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Original Article

Early clinical outcome after right anterolateral thoracotomy as an alternative for median sternotomy for mitral valve replacement

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Abstract

Background: The advantages of the right anterolateral thoracotomy (RALT) approach for mitral valve surgery over standard median sternotomy (MS) are still debatable. The objective of this study was to evaluate and compare the postoperative clinical outcome after RALT and MS for mitral valve replacement.

Methods: This prospective observational study included 40 patients who underwent mitral valve replacement between January 2016 and August 2018. Patients were assigned to two groups, the first group included 20 patients who had conventional median sternotomy approach and the second group included 20 patients who had right anterolateral thoracotomy with the complete cannulation and aortic cross-clamping conducted through the same incision.

Results: In comparison to MS, RALT had significantly higher cross-clamp time (77.7±16.1 vs 45.8±8.7 minutes, P < 0.01), total bypass time (105.2±12.7 vs 72.2±10.4 minutes, P < 0.01), and total operative time (287±41 vs 231±36 min, P < 0.01), in addition to significantly lower ventilation time (4.2±1.51 vs 6.1±1.84 hours, P < 0.01), blood loss (229±85 vs 335±137 ml), amount of blood transfusion (1.41±0.6 vs 2.19±1.1 units, P < 0.01), ICU stay duration (2.11±0.49 vs 2.78±0.82 days, P < 0.01), pain scores at 1st and 2nd postoperative days (5.67±0.79 vs 7.81±0.53, p < 0.01), and total hospital stay duration (7.2±1.3 vs 8.4±1.6 days, P = 0.01). Patients' satisfaction about their wound was significantly higher in RALT group compared to MS group (95% vs 30%, P < 0.01).

Conclusion: The RALT approach for mitral valve surgery could be a safe and effective approach when compared to median sternotomy. RALT could be associated with a reduction of blood loss, blood transfusion, wound infection, in addition to shorter ICU and hospital stay.

KEYWORDS

Mitral valve, Cardiac surgical procedures, Thoracotomy; Sternotomy

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Introduction

Median sternotomy (MS) is the gold standard approach for surgical treatment of cardiac diseases with proven excellent long-term outcomes [1]; however, it carries the risk of deep sternal wound infection, delayed recovery, and increased hospital stay [2]. A variety of minimally invasive techniques have been developed, including right thoracotomy, to improve the functional and cosmetic outcomes [3].

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Less invasive approaches for mitral valve surgery can offer certain advantages over MS, notably reduced surgical trauma [4], reduced postoperative discomfort, low perioperative morbidity [5], low rates of reoperation [6], decreased postoperative recovery time, increased patient satisfaction, and reduced cost [7, 8].

Right anterolateral thoracotomy (RALT) is a less invasive approach for mitral valve surgery, which provides better surgical exposure of the mitral valve with favorable cosmetic results, presenting a good option for young female patients [9]. However, sternotomy is still the most common incision for cardiac surgery, including mitral valve surgery, which could be attributed to better access to all cardiac chambers and great vessels [10].

Therefore, the objectives of the present study were to evaluate our experience with RALT compared to MS for mitral valve replacement and to report the postoperative clinical outcome.

Patients and Methods:

This prospective cohort study was conducted from January 2016 to August 2018 after being approved by the local Ethical Committee of Research at Assiut University. Informed consent was taken from all patients prior to their enrolment in the study.

The inclusion criteria were patients aged >18 years old and undergoing isolated mitral valve replacement. We excluded patients younger than 18 years old, patients with congenital heart disease, concomitant procedure, obesity (BMI > 30 kg/m2), chest wall deformity, and patients with significant pulmonary, renal, hematologic, hepatic, endocrine, metabolic or neurologic impairment. The study included 40 patients who were assigned to two groups: group (I) included 20 patients who underwent conventional MS approach, and group (II) included 20 patients who underwent RALT with the complete cannulation and aortic cross-clamping conducted through the same incision.

The diagnosis of the mitral valve disease was established with transthoracic 2D Echocardiography (TTE). The preoperative workup included full history taking, clinical examination, routine laboratory investigations, chest X-ray, and echocardiography.

For the MS approach, aortic and bi-caval cannulation was performed, and mild hypothermia (32°C) was used for cardiopulmonary bypass. RALT patients were positioned supine with the right shoulder elevated 30-50 degrees and the right arm at the patient's side with exposure of mid axillary line on the right side. These patients were intubated with a dual-lumen endotracheal tube or with an endobronchial blocker placed in the right mainstem bronchus. A 10-12 cm incision in the right sub-mammary fold was made, starting 3-5 cm from the lateral border of the sternum. After mobilization of the breast tissue, the pleural cavity was entered through 4th intercostal space. Then, the pericardial sac was opened, and the pericardium was fixed to the wound edge with heavy silk sutures to provide good exposure of the ascending aorta. The ascending aorta was cannulated using gentle traction to expose the site of cannulation. Then, bi-caval cannulation was performed, and an aortic cross-clamp was applied using a long-curved clamp. Cardioplegia was delivered through the aortic root. The left atrium was opened through an incision posterior and parallel to the interatrial groove that accessed the mitral valve. The excision and replacement of the mitral valve were performed in the usual manner, followed by re-warming, de¬-airing, and closure of left atriotomy. De-cannulation was then performed, and the suture line secured before giving the protamine. The chest was then closed in layers leaving one thoracic drain.

All patients were evaluated thoroughly during their intensive care unit (ICU) and hospital stay. The collected data included: Aortic cross-clamp time, total bypass time, total operative time (defined as the time from skin incision to skin closure), postoperative blood loss, duration of ICU and hospital stay, ICU morbidities, postoperative pain score, and any postoperative complication including wound infection, and arrhythmias. Patients were followed up for 3 months in the outpatient clinic for wound sequelae, pain, patient satisfaction, and breathlessness.

Table 1: Preoperative demographic, clinical, and echocardiographic characteristics of studied groups. (Continuous variables are presented as mean± SD and categorical variables as number and percent)

Variable	MS (n=20)	RALT (n=20)	P-value
Age (years) mean ± SD, range	34.2 ± 5.7	35.3 ± 5.8	0.54
Sex (M/F)	12 (60%)/8 (40%)	14 (70%)/6 (30%)	0.50
Body mass index(kg/m2)	23.1 ± 2.74	22.8 ± 2.49	0.71
NYHA class	2.52 ± 0.61	2.41 ± 0.71	0.60
Mitral valve lesion:			
Mitral stenosis	10 (50.0%)	11 (55.0 %)	0.75
Mitral regurgitation	6 (30.0%)	7 (35.0%)	0.73
Double Mitral lesion	4 (20.0%)	2 (10.0%)	0.37
EF (%)	61.1 ± 4.92	63.2 ± 5.60	0.21
LA (cm)	4.91 ± 0.61	5.09 ± 0.54	0.32
LVED (cm)	4.98 ± 0.81	5.18 ± 0.74	0.42
LVES (cm)	3.29 ± 0.57	3.47 ± 0.48	0.28
PAP (mmHg)	39.2 ± 10.8	41.8 ± 9.4	0.42

MS: Median sternotomy, RALT: Right anterolateral thoracotomy, EF: Ejection fraction, LA: Left atrium, LVEDD: left ventricular end-diastolic dimension, LVESD: Left ventricular end-systolic dimension, PAP: Pulmonary artery pressure.

Statistical Analysis

Statistical analysis was performed using the SPSS for Windows version 20, (SPSS Inc., Chicago, IL). Quantitative data were expressed as mean ± standard deviation, and qualitative data were expressed as number and percentage. Quantitative continuous variables were analyzed using the Student T-test or non-parametric Mann-Whitney test as appropriate. Comparisons between pre and postoperative variables were performed with the paired sample T-test. Categorical data were analyzed using Chi-square or Fisher's exact test. For all statistical comparisons, a P-value of <0.05 was considered significant.

Results

There were no statistically significant differences between groups regarding preoperative demographic, clinical, and echocardiographic characteristics (Table 1).

Intra- and postoperative outcomes in the studied groups are shown in (Table 2), the RALT group had a significantly higher cross-clamp time and total bypass time compared to the MS group (P < 0.01). The mean total operative time was significantly higher in the RALT approach compared to the MS approach (P < 0.01). Ventilation time was significantly higher in the MS group (6.1 ± 1.84 h vs. 4.2 ± 1.51 h, P < 0.01). The MS group required a significantly higher amount of blood transfusion (2.19 ± 1.1 units vs. 1.41 ± 0.6 units, P < 0.01). (Table 2)

Two patients (10.0%) in the MS group required re-exploration for bleeding due to excessive blood drainage (> 4 ml / Kg/ hour), while no patients required re-exploration for bleeding in RALT group. In the 1st postoperative day, the RALT group had significantly lower pain scores compared (7.65 ± 0.56 vs. 9.77 ± 0.61, P < 0.01).

Ten cases in the MS group (50%) suffered from postoperative complications versus 6 cases (30%) in the RALT group, with no significant difference between the groups. There was no reported mortality. The results demonstrated that the mean duration of hospital stay was significantly higher in the MS group compared to the RALT group (8.4 ± 1.6 vs. 7.2 ± 1.3 days, P= 0.013). (Table 2)

Patient satisfaction was significantly higher RALT group compared to MS group; 6 patients (30.0%) in the MS group were satisfied with their

Table 2: Intra- and postoperative outcomes. Continuous variables are presented as mean± SD and categorical variables as number and percent)

Variable	MS (n=20)	RALT (n=20)	P-value
Cross Clamp time (min)	45.8 ± 8.7	77.7 ± 16.1	<0.01
Total Bypass time (min)	72.2 ± 10.4	105.2 ± 12.7	<0.01
Total operative time (min)	231 ± 36	287 ± 41	<0.01
Inotropic Support	9 (45.0%)	14 (70.0%)	0.10
DC Shock	6 (30.0%)	8 (40.0%)	0.50
Ventilation time (hours)	6.1 ± 1.84	4.2 ± 1.51	<0.01
Blood loss (ml)	335 ± 137	229 ± 85	<0.01
Blood transfusion (unit)	2.19 ± 1.1	1.41 ± 0.6	<0.01
ICU stay (days)	2.78 ± 0.82	2.11 ± 0.49	<0.01
Re-exploration	2 (10%)	0	0.14
Hospital stay (days)	8.4 ± 1.6	7.2 ± 1.3	0.01
Pain scores (1st day)	9.77 ± 0.61	7.65 ± 0.56	<0.01
Pain scores (2nd day)	7.81 ± 0.53	5.67 ± 0.79	<0.01
Hypertrophic scar	5 (25%)	2 (10%)	0.21
Patient wound satisfaction	6 (30%)	19 (95%)	<0.01
Arrhythmias	7 (35%)	4 (20%)	0.28
Lung atelectasis	0	1 (5%)	0.31
Superficial wound infection	3 (15%)	1 (5%)	0.29
Pleural effusion	2 (10%)	3 (15%)	0.63
Pericardial effusion	4 (20%)	6 (30%)	0.46

MS: Median sternotomy, RALT: Right anterolateral thoracotomy

wound, while 19 patients (95.0%) in the RALT group were satisfied with their wound (P < 0.01).

The result of the X-ray findings and echocardiography during 3 months after surgery in both groups showed that 2 patients (10%) had mild pleural effusion in the MS group compared to 3 patients (15.0%) in the RALT group with no statistical significance differences between both groups (P=0.63). A small amount of pericardial effusion was recorded in 4 cases in the MS group versus 6 cases in the RALT group (P=0.46).

No significant differences were noticed between both groups regarding pre and post-operative echocardiography variables (Table 3).

Discussion

In order to reduce the significant risk of postoperative infection and dehiscence after the MS approach for mitral valve surgery, the RALT approach has been suggested as an alternative approach with low perioperative morbidity and mortality [4, 7]. The aim of this study was to evaluate the safety and efficacy of mitral valve replacement through a right anterolateral thoracotomy and to compare the results of this approach with the conventional median sternotomy approach.

The thoracotomy approach is performed through a small incision of 10-12 cm in length that can improve the cosmetic result due to a small scar, which is less visible, especially in females, in comparison to a mean length of 25 cm for sternotomy approach [5]. El Fiky and colleagues [11] reported an incision length of 12–15 cm after RALT. Reduction in the size of the operative incision was associated with reduced postoperative discomfort, shorter ICU and hospital stay, earlier recovery and return to work, and an overall improvement in patient satisfaction [12].

The present results showed that the RALT group had higher cross-clamp and bypass time

compared to the MS group. These results agreed with Malik and coworkers [4] who compared standard MS with the RALT approach for mitral valve replacement. They found that aortic cross-clamp time was 61± 15 minutes in the MS group and 69 ± 12 min in the RALT group. The observed cross-clamp time was consistent with other series [5, 13]. Moreover, these results agreed with those of a systematic review and meta-analysis [14]. However, Shah and colleagues [8] found that there was a statistically significant difference in cross-clamp time was found between the two groups, cross-clamp time was 45.3±8.3 minutes in the MS group and 41.7±5.7 minutes in the RALT group.

In the present study, ventilation time was significantly higher in the RALT group. Similar to our findings, Malik and coworker [4] found that ventilation time in The MS group was 8.9 ± 0.8 hours and 6.75 ± 1 hour in the RALT group. In addition, these results are in line with other authors [11, 15, 16] who found that postoperative mechanical ventilation is significantly lower in patients undergoing thoracotomy for mitral valve surgery, and it may be related to less postoperative pain and minimal effect on respiratory mechanics.

The present results demonstrated that the MS group required a higher amount of blood transfusion compared to the RALT group. A reduction in postoperative bleeding and transfusion requirements has been suggested as a potential advantage of minimally invasive valve surgery. This benefit is essential given the significant morbidity and mortality associated with transfusions and re-exploration for bleeding [17, 18].

Our results showed that patients of MS group had significantly higher ICU stay compared to those of the RALT group. It has been reported that thoracotomy proved to be superior to sternotomy in terms of postoperative ICU stay; this is consistent with other studies [5, 13]. The present results showed that in 1st and 2nd postoperative days, the RALT group had significantly lower pain scores compared to the MS group. A reduction in pain and faster return to regular activity is the most consistent finding of all the potential benefits of less invasive approaches [19-22]. Moreover, less time was required to return to normal activities was noted as an additional advantage for the thoracotomy approach [19, 20].

Table 3: Comparison between preoperative and 3 months postoperative trans-thoracic echocardiography in both groups (Data are presented as mean and standard deviations)

Variable		MS (n=20)	RALT (n=20)	*P-value (Inter-groups)*
EF %	Preoperative	61.1 ± 4.9	63.2 ± 5.6	0.21
	3 months postop.	58.7 ± 2.7	60.8 ± 4.2	0.07
P-value (Intragroup)		0.042	0.09	
LA (cm)	Preoperative	4.91 ± 0.61	5.09 ± 0.54	0.32
	3 months postop.	4.63 ± 0.41	4.76 ± 0.52	0.38
P-value (Intragroup)		0.041	0.032	
LVED (cm)	Preoperative	4.98 ± 0.81	5.18 ± 0.74	0.42
	3 months postop.	4.67 ± 0.55	4.88 ± 0.43	0.18
P-value (Intragroup)		0.09	0.046	
LVES (cm)	Preoperative	3.29 ± 0.57	3.47 ± 0.48	0.28
	3 months postop.	2.91 ± 0.24	3.07 ± 0.27	0.06
P-value (Intragroup)		<0.01	<0.01	
PAP (mmHg)	Preoperative	39.2 ± 10.8	41.8 ± 9.4	0.42
	3 months postop.	34.2 ± 9.2	34.9 ± 7.5	0.81
P-value (Intragroup)		0.037	<0.01	

MS: Median sternotomy, RALT: Right anterolateral thoracotomy, EF: Ejection fraction, LA: Left atrium, LVEDD: left ventricular end-diastolic dimension, LVESD: Left ventricular end-systolic dimension, PAP: Pulmonary artery pressure

The present results demonstrated that the hospital stay was significantly higher in the median sternotomy group. Similarly, Malik and coworkers [4] found that there was a significant difference between groups in the duration of postoperative hospital stay, which is consistent with other studies [18].

Regarding patient satisfaction, the present results demonstrated that patient satisfaction was significantly higher in the RALT group. In other studies, the cosmetic end product of the right thoracotomy technique was excellent, especially in young females. These features are consistent with several studies [23-25].

Transthoracic echocardiography parameters were significantly decreased at 3 months postoperative compared to preoperative values in both groups; however, no significant differences were noticed between both groups. These results are in agreement with many authors [4, 8, 26, 27, 28]. The changes in left ventricular (LV) dimensions reflect the improvement of LV geometry and performance after surgery.

Bleeding and re-exploration were less in the RALT group. This may be the result of the smaller incision, which lessens the potential for bleeding. It is possible to stop bleeding from a minimally invasive incision during entry, whereas sternal bleeding from a standard sternotomy continues throughout the operative procedure [8]. It is suspected that a sternotomy will continue to bleed into the mediastinum even after it has been re-approximated.

Generally, our contemporary work confirmed the advantages of RALT for mitral valve surgery in regard to less trauma, less bleeding, less wound infections, less pain, favorable cosmesis, faster recovery, and shorter hospital length of stay.

Study limitations

The study has several limitations, including small patients' numbers and lack of randomization. Several risk factors are unequally distributed between groups and may have affected the outcomes. Additionally, this is a single-center experience, and generalization of the results may not be feasible. Finally, the follow-up period is short, and longer follow-up is recommended.

Conclusion

The RALT approach for mitral valve surgery was associated with good exposure of the mitral valve. This approach may be associated with less blood loss, and transfusion, shorter ICU and hospital stay, and better patients' satisfaction. RALT may be recommended as an alternative to standard median sternotomy for patients undergoing mitral valve replacement.

Conflict of interest: Authors declare no conflict of interest.

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