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Ashraf Abdelaziz
National Heart Institution

Emmanuel L. Aziz
National Heart Institution

Hazem G. Bakr
National Heart Institution, dr_hazem212@hotmail.com

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Original Article

Comparative study between right-sided minithoracotomy versus upper partial ministernotomy in isolated mitral valve replacement (early outcome)

Hazem G. Bakr[a], Emmanuel L. Aziz[b], Ashraf Abdelaziz[a]

Departments of [a]Cardiothoracic Surgery and [b]Cardiology, National Heart Institution, Cairo, Egypt

Abstract

Background

In recent years, minimally invasive surgical techniques have become increasingly popular in heart surgery. The most common incisions used in minimally invasive mitral valve replacement are ministernotomy and minithoracotomy. It is still up for dispute whether one incision is superior to the other.

Patients and methods

The results of 60 patients who had solitary mitral valve replacement were studied using a prospective comparative analysis. In group A ($n = 30$), a minimally invasive right anterior minithoracotomy technique was performed, whereas in group B ($n = 30$), a partial upper ministernotomy procedure was used.

Results

The results in both groups reveal no statistically significant difference. However, the hospital stay, ventilation time, and blood loss had better results in right minithoracotomy group, whereas in the upper ministernotomy group, postoperative pain had better results. In group A, blood loss was 325.3 ± 164.2, whereas in group B, it was 413.3 ± 159.3. In group B, postoperative pain was 1.9 ± 0.8 days better than group A (2.3 ± 0.7 days). Group A had a significantly longer operative time (295 ± 22.7) than group B (213 ± 28.4). In both groups, inotropes were determined to be negligible.

Conclusion

The results of a right anterior minithoracotomy and an upper ministernotomy approach in patients undergoing isolated mitral valve repair (MVR) are similar, with no notable differences. However, a right anterior minithoracotomy reduces (not significantly) the need for blood transfusions, assisted ventilation time, and hospital stay, whereas an upper ministernotomy reduces postoperative pain. Furthermore, the cross-clamping and the total operative time is highly significantly increased in the right anterior minithoracotomy approach.

Keywords: Minimally invasive procedures, mitral valve replacement, right minithoracotomy, upper ministernotomy

Introduction

Because it provides excellent access to the heart, the median sternotomy has been the standard method for all forms of open heart surgery for many years. It is, however, linked to a high risk of morbidity, including severe pain from rib and thoracic ligament tension. It is also associated with an increased risk of sternal wound infection, which necessitates debridement and esthetic surgery restoration, as well as a higher risk of mortality [1].

Correspondence to: Hazem G. Bakr, MD,
Department of Cardio-Thoracic Surgery, Lecturer of Cardiac Surgery,
National Heart Institute, KitKat Square, Imbaba, Cairo, Egypt.
Tel: 00201000980986;
E-mail: dr_hazem212@hotmail.com

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Cardiac surgeons have created less invasive mitral valve surgeries in an effort to reduce the invasiveness and perioperative impairment associated with heart valve surgery. A nonsternotomy (typically a minor thoracotomy) incision is used, as well as some combination of cannulation, tissue manipulation, aortic obstruction, or visualization procedures [2].

In the past few years, there have been significant advancements in minimally invasive cardiac procedures. Surgeons may now implant bypass grafts on the heart and perform valvular heart procedures without the requirement for the typical sternotomy incision thanks to the development of novel methods and cannula systems [3,4].

As new technology and devices become accessible, minimally invasive heart valve operations are becoming increasingly common. A big incision expands the surgeon's operational field and also expands the risk of morbidity and fatality. The intact chest wall, on the contrary, will keep the chest wall intact, improving sternal stability and allowing for faster extubation, especially in obese individuals [1].

Minimally invasive valve surgery is projected to provide a less traumatic procedure with less blood loss, less postoperative discomfort, and a faster recovery time [5,6].

Aim

The aim of this study was to compare the early outcomes (6 months postoperatively) of right anterior minithoracotomy versus partial mini-upper sternotomy approach in patients with isolated mitral valve disease requiring mitral valve replacement according to inclusion criteria.

Patients and methods

A prospective comparative study included 30 patients who underwent mitral valve surgery in the period between March 2019 and January 2022 at the National Heart Institute. They were divided into two groups:

(1) Group A: it included 30 patients who underwent mitral valve surgery through right anterior minithoracotomy via cardiopulmonary bypass using femoral artery and femoral vein cannulation.
(2) Group B: it included 30 patients who underwent mitral valve surgery through J-shape partial upper-mini sternotomy using central cannulation.
    (a) The patients have been followed up for 6 months.

Inclusion criteria:

(1) Patients with isolated mitral valve disease requiring mitral valve replacement surgery were included.

Exclusion criteria:

The following were the exclusion criteria:

(1) Patients with other valvular disease rather than isolated mitral surgery.
(2) Combined cardiac disease (valvular, congenital, or ischemic heart disease).
(3) Emergency cases.
(4) Redo cases.
(5) Patients have significant pulmonary hypertension.
(6) Preoperative comorbidities (hepatic, renal, pulmonary, etc.).

Preoperative evaluation

(1) Informed consent, history taking, and clinical examination were done.
(2) Routine investigations were as follows:
    (a) Routine preoperative laboratory investigations, ECG, radiological examination, echocardiography, preoperative transesophageal echocardiogram (TEE), and coronary angiography for patients above 40 years.
    (b) Respiratory function tests.
    (c) Computed tomography aortography (to assess site of cannulation).

Operative procedures

Anesthesia

The patient was prepared for mitral valve replacement as usual. The procedure was carried out under general anesthesia. The patient was sedated and intubated. A probe for transesophageal echocardiography was inserted.

In group A, the patients were positioned supine and an air sack was put under the right scapulae to allow the surgeon to shift the patient's right chest upward or lower throughout the surgery as needed for a greater working field exposure. The patient's anterior and right lateral chest walls, as well as both groin areas, were draped.

Surgical approach

The surgery was carried out in group A via an incision in the right fourth intercostal region between mid-clavicular line medially and anterior axillary line laterally. The medial angle of incision was positioned lateral to the right internal mammary artery, which was 1.5–2 cm lateral to the sternal border, and the lateral angle considering the other mean length of incision of 6–10 cm, which varies in various patients.

The pericardium was incised, and stay sutures were put on the incised pericardium's lateral edge. Preparation was commenced on the groin. Both femoral vein and femoral artery were exposed and cannulated guided by TEE.

Cardioplegia was administrated in the conventional manner. The cannula for the aortic root was inserted centrally as usual. To ensure a bloodless field, cardioplegia was administrated in the conventional manner.

Myocardial protection is administered as a single dose/shot of crystalloid solution (Custodiol) into both coronary ostia antegradely. Cross-clamping was done via a Chitwood cross-clamp through a separate incision in the 3rd intercostal space at the posterior axillary line.

In group B, an upper J-shaped partial ministernotomy incision into the third or fourth intercostal space was made using central aorto-caval cannulation.

Data recorded were as follows:
(1) Operative time.
(2) Time of aortic cross-clamp and extracorporeal circulation.
(3) Demographic data and clinical characteristics.
(4) Inotropes.
(5) Echocardiographic finding.
(6) Pulmonary function test.

Postoperative data

(1) ICU stay, ventilation, inotropic agents when indicated, and postoperative echocardiography.

Judgment criteria

The main judgment criteria were as follows:
(1) Vital signs (blood pressure, temperature, pulse, urine output, and oxygen saturation).
(2) ECG first day, 48 h, and end of the first week.
(3) Echocardiography.
(4) Pulmonary function test.

The postoperative echocardiography

An echocardiography was done before discharge to monitor:
(1) Left ventricular end-diastolic diameter (LVEDD) and left ventricular end-systolic diameter (LVESD).
(2) Postoperative Ejection fraction (EF).

Ethical considerations

The institutional committee's ethical criteria were followed during all proceedings. Ethics Committee approved the study.

Results

This study was done to compare the procedure and early postoperative outcome (6 months postoperatively) of the right anterior minithoracotomy technique versus the minimally invasive approach through a J-shaped mini-upper sternotomy approach in patients with isolated mitral valve disease requiring mitral valve replacement.

Demographic data

Table 1.

Preoperative data analysis

Tables 2 and 3.

Operative analysis

Tables 4–6.

Postoperative data analysis

Table 7.

Inotropic needs were found to be nonsignificant in both groups Tables 8–10.

Table 1: Age and sex of both groups

	Mean±SD		*P*
	Group A	Group B	
Age (years)	35.65±10.70	36.35±12.25	NS
Male	10	12	NS
Females	20	18	NS

NS, nonsignificant. $P<0.05$ is considered significant.

Table 2: Preoperative echocardiography in both groups

Preoperative echocardiography	Mean±SD		*P*
	Group A	Group B	
EF%	56.62±8.55	55.64±12.07	NS
EDD	5.24±0.66	5.53±0.71	NS
ESD	3.50±0,88	3.47±0.85	NS
Left atrial dimension	4.5±0.7	4.4±0.9	NS
Pulmonary artery pressure	41.6±6.5	39.7±5.7	NS

EDD, end diastolic dimension; EF%, ejection fraction %; ESD, end systolic dimension; NS, nonsignificant. $P<0.05$ is considered significant.

Table 3: Preoperative NYHA classification

Preoperative NYHA classification	Group A	Group B	*P*
I	5	6	NS
II	20	18	NS
III	5	6	NS
IV	0	0	NS

Table 4: Difference of total operative time, cross-clamp, and total bypass time in both groups

	Mean±SD		*P*
	Group A	Group B	
Cross clamp (min)	75.4±28.5	54.9±9.8	0.041* Significant
Total bypass time (min)	121.7±32.2	71.8±14.9	<0.001* Highly significant
Total operation time (mean±SD) (min)	295±22.7	213±28.4	<0.001* Highly significant

NS, nonsignificant. *Statistically significant. $P<0.05$ is considered significant.

Table 5: Patients requiring inotropic support and DC shock during weaning from cardiopulmonary bypass

	Group A [*n* (%)]	Group B [*n* (%)]	*P*
DC shock	15 (50)	18 (60)	NS
Inotropic support	8 (26.6)	11 (36.6)	NS

NS, nonsignificant. $P<0.05$ is considered significant.

Discussion

MVR mortality and postoperative complications have decreased considerably in the preceding decade, despite a rise in the number of elderly patients and those with major comorbidities [4]. As new technology and surgical and anesthetic procedures have developed, minimally invasive surgery has become a safe and successful treatment option with increasing patient satisfaction [1]. Ministernotomy and minithoracotomy are the two most common incisions for minimally invasive mitral valve replacement [6].

Table 6: Operative and postoperative parameters in both groups that show the upper hand of minimally invasive surgery

	Mean±SD		*P*
	Group A	Group B	
Length of skin incision (cm)	7.1±1.4	9.1±2.2	0.04*
Ventilation (h)	2.9±1.7	3.5±2.3	NS
Blood loss (ml)	325.3±164.2	413.3±159.3	NS
Blood transfusion (U)	0.6±1.1	1±0.9	NS
Postoperative pain			
Within 5 days	2.3±0.7	1.9±0.8	NS
Total hospital stay (day)	5.2±0.8	6.5±1.3	NS

NS, nonsignificant. *Statistically significant. *P*<0.05 is considered significant.

Table 7: Inotropic need in both groups

	Group A [*n* (%)]	Group B [*n* (%)]	*P*
Inotropes	8 (26.6)	11 (36.6)	NS

NS, nonsignificant. *P*<0.05 is considered significant.

Table 8: Postoperative complications of both approaches

Postoperative complications	Group A [*n* (%)]	Group B [*n* (%)]	*P*
No complications	25 (83)	24 (80)	NS
Arrhythmias	3 (10)	2 (6.6)	NS
ARDS	1 (3.3)	2 (6.6)	NS
Superficial wound infection	1 (3.3)	2 (6.6)	NS
Mortality	0	0	NS

There was no statistically significant difference regarding postoperative complications in both groups.

Table 9: Postoperative echocardiography in both groups after 3 months

Postoperative echocardiography	Mean±SD		*P*
	Group A	Group B	
EF%	56.3±6.5	55.44±7.62	NS
EDD (cm)	5.1±0.60	5.2±0.64	NS
ESD (cm)	3.5±0,64	3.84±0.61	NS
Left atrial dimension	4.2±0.3	4.5±0.79	NS
Pulmonary artery pressure	37.5±5.3	36.2±4.5	NS

EDD, end diastolic dimension; EF%, ejection fraction %; ESD, end systolic dimension; NS, nonsignificant. *P*<0.05 is considered significant.

In our study, the mean age in group A was 35 years, whereas in group B was 36 years. The age groups in our study are younger than the age groups in other studies. Sundermann *et al*. [7] reported a mean age of 57 years, and also in other studies such as McClure *et al.* [8] and Cosgrove and Gillinov [3], the mean ages were above 50 years. The younger mean age in our series may be attributed to earlier and repeated affection by rheumatic fever, which is endemic in most developing countries, including Egypt.

Minimally invasive MVR has been shown to lessen postoperative complications, resulting in a faster recovery, a shorter hospital stay, less discomfort, better cosmetic results, and the utilization of fewer hospital resources [9]. Menkis *et al*. [10] found that minimally invasive MVR reduced blood transfusions, mechanical ventilation, and hospital stay. Svensson and Cambria [11] reported that less perioperative bleeding and fewer blood transfusions are likely owing to the less extensive mediastinal dissection required for the right anterior minithoracotomy approach. However, our study showed no statistically significant difference between two groups regarding blood transfusion. Our results are consistent with those of Cheng *et al*. [12], who showed no statistically significant difference between both groups in the total number of patients requiring blood transfusion.

The results show that right anterior minithoracotomy MVR is a safe and reproducible treatment with minimal postoperative mortality and morbidity and high midterm survival. Patients who had MVR via a right anterior minithoracotomy had a lower rate of postoperative blood transfusions, as well as a shorter breathing time and postoperative length of stay, than patients who underwent MVR via an upper ministernotomy [9]. Sundermann *et al.* [7] reported a mean hospital stay of 9.4 ± 3.4 days in the sternotomy group and 7.6 ± 3.2 days in the thoracotomy group, whereas our data showed a mean hospital stay of 5.2 ± 0.8 days in minithoracotomy group and 6.5 ± 1.3 days in the ministernotomy group.

Regarding postoperative pain, the upper-mini sternotomy technique had similar results to that of the right anterior ministernotomy strategy in terms of postoperative pain, and the difference was not significant. Cooley [13] reported a pain score of 4.1 for thoracotomy approach and 4.4 for the sternotomy approach during hospitalization of the patients.

Furthermore, we observed that with the right anterior minithoracotomy method, cross-clamping and total surgical times are greatly increased. Our data were similar to the study of Sundermann *et al.* [7]. The study found cross-clamp time was significantly longer with minimal invasive group versus conventional median sternotomy (94 vs. 74 min). One of the disadvantages of the right minithoracotomy approach is that it needs a learning curve for the surgeon and team to be able to perform the procedure through a smaller incision in a faster time. Shinfeld *et al*. [14] reported that in the beginning of the learning curve, the cross-clamp time was 25 min longer in the minimal invasive group compared with the sternotomy group. However, with experience, the cross-clamp time improved in their center but still remained 15% longer in the minimally invasive group.

The length of incision was compared in both groups; the mean length in group A was 7.1 ± 1.4 cm and in group B was 9.1 ± 2.2 cm, with a statistically significant difference. In our study, group A patients had femoral cannulation of the both femoral artery and vein; the cannulation was through the small 3–4-cm transverse incision in the groin between the pubic tubercle

Table 10: Postoperative echocardiography in both groups after 6 months

Postoperative echocardiography	Mean±SD		*P*
	Group A	Group B	
EF%	57.2±6.5	56.54±8.77	NS
EDD (cm)	4.61±0.40	5.2±0.64	NS
ESD (cm)	3.4±0.52	3.5±0.73	NS
Left atrial dimension	4.1±0.25	4.2±0.79	NS
Pulmonary artery pressure	36.4±3.3	34.3±4.1	NS

EDD, end diastolic dimension; EF%, ejection fraction %; ESD, end systolic dimension; NS, nonsignificant. *P*<0.05 is considered significant.

and the anterior superior iliac spine. The femoral cannulation was easy in all patients. We did not need any aortic cannulation. Several studies reported the use of femoral cannulation for arterial blood flow. Moreover, we believe that the chief disadvantages of right minithoracotomy are the limited field and the relative inaccessibility for cannulation of the aorta [2,12].

In our study, there was no statistically significant difference between both groups regarding ICU stay and ventilation time. However, most of the studies performed showed that the mean ICU stay was less in the minithoracotomy group. The mean ICU stay reported by Shah *et al.* [15] in the minithoracotomy group was 17.1 ± 4.2 h, whereas in the ministernotomy group, it was 21.9 ± 3.7 h. This is consistent with the studies by Yung *et al*. [16] (36.3 ± 5 h) and Aybek *et al.* [17] (18 h).

Regarding mortality and postoperative complications, our study revealed no statistically significant difference in both groups. Moreover, for the major end-point of 30-day and 90-day mortality, the authors discovered no significant differences between the groups [1,2,5].

Finally, right anterior minithoracotomy patients required more time for cardiopulmonary bypass and aortic cross-clamping than those who received upper-ministernotomy. This was a limitation in our method, meaning that exposing and implanting the prosthetic valves are more challenging than the conventional way.

Conclusion and Recommendation

The results of a right anterior minithoracotomy and an upper ministernotomy approach in patients undergoing isolated MVR are similar, with no notable differences. However, a right anterior minithoracotomy reduces (not significantly) the need for blood transfusions, assisted ventilation time, and hospital stay, whereas an upper ministernotomy reduces postoperative pain. However, the cross-clamping and the total operative times are highly significantly increased in the right anterior minithoracotomy approach. Moreover, the right minithoracotomy approach needs a learning curve for the surgeon and team to be able to perform the procedure through a smaller incision in a faster time. Our findings suggest that cardiac surgery is still debatable in terms of cost-effectiveness, making econometric analysis a critical component of any future assessment of innovative cardiovascular therapy. Additional multicenter investigations are needed to corroborate our findings.

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Conflicts of interest

There are no conflicts of interest.

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