopulmonary bypass was established and patient was cooled to 34ºC. A Cygnet aortic cross clamp,[14] was used to cross clamp the aorta. A long cardioplegic needle was used to deliver cold blood cardioplegia antegradely into the aortic root. A single dose of Del Nido cardioplegia gave comparable myocardial protection to normal blood cardioplegia during minimally invasive cardiac surgery (MICS).[15]

Even better results in terms of reduced myocardial injury may be obtained.[16] A left atriotomy was perfor-med after dissecting the interatrial groove. A specially designed left atrial retractor was inserted into the pro-thorax via a separate stab incision, and the left atrial incision was retracted in the direction of the sternum. The mitral valve is then examined and replaced or repaired under direct vision. After completing the mitral procedure, the left atriotomy was closed and 02 right ventricular epicardial pacing wires were placed. The aorta was declamped and deairing was performed via the cardioplegia puncture site on the ascending aorta. The patient was weaned off CPB and femoral cannulas were removed. After securing hemostasis and placement of pericardial and right pleural drains, the chest was closed in layers.

(CPB) time, cross clamp (CX) time, intensive care unit (ICU) stay, post-operative pain, & hospital length of stay (LOS) were all major outcomes of interest.

RESULTS

MIMVS is technically challenging for surgeons. Therefore, the overall CPB and CXT were more prolonged in MIMVS as compared to patients who underwent MFS approach to mitral valve replacement as shown in Figure-1 & 2. The majority (n=42, 84%) of MIMVS group patients had CPB time between 122-201 minutes, whereas, majority (n=33, 66%) of MFS group had CPB time between 81-134 minutes.

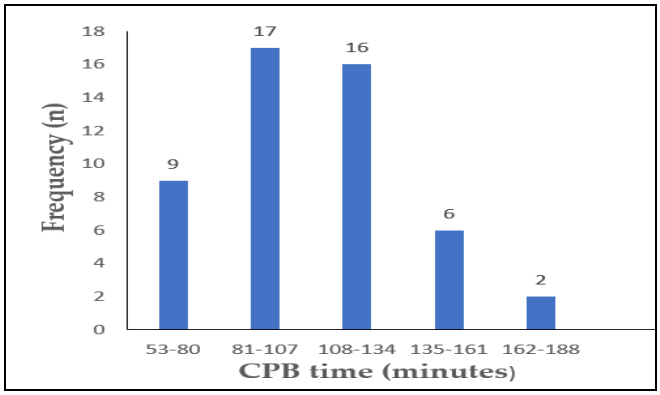

Figure-I: Median Full Sternotomy (MFS) Cardiopulmonary Bypass Time.

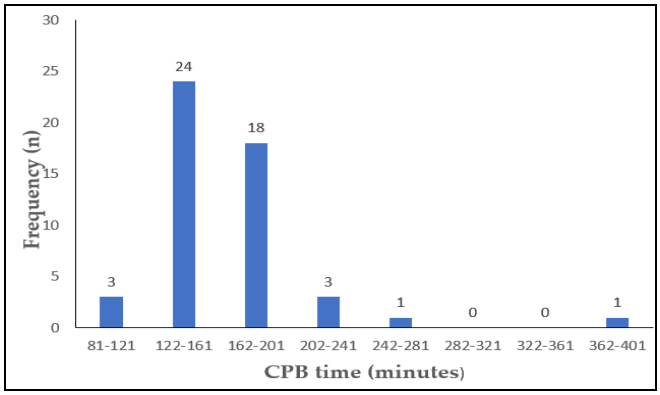

Figure-II: MIMVS Cardiopulmonary Bypass Time

In MIMVS group maximum number of the patients (n=36,72%) had ICU stay of 50-70 hours duration, whereas, in MFS` group, maximum number of patients (n=40, 80%) stayed in ICU for 10-30 hours. duration (Table-I).

As the CPB and CX times of MIMVS group were comparatively longer than that of MFS group. Normal distribution for CX time showed that the mean CX time for MFS approach was 72.08 minutes while that for MIMVS was 96.9 minutes. Similarly, the median and mode for MFS were 68.5 minutes and 47 minutes respectively. The same for MIMVS were 95 minutes and 100 minutes (Table-II).

One of the primary causes of morbidity following cardiac surgery is post-operative pain. Figure-3 shows a comparison between the post-operative pain resulting from both the techniques. As it can be inferred that patients undergoing MIMVS experienced pain less than or equal to 5 on a pain scale of 1-10 (as per pain scale questionnaire) as opposed to majority of the MFS patients who experienced pain more than 6.

Many studies have shown that the more post-operative pain patient complains about, hospital stay becomes longer, and therefore leading to increase in morbidity.

Table-I: Duration of ICU stay in patients of MFS & MIMVS

Duration of ICU stay (hours)	MIMVS Group (n=50)%	MFS Group (n=50)%
10 hrs	0 (0%)	28 (56%)
30 hrs	9 (18%)	12 (24%)
50 hrs	26 (52%)	2 (04%)
70 hrs	10 (20%)	4 (08%)
90 hrs	3 (6%)	1 (02%)
110 hrs	0 (0%)	1 (02%)
130 hrs	1 (2%)	1 (02%)
150 hrs	0 (0%)	1 (02%)
610 hrs	1 (2%)	0 (0%)

Table-II: CX Time of MFS & MIMVS

	Mean(min)	Median(min)	Mode(min)
MFS	72.08 min	68.5 min	47 min
MIMVS	96.9 min	95 min	100 min

ICU=Intensive Care Unit; MFS= Media Full Sternotomy; MIMVS= Minimally Invasive Mitral Valve Surgery

Majority of the MIMVS patients were discharged before 6th post-operative day as compared to their counterparts who left the hospital on or after 6th post-operative day.

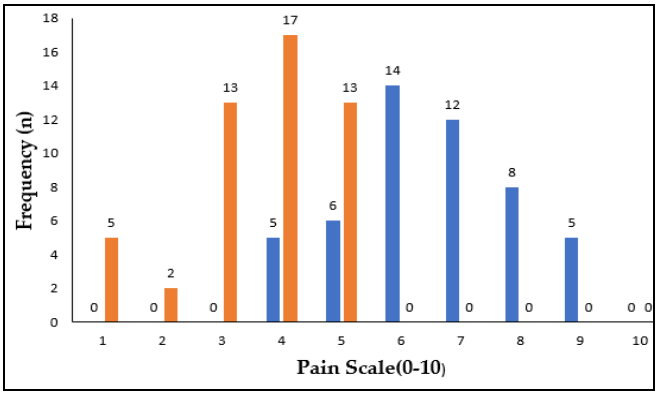

Figure-3: Pain Severity in MFS and MIMVS Patients

DISCUSSION

Since last two decades, there have been rapid development in the area of minimally invasive cardiac surgery, besides many studies have shown positive clinical outcomes with minimally invasive techniques. Improved patient satisfaction, less post-operative pain, decreased length of hospitalization and improved cosmesis have all been claimed attributable to

MIMVS.[17,18] As per earlier research, the baseline characteristics of median full sternotomy patients were considerably different from minimally invasive patients, with MFS patients having a higher perioperative risk.19 At our institute, the selection of a patient for MIMVS entailed a thorough evaluation of the suitability and safety of such a technique established on the patient's preoperative risk. Patients undergoing minimally invasive surgery had a lower BMI than MFS patients.[4] The majority of re-operative cases among unmatched pairs were performed using a MFS approach. With the passage of time, as our institutional experience grew, more number of cases with multiple risk factors were operated through minimally invasive technique. The MIMVS group's cross-clamp and CPB timings were longer than those of the sternotomy group (85.6 vs. 63.4 minutes for the Cx duration and 129.2 vs. 97 minutes for the CPB time, respectively).[20] Despite prolonged CPB durations 20, markers for both systemic inflammation and cardiac damage were not increased in the MIMVS group. Major perioperative complications and 30-day mortality between the two groups did not differ significantly. Patients with MIMVS and MFS both have excellent short-term survival rates. Thus, when compared to match MFS controls, a minimal access method for surgery of mitral valve did not seem to affect morbidity and mortality in our sequence. Moscarelli et al. performed a meta-analysis that comprised of 18 researches with a total of 1,905 patients, for analyzing multiple outcome measures such as: recurrence of moderate to severe mitral regurgitation (MR), need for redo surgery and in hospital mortality after MIMVS or MFS mitral valve surgery. On comparing the two groups, there were no significant differences in unsuccessful repairs (1.6% Vs. 3%), recurring MR or redo procedures (1.7% Vs. 1.3%), or hospital mortality (1% Vs. 1.3%).[20] In spite of imparting comparable clinical outcomes to conventional MFS method, the MIMVS group had a shorter overall length of hospitalization. MIMVS study participants had a two-day shorter overall length of stay, according to our analysis. Improved inpatient functional status may be one of the drivers of decreased hospital length of stay among MIMVS patients. The same have been observed by studies performed at other centres.[19,21,22] Postoperative follow up showed that stability and efficacy of mitral valve replacement was same in both group, neither para valvular leak nor mitral regurgitation occurred. Recovery of heart function was same in both groups Minimally invasive patients appear to reach significant physical therapy milestones more frequently than MFS patients, for obvious reasons. Furthermore, the shorter hospital stay may be due to improved postoperative respiratory function and less postoperative pain. But contradictory to that, Zhai *et al.* showed that the severity of pain was same in both the groups.[21] This difference might have been related to the difference in the target population. We as well as others have showed that a minimally invasive method is linked with overall improved patient satisfaction when reviewed in follow-up clinics.[17,18]

May be due to prolong single lung ventilation, increased proportion of minimally invasive patients were intubated for more than 24 hours, but the results were not statistically significant. After the MIMVS patient has been discharged from the hospital, a significant improvement in functional status may occur. In our series, post-operative pain was one of the factors that lead to reduced hospital length of stay but the exact cause is not entirely evident. Early on, there was concern that the MIMVS group, which required longer operating hours and more sophisticated operating instruments, would cost the healthcare facilities more money.[23]

However, later studies have shown that MIMVS may be less expensive than the standard sternotomy procedures.[24,25] The reasons for the decreased cost of MIMVS operations include brief hospital stay, less need of postoperative blood transfusions, and a lower occurrence of infection.[26] In an era of increasing financial constraints, a minimally invasive approach that results in shorter hospital stays has translated into lower overall resource utilization.

LIMITATIONS OF STUDY

Although we tried our level best to match the two groups, selection bias still cannot be ruled out as applicable to all retrospective studies. Early and late follow-up was limited in both groups. Moreover, the intricate and advanced surgical skills required for minimally invasive technique have a potential role with regards to increase in CPB and Cx times.

CONCLUSION

MIMVS is a reproducible, safe and efficacious surgical method compared with the traditional MFS approach and it should be more commonly utilized in surgical treatment of mitral valve disease.

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Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

MAK: Concept, manuscript writing, intellectual contribution, study design

TA: Manuscript writing, editing, data collection

NS: Data collection, data analysis, editing

AMJ: Data analysis, data collection, editing

MAI: Intellectual contribution, concept, final approval

SMHK: Concept, editing, final proof reading

RJ: Manuscript editing, data collection, analysis

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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