Early outcome of minimally invasive mitral valve surgery

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Abstract

Background: Minimally invasive mitral valve surgery (MIMVS) is safe, with low perioperative morbidity, and low rates of reoperation. Minimally invasive mitral valve surgery has been proven a feasible alternative to the conventional full sternotomy approach with low perioperative morbidity and short-term mortality. Efforts to minimize surgical trauma, hasten patient recovery, increase patient satisfaction, and reduce cost without compromise to surgical repair or replacement techniques, continue to be the rationale for minimally invasive procedures.

Methods: In this study 30 patients with mitral valve disease (MVD) requiring mitral valve surgery selected by purposive non probability sample. The study was done at the Armed Forces Hospitals (mainly Maadi & Galaa Armed Forces Hospitals). 15 patients attended to do mitral valve surgery by traditional sternotomy (group B), other 15 patients by less invasive surgery (Rt. anterolateral mini-thoracotomy) (group A) with femoral artery and vein cannulation.

Results: There was no statistical difference between the two groups preoperatively regarding their age, sex, NYHA class, EF%, LA dimension, spirometric study. There was no operative mortality in both groups but fewer postoperative complications occurred in both groups. Total hospital stay, ICU stay, postoperative bleeding, inotropic requirement, ventilatory support, blood transfusion was less in group “A”, with better cosmetic appearance, and more cost effective.

Conclusion: Right anterolateral mini-thoracotomy minimally invasive technique provides excellent exposure of the mitral valve, even with a small atrium and offers a better cosmetic lateral scar which is less prone to keloid formation. In addition, minimally invasive right anterolateral mini-thoracotomy is as safe as median sternotomy for mitral valve surgery, with fewer complications and postoperative pain, less ICU and hospital stay, fast recovery to work with no movement restriction after surgery. It should be
used as an initial approach for mitral valve surgery. Furthermore, it was believed that less spreading of the incision, no interference with the diaphragm and less tissue dissection might improve outcomes, particularly respiratory function.

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Keywords: Minimally invasive right anterolateral mini-thoracotomy; Mitral valve surgery; Median sternotomy

1. Introduction

In the mid-1990s, minimally invasive approaches for mitral valve operations were pioneered with the intent of reducing morbidity, postoperative pain, and blood loss; improving cosmeses; shortening hospital stay; and reducing cost compared with the 50-year-old conventional median sternotomy approach [2].

Furthermore, it was believed that less spreading of the incision, no interference with the diaphragm and less tissue dissection might improve outcomes, particularly respiratory function [3,4].

Although clinical studies suggest that some of these benefits have been realized, there has been no confirmatory large study or randomized trial [2,5].

Therefore, we performed a comparative analytic of short term outcomes in patients who underwent minimally invasive mitral valve surgery through right anterolateral thoracotomy with those who underwent conventional full sternotomy.

2. Patients and Methods

2.1. Patients

Thirty patients underwent isolated mitral valve surgery with or without tricuspid valve repair; patients undergoing concomitant aortic valve surgery, coronary artery bypass grafting, or reoperation were excluded, as were those with endocarditis. The more recently investigated approaches of right mini-thoracotomy and robotic procedures were not included. A minimally invasive approach was intended in fifteen (50%) patients, and conventional full median sternotomy was intended in fifteen (50%) patients.

Data were in part retrieved from the prospective Cardiovascular Information Registry and in part from each patient's medical record. These data were approved for use in research, with patient consent waived.

2.2. Surgical technique

Conventional general anesthesia was used in all patients, regardless of surgical approach. In those receiving a full median sternotomy, the mitral valve was usually visualized through an incision in the left atrium anterior to the right pulmonary veins. Patients who underwent minimally invasive surgery had a 3- to 4-inch (8- to 10-cm) skin incision through anterolateral mini-thoracotomy.

With these minimally invasive chest-wall incisions, the mitral valve was accessed through a left atrial incision. Routine mitral valve replacement techniques were used. Vacuum-assisted cardiopulmonary bypass with bi-femoral cannulation was used in patients underwent MV surgery through minimally invasive technique while bicaval, cental ascending aortic cannulation were used for patient who underwent classical sternotomy.

Intraoperative transfusions, anesthetic technique were at the anesthesiologist's discretion. Intraoperative and postoperative transfusion, extubation, and pain scores were not derived from protocols.

2.3. Study design

Data was collected, verified and edited on a personal computer then analyzed by SPSS, EPICalc software program to get the final results, the following tests were used Arithmetic mean, standard deviation and hypothesis “t” test (Student test) for quantitative values. The chi-square test \( (\chi^2) \) for qualitative values expressed. A proportions analysis was performed by using life table methodology.
2.4. Methods and surgical technique

In this study a 30 patients with MVD requiring mitral valve surgery were non randomly selected. The case study was prospective for 6 months & retrospective for 3 years. The patients were divided into two randomized groups. Group “A”: Included fifteen patients who underwent mitral valve surgery through right anterolateral mini-thoracotomy by direct vision with femoral artery and vein cannulation. This procedure included peripheral cardiopulmonary bypass, antegrade cardioplegia, and transthoracic flexible Cosgrove aortic clamp occlusion.

Group “B”: Included fifteen patients who underwent mitral valve surgery through standard median sternotomy. This patient population was examined to identify the effect of technique on short term outcome.

Preoperative data collection, history taking& clinical examination& laboratory investigations& electrocardiogram (ECG), radiological examination, respiratory function tests (RFTs). Also operative data, anesthetic procedure like using double lumen endotracheal tube and TEE, total operative time, cross clamping time, CPB time, intraoperative bleeding, need for blood transfusion for patients undergoing mitral valve surgery are routinely collected. Postoperative data in ICU morbidities like arrhythmias and need for IABP or mechanical support, blood transfusion, time for ventilation support, total ICU stay. Also postoperative follow up for the wound, cosmetic appearance, pain, patient recovery, return to work and usual life activity, total hospital stay, need for readmission for any reasons, lastly patient satisfaction, cost effective of both procedure.

Data was collected, verified and edited on a personal computer then analyzed by SPSS, EPICalc software program to get the final results.

The following tests were used Arithmetic mean, standard deviation and hypothesis “t” test (Student test) for quantitative values. The chi-square test (\(\chi^2\)) for qualitative values expressed. A proportions analysis was performed by using life table methodology.

3. Results

3.1. Preoperative assessment

There was no statistically significant difference as regards the age, sex, NYHA, preoperative echocardiographic findings also preoperative Spirometric study revealed no statistical significant.
3.2. **Intra-operative course**

There was no statistical significance between the two groups as regards the cross clamp time and the total bypass time. The total bypass time in group “A” was $157 \pm 47.9$ min while in group “B” it was $128.3 \pm 63.25$ min. Cross clamp time in group “A” was $106.2 \pm 27.3$ min while in group “B” it was $94.66 \pm 45.5$ min; with a P value more than 0.05. Yet minimally invasive group need more time for cross camp and so total bypass time (Figs. 1 and 2).

Picture shows 7 cm right anterolateral sub mammary skin incision included the MI chest retractor, Cosgrove aortic cross clamp, ordinary left atrial retractor and pericardial stitches.

The surgical procedure in group “A” included 10 cases (67%) of mitral valve replacement, 4 cases (26%) of mitral valve replacement plus tricuspid valve repair, 1 case (7%) of mitral valve repair. In group “B”, there was 9 cases (60%) of mitral valve replacement, 6 cases (40%) of mitral valve replacement plus tricuspid valve repair, no case of mitral valve repair.

The mean length of incision in group “A” was $8.2 \pm 1.85$ cm ranged from 6 to 12 cm. While in group “B” the mean length was $19.66 \pm 2.46$ cm ranged from 16 to 24 cm which is statistically higher than that of group “A” (P value < 0.01).

Picture showing 8 cm right sub mammary skin incision of MIMVS.

The mean total operation time in group “A” was $229.7 \pm 83.6$ min, while in group “B” the mean operation time was $173.66 \pm 65.99$ cm, with a P value < 0.05, denoting statistical significance as regards the operation time.

| Table 1 | Intra-operative course. |
| --- | --- | --- | --- | --- |
| | Group A | Group B | P value | Sig. |
| Cross clamp (min.) | $106.2 \pm 27.3$ | $94.66 \pm 45.5$ | <0.05 | NS |
| Total bypass time | $157 \pm 47.9$ | $128.3 \pm 63.25$ | <0.05 | NS |
| Skin incision | | | | |
| Range (cm) | 6–12 | 16–24 | | |
| Mean ± SD (cm) | $8.2 \pm 1.85$ | $19.66 \pm 2.46$ | >0.01 | HS |
| Total operation time (mean ± SD) (min.) | $229.7 \pm 83.6$ | $173.66 \pm 65.99$ | >0.05 | S |

>0.05 significant, >0.01 highly significant, >0.05 non-significant.
3.3. Intensive care course

The ventilation time for group “A” ranged from 4 to 10 h, with a mean ± SD of 6 ± 1.85 h. In group “B” the ventilation time ranged from 6 to 24 h with a mean ± SD of 10.5 ± 4.98 h. This shows that there is a statistically significant difference.

In group “A”, blood drainage ranged from 125 to 400 ml during the first 24 h, with a mean ± SD of 265 ± 78.5/first 24 h. In group “B”, the blood loss ranged from 175 to 1150 ml during the first 24 h, with a mean ± SD of 460 ± 260 ml/first 24 h, this shows that there is a highly statistically significant difference.

The amount of blood units transfused to group “A” ranged from 0 to 2 units with a mean of 0.2 ± 0.56 units, while in group “B” it ranged from 0 to 3 units with a mean of 0.87 ± 1 units with statistically significant difference.

In group “A”, the ICU stay ranged from 1 to 7 days, with a mean of 3 ± 1.92 days, while in group “B” the range was 2–10 days with a mean of 3.86 ± 2 days, which shows that the ICU stay in the minimally invasive group is less than the sternotomy group, with no statistically significant.

This data presented in Table 2.

3.4. Post-operative course

There was a highly statistically significant different in the FVC, FEV1%, FEV1, FVC% and no significant change in FEV1/FVC between both group denoting better post-operative pulmonary function of minimally invasive (group A) patients. A comparison between the pre and post-operative pulmonary functions showed that in group (A) there is mild deterioration in all functions except FEV1/FVC, with no statistically significant.

A comparison between the pre and post-operative pulmonary functions showed that in group (B) there is marked deterioration in all functions except FEV1/FVC, this deterioration is highly significant statistically.

In group “A”, the mean pain score in the fifth post-operative day was 11.2 ± 3.7. Pain score in group “B” during the fifth post-operative day was 17.4 ± 5.22. So the pain was less in group “A”, with highly statistically significant difference.

In group “A”, there were 5 patients (33%) with complications. Three patient (20%) developed postoperative arrhythmias. One patient (7%) right ARDS with total lung collapse. One patient (7%) had superficial wound infection involving only the skin.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Group A</th>
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<td><strong>Ventilation (hours)</strong></td>
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<td>Range</td>
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<td>SD</td>
<td>1.92</td>
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>0.05 significant, >0.01 highly significant, >0.05 non-significant.
In group “B”, 5 cases (33%) suffered from post-operative complications. Three patients (20%) developed post-operative arrhythmias. Two patients (13%) had superficial wound infection involving only the skin. There was no statistical significant difference as regards post-operative complications in both groups.

The range of hospital stay in group “A” was 7–23 days with a mean of 10.4 ± 5.5 days, while in group “B” the range was 8–25 days with a mean of 16.6 ± 6 days. This shows that the total hospital stay in the minimally invasive group was less than sternotomy group.

Group (A) more operative cost than group (B) with highly statistically significant difference. Despite Minimally invasive surgeries being a more expensive procedure (+3 thousand L.E) it is met by a shorter total hospital stay, fewer post-operative complications, less postoperative pain, less postoperative blood transfusion, less ventilation time, better cosmeses, respiratory functions, more patient satisfaction especially between the females of both group which give better life quality and outcome resulting in an overall lower cost.

Our findings confirm that cardiac surgery remains controversial from a cost-effectiveness standpoint, making econometric analysis an important component for any future evaluation of novel cardiovascular therapies. Our findings need to be confirmed by additional multicenter studies.

This data presented in Table 3.

4. Discussion

Large median sternotomy is the current approach in cardiac surgery. It is not devoid of drawbacks for the patients (postoperative bleeding, wound infection, back pain, sternal dehiscence, and visible scar). The search for smaller incisions suited specifically for each different operation is therefore appropriate [6].

Minimally invasive mitral valve surgery is safe, with low perioperative morbidity, and low rates of reoperation, it has been proven a feasible alternative to the conventional full sternotomy approach with low perioperative morbidity and short-term mortality, efforts to minimize surgical trauma, which hasten patient recovery, increase patient satisfaction, and reduce cost, without compromise to surgical repair or replacement techniques [1].

In our study, the preoperative evaluation showed that there was no statistically significant difference as regards the age, sex, NYHA, preoperative echocardiographic findings also preoperative spirometric study revealed no statistical significant.

Regarding intraoperative comparison, there was no statistically significant difference in the cross-clamp time, total bypass time, but there is a significant difference in total operation time, this difference may be due to the new experiences in this MIMVS and the lack of instrumentation and the narrow field of MIMVS. The length of the incision was highly significantly lesser in group “A” than in group “B”.

Other studies also showed that the minimally invasive group needs more time for cross clamp, total bypass and operative procedures [7,8].
There was significant difference in the intensive care parameters. The mechanical ventilation time was shorter in group “A”, the blood loss and the blood transfusion required was lesser in group “A”. The ICU stay was shorter in group “A”. Pulmonary functions were markedly reduced in group “B” than in group “A” other study also showed that the mechanical ventilation time, blood loss and the blood transfusion was less in minimally invasive group [7].

There was highly significantly less postoperative pain in group (A) than in group (B). Total hospital stay was less in group (A) than in group (B). The postoperative complications of group “A” were less serious than those in group “B” but there was no statistical significance regarding the number of complicated patients. MIMVS was more cost effective than sternotomy group. MIMVS, if performed through a right anterolateral minithoracotomy would not only be better accepted cosmetically by patients, but also make redo surgery through median sternotomy easy and trouble free from reentry bleeding. Other studies also showed the same results postoperatively [8,9].

4.1. Principle findings

This study confirms the previously unproved perception that there are no disadvantages to minimally invasive surgery; that is, procedure time is not lengthened, risks are comparable or less, transfusions are less frequent, respiratory function is better, early postoperative pain is less, length of stay is comparable or shorter, long-term survival is comparable.

Less perioperative bleeding and fewer blood transfusions are likely due to the less extensive mediastinal dissection required for the minimally invasive approach. Less pain is likely related to less surgical dissection, lack of spreading of the sternum, and no escalation of tension on the posterior rib head and costo-vertebral ligaments because the chest wall is not opened like a trap door. The better pulmonary function can be explained by less chest wall pain, patients might have less splinting of the chest and thus can breathe more deeply.

4.2. Limitations

Although the use of minimally invasive mitral valve surgery provided the opportunity for comparisons with conventional surgery, the small number of cases studied, the new learning curve may affect the final results specially operation time and bypass time. This is also a single-institution study, which limits its generalizability. Nevertheless, timing to extubation, spirometric values, and pain scores would largely have been uninfluenced by potential surgeon biases because these were determined or routinely collected by respiratory therapists, anesthesiologists, ICU physician or nurses.

5. Conclusion

It is obvious that not only better cosmoses drive surgeons to perform less invasive cardiac surgical procedures. The less invasive procedures are also intended to minimize harm to patients by reducing blood loss, reducing the amount of blood transfusion, reducing the danger of infection by minimizing wound dimensions, thereby shortening the patient's ICU and hospital stay and decreasing costs with no compromise to surgical repair or replacement technique [10].

In our less invasive study group, we achieved less mediastinal drainage and blood loss, so that less blood and blood products were required for transfusion. The ICU stay and hospital stay were significantly shorter in the study group, and there were fewer incidences of major complications such as wound infection and mediastinitis and with better postoperative pulmonary functions. Right anterolateral mini-thoracotomy provides excellent exposure of the mitral valve and offers a better cosmetic lateral scar.

It is almost safe as median sternotomy for primary mitral valve surgery and 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.

Conflict of interest

None.
References


