



Original Article

Postoperative Outcomes of Minimally Invasive versus Conventional Mitral Valve Repair; A Randomized Study

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Abstract

Background: Minimally invasive mitral valve surgery (MIMVS) is associated with less surgical trauma. However, its advantages over the conventional approach are controversial. This study aims to compare the early postoperative pain, hospital stay, and pulmonary function between minimally invasive and conventional mitral repair.

Methods: Fifty patients with non-ischemic mitral valve disease who had mitral valve repair between 2017 and 2019 were included in the study. Patients were randomly divided into two equal groups. Group A (n=25) included patients who had minimally invasive mitral valve repair via anterolateral mini-thoracotomy with video assistance, and Group B (n=25) included patients who had mitral valve repair via median sternotomy.

Results: The cross-clamp (99.45±16.01 vs. 87.5±19.16 min; p= 0.058) and the total bypass times (134.08±27.38 vs. 120.71±22.18 min; p= 0.35) were non-significantly longer in Group A. Operative time was significantly longer in Group A (207.08±44.31 vs. 173.54±28.25 min; p= 0.001). The ICU stay in Group (A) was 2.58±1.44 days, and in Group (B), the ICU stay was 3.75±1.77 days (p= 0.001). The hospital stay was 7.87±1.59 days in Group A, and 14.5 ±5.05 days in Group B (P<0.001). Postoperative FEV1 was 2.06±0.63 L in Group A and 1.39±0.43 L in Group B (p= 0.001). There was no difference in postoperative ejection fraction between both groups (p= 0.9).

Conclusion: Minimal invasive mitral valve repair could reduce postoperative pain, length of ICU, and hospital stay and improve the postoperative respiratory function when compared to the conventional approach.

KEYWORDS

Minimal invasive mitral valve surgery; Mitral valve repair

Article History

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Introduction

Minimally invasive techniques are less traumatic compared to conventional approaches. Minimally invasive mitral valve surgery (MIMVS) has gained popularity in the last decade [1–3]. The routine use of MIMVS is associated with less surgical trauma, postoperative pain, blood loss, ventilation time, intensive care unit, and total

hospital stay. This could lower the load on postoperative rehabilitation services, increase the turnover, and improve the postoperative cosmetic results. In addition, it has lower postoperative complications compared to the conventional method [3–5].

It was found that the stress response in minimally invasive surgery is much less than the

conventional approach. Stress hormones, including catecholamines, steroids, and thyroxin, were lower in patients who had minimally invasive surgeries [1,2,5,6].

Patient selection for MIMVS is crucial to avoid the risks of vascular complications caused by femoral cannulation and retrograde perfusion [3,5]. Mitral valve repair needs well-trained surgeons as well as optimal exposure and valve visualization to enable surgeons to make precise analyses and assessments of the diseased valve. Thus, in this study, we compared the early outcomes of minimally invasive mitral valve repair to the conventional approach.

Patients and Methods:

Study design

This research is a randomized study conducted in the National Heart Institute, Giza, Egypt, from May 2017 till April 2019. The Ethical Committee approved the study, and informed patients' consents were obtained.

Inclusion Criteria

We included 50 patients with non-ischemic mitral valve disease with or without tricuspid valve disease. We divided the patients randomly into two equal groups. Group A (n=25) included patients who had minimally invasive mitral valve repair via anterolateral mini-thoracotomy, and Group B (n=25) included patients who had mitral valve repair via median sternotomy.

Exclusion Criteria

We excluded patients who had concomitant surgery, redo sternotomy, or contraindications to femoral cannulation or peripheral vascular disorders. Additionally, we excluded patients who had prior right lung surgery or radiotherapy to the right side of the chest and impaired preoperative pulmonary function.

Study data

All patients had a preoperative examination, full laboratory investigations, echocardiography, and pulmonary function tests. Coronary angiography was performed when indicated. We recorded the type of repair, cardiopulmonary

bypass and cross-clamp times, and operative complications.

The amount of blood loss, duration of mechanical ventilation, ICU and hospital stay, postoperative complications, and postoperative pain severity were compared between groups.

Surgical Technique:

Induction of general anesthesia was performed with propofol, pancuronium, and fentanyl and maintained with propofol and fentanyl. In the MIMVS group, single-lung ventilation was used for all patients.

The femoral cutdown technique was adopted for femoral cannulation for all patients. After the preparation of the groin, a transverse skin incision was made over the femoral vessels just below the inguinal ligament. After that, the dissection was performed to expose the femoral artery and vein; then, a purse-string (5-0) Gortex suture was placed.

A femoral vein was punctured, then, the guidewire was passed through the introducer sheath and was introduced into the right atrium under echocardiographic guidance. The sheath was removed; venous cannula dilators were essential in tunneling the cannula path, then the venous cannula sized (23-25 Fr) multistage quick draw cannula was introduced over the guidewire until it reached the final position. The venous cannula was de-aired by partially unclamping and expelling blood before connecting to the venous line.

The femoral artery was cannulated with (16-18 Fr) Edward Femoral Cannula. Then a stay suture was placed on the skin as a tourniquet over the cannula body to secure it in place.

The MIMVS group patients underwent right anterolateral mini-thoracotomy via the 4th intercostal space. Once the thoracotomy was performed, two working ports were made. The pericardial incision was performed with strict precautions to avoid phrenic nerve injury, so; we keep the incision 3-4 cm above the phrenic nerve. A standard cardioplegia catheter was placed in the

Table 1: Demographic and Perioperative Data

	Group A (n= 25)	Group B (n= 25)	P-value
Age Mean±SD	42.72±12.67	49.52±12.38	0.061
Gender n (%)			
• Males	5 (20%)	6 (24%)	
• Females	20 (80%)	19 (76%)	
BMI Mean±SD	28.48±4.82	28.08±4.15	0.754
NYHA Class	2.44±0.82	2.32±0.75	0.591
Comorbidities			
• AF	12 (48%)	14 (56%)	
• Hypertension	6 (24%)	10 (40%)	
• Diabetes mellitus	5 (20%)	8 (32%)	0.09
• COPD	3 (12%)	0	
Mitral Valve pathology			
• Annular dilatation	8 (32%)	6 (24%)	
• Barlow disease	12 (48%)	14 (56%)	
• Rheumatic Fever	5 (20%)	5 (20%)	0.8
Tricuspid Valve disease	8 (32%)	15 (60%)	0.032
Preoperative ECHO			
• EF (%)	60.04±8.34	60.52±6.18	0.818
• LVESD	3.50±0.58	3.29±0.62	0.220
• LVEDD	5.24±0.68	5.11±0.85	0.563
• LA	5.12±0.80	5.48±0.92	0.158
• PASP	46.44±14.81	50.16±12.06	0.335
Preoperative PFTs			
• FEV1 (L).	2.42±0.72	2.67±0.68	0.216
• FVC (L).	2.68±0.78	2.86±0.66	0.386
• FVC (%).	65.50±13.62	65.35±7.53	0.853

BMI = Body Mass Index; NYHA = New York Heart Association; AF = Atrial Fibrillation; COPD = Chronic Obstructive Lung Disease; EF = ejection fraction; LVESD = Left Ventricular End Systolic Diameter; LVEDD = Left Ventricular End Diastolic Diameter; LA = Left Atrium; PASP = Pulmonary Artery Systolic Pressure; FEV1 = Forced Expiratory Volume in the first second; FVC = Forced Vital Capacity.

ascending aorta, and the infusion and venting lines were connected in the usual fashion.

The aorta was clamped with the Chitwood clamp and inserted laterally in the 2nd intercostal space. Once the aortic cross-clamp was correctly placed, the antegrade cardioplegia with a single dose of the crystalloid solution was delivered. The temperature during cardiopulmonary bypass was maintained at 32° C.

The left atriotomy was performed, and the mitral valve was exposed then the mitral valve evaluation was performed.

Statistical analysis:

Data were analyzed using the Statistical Package for Social Sciences (SPSS) software program (version 23) (IBM Corp, Armonk- NY, USA). The qualitative variables were recorded as frequencies and percentages and compared with the chi-square test or Fisher exact test when appropriate. The quantitative measures were presented as means ± standard deviation (SD) and were compared with student t-test. P-value < 0.05 was considered significant.

Results

Patient characteristics and preoperative data were summarized in Table 1. Fifty cases had mitral

Table 2: Intra-operative Data

	Group A (n= 25)	Group B (n= 25)	P-Value
CPB (min)	134.08±27.38	120.71±22.18	0.350
Cross-clamp time (min)	99.45±16.01	87.5±19.16	0.058
Total operative time (min)	207.08±44.31	173.54±28.25	0.001
Incision length(cm)	5.6±0.65	20.25±2.32	0.001
Ventilation time (hs)	5.68±1.42	10.64±4.95	0.001
Blood Loss (ml)	243.2±76.72	490.2±192.42	0.001
Blood Transfusion (No. of patients)	2 (8%)	5 (20%)	0.159
ICU Stay	2.4 ± 1.08	3.68 ± 1.52	0.001
Postoperative PFTs			
• FEV1 (L).	2.06±0.63	1.39±0.43	0.001
• FVC (L).	2.22±0.61	1.48±0.45	0.001
• FVC (%)	57.98±12.33	38.78±10.80	0.001
Postoperative ECHO			
• EF (%).	56.37±5.94	56.25±3.42	0.929
• LVESD	3.68±0.59	3.46±0.57	0.205
• LVEDD	5.23±0.64	5.07±0.85	0.485
• LA	4.89±0.62	5.30±0.86	0.062
• PASP	43.62±9.17	46.37±10.57	0.341

CPB = Cardiopulmonary Bypass; ICU = Intensive Care Unit; FEV1 = Forced Expiratory Volume in the first second; FVC = Forced Vital Capacity EF = ejection fraction; LVESD = Left Ventricular End Systolic Diameter; LVEDD = Left Ventricular End Diastolic Diameter; LA = Left Atrium; PASP = Pulmonary Artery Systolic Pressure.

valve repair; the Cosgrove band was used 24 patients (48%) patients Edwards ring was used in 26 patients. Twenty-three patients (46%) had a concomitant tricuspid valve repair via DeVaga segmental technique. (Table 2). Two cases required DC shock in the group (A) 8%, and four cases in the group (B) 16%. No patient was converted to median sternotomy.

ICU Complications:

ICU course was smooth with no special events and no mortality in both groups. One case had a chest infection in each group, and three patients (12%) had arrhythmia in Group A and four patients (16%) in Group B.

Postoperative PFTs study:

There was a significant difference in the FVC, FEV1, FVC % between both groups with the better postoperative pulmonary function of the minimally invasive group. (Table 2)

Postoperative echocardiography Findings:

Follow-up Echo showed no significant difference in ejection fraction, left ventricular internal dimensions, left atrial dimension, or pulmonary artery systolic pressure (PASP) between both groups 1-month postoperatively (Table 2).

Postoperative pain:

Postoperative pain score assessed with the visual analog scale was compared between the two groups. In Group A, the mean pain score in the 5th postoperative day was 3.95± 1.54, while the pain score in Group B in the 5th postoperative day was 7.54± 1.47 (P= 0.001).

Postoperative complications:

In Group A, three patients (12%) had postoperative arrhythmias, wound infection occurred in one patient (4%), and one patient had ARDS (4%). In Group B, four patients (16%) had arrhythmias, and superficial wound infection occurred in three patients (12%), which involved the skin and were managed medically. One patient

had a complete heart block that required a permanent pacemaker. There was no statistically significant difference in the postoperative complications in both groups.

Hospital stay in Group A ranged from 6 to 12 days with a mean of 6.04 ± 1.10 days, and in Group B, it was 6-21 days (11.04 ± 3.93 days; $p = 0.001$).

Discussion

MIMVS was associated with less surgical trauma and better cosmetic results when compared to the conventional approach [7]. The improvement in endoscopic instruments and technology and the perfusion circuits made the transition inevitable. The Society of Thoracic Surgeons reported that 20% of all mitral valve surgeries are performed using minimally invasive techniques, and 50% are robotically assisted [8,9]. The preoperative characteristics of our patients were comparable to other studies [10–13].

The preoperative echocardiographic showed that in Group (A) there were 17 patients (68%) with isolated mitral valve disease, and eight patients (32%) had mitral and tricuspid valve disease. In Group (B) there were 10 cases (40%) with isolated mitral valve disease, and 15 patients (60%) had mitral and tricuspid valve disease. The preoperative echocardiographic data were comparable between both groups and consistent with the published series [14,15]. The conversion rate to sternotomy was zero in our series, which is comparable to other studies [16].

All patients had normal preoperative respiratory function with no difference between both groups. Assessing the degree of respiratory dysfunction that can result from mitral disease is an essential preoperative investigation [17]. Minimally invasive surgery is associated with a smaller skin incision, similar to the finding of this study [13]. Reduction in the size of the incision was associated with lower pain score, shorter ICU and hospital stay, and earlier recovery with better patient's satisfaction [7,14,16].

The cross-clamp, total bypass, and operative times were longer in Group A. This could be attributed to the learning curve and the setup

required for the minimally invasive approach. Falk and coworkers found that the cross-clamp time was significantly increased with MIMVS. Shinfield and coworkers reported a significantly longer cross-clamp time in the MIMVS at the beginning of the learning experience [18,19].

In our study, Group A had femoral cannulation of both femoral artery and vein. The femoral cannulation was accessible in all patients, and we did not need any aortic cannulation. Femoral cannulation can be done via a percutaneous approach [20].

In our study, there were attempts for intraoperative extubation, which was done in four patients in Group A. The postoperative mechanical ventilation was longer in Group B. The reason for the delayed extubation in the group (B) is attributed to delayed conscious recovery in five patients, bleeding in two patients, and respiratory dysfunction in three patients.

Other studies showed that postoperative mechanical ventilation was significantly lower in patients who had minimally invasive mitral valve surgery [13,16]. Glauber and coworkers reported in their study performed on 1604 patients, 78 patients (4.9 %) of all patients need reexploration because of bleeding, 48 patients (4.2 %) in the mitral valve repair group, and 30 patients (6.4 %) in the mitral valve replacement group. Minimally invasive surgery was associated with lower bleeding and re-exploration [21].

In our study, the blood drainage was lower in Group A, and none of our patients required re-exploration for bleeding, and we cannot comment on the incidence of reopening in both groups due to a limited number of patients. Other studies reported that the incidence of re-exploration after minimally invasive heart surgery is nearly negligible [22]. Additionally, the amount of blood transfusion required in group A was less. Holzhey and colleagues showed that blood units needed were 3.6 ± 1.2 units in the MIMVS group while 4.6 ± 1.6 units in the sternotomy group [9].

The ICU stay was less in Group A, which could be attributed to the rapid recovery, less blood loss,

and good respiratory function. In a study by Shah and coworkers, the duration of ICU stay longer in the sternotomy group, and this is consistent with other studies [13,23–25].

Postoperative spirometry was performed for all patients. Group A had no significant reduction one month after surgery, denoting better postoperative pulmonary functions than the sternotomy group. Grossi and colleagues compared pulmonary function in patients who had a port-access coronary artery bypass versus the standard sternotomy. Pulmonary functions were better in the minimally invasive approach in the early postoperative period, and the difference persisted up to 6 months [26].

After discharge from the hospital, all patients had a follow-up echocardiography one month later with no difference between groups. The pain after sternotomy is relatively low. MIMVS offered less pain compared to sternotomy. In this study, the pain score was lower with MIMVS, which is consistent with other studies [4,27]. Improved postoperative pain may have an impact on the time required to return to normal activity.

The complications reported in both groups were not statistically different. This may be due to a limited number of studied cases. Postoperative arrhythmia was related to the inflammatory response during surgery. Atrial fibrillation was lower in patients who had minimally invasive surgery compared to the standard sternotomy [9,28,29].

The postoperative wound infection was comparable between both groups. It was reported in other series that the rate of infection was lower in patients who had thoracotomy compared to sternotomy [13,24].

Conclusion

Minimal invasive mitral valve repair could reduce postoperative pain, length of ICU, and hospital stay and improve the postoperative respiratory function when compared to the conventional approach.

Conflict of interest: Authors declare no conflict of interest.

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