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Original Article

Right mini-thoracotomy versus median sternotomy for mitral valve replacement

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Abstract

Background: The advantages of minimally invasive mitral valve surgery over the conventional approach is still debated. This study aimed to evaluate early outcomes after mitral valve replacement (MVR) using the right mini-thoracotomy (RMT) versus median sternotomy (MS).

Methods: We prospectively included 60 patients who had MVR from May 2015 to June 2017. We classified patients into two groups; Group A (n= 30) had RMT, and Group B (n= 30) had MS. Postoperative pain score, wound satisfaction, and clinical and echocardiographic outcomes were compared between both groups.

Results: The mean age was 39.90 ± 12.34 years in Group A and 45.75 ± 13.10 years in Group B (p= 0.08). Preoperative and echocardiographic data showed no statistical significance difference between the groups. Group A had longer aortic cross-clamp (118.85 ± 40.56 vs. 70.75 ± 24.81 minutes, p<0.001) and cardiopulmonary bypass times (186.70 ± 67.44 vs. 104.65 ± 42.60 minutes, p<0.001). Group B had more blood loss (565 ± 344.3 vs. 241.5 ±89.16 ml/24 hours, p<0.001). The median pain score was 1 (range: 1- 3) in Group A and 4 (2- 8) in Group B (p<0.001), and the median wound satisfaction was 1.5 (1- 4) in Group A and 4 (1- 7) in Group B (p<0.001). Wound infection occurred in 1 (3.3%) patient in Group A and 6 (20%) patients in Group B (p=0.04).

Conclusion: Mitral valve replacement through the right mini-thoracotomy could be a safe alternative to median sternotomy. The right mini-thoracotomy was associated with longer operative times but better pain and wound satisfaction scores and lower wound infection.

KEYWORDS
Mitral valve replacement; Right mini-thoracotomy; Median sternotomy; Minimally invasive

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Introduction

Median sternotomy (MS) is the conventional approach for mitral valve surgery. In the late 1990s, minimally invasive mitral valve surgery (MIMVS) was introduced to the surgical options to manage mitral valve diseases [1]. This procedure can minimize surgical trauma, operative mortality, morbidity, and improve the quality of life. The reduced incision length may be of importance to young females and elders [2]. MIMVS has a limited operative field, which may negatively affect the outcomes and increase the risk of intraoperative

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myocardial and cerebral complications [3]. On the other hand, several surgeons believe that the technique is safe and reproducible with good cosmetic results [4].

It is not known whether the potential benefits of The MIMVS could outweigh the potential drawbacks of limited operative exposure, more prolonged cardiopulmonary bypass, and aortic cross-clamp times [5]. This study compared postoperative outcomes after mitral valve replacement (MVR) using the right mini-thoracotomy (RMT) versus conventional median sternotomy (MS).

Patients and Methods:

Design

This prospective observational study included 60 patients who had MVR between May 2015 to June 2017. The patients were grouped into two equal groups. The assignment to each group was based on the surgeons' choice and experience.

Groups and technique

Group "A" patients underwent MVR using RMT, and Group B included patients who had MS. In Group A, general anesthesia was conducted with a double-lumen endotracheal tube (DLT) with full monitoring. The patient was fully draped in the supine position, leaving two groin areas and right hemithorax exposed. We performed a 6-5 cm RMT incision at the 4th intercostal space (ICS), between mid-clavicular and anterior axillary lines at the sub-mammary crease. Using DLT, the right lung was deflated, and the pleural cavity was opened. Zero angle camera-connected to a screen was introduced into the pleural cavity through a 12 mm port at 4th ICS at the midaxillary line. The pericardium was inspected and opened longitudinally anterior to the phrenic nerve from the inferior vena cava (IVC) to the superior vena cava (SVC). Through 4 cm incision 2 cm below the inguinal ligament, cannulation of the femoral vein and artery was made. We used a soft tissue retractor at the RMT incision. A long cardioplegia cannula (CC) was inserted at the ascending aorta. Chitwood aortic cross-clamp (ACC) was inserted through 2nd ICS to occlude the aorta distal to the CC. Cardioplegia solution was infused to arrest the heart. Perfusionist goes down with temperature to 32 °C.

In group "B," 30 patients had MVR through MS. In this approach, the patient was positioned supine after general anesthesia with an endotracheal tube and full monitoring. The patient was fully draped, leaving all chest exposed from the suprasternal notch to level below the xiphoid process by 2 inches. The incision started from just below the suprasternal notch to the xiphoid process. Central cannulation was done with the aortic cannula in the ascending aorta and bicaval in the superior and inferior vena cava (SVC, IVC). We performed MVR with the same steps in both groups.

Table 1: Preoperative and operative data. Continuous variables are presented as mean and SD and categorical variables as number and percentages

	Group A (n= 30)	Group B (n= 30)	P-value
Age (years)	39.90 ± 12.34	45.75 ± 13.10	0.08
BMI (Kg/m2)	25.45 ± 2.31	25.68 ± 2.47	0.71
Atrial fibrillation	15 (50%)	21 (70%)	0.2
Ejection fraction (%)	62.20 ± 7.33	62.15 ± 8.32	0.98
RV diameter (cm)	2.13 ± 0.26	2.27 ± 0.47	0.16
PAP (mmHg)	55.65 ± 12.73	59.30 ± 15.31	0.32
LA diameter (cm)	5.48 ± 0.84	5.46 ± 0.67	0.92
ACC (minutes)	118.85 ± 40.56	70.75 ± 24.81	<0.0001
CBP (minutes)	186.70 ± 67.44	104.65 ± 42.60	<0.0001
TOT (minutes)	300.75 ± 74.50	237.00 ± 22.15	<0.0001

ACC: aortic cross-clamp; BMI: body mass index; CBP: cardiopulmonary bypass; EF: ejection fraction; LA: left atrium; PAP: pulmonary artery pressure; RV: right ventricle; TOT: total operative time

Table 2: Postoperative data. Continuous variables are presented as mean and SD or median (range) and categorical variables as number and percentages

	Group A (n=30)	Group B (n=30)	P-value
MV (Hours)	6.00 ± 3.63	7.10 ± 2.00	0.15
ICU (Hours)	48.80 ± 15.55	49.75 ± 26.55	0.87
Blood loss (ml/24Hr)	241.5 ±89.16	565 ± 344.3	<0.001
Blood transfusion (Units)	1.05 ± 1.00	1.30 ± 0.73	0.27
Pain score (mean)	1 (1- 3)	4 (2- 8)	<0.001
Wound satisfaction (mean)	1.5 (1- 4)	4 (1- 7)	<0.001
Wound infection (within 1 week)	1 (3.3%)	6 (20%)	0.04

ICU: intensive care unit; MV: mechanical ventilation

Data

Each patient underwent full history taking, clinical assessment, and preoperative laboratory, and radiological examinations. The echocardiographic assessment included measurement of the left ventricular ejection fraction (LVEF), the left atrial size (LA), right ventricle diameter (RV), and the pulmonary artery pressure (PAP).

Postoperatively, the patient was transferred intubated to the intensive care unit (ICU). We reported the duration of mechanical ventilation (MV), blood loss, need for blood transfusion, and ICU stay duration.

Questionnaires were conducted to assess the degree of pain related to the surgical wound using the visual analog scale and the wound's cosmetic result [6]. Follow up was carried out in the outpatient clinic postoperatively. The 6th-month postoperative TTE was routinely done to exclude pericardial effusion presence, ensuring a well-functioning mitral valve.

Statistical analysis:

Quantitative variables were expressed as mean and SD and compared with the t-test or Mann-Whitney test. Qualitative data were expressed as number (n) and percentage and compared with the Chi-square test or Fisher exact test. Statistical significance was tested using an IBM compatible computer and IBM SPSS statistics (version 15; SPSS Inc., Chicago, Illinois, USA). A p-value of less than 0.05 was considered statistically significant.

Results

Preoperative and operative data

The mean age was 39.90 ± 12.34 years in Group A and 45.75 ± 13.10 years in Group B. Preoperative and echocardiographic data showed no statistical significance difference between the groups. Aortic cross-clamp, CBP, and total operative times were significantly longer in Group A (Table 1).

Postoperative outcomes

Blood loss was significantly more in Group B, and pain score, wound satisfaction (including cosmetic-visual analog scale (VAS), patient satisfaction-VAS), and wound infection were better in Group A. While there was no difference in the duration of MV, blood transfusion, and ICU stay (Table 2). On comparing the 6th-month postoperative echocardiographic findings, we detected no significant difference between both groups (Table 3).

Table 3: The 6th-month postoperative echo-cardiographic data. Continuous variables are presented as mean and SD

	Group A (N=30)	Group B (N=30)	P-value
EF (%)	61.80 ± 6.67	62.65 ± 8.99	0.68
RV (cm)	1.95 ± 0.20	1.95 ± 0.52	0.968
PAP (mmHg)	31.50 ± 3.49	32.35 ± 4.51	0.42
LA (cm)	4.55 ± 0.49	4.81 ± 0.56	0.06

EF: ejection fraction, LA: left atrium; RV: right ventricle, PAP: pulmonary artery pressure

Discussion

Minimally invasive mitral valve surgery is becoming popular. Many advantages were obtained, including reducing surgical trauma, decreased bleeding and postoperative pain, reduced incidence of sternal wound infections, reduced length of hospital stay, and shortened recovery period after surgery [7].

In this study, we compared the outcomes after MVR through RMT vs. MS. the mean age and BMI matched similar studies [8,9]. While in comparison with a study done by EL-Fiky and associates, both groups were relatively older [10]. The mean age was 22 ± 10 years for the test group and 23 ± 9 years for the control group. But this was lower than the mean age in other studies [11]. That may be due to rheumatic etiology, which was the most common cause of valve pathology in both groups [10]. Both groups had similar preoperative echocardiographic parameters comparable with other studies [10-12].

In Group "A," ACC and CPB were significantly longer than Group "B." Similar results were found in other studies [5,12,13]. This could be attributed to the more technically demanding and time-consuming technique. While in another study by Iribane and coworkers [14], ACC for MIMVS decreased after considerable time because of the learning curve. Additionally, other authors reported significantly longer total cross-clamp time and total bypass time in minimally invasive mitral valve surgery [8,9]. In another study by Badkhal and associates [11], CPB time was 142.5 ± 25.1 in MIMVS and 126.7±27.2 in MS. Modi and coworkers [5] reported that CPB and ACC times were longer with MIMVS, but they suggested that ACC and CPB can be reduced with experience. Certain high-volume centers reported shorter operative times [15].

In this study, total operative time in Group "A" was significantly longer than that in Group "B." A similar result was found in another relevant meta-analysis of 9 studies by Cheng and associates [12]. Other studies showed non-significantly longer operative time [11, 16]. This increase in operative times may be due to new steps during MIMV, e.g., peripheral cannulation, using long-shafted instruments in a small operative field. These steps need to be mastered during the learning curve.

Postoperative bleeding in Group "A" was significantly reduced than that of Group "B" and the need for blood transfusion was significantly lower. Ideally, chest tubes are removed when drainage is less than 100mL over 8 hours [17]. Reduction in postoperative bleeding and transfusion requirements has been suggested as a potential advantage of MIMVS. This benefit is important as it decreases morbidity and mortality associated with transfusions and re-exploration for bleeding [18]. Ding and colleagues suggested that one of the main advantages of MIMVS is the reduction in blood loss and reoperation for bleeding [13].

In the current study, mechanical ventilation time and ICU stay were shorter in Group "A," but both were not significant. Similar results were found in other studies [11, 16]. Other studies reported significantly shorter mechanical ventilation time and ICU stay [8, 9, 19]. Another meta-analysis of 15 studies showed that mechanical ventilation time and ICU stay were significantly reduced [12]. On the other hand, Ding and his colleagues reported that prolonged ventilation in MS patients might be attributed to postoperative respiratory complications [13]. There was no strong evidence to confirm this result. The keys to successful early extubation include an appropriate balance of sedation and analgesia.

In our study, postoperative pain assessed with the visual analog scale was reduced significantly in Group "A" than that in Group" B," which was similar to another study [20]. Compared with MS, thoracotomy incisions were associated with less pain, discomfort, and postoperative analgesics. The most insightful evidence comes from 2 studies [21,22]. They reported that patients undergoing surgery via a minimally invasive approach as their second procedure, their recovery was faster with less pain than their original MS.

In this study, wound satisfaction was significantly higher in Group "A" than Group "B." This finding was observed in another study by Ding and coworkers [13], who reported 282 of 308 patients (91.5%) who were satisfied with the cosmetic result of RMT.

In the current study, there were no significant differences in postoperative echocardiographic data between both groups. These results are similar to other studies [23]. In their meta-analysis [12], Cheng and coworkers reported no significant difference in mitral valve leak or insufficiency, percentage of patients who developed infective endocarditis, and no difference in freedom from valve-related reoperation between groups at one-year follow-up. Gammie and associates [24] reported that reoperation for valve dysfunction was insignificant for MIMVS. Brittain and coworkers [25] reported similar results, with a mean follow-up of 19.1 ± 16.4 months. There was a significant reduction in right ventricular systolic pressure (RVSP) from 49.9 ± 16.2 to 41.7 ± 13.7 mmHg and a pattern toward a decline in the LA dimension. They reported a decrease in mean PAP. Dokhan and associates reported similar results as regards a decrease in mean PAP and LA diameter. PAP was 30.20±2.09 mmHg in 3 months postoperative TTE. LA diameter decreases to 4.38±0.51cm and 4.49±0.52 cm in both groups in their study [9].

Limitations:

This study was limited by small sample size, short-term follow-up, and inter-observer variability in interpreting the echocardiographic findings.

Conclusion

Mitral valve replacement through the right mini-thoracotomy could be a safe alternative to median sternotomy. The right mini-thoracotomy was associated with longer operative times but better pain and wound satisfaction scores and lower wound infection.

Conflict of interest: Authors declare no conflict of interest.

References

1. Cosgrove DM, Sabik JF,Navia JL. Minimally invasive valve operations. Ann Thorac Surg. 1998; 65: 1535–9.
2. Vanermen H, Wellens F, Geest DR. Video-assisted Port-Access mitral valve surgery: from debut to routine surgery. Will Trocar-Port-Access cardiac surgery ultimately lead to robotic cardiac surgery. Semin Thorac Cardiovasc Surg. 1999; 11(3): 223-34.
3. Mohr FW, Falk V, Diegeler A, Walther T, van Son JA, Autschbach R. Minimally invasive port-access mitral valve surgery. J Thorac Cardiovasc Surg. 1998; 115 (3): 567-74.
4. Anyanwu AC, Adams DH. Should complex mitral valve repair be routinely performed using a minimally invasive approach. Curr Opin Cardiol. 2012; 27 (2): 118-24.
5. Modi P, Hassan A, Chitwood WJ. Minimally invasive mitral valve surgery: a systematic review and meta-analysis. Eur J Cardiothorac Surg. 2008; 34: 943-52.
6. Bodian CA, Freedman G, Hossain S, Eisenkraft JB, Beilin Y. The visual analog scale for pain: clinical significance in postoperative patients. Anesthesiology. 2001; 95 (6): 1356-61
7. Kastengren M, Svenarud P, Ahlsson A, Dalen M. Minimally invasive mitral valve surgery is associated with a low rate of complications. JIM. 2019, 286 (6); 614–626.
8. Mahgoub AM, Elbanna TS, Abdelrahrman AM, Shafik M, Abdelraouf ME. Early outcome of thoracoscopic minimally invasive versus conventional mitral valve surgery in mitral valve diseases. A'-Azhar Med J. 2017; 46 (1): 105-12.
9. Dokhan AL, Abd El-Raouf ME, Ibrahim IM, Abdellatif MG. Evaluation of early outcomes after mitral valve replacement in rheumatic heart patients with pulmonary hypertension. Menoufia Med J. 2016; 29: 674–679.
10. El-Fiky M, El-Sayegh T, El-Beishry A, et al. Limited right anterolateral thoracotomy for mitral valve surgery. European Journal of Cardio-Thoracic Surgery. 2000; 17: 710–713.
11. Badkhal A, Thakre A, Joge U, Kawlkar U. Comparison of standard midline sternotomy and minimally invasive thoracotomy for mitral valve replacement. International Journal of Contemporary Medical Research. 2016; 3: 3218–3221.
12. Cheng D, Martin J, Lal A, et al. Minimally Invasive Versus Conventional Open Mitral Valve Surgery. A Meta-Analysis and Systematic Review. Innovations 2011; 6: 84–103.
13. Ding C, Jiang D, Tao K, et al. Anterolateral minithoracotomy versus median sternotomy for mitral valve disease: a meta-analysis. J

Zhejiang Univ-Sci B (Biomed & Biotechnol) 2014; 15: 522–532.
14. Iribarne A, Russo MJ, Easterwood R, et al. Minimally invasive versus sternotomy approach for Mitral Valve Surgery: A Propensity Analysis. Ann ThoracSurg2010; 90: 1471–1478.
15. Mihaljevic T, Cohn LH, Unic D, Aranki SF, Couper GS, Byrne JG. One Thousand Minimally Invasive Valve Operations Early and Late Results. Ann Surg. 2004; 240: 529–534.
16. Dogan S, Aybek T, Risteski PS, et al. Minimally invasive port access versus conventional mitral valve surgery: prospective randomized study. Ann Thorac Surg. 2005; 79: 492– 8.
17. Wolfe JA, Malaisrie SC, Farivar RS, et al. Minimally Invasive Mitral Valve Surgery: Surgical Technique and Postoperative Management. Innovations. 2016; 11: 251–259.
18. Konertz W, Waldenberger F, Schmutzler M,Ritter J, Liu J. Minimal access valve surgery through superior partial sternotomy: a preliminary study. J Heart Valve Dis 1996; 5: 638-40.
19. Binder Rk, Webb JG. Percutaneous mitral and aortic paravalvular leak repair: indications, current application, and future directions. CurrCardiol Rep. 2013; 15: 342.
20. Lucà F, Garsse L, Rao C, et al. Minimally invasive mitral valve surgery: a systematic review. Hindawi Publishing Corporation 2013; Article ID 179569, 10 Pages.
21. Felger JE, Chitwood WR, Nifong LW, Holbert D. Evolution of mitral valve surgery: toward a totally endoscopic approach. Ann Thorac Surg 2001; 72: 1203–9.
22. Vlessis A, And Bolling SF. Mini-reoperative mitral valve surgery. J Card Surg. 1998; 13: 468-470.
23. Aybek T, Dogan S, Risteski P, et al. Two Hundred Forty Minimally Invasive Mitral Operations Through Right Minithoracotomy. Ann Thorac Surg 2006; 81:1618 –24.
24. Gammie JS, Zhao Y, Peterson ED, Obrien SM, Rankin JS, Griffith BP. Less-invasive mitral valve operations: trends and outcomes from the society of thoracic surgeons adult cardiac surgery database. Ann Thorac Surg. 2010; 90: 1401–1410.
25. Brittain L, Goyal S, Sample M, et al. Minimally-invasive fibrillating mitral valve replacement for patients with advanced cardiomyopathy: a safe and effective approach to treat a complex problem. J Thorac Cardiovasc Surg 2014; 148: 2045–2051.