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Is Right lateral Mini-thoracotomy Preferable to Intermediate Sternotomy in Mitral Valve Surgery?

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ABSTRACT

Background: As early as the era of cardiopulmonary bypass, Median Sternotomy was used to execute mitral valve surgeries. Minimally invasive mitral valve surgery (MVS) through right mini-thoracotomy has lately received a great deal of interest. The major aim of this study was to evaluate clinical outcome of anterior thoracotomy compared to traditional median sternotomy for mitral valve replacement. **Methods:** 146 subjects with mitral valve disease (moderate to severe) scheduled to undergo elective mitral valve replacement were separated into two groups: group I through conventional median sternotomy and group II through anterior thoracotomy. **Results**: A statistically significant difference was found in cross-clamp time between the two groups. Cross-clamp time was higher in group II (67.2 ± 5.6 minutes) than group I (46.05 ± 4.7 minutes). Total bypass time was higher in group II (86.2 ± 5.7 hours) than group I (75.5 ± 5.1 hours). Also, total operating time was higher in group II (276.2 ± 5.6 minutes) than group I (238.1 ± 5.6 minutes). A significant discrepancy was found between VAS scores in the two groups in the 1st and 2nd day and time to return to normal activity that were higher in group I than group II. Hypertrophic scar was found in 21 patients (28.7%) of group I and 7 patients (9.5%) in group II with statistically significant difference. 24 patients in group I (32.8 percent) and 68 patients in group II (93.1 percent) were happy with the look and aesthetic quality of their scars. **Conclusions:** Mitral valve replacement through minimally invasive right anterolateral thoracotomy has a longer cross-clamp duration, total bypass time, and total operating time than the standard median sternotomy, but it is a viable option. It results in less bleeding, less discomfort, a shorter hospital and ICU stay, and a quicker recovery.
Keywords: Mitral valve replacement, Sternotomy, Thoracotomy, Anterior, Median.

INTRODUCTION

Maintaining pressure gradients between cardiac chambers and ensuring unidirectional blood flow without reflux from or into the heart is the primary function of heart valves. The aortic valve is the most important of all the heart valves. Most often affected by rheumatic heart disease are the mitral and aortic valves. Rheumatic fever, which causes heart disease, mostly influences the mitral valve, causing stenosis of both commissures and consequent mitral regurgitation (1).

The success of cardiac surgeries has increased dramatically in the last decade due to significant advances in surgical methods and the use of developed instrumentation. A improved prognosis has been documented for less invasive heart valve surgery (2). As far back as the early days of cardiopulmonary bypass, mitral valve operations were performed through a median sternotomy. Even though median sternotomy is the conventional procedure for mitral valve surgeries, it is not always used, these procedures have been related to postoperative instability and incidences of sternal osteomyelitis (3,4).A right anterolateral thoracotomy (RALT) is routinely used to treat mitral valve dysfunction. In various studies, RALT has been proposed as an alternative to the conventional middle sternum for patients undergoing mitral valve replacement. RALT is a minimally invasive approach for mitral valve surgery that improves operative exposure to the mitral valve while also providing good cosmetic results, making it a popular choice for young female patients (5). It has been demonstrated that median sternotomy (MS), the gold standard approach for surgical treatment of cardiac problems, provides good long-term results (6). However, it carries a risk of infection of deep sternal wounds, prolonged hospital stay, and delayed healing (7). A thoracotomy is preferable than a sternotomy in terms of ICU stay after surgery, reduced infection rate, early ambulation, quicker healing, and cost-effectiveness (8). Therefore, mitral valve replacement was compared between anterior thoracotomy and typical median sternotomy.

METHODS

This clinical compararative study was carried out on 146 volunteers (74 male patients and 72 female patients) from Cardiothoracic Surgery Department – Zagazig university Hospitals July 2019-June 2021). Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria: Age > 18 years. The patients scheduled for elective mitral valve surgery had moderate to severe mitral valve disease, characterized by both stenosis and regurgitation.

Exclusion criteria: Age <18 years. Patients with congenital heart disease and concurrent procedures, chest wall malformation, obesity, and patients with pulmonary, renal, hematological, hepatic, metabolic, endocrine, or neurological insufficiency.

Study population: The study included a total number of 146 patients. Patients were separated into two groups: Group I: 73 individuals in Group I had standard median sternotomy. Group II: 73 patients underwent anterior thoracotomy.

Measurements of some parameters: All participants were subjected to a complete medical history, a comprehensive physical and clinical examination, with a focus on the cardiovascular system. Transthoracic 2D Echocardiography was used to confirm the diagnosis of mitral valve disease. The participants underwent standard blood tests and a chest X-ray as part of the study. Regarding gender, age, ejection fraction, and NYHA Class, the two groups were matched. Both groups received the same general anaesthesia and venous and arterial monitoring.

In median sternotomy group: the operative steps were same except aortic and bi-caval cannulation were performed. Patients were voluntarily ventilated until extubation requirements were met. After a thorough evaluation of their hemodynamics and general health, patients who were extubated were transferred to the step-down unit. Just after the chest drain tube was removed, an oral anticoagulant was recommended. During the procedure, the same intravenous antibiotic treatment was delivered and continued until the fifth post-operative day. Then an oral form was continued till hospital staying. Patients in the thoracotomy group were positioned on their backs with their right shoulder elevated 30 to 50 degrees and their right arm at their side, exposing the right mid-axillary line. The right trachea was intubated with a double-lumen endotracheal tube. Surgical incision was done using right sub-mammary line extending from the lateral border of the sternum up to right anterior or mid axillary line. The incision was performed along the right sub-mammary line, extending from the lateral border of the sternum up to right anterior or mid axillary line. The thoracic cavity was accessed by the fourth right intercostal gap, after breast tissue was delicately mobilized. Cross-clamping the aorta with a long, curved clamp, and administering blood cardioplegia via the aortic root cannula after establishing cardiopulmonary bypass and chilling the blood to 32 °C. Left atriotomy was done via the interatrial groove, and the damaged valve was excised and replaced with a prosthetic valve. The left atriotomy was closed with a prolene (3-0) suture after valve placement, and de-airing was performed before the cross-clamp was removed.

On both groups of patients, weaning and de-cannulation were carried out using standard methods. A protamine infusion was used to offset the heparin's effects, and proper hemostasis was accomplished. Two drain tubes were left in place as the chest was closed in stages.

The length of the incision, the mean cross-clamp duration, the surgical exposure, the mean bypass time, the ICU stay, the blood loss, the hospital stay, and the pain score (using the 10-cm visual analogue score (VAS) where score 0 is no pain and score 10 is the worst imaginable pain (9)) are all factors to consider. Scar, cosmetic quality, healing and sepsis were collected and evaluated. In the outpatient clinic, patients were monitored for six months for wound sequelae, pain, patient satisfaction, and shortness of breath.

Statistical analysis Data were analyzed using SPSS software (USA). The parametric data expressed as mean ± SD or number (%). The statistical comparisons were carried out using independent student's t-test for parametric data and Mann-Whitney for non-parametric data. Chi square test was used for comparisons between categorical data. The level of significance will be identified at P<0.05.

RESULTS

In the sternotomy group, the mean age was 33.8 ±4.9 and in the thoracotomy group, it was 34.1 ±4.5. The Sternotomy group consisted of 35 males (47.9%), and 38 females (52.1%). Thoracotomy group had 39 males (53.4%) and 34 females (46.6%). The mean BMI was 25.9 ± 3.2 and 25.5 ± 4.05 in both groups respectively (Table 1).

The two groups were equivalent in terms of risk factors, vital signs, etiology and diagnosis of lesion, NYHA and ejection fraction (Table 1). Regarding cross-clamp time, a statistically significant distinction existed between the two groups (<0.001). Cross-clamp time in the sternotomy group was 46.05 ±4.7 minutes and in the thoracotomy group it was 67.2 ±5.6 minutes. Additionally, the overall bypass time for sternotomy was 75.5 ±5.1 hours and 86.2 ±5.7 hours for thoracotomy (<0.001), and total operating time was 238.1 ± 5.6 and 276.2 ± 5.6 minutes for sternotomy and thoracotomy respectively (<0.001). Ventilation time was 6.5 ± 1.1 and 4.4 ± 1.07 hours for sternotomy and thoracotomy respectively (<0.001) (Table 2). Blood loss and blood transfusion were higher in sternotomy group than thoracotomy group (statistically significant) (Table 2). The difference in incision length between the two groups was statistically significant (0.001). Mean incision lengths for sternotomy and thoracotomy were 16.7 ±1.35 cm and 10.7 ±1.1 cm, respectively (Table 2). The average length of stay in the ICU was 2.9 ± 0.9 days in the sternotomy group and 1.7 ± 0.58 days in the thoracotomy group (0.001) (Table 2). With 11.2 ±1.8 days for sternotomy and 8.8 ±1.3 days for thoracotomy, There was a substantial variation in post-operative hospital stays (0.001) (Table 2). Regarding the Visual analogue scale (VAS) score, there were substantial differences between both groups in the 1st and 2nd day and time to return to normal activity that were higher in sternotomy group than thoracotomy group ((Table 2). No significant differences in the incidence of superficial wound infection were detected between the sternotomy and thoracotomy groups, which occurred in 9 (12.3%) and 4 (5.5%) patients, respectively. Hypertrophic scar was found in 21 patients (28.7%) of sternotomy group and 7 patients (9.5%) in thoracotomy group with statistically significant difference. 24 (32.8%) of patients in the sternotomy group and 68 (93.1%) of patients in the thoracotomy group were comfortable with the appearance and aesthetic quality of their scars, respectively (Table 2).

Regarding arrhythmias, pleural effusion, pericardial and mortality, there was a non-significant difference. (Table 2).

Table 1: Demographic data of the studied groups

	Standard Median Sternotomy Group (n=73)	Right Anterolateral Thoracotomy Group (n=73)	P value
Age (years)	33.8 ± 4.9	34.1 ± 4.5	0.79
Gender Male (1) **Female (0)**	35 (47.9%) 38 (52.1%)	39 (53.4%) 34 (46.6%)	0.5
BMI	25.9 ± 3.2	25.5 ± 4.05	0.48
Diabetes	18 (24.6%)	22 (30.1%)	0.45
Hypertension	53 (72.6%)	54 (73.9%)	0.85
Dyslipidemia	28 (38.3%)	32 (43.8%)	0.5
Smoking	18 (24.6%)	19 (26%)	0.84
Pulse	80.2 ± 10.2	78.6 ± 10.6	0.34
Systolic Blood pressure	141.8 ± 16.2	146.1 ± 14.3	0.09
Diastolic Blood Pressure	84.4 ± 10.1	86.6 ± 9.1	0.27
Etiology **Rheumatic**	57 (78.1%)	55 (75.3%)	0.69

	Standard Median Sternotomy Group (n=73)	Right Anterolateral Thoracotomy Group (n=73)	P value
Degenerative	16 (21.9%)	18 (24.7%)	
Lesion diagnosis Stenosis	35 (47.9%)	38 (52.1%)	0.63
Regurgitation	21 (28.8%)	16 (21.9%)	
Double Mitral lesion	17 (23.3%)	19 (26%)	
NYHA	2.5 ± 0.86	2.4 ± 0.88	0.41
EF	57.2 ± 10.1	57.9 ± 10.4	0.67

Data are represented as mean ± SD. Data are analyzed using independent t test and Mann Whitney test. Categorical data analyzed using chi square test. EF:Ejection fraction

Table 2: Distribution of study subjects according to the Intraoperative and Postoperative Variables

	Standard Median Sternotomy Group (n=73)	Right Anterolateral Thoracotomy Group (n=73)	P value
Cross Clamp time (min)	46.05 ± 4.7	67.2 ± 5.6	<0.001*
Total Bypass time (min)	75.5 ± 5.1	86.2 ± 5.7	<0.001*
Total operative time (min)	238.1 ± 5.6	276.2 ± 5.6	<0.001*
Ventilation time (hours)	6.5 ± 1.1	4.4 ± 1.07	<0.001*
Blood loss (ml)	356.1 ± 5.6	190.3 ± 9.9	<0.001*
Blood transfusion (unit)	2.4 ± 0.7	1.4 ± 0.5	<0.001*
length of incision	16.7 ± 1.35	10.3 ± 1.1	<0.001*
ICU stay (days)	2.9 ± 0.9	1.7 ± 0.58	<0.001*
Hospital stay	11.2 ± 1.8	8.8 ± 1.3	<0.001*
VAS 1st day	9.06 ± 0.65	7.1 ± 0.81	<0.001*
VAS score 2nd day	7.6 ± 0.72	5.6 ± 0.76	<0.001*
Time to normal activity (weeks)	11.2 ± 1.3	8.2 ± 0.94	<0.001*
Superficial wound infection	9 (12.3%)	4 (5.5%)	0.13
Hypertrophic scar	21 (28.7%)	7 (9.5%)	0.003*
Patient wound satisfaction	24 (32.8%)	68 (93.1%)	<0.001*
Arrhythmias	9 (12.3%)	6 (8.2%)	0.41
Pleural effusion	6 (8.2%)	4 (5.5%)	0.51
Pericardial effusion	7 (9.5%)	5 (6.8%)	0.54
Mortality rate within 6 months	2 (2.7%)	1 (1.4%)	0.55

Data are represented as mean ± SD. Data are analyzed using independent t test and Mann Whitney test. Categorical data analyzed using chi square test.

DISCUSSION

Median Sternotomy was utilized for mitral valve procedures. Minimally invasive mitral valve surgery (MVS) through right mini-thoracotomy has lately received a great deal of interest.

All of our research participants were at least 18 years old, with an average age of 33.8 ±4.9 years for the sternotomy group and the average age of the thoracotomy group study participants being 34.1 ±4.5 years. In the sternotomy group, 47.9% of the patients were male and 52.1 percent were female, while in the thoracotomy group, male were 53.4% and female were 46.6%. The age and gender differences between the two groups were not statistically significant. According to ACC/AHA recommendations, **Badkhal et al. (10)**

prospectively randomized 60 patients with severe mitral valve disease slated for elective mitral valve replacement to either right anterolateral thoracotomy (n:30) or standard median sternotomy (n:30). Age and gender differences between the two groups were not statistically significant.

According to the etiology, rheumatic valve disease is found in 78.1 percent of the sternotomy group and 75.3% of the thoracotomy group. Degenerative disease was present among 21.9% of sternotomy group and 24.7% among thoracotomy group. Mitral stenosis was found in 47.9% of sternotomy patients and 52.1 percent of thoracotomy patients, mitral regurgitation was found in 28.8% of sternotomy patients and 21.9 percent of thoracotomy patients, and double lesions were found in 23.3 percent of sternotomy patients and 26 percent of thoracotomy patients. The ejection % for the sternotomy group was 57.2 10.1, whereas the ejection fraction for the thoracotomy group was 57.9 10.4. All of these differences were statistically insignificant (p value > 0.05) between the two study groups. In agreement with our study, **Mawar et al. (1)** found no statistically meaningful difference between the two groups in terms of etiology, diagnosis, or ejection fraction. **Lange et al. (11)** allocated 194 individuals with mitral valve disease at random. These patients were scheduled to have elective mitral valve surgery with either a standard median sternotomy (n: 97) or an anterior lateral thoracotomy for mitral valve replacement (n = 97). In terms of ejection rate, the difference between the two groups was not statistically significant (p value > 0.05). Based on the intraoperative and postoperative study characteristics, we found that operative time, total bypass time, cross-clamp time were shorter among sternotomy group than among thoracotomy group. This came in agreement with **Mawar et al. (1)** who reported that the mean operation duration (min) was shorter (138.3 ± 31.5) among sternotomy group than among thoracotomy group (178.1 ± 24.7) but it did not reach a significant difference. Cardiopulmonary bypass time was 71.7 ± 15.2 among sternotomy group and 81.5 ± 13.1 among thoracotomy (p value 0.05) group The sternotomy group had aortic clamp time of 30.1 8.4 minutes while the thoracotomy group had aortic clamp time of 32.1 7.2 minutes (p value > 0.05). **Sundermann et al. (12)** in a comprehensive review and meta-analysis, chose 20,000 individuals with diseased mitral valve. Mitral valve replacement was prospectively randomized to either a right anterior lateral thoracotomy or a regular sternotomy for these patients who were scheduled for elective mitral valve surgery. They found that total operative time, total bypass time, cross-clamp time were higher among thoracotomy than sternotomy group, with statistically significant difference. In addition, **Shah et al. (13)** reported that the mean aortic cross-clamp time in the sternotomy group was 45.3±8.3 minutes against 41.7±5.7 minutes in the thoracotomy group (p=.0.04). The measured results were far below the highest cutoff value of 150 minutes for cross-clamp time, which is linked to postoperative morbidity, especially stroke.

In the present study, VAS score, blood loss, ventilation time, and the need to blood transfusion were higher in sternotomy group than thoracotomy group with statistically significant difference. In agreement with our study, **Mawar et al. (1)** reported that score of visual analogue scale was 45.4 ± 12.8 among sternotomy group and 42.0 ± 14.2 among thoracotomy group. Mechanical ventilation time was 6.1 ± 2.4 among sternotomy group and 4.3 ± 1.1 among thoracotomy group. Blood transfusion (unit) was 2.2 ± 3.2 among sternotomy group and 1.4 ± 1.1 among thoracotomy group. But all of them did not reach significant difference. In addition, **Sündermann et al. (12), Lucà et al. (14), Murphy et al. (15)** found that need for blood transfusion and blood loss were lower in thoracotomy group than sternotomy group, with statistically substantial difference. Also, **Attallah et al. (5)** reported that blood loss was (229±85 vs 335±137 ml), amount of blood transfusion was (1.41±0.6 vs 2.19±1.1 units, P < 0.01) and this came in agreement with our results.

In the current study, superficial wound infection was higher among sternotomy group than among thoracotomy group, but it did not reach significant difference while there was significant difference regarding to ICU length of stay and hospital stay. In agreement with our study, **Mawar et al. (1)** found that infection was higher (9%) among sternotomy group than among thoracotomy group (4%) but it did not reach significant difference. Hospital stay (days) was 10.5 ± 2.8 among sternotomy group and 8.2 ± 0.9 among thoracotomy group (p value < 0.05). ICU stay (days) was 1.6 ± 1.4 among sternotomy group and 1.9 ± 0.7 among thoracotomy group (p value < 0.05). In addition, **Sündermann et al. (12), Svensson et al. (16), Tabata and Cohn (17), Yamada et al. (18)** found that ICU LOS, LOS in hospital were lower in thoracotomy group than sternotomy group with statistically significant difference. Also, **Shah et al. (13)** showed that the

ICU stay period was higher in sternotomy than in thoracotomy (21.9 ±3.7 hours vs. 17.1 ±4.2 hours) and that there was there was a significant difference (P= 0.02) in the length of postoperative hospitalization between the two groups (11.1 ±0.8 days vs 9.2 ±1.7 days). They also found that the median sternotomy, which is commonly utilized to gain access to the mitral valve, is associated with a high risk of infection and dehiscence after the procedure. In addition, especially in young women, the resultant scar is of low cosmetic quality and may have negative psychological effects. To circumvent these complications, a confined anterolateral thoracotomy with conventional cannulation may be utilized. In the thoracotomy group, early ambulation led to a shorter hospital stay, an earlier assessment of the patient's condition, and a quicker recovery. The incision of the thoracotomy group appeared superior to that of the sternotomy group. In sternotomy, the scar was entirely visible from the front, but in thoracotomy, even in males, it was less noticeable and located laterally. In females, the bulk of the incision length was concealed behind the breast. This increased its psychological convenience. According to **EL-FIKY, et al. (19),** the wound in their patients was completely invisible, and more patients favoured this treatment. In our study, the appearance of the scar was better in the thoracotomy group than in the sternotomy group. Hypertrophy was found in 28.7% of sternotomy patients and 9.5 percent of thoracotomy patients. The aesthetic effect of the correct thoracotomy procedure was favorable, particularly in females. These characteristics were similar to those found in most research (20-22).

CONCLUSION

For mitral valve replacement, we conclude that less invasive right anterolateral thoracotomy is a viable alternative to the conventional median sternotomy, with shorter hospital and ICU stays, less bleeding, faster recovery, lower pain scores, and greater patient satisfaction.

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