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Minimally Invasive Mitral Valve Surgery versus Median Sternotomy: The Assiut Heart Hospital Experience

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ABSTRACT

Objective: The aim of the current study was to compare minimally invasive mitral valve surgery (MIMVS) with conventional mitral valve surgery via median sternotomy. **Patients and methods**: A total of 73 patients were recruited for a mitral valve surgery either minimally invasive (27 patients) or conventional open heart (46 patients) mitral valve surgery. **Results**: Patients in the MIMVS group reported less bleeding with fewer rates of transfusion and shorter hospital stay. Moreover, no differences were reported regarding major complications including stroke and myocardial infarction. Also, there was no difference in total hospital costs. Meanwhile, the MIMVS group presented a significant rise in the time of cardiopulmonary bypass, cross clamp and procedure. Six weeks follow up showed no significant differences in mortality. The causes of death in the MIMVS patient and the 2 patients in sternotomy group were non-cardiac, but due to infection by covid-19 which ended by respiratory failure.

Conclusion: MIMVS could be more beneficial for mitral valve patients with consideration of inclusion criteria.

Keywords: Minimally invasive mitral valve surgery, Conventional mitral valve surgery, Invasive median sternotomy, Mitral valve, Clinical trial, Assiut University.

INTRODUCTION

Routine median sternotomy for mitral valve patients still exists worldwide. However less invasive approaches are now increasingly employed [1]. Although, minimally invasive procedures are considered the standard approach, whether they are superior to mitral valve sternotomy is still debatable [2].

The first minimally invasive mitral valve surgery (MIMVS) was described by **Chitwood *et al.*** [3] and by **Mohr *et al.*** [4]. **Sunndermann *et al.*** [5] used predominantly right anterio-lateral mini-thoracotomy in MIMVS. Clinical decision-making in patients with MV disease depends on including ventricular function, atrial dilatation and fibrillation, secondary pulmonary hypertension and sudden death [6]. Moreover, many studies reported good results for MIMVS compared with conventional sternotomy regarding less morbidity, surgery trauma, associated pain, hospital stay, and earlier return to full activities with improved cosmetic results [7,8]. This study aimed to compare the short-term outcomes between the minimally invasive and the sternotomy approaches in patients undergoing mitral valve surgery.

PATIENTS AND METHODS

The current prospective comparative study was performed at the Assiut Heart Hospital of Assiut University, Egypt during the period from March 2021 to September 2022.

Patients with mitral valve disease with or without mild to moderate tricuspid valve regurgitation were randomly assigned to either MIMVS or conventional mitral valve surgery through sternotomy. A simple randomization method was used. Patients were totally excluded from the study if they had an associated aortic valve disease, coronary artery bypass grafting, endocarditis, and/or were undergoing an emergency procedure. Also, patients were excluded from the MIMVS and assigned to conventional mitral valve surgery if they had dilated ascending aorta (>4 mm), aortic regurgitation (>1 mm), severe peripheral vascular disease, ascending aorta calcification, right lung surgery, and/or right pleural cavity adhesions.

All patients underwent routine investigations including complete history and clinical examination, pre-operative electrocardiogram and trans-esophageal echocardiography, post-operative transthoracic echocardiography at discharge, routine blood analysis, chest X-ray, cardiac markers and complete lipid profile.

Anesthetic technique: All patients underwent a standard induction protocol. Prior to surgery, pulse oximeter, 5-lead ECG, invasive and non-invasive blood pressure monitors were attached followed by the establishment of an intravenous line. Patients were pre-oxygenated with 100% oxygen before induction. Anesthesia was induced with 2 to 2.5 mg/kg IV propofol titrated at around 40 mg every 10 seconds, 5 µg/kg fentanyl, and either 0.5 mg/kg atracurium or 0.2 mg/kg cisatracurium. Vital signs were recorded at the various stages, including tracheal intubation, incision, opening of sternum, and transfer to ICU. Anesthesia was maintained with sevoflurane which

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was switched to 1.2% isoflurane, with infusion of anesthesia fentanyl 1 mg/kg/hour, and the same relaxant used in induction. Controlled mechanical ventilation with oxygen/air 50%:50% was used. In cases of heart rate drop or increase < 45/min and > 100/min, atropine or esmolol respectively were given. If SBP fells <80 mmHg, ephedrine, adrenaline, or dopamine was given.

Surgical technique: For the sternotomy group, median sternotomy and pericardial opening were performed. Cardiopulmonary bypass (CPB) was established using aorto- bicavel cannulation, with intermittent cardioplegia through cardioplegia cannula in the aorta. After the arrest of the heart, mitral valve was exposed after opening of the left atrium, and then mitral valve replacement was done.
For the MIMVS group, patients were took supine position with elevation of the right side of the chest and abduction of the right arm to expose axillary region and defibrillation pads were put externally. A right seven cm infra-mammary incision was done and via the fourth intercostal space the chest was interred. Femoral vessels were synchronously exposed by incision supra inguinal. Femoral arterial cannula inserted after heparin induction. Multistage femoral venous cannula was advanced to the right atrium. We opened the pericardial sac and we fixed the pericardium with retraction sutures. Aortic occlusion was done by using aortic clamp and CPB system was used. After cardiac arrest mitral valve was exposed by opening of the left atrium and replacement was performed. At the end of the procedure left atrium was closed, the chest wound was closed and drainage tube was applied.

Ethical Consideration:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Assiut University (IRB no. 17300904). Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

Analysis was performed in SPSS statistics for windows V.26. Quantitative data was expressed by M±SD and compared using independent T-test.

RESULTS

Among the recruited 73 patients, 27 (36.99 %) underwent minimally invasive mini thoracotomy while 46 (63.01 %) underwent conventional full median sternotomy. The discrepancy in number of patients in both groups is due to the presence of many exclusion criteria for the MIMVS technique. Patients who were originally randomly assigned to the MIMVS but had any of the exclusion criteria were re-assigned to the sternotomy group.

The pre-operative criteria of the two studied groups are shown in **table 1**. Patients in the MIMVS group seemed be younger with no significant difference (32.63 vs. 34.15) comparing to sternotomy group. However, creatinine concentration was significantly low in MIMVS comparing to sternotomy group (82.74 vs. 88.67). In addition, less symptoms were observed in the MIMVS group in terms of NYHA class III+ IV, 4 (14.8%) versus 8 (17.4%), respectively. Moreover BMI, LVEF, COPD, arterial hypertension and pulmonary hypertension showed no significant differences in the two groups. However, smoking was non-significantly higher in the sternotomy group comparing to MIMVS 11 (23.9%) and 5 (18.5%), respectively.

Table (1): Pre-operative criteria in the two surgical groups.

Variable	MIMVS (N=27)	Sternotomy (N=46)	P-value
Age (Years)	32.63±7.77	34.15±8.42	0.22
Gender Male: n (%) Female: n (%)	 9 (33.3%) 18 (66.7%)	 31 (67.4%) 15 (32.6%)	
BMI	28.37±1.82	29.46±1.52	0.15
Arterial Hypertension	8 (29.6%)	10 (21.7%)	0.7
COPD	3 (11.1%)	4 (8.7%)	0.5
Peripheral Arterial Disease	0	1 (2.2%)	1.0
Smoking	5 (18.5%)	11 (23.9%)	0.7
LVEF (%)	59.63±6.13	58.72±5.42	0.20
Pulmonary Hyper Tension	3 (11.1%)	6 (13.04%)	0.8
Creatinine Concentrations (µM/L)	82.74±4.88	88.67±5.25	0.001
NYHA			
I+II	9 (33.3%)	13 (28.3%)	0.7
III + IV	4 (14.8%)	8 (17.4%)	1.0
Mitral Valve Stenosis	2 (7.4%)	4 (8.7%)	1.0
Mitral Valve Pathology			
Rheumatic	27 (100%)	46 (100%)	--------

Perioperative and postoperative results are showed in tables 2 and 3. Surgery duration (264.74 versus 210.59, P <0.006), cardiopulmonary bypass (140.63 versus 102.15, P <0.001) and cross clamping (95.11 versus 82.61, P <0.006) were significantly longer in the MIMVS group than the sternotomy group. Moreover, MIMVS showed more percentage of delirium 3 (11.1%) vs. 2 (4.3%) in sternotomy. On the other hand, MIMVS showed less postoperative blood loss (447.78 versus

613.07, P <0.05) than sternotomy and less time of extubation (2.81 versus 3.82, P <0.05) respectively. Moreover, the present study revealed that ICU time and hospital stay were significantly shorter in MIMVS group compared to sternotomy group.

Meanwhile no significant differences reported between the two groups regarding major complications including cerebrovascular stroke, myocardial infarction and pneumonia. However wound infection was reported in two patients in sternotomy group while no infection reported in MIMVS.

Six weeks follow up showed no significant differences in mortality. The causes of death in the MIMVS patient and the 2 patients in sternotomy group were non-cardiac, but due to infection by COVID-19 which ended by respiratory failure.

Table (2): Intra-operative results in the two surgical groups.

Variable	MIMVS	Sternotomy	P-value
CPB (Minutes)	140.63±8.74	102.15±16.71	0.001
Cross clamp (Minutes)	95.11±12.72	82.61±14.96	0.006
Operation time (Minutes)	264.74±27.52	210.59±24.15	0.006
Transfusion	2.89±2.06	4.74±3.23	0.075

Table (3): Post-operative results in the surgical groups.

Variable	MIMVS	Sternotomy	P value
Delirium	3 (11.1%)	2 (4.35%)	1.0
Blood loss (ml/24hrs)	447.78± 256.02	613.07±233.35	0.05
Duration of mechanical ventilation (Hours)	2.81±1.21	3.82±1.42	0.05
ICU time (Days)	2.26±0.45	3.11±0.83	0.05
Total Opioid Consumption	387.1 ± 56.3	452.9 ± 55.7	0.01
Visual analogue pain score	3 (5)	4 (5)	0.06
Post-operative stay in hospital (Days)	5.89±0.85	7.92±1.55	0.01
6 weeks mortality	1 (3.7%)	2 (4.35%)	0.8
Pneumonia	2 (7.4%)	4 (8.7%)	1.0
Stroke	1 (3.7%)	1 (2.2%)	1.0
Wound infection	0	2 (4.3%)	0.1
Re-exploration for bleeding	2 (7.4%)	5 (10.7%)	0.9

DISCUSSION

Recently, minimally invasive approaches have been increasingly used for heart valve surgery. However, surgeons are still in doubt regarding their cost-effectiveness [1]. Our result showed that a minimally invasive approach is as safe as median sternotomy regarding short-term complications including mortality. Moreover, despite longer operative and cardiopulmonary duration, MIMVS showed significantly less blood loss and transfusions which goes hand in hand with the data obtained by [1,9]. Similarly, in a large-meta-analysis **Cheng *et al.*** [10] reported less bleeding and transfusion rates in MIMVS compared to sternotomy. However, **Paparella *et al.*** [11] reported no difference in the incidence of thromboembolic events between the two groups. **Santana *et al.*** [12] in their retrospective study of minimally invasive surgery in patients with chronic obstructive pulmonary disease, reported lower rate of hospital mortality and all postoperative complications than patients undergoing sternotomy. Moreover, **Yoo *et al.*** [13] in their retrospective study of patients had mitral valve surgery for degenerative mitral valve disease by mini-thoracotomy or conventional sternotomy, reported longer ICU and hospital stay in sternotomy group, while no significant difference reported in bleeding, renal affection or re-operation for recurring MR. Moreover, they reported lower mortality and stroke rates in minimally invasive group vs sternotomy group. Using minimally invasive mitral valve surgery, **Ko *et al.*** [14] reported stroke and mortality rates as low as 0.3% and 1.27%, respectively. Similarly, **Sundrmann *et al.*** [5] and **Al Otaibi *et al.*** [15] showed similar stroke and mortality rates in their two meta-analyses.

Meanwhile, in their high volume MIMVS Center, **Glauber *et al.*** [8] reported stroke and mortality rates in the ranges of 2.0% - 2.9% and 0.8-4.2%, respectively. However, **Murzi *et al.*** [16] reported that higher stroke risk in MIMVS was associated with retrograde arterial flow or the use of endo-aortic balloon. **Ko *et al.*** [14] reported a 5% re-exploration rate, which is comparable with many of the previous literatures. However, they reported excess 30-day mortality in patients with LVEF < 50 and with decreased glomerular filtration rate (GFR).

Cao *et al.* [17] in their meta-analysis is no statistically significant differences between the two surgical procedures except for a shorter hospital stay as well as longer CPB and cross clump time in MIMVS. Similarly, **Nasso *et al.*** [18] recorded that CPB, aortic cross clamp and operative time were significantly longer while ICU stay, respiratory dependency and hospital stay were significantly shorter in the MIMVS group. **Mohammed *et al.*** [19] observed in their study which included 340 MIS versus 414 MS patients that the quality of evidence by New castle –Ottawa scale was good for all patients. However, the study revealed that cardiopulmonary bypass

time was more in MIS patients. The authors added that, aortic-clamp time was longer in MIS patients. However, they reported no differences regarding motility, bleeding, and infection or staying at hospital. **Moscarelli *et al*. [20]** mentioned in their study which included 100 patients (50 underwent for MIS and 50 for MS) that the patients with MIS group showed a faster recovery of physical activity and better health related quality of life immediately in post-operative comparing to MS group.

Silva *et al.* [21] in their famous article reported that MIS technique associated with lower –intensity of pain starting from the third post-operative day and less pain sites comparing to MS procedures.

Padaline *et al.* [22] reported that the improving surgical outcomes in CHD patients stimulate surgeon's interest toward minimally invasive procedures to in order to reduce trauma and improve style of life and cosmetic outcomes, in addition to decrease hospital stay.

Limitation of the study: Inability to recruit more patients.

CONCLUSION

MIMVS is safe, effective, reproductible and with good short-term outcomes including low stroke and mortality rates compared to conventional sternotomy. In recommendation, MIMVS could be more superior to median sternotomy.

Disclosure

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REFERENCES

1. **Pojar M, Karalko M, Dergel M *et al.* (2021):** Minimally invasive or sternotomy approach in mitral valve surgery: a propensity-matched comparison. J Cardiothorac Surg., 16(1):228.
2. **Sündermann S, Czerny M, Falk V (2015):** Open vs. Minimally Invasive Mitral Valve Surgery: Surgical Technique, Indications and Results. Cardiovascular Engineering and Technology, 6(2):160-6.
3. **Chitwood W, Wixon C, Elbeery J *et al*. (1997):** Video-assisted minimally invasive mitral valve surgery. J Thorac Cardiovasc Surg., 114(5):773-80.
4. **Mohr F, Falk V, Diegeler A *et al.* (1998):** Minimally invasive port-access mitral valve surgery. J Thorac Cardiovasc Surg., 115(3):567-74.
5. **Sündermann S, Sromicki J, Rodriguez H *et al*. (1989):** Mitral valve surgery: right lateral minithoracotomy or sternotomy? A systematic review and meta-analysis. J Thorac Cardiovasc Surg., 148(5):1989-95.e4.
6. **Vahanian A, Alfieri O, Andreotti F *et al*. (2012):** Guidelines on the management of valvular heart disease (version 2012): the Joint Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). Eur J Cardiothorac Surg., 42(4):S1-44.
7. **Aybek T, Dogan S, Risteski P *et al*. (2006):** Two hundred forty minimally invasive mitral operations through right minithoracotomy. Ann Thorac Surg., 81(5):1618-24.
8. **Glauber M, Miceli A, Canarutto D *et al.* (2015):** Early and long-term outcomes of minimally invasive mitral valve surgery through right minithoracotomy: a 10-year experience in 1604 patients. J Cardiothorac Surg., 10:181.
9. **Grant S, Hickey G, Modi P *et al.* (2019):** Propensity-matched analysis of minimally invasive approach versus sternotomy for mitral valve surgery. Heart, 105(10):783-9.
10. **Cheng D, Martin J, Lal A *et al.* (2011):** Minimally invasive versus conventional open mitral valve surgery: a meta-analysis and systematic review. Innovations (Phila), 6(2):84-103.
11. **Paparella D, Fattouch K, Moscarelli M *et al*. (2020):** Current trends in mitral valve surgery: A multicenter national comparison between full-sternotomy and minimally-invasive approach. Int J Cardiol., 306:147-51.
12. **Santana O, Reyna J, Benjo A *et al.* (2012):** Outcomes of minimally invasive valve surgery in patients with chronic obstructive pulmonary disease. Eur J Cardiothorac Surg., 42(4):648-52.
13. **Yoo J, Kim J, Jung S *et al.* (2014):** Echocardiographic assessment of mitral durability in the late period following mitral valve repair: minithoracotomy versus conventional sternotomy. J Thorac Cardiovasc Surg., 147(5):1547-52.
14. **Ko K, de Kroon T, Post M *et al.* (2020):** Minimally invasive mitral valve surgery: a systematic safety analysis. Open Heart, 7(2):e001393.
15. **Al Otaibi A, Gupta S, Belley-Cote E *et al*. (2017):** Mini-thoracotomy vs. conventional sternotomy mitral valve surgery: a systematic review and meta-analysis. J Cardiovasc Surg., 58(3):489-96.
16. **Murzi M, Cerillo A, Gasbarri T *et al*. (2017):** Antegrade and retrograde perfusion in minimally invasive mitral valve surgery with transthoracic aortic clamping: a single-institution experience with 1632 patients over 12 years. Interact Cardiovasc Thorac Surg., 24(3):363-8.
17. **Cao C, Gupta S, Chandrakumar D *et al*. (2013):** A meta-analysis of minimally invasive versus conventional mitral valve repair for patients with degenerative mitral disease. Ann Cardiothorac Surg., 2(6):693-703.
18. **Nasso G, Bonifazi R, Romano V *et al*. (2014):** Three-year results of repaired Barlow mitral valves via right minithoracotomy versus median sternotomy in a randomized trial. Cardiology, 128(2):97-105.
19. **Mohammed H, Yousuf Salmasi M, Caputo M *et al*. (2020):** Comparison of outcomes between minimally invasive and median sternotomy for double and triple valve surgery: A meta-analysis. J Card Surg., 35(6):1209-19.
20. **Moscarelli M, Lorusso R, Abdullahi Y *et al.* (2021):** The Effect of Minimally Invasive Surgery and Sternotomy on Physical Activity and Quality of Life. Heart Lung Circ., 30(6):882-7.
21. **Silva J, Cavalcante M, Montenegro R *et al*. (2020):** Minimally Invasive Cardiac Surgery versus Sternotomy – Pain Investigation. Int. J. Cardiovasc Sci., 33(1):24-33.
22. **Padalino M, Pittarello D, Vida V *et al*. (2020):** Minimally Invasive Approach in Surgery for Congenital Heart Disease. https://www.semanticscholar.org/paper/Minimally-Invasive-Approach-in.