

Assessment of Mitral Valve Replacement Through Standard Median Sternotomy Versus Minimally Invasive Approach (Anterolateral Thoracotomy) with Short-Term Results

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ABSTRACT

Background: When it comes to mitral valve repair, minimally invasive procedures are safe, have low post-operative morbidity, and have a low recurrence rate.

Objective: This aimed to compare procedure & early outcomes of patients who met the inclusion criteria for mitral valve surgery to those who do not need surgery using the standard method.

Patients and methods: Mitral valve surgery was performed on 40 individuals with mitral valve disease (MVD) who were selected at random. The study was conducted in Zagazig University Hospital and El-Maadi, El-galaa, and Kobri El-Koba military hospitals. A standard sternotomy was used to perform mitral valve surgery on 20 patients in group A, whereas a level I less invasive procedure, involving a Rt. anterolateral minithoracotomy under direct vision and femoral artery and vein cannulation, was performed on the other 20 patients in group B.

Results: In group (A), postoperative discomfort was much less than in group (B). Compared to group (B), group (A) spent less time in the hospital overall. No statistical significance could be found in the number of complex patients between groups A and B, despite the fact that complications in group A were less severe. The minimally invasive mitral valve surgery (MIMVS) procedure was more affordable than sternotomy surgery.

Conclusion: Primary mitral valve surgery can be performed with this technique, which is nearly as safe as a median sternotomy. Using this method, extra incisions in the groin can be avoided while still getting outstanding cosmetic outcomes.

Keywords: Mitral valve replacement, median sternotomy, anterolateral thoracotomy.

INTRODUCTION

For many years, the full median sternotomy has been the conventional method for open heart surgery. As long as it has been accepted, the full sternotomy incision is regularly criticised for being too long and resulting in post-operative pain and complications such as wound infection and unsteadiness⁽¹⁾. Reducing post-operative pain and recovery time are some of the benefits of mitral valve procedures that are less extensive⁽²⁾.

The procedure to repair the mitral valve using minimally invasive techniques is safe, with low postoperative morbidity and a low reoperation rate. Surgeons have shown that MIMVS is an option to full sternotomy with low post-operative morbidity and mortality. Without compromising on surgical repair or replacement techniques and with an emphasis on minimally invasive procedures to lessen surgical stress and speed up the recovery of patients, minimally invasive procedures are becoming increasingly popular⁽³⁾.

A major goal of today's minimally invasive surgical methods is to reduce complications associated with the big incisions that are currently being used⁽⁴⁾. Increasing numbers of patients have demonstrated the effectiveness of a less invasive procedure for mitral valve surgery, and it is now widely recognized. Greater surgical vision and precision can be achieved due to the absence of cannula in the operating room. With this method, you get better cosmetic outcomes, less sternal infection, less discomfort and blood transfusion, faster

recovery and a shorter hospital stay in the process, and less blood transfusion. When the risk of sternotomy dehiscence is high in chronic obstructive pulmonary disease (COPD) patients, when it comes to surgery, the sternotomy strategy is easier to apply because most doctors are already familiar with this method. There is no need for specialized equipment or a battle for the depth of the operative field with this method⁽¹⁾.

All minimally invasive approaches benefit from the use of TEE in the installation of a venous cannula and de-airing of the patient. The tiny incision makes it difficult to detect dissection, periprotective leaking, and LV distension, all of which can be detected with this technique. In all cases, external defibrillator pads should be used⁽¹⁾.

The goal of this study was to compare the procedure & early outcome of traditional sternotomy versus less invasive technique in patients with mitral valve disease requiring surgery according to inclusion criteria.

PATIENTS AND METHODS

Mitral valve surgery was performed on 40 individuals with MVD who were selected at random. The study was conducted in Zagazig University Hospital and El-Maadi, El-galaa, and Kobri El-Koba military hospitals. A standard sternotomy was used to perform mitral valve surgery on 20 patients in group A, whereas a level I less invasive procedure, involving a Rt. anterolateral minithoracotomy under direct vision and femoral artery and vein cannulation, was performed on the other 20

patients in group B. Data were collected from medical records of retrospective cases & by patient structure interview of both retrospective and prospective cases.

Inclusion Criteria: Patients with mitral valve disease, whether or not they have tricuspid valve disease.

Exclusion Criteria: Combined cardiac disease (mitral valve disease with tricuspid valve disease is the only exception as mentioned in inclusion criteria), ischemic mitral valve disease, patients with left atrial thrombus, and significant pathology in the respiratory or endocrine, metabolic or neurological systems of the patient.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee (ZU-IRB#6872). Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

All studied groups underwent the following:

1. History taking: A thorough and detailed history was taken, as regards age, sex & functional class.

2- Clinical examination: A complete clinical general and local cardiological examination was performed.

3- Laboratory investigations: Serum electrolytes, liver function tests, fasting blood sugar, kidney function tests, complete blood count (CBC), and prothrombin time and concentration.

4- Electrocardiogram (ECG).

5- Plain x-ray for chest posteroanterior view in the erect position and Echocardiography.

6-Respiratory function tests (RFTs).

Intra-operative procedures:

Anesthetic technique:

Using a local anaesthetic, an arterial cannula was placed in the non-dominant artery to facilitate endotracheal intubation in a patient who had been given pancuronium 0.02 mg/kg. An additional hypnotic dosage of propofol 0.5-1 mg/kg and three leads ECG monitoring were performed. Another 100-200 g of fentanyl was given to the patient, depending on their state. The trachea was intubated orally with an endotracheal tube of the correct size once the muscles had completely relaxed (double lumen tube was used in minimally invasive patients). All patients were kept anaesthetized with isoflurane 0.5-1.0 percent inhalation.

The right internal jugular vein was implanted after induction using a triple lumen central venous catheter and a single lumen catheter (Angiocath 16 gauge). As part of the procedure, an intraurethral catheter was also put in. Anesthesiologists used TEE as an essential step in minimally invasive procedures.

Cardiopulmonary bypass (CPB):

They employed membrane oxygenators. Blood hemoglobin levels were maintained at 28 percent throughout CPB. In order to preserve the heart during the procedure, 28°C systemic cooling, an iced saline bath to keep the myocardial temperature at 15°C, and most significantly, antegrade crystalloid cardioplegia were used. The ascending aorta was flooded with pressure, causing cardioplegia. Usually, cardiac arrest could be induced within a minute. Every 30 to 40 minutes, 15-20 ml/Kg of cardioplegia was administered intravenously to the patient.

Surgical technique:

Group "A" (MIMVS):

With the right shoulder lifted 30-50 degrees and the right arm at one's side, the mid-axillary line on the right side was exposed in supine individuals. Two-lumen tracheal tubes or endobronchial blockers inserted into the right main stem bronchus were used to intubate these patients. The fourth intercostal space, the incision is made. Under direct view, exposed 2 cm ventral to the phrenic nerve and carried 2 cm above the cardiac pericardium. Doing this operation counterclockwise shifts the left atrium laterally and ventrally. The posterior pericardial margin was retracted by three lateral retraction sutures.

In order to begin cardiopulmonary bypass, the cannulation of the femoral vein and artery should precede the mediastinal dissection. Two concentric purse strings were attached to the femoral vein and artery with 5-0 polypropylene suture. Femoral cannulas were typically inserted initially, as they're the most common. In order to improve drainage from the superior vena cava, a 17-fr percutaneous cannula was simultaneously inserted into the right internal jugular vein by the anesthetic team. It is necessary to utilize an echocardiography to direct a heparinized guidewire upwards via the femoral vein in order to obtain access to the superior vena cava. In order to insert an arterial cannula, an arteriotomy was formed within the purse strings and dilated until it is big enough. In order to ensure that the venous cannula is placed correctly and reach its intended location, echo guidance is required. Ascending aorta was clamp occluded externally. The left atrium was exposed next to the interatrial groove while the patient's heart was on cardiopulmonary bypass.

For mitral valve replacement, the chordal sparing method is preferred since it preserves annuloventricular integrity and improves survival. To shut the left atrium after mitral surgery, a left ventricular vent is inserted via the incision in the left atrium, placed into the left ventricle via the mitral valve. Draining into the cardiopulmonary circuit with full venous supply is then permitted to proceed as normal. A DC shock of 10-30 Joules was administered using the pediatric paddles if the heart continued to fibrillate. The heart is allowed to fill while suction is maintained on the aortic root when

cardiac contraction resumes. Cardiopulmonary bypass can be terminated once the patient has been fully warmed up and his or her heart function has been restored. Placement of pacing wires is followed by pericardial closure with interrupted sutures over a drain. In order to minimise post-operative pain. Marcaine was used in an intercostal block procedure.

Group “B” (Sternotomy):

Using electrocautery, the incision is prolonged down to the sternal periosteum by electrocuting from a point 2 centimeters below the sternal notch and 2 centimeters beyond its distal tip. Opened just to the point where appropriate exposure might be achieved. After removing the thymus gland and locating the left innominate vein, the pericardium was exposed. A similar technique is followed in both groups after cardiac resuscitation has been initiated. Decannulation and hemostasis were achieved after mitral valve surgery or replacement and cardiopulmonary bypass weaning.

Retrocardiac, retrosternal, and pleural tubes were used to place the chest tube. The pericardium was then approximated with continuous sutures over the aortic root, and pacemaker wires were implanted. Six to nine strong stainless steel wires were then threaded through the sternum to resemble the sternum. The twisted wires were then carefully lowered into the sternum to eliminate any outward protrusion. Using thick, absorbable suture, the linea Alba and the pectoralis fascia were sewn together. 2/0 and 4/0 subcuticular sutures were used to seal the subcutaneous tissue before the skin is stitched shut.

Post-operative evaluation of both groups:

At the intensive care unit and at the hospital, all patients underwent thorough evaluation. The data listed below were collected for statistical purposes: Pain score, respiratory function tests, other complications, total hospital stay, operative cost, and cost effective.

Statistical analysis

In order to analyze the data acquired, Statistical Package of Social Services (SPSS) version 20 was used to execute it on a computer. In order to convey the findings, tables and graphs were employed. The quantitative data were presented in the form of the mean, median, standard deviation, and confidence intervals. The information was presented using qualitative statistics such as frequency and percentage. The student's t test was used to assess the data while dealing with quantitative independent variables. Pearson Chi-Square and Chi-Square for Linear Trend (X^2) were used to assess qualitatively independent data. The significance of P value of 0.05 or less was determined.

RESULTS

Preoperative assessment:

Non-significant differences were found among age,

gender or BMI between the studied groups (Table 1).

Table (1): Demographic data and clinical characteristics of the patients

	Group A	Group B	P value	Sig.
Number	20	20		
Age				
Range	16-61	29-65		NS
Mean ± SD	42.73 ± 12.96	49.8 ± 12.47	>0.05	
Male %	15%	25%	>0.05	NS
BMI				
Mean ± SD	28.66 ± 5	27.9 ± 4.57	>0.05	NS

Intra-operative course:

There was no statistical significance between the two groups as regards the cross clamp time and the total bypass time. In group “B” the mean length was 8.2 ± 1.85 cm ranged from 16 to 24 cm which was statistically higher than that of group “A” (P value < 0.01). Also, there was statistical significance regarding operation time (Table 2).

Table (2): Cross clamp & total bypass, length of skin incision & total operation time in both groups

In both groups, the cross clamp and the overall bypass time				
	Group A	Group B	P value	Sig.
Cross clamp (min.)	94.66 ± 45.5	106.2 ± 27.3	>0.05	NS
Total bypass time	128.3 ± 63.25	157 ± 47.9	>0.05	NS
Skin incision length				
	Group A	Group B	P value	Sig.
Range (cm)	16 – 24	6 - 12		
Mean ± SD (cm)	19.66 ± 2.46	8.2 ± 1.85	< 0.01	HS
Total operation time in both groups				
	Group A	Group B	P value	Sig.
Total operation time (mean ± SD) (min.)	173.66 ± 65.99	229.7 ± 83.6	<0.05	S

Intensive care course:

Both groups of patients required post-operative mechanical breathing, and no patients were extubated in the operating room during the procedure. In terms of

post-operative mechanical ventilation time, the two groups differed statistically. In the first 24 hours, there was a statistically significant difference between the two groups, with the minimally invasive group staying in the ICU for less time than the sternotomy group (Table 3).

Table (3): Ventilation, blood loss, blood transfusion and total ICU stay

	Group A	Group B	P value	Sig.
Ventilation (hours)	6 - 24	4 - 10	<0.05	S
Range	10.5 ±	6 ±		
Mean ± SD	4.98	1.85		
Blood loss (ml)	175 - 1150	125 - 400	<0.01	HS
Range	460 ±	265 ±		
Mean ± SD	260	78.5		
Blood transfusion (unit)	0 - 3	0 - 2	<0.05	S
Range	0.87 ±	0.2 ±		
Mean ± SD	0.11	0.04		
ICU stay (day)	2 - 10	1 - 7	>0.05	NS
Range	3.86 ±	3 ±		
Mean ± SD	0.86	1.92		

Post-operative pain:

Pain was less in group "A", with highly statistically significant difference as shown in table (4).

Table (4): Pain score among the two groups (mean ± SD)

	Group A	Group B	P value	Sig.
5th day postoperative pain (mm)	17.4 ± 5.22	11.2 ± 3.7	<0.01	HS

Post-operative complications:

One in five (5%) of the patients who had postoperative arrhythmias recovered and returned to normal sinus rhythm within six weeks of discharge. One patient (5%), right ARDS with entire lung collapse, which responded to medical and physiotherapy and completely resolved on the 5th postoperative day, was the only one to have this problem. An infection that was only visible on the skin was found in two patients (10%) and was treated with a course of antibiotics.

Post-operative problems occurred in 7 cases (35%) in group "B." Approximately 20% of individuals had postoperative arrhythmias following surgery. For three of them, this difficulty vanished four weeks later. Patients with a skin-only illness were treated with regular dressings and medicines in three out of fifteen cases (Table 5).

Table (5): Post-operative complications of both approaches

	Group A	Group B	P value
Without complications	13(67%)	13(67%)	>0.05
Arrhythmia	3(20%)	3(20%)	>0.05
ARDS	-	1(7%)	>0.05
Wound infection	2(13%)	1(7%)	>0.05

The minimally invasive group's hospital stay was shorter than that of the sternotomy group, and this difference was highly significant (Table 6).

Table (6): Total hospital stay of both groups

	Group A	Group B	P value	Sig.
Total hospital stay	8 - 25	7 - 23	< 0.01	HS
Range	16.6 ±	10.4 ±		
Mean ± SD	3.11	2.5		

For the additional money spent on these procedures, patients get better results and a shorter hospital stay, as well as fewer complications and blood transfusions after the surgery, a shorter time spent in the recovery room, and an overall better quality of life. This was especially true for the female patients in both groups resulting in a lower overall cost (Table 7).

Table (7): Operative and post-operative parameters in both groups that showed the upper hand of minimally invasive surgery

	Group A	Group B	P value	Sig.
Length of skin incision (cm)	19.66 ± 2.46	8.2 ± 1.85	<0.01	HS
Ventilation (hour)	10.5 ± 4.5	6 ± 1.85	<0.05	S
Blood loss (ml)	460 ± 260	265 ± 78.5	<0.01	HS
Blood transfusion (unit)	0.87 ± 1	0.2 ± 0.56	<0.05	S
5th day postoperative pain (mm)	17.4 ± 5.22	11.2 ± 3.7	<0.01	HS
Total hospital stay(day)	16.6 ± 6	10.4 ± 5.5	<0.01	HS
Postoperative FVC (liter)	1.6 ± 0.53	2.26 ± 0.75	<0.01	HS
Postoperative FEV1 (liter)	1.5 ± 0.5	2.12 ± 0.77	<0.05	S
Postoperative FVC%	41.6 ± 12.7	58.7 ± 12.3	<0.01	HS
Postoperative FEV1%	48.9 ± 14.9	66.8 ± 14.8	<0.01	HS

DISCUSSION

Many patients prefer the reduced postoperative discomfort and quicker recovery that less invasive mitral valve surgery provides ⁽²⁾.

In our study, the mean age in group "A" was 42.73 ± 12.96 years, while in group "B", it was 49.8 ± 12.47 years. Compared to other studies, the age groupings in ours were considerably younger. **Eugene et al.** ⁽²⁾ reported a mean age of 55.3 ± 13.6 years. Also, in studies of **McClure et al.** ⁽³⁾ and **Loulmet et al.** ⁽⁴⁾, the mean age was above 50 years. Because rheumatic fever is prevalent in many underdeveloped countries, including Egypt, the lower mean age in our study may be due to earlier and more frequent occurrences. Mean ages in our study groups were not statistically different. In terms of sex, 80% of patients were females, and 20% were males. This demonstrates the superiority of feminine affection over males.

Inan et al. ⁽⁵⁾ reported a mean incision length of 9.2 ± 1.2 cm in the thoracotomy group and 29 ± 3 cm in the sternotomy group. There was almost no difference between the two studies in thoracotomy incision. The mean length of the sternotomy incision was less in our study. This may be because in our study the skin incision was done from the manubriosternal angle till the xiphoid process.

The time from weaning from the cardiopulmonary bypass to the end of the operation was significantly lower in group "B". Right mini-thoracotomy approach had the disadvantage of requiring a learning curve for the surgeon and team in order to be able to carry out the treatment with a smaller incision and faster time ⁽⁶⁾.

No attempt was made in the operating room to extubate the patient during our research. Mechanical breathing was required for each patient in both groups. The postoperative mechanical ventilation ranged from 4-10 hours with a mean of 6 ± 1.85 hours in group "A". In group "B", the ventilation time was significantly higher and ranged from 6-24 hours, with a mean of 10.5 ± 4.5 hours with a statistical significant difference. **Kumar et al.** ⁽⁷⁾ and **Wang et al.** ⁽⁸⁾ studies showed that minimally invasive mitral valve surgery reduced the need for postoperative mechanical breathing greatly.

None of the patients in group "A" or in group "B", required re-exploration for bleeding. In this study, we could not comment on the incidence of re opening in both groups because of the limited number of patients, which could not reflect the significance of re-exploration. Other studies reported that the incidence of re-exploration after minimally invasive heart surgery is nearly negligible ^(9, 10, 11).

Walther et al. ⁽¹²⁾ and **Sewilam et al.** ⁽¹³⁾ reported that postoperative pain score was 2.7 ± 1.6 in group (A) and 3.82 ± 0.99 in group (B). Within the first seven days following surgery, pain levels dropped gradually, and patients who had an anterolateral minithoracotomy experienced more discomfort during

the first 24 hours, according to the study. Patients who had anterolateral minithoracotomy experienced reduced pain on the third postoperative day. Patients who underwent a lateral mini-thoracotomy were less likely to experience pain than those who got a median sternotomy, which can create bone friction when the patient is moving.

On the fifth postoperative day, one patient (5%) in group (A) experienced ARDS with complete lung collapse, which was treated medically and physically. Also **Gamil et al.** ⁽¹⁰⁾ reported 4% incidence of lower lobe collapse, a complication, which could be avoided by intense physiotherapy.

One patient in group (A) had a superficial wound infection that was treated with antibiotics and frequent dressings. Two patients in group (B) (10%) suffered from a superficial wound infection affecting only the skin, which was treated with regular dressing changes and antibiotics. In 1993, a study by **Kumar & colleagues** ⁽⁷⁾ found that 2.7% of their patients had a superficial wound infection. Although, **Gamil et al.** ⁽¹⁰⁾ reported that the incidence of wound infection is higher in the sternotomy group and they attributed this finding to the fact that in smaller incisions, the potential for wound infection is less. Yet, in 1999, **Dabritz et al.** ⁽¹⁴⁾ experienced an incidence of 3.5 % of wound infection, and they did not relate this complication to the approach used.

In our study, difference was statistically highly significant regarding mean hospital stay with a P value < 0.01 . Minithoracotomies had a shorter hospital stay compared to sternotomies, according to all of the studies.

In 2000, **Inan et al.** ⁽⁵⁾ reported a mean hospital stay of 5.9 ± 2 days in the thoracotomy group and 8.8 ± 3 days in the sternotomy group.

CONCLUSION

It almost safe as median sternotomy for primary mitral valve surgery that could be used as an initial approach to mitral valve surgery. Using this approach, additional incisions in the groin with their potential complications can be avoided while achieving excellent cosmetic results.

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